Course Catalogue of Post-Graduate Programmes as per ICAR BSMA Recommendation

Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar

2023

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Post Graduate Course Catalogue

Common Compulsory Non-Credit Courses

College of Veterinary Sciences

College of Dairy Science and Technology

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FORWORD

From Worthy Vice Chancellor

PREFACE

From Dean Post Graduate Studies

COMMON COURSES

Non-credit compulsory courses for M.V.Sc.

Course No.	Course title	Credit hours	Semester
PGS 501	Library and information services	0+1	I and II
PGS 502	Technical writing and communication skills	0+1	I and II
PGS 503 (e-course)	Intellectual property and its management in Veterinary and animal husbandry	1+0	I and II
PGS 504	Basic concepts in laboratory techniques for M.V.Sc	0+1	I and II
	Basic concepts in laboratory techniques for M.Tech.		
PGS 506 (e-course)	Disaster management	1+0	I and II

Syllabus of Common Courses for PG programmes

PGS 501 LIBRARY AND INFORMATION SERVICES (0+1)

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e- resources access methods.

PGS 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS (0+1)

Objective

To equip the students/ scholars with skills to write dissertations, research papers, etc. To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical (Technical Writing)

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.;
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
- Writing of abstracts, summaries, précis, citations, etc.;
- Commonly used abbreviations in the theses and research communications;
- Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations;
- Writing of numbers and dates in scientific write-ups;
- Editing and proof-reading;
- Writing of a review article;
- Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks);
- Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription;
- Accentual pattern: Weak forms in connected speech;
- Participation in group discussion;
- Facing an interview;
- Presentation of scientific papers.
- Exercises on plagiarism

Suggested Readings

1. Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.
2. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
3. Collins' Cobuild English Dictionary. 1995.
4. Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
6. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
7. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.

8. Mohan K. 2005. Speaking English Effectively. MacMillan India.
9. Richard WS. 1969. Technical Writing.
10. Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
11. Wren PC and Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

PGS 503 (e-course) INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN VETERINARY AND ANIMAL HUSBANDRY (1+0)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge- animal health and production based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of animal breeds/strains and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

1. Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
5. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
6. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES FOR M.V.Sc. (0+1)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

- Safety measures while in Lab;
- Handling of chemical substances;
- Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;
- Washing, drying and sterilization of glassware;
- Drying of solvents/ chemicals;
- Weighing and preparation of solutions of different strengths and their dilution;
- Handling techniques of solutions;
- Neutralisation of acid and bases;
- Preparation of buffers of different strengths and pH values;
- Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oil-bath;
- Electric wiring and earthing;
- Preparation of media and methods of sterilization;
- Cell/Tissue cultures
- Description of animal species and breeds

Suggested Readings

1. Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
2. Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES FOR M.Tech. (0+1)

Objective To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

1. Safety measures while in Lab;
2. Handling of chemical substances;

3. Use of burettes, pipettes, measuring cylinders, flasks, 8 separator funnel, condensers, micropipettes and vaccupets;
4. Washing, drying and sterilization of glassware;
5. Drying of solvents/ chemicals;
6. Weighing and preparation of solutions of different strengths and their dilution;
7. Handling techniques of solutions;
8. Neutralization of acid and bases;
9. Preparation of buffers of different strengths and pH values;
10. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil-bath;
11. Electric wiring and earthing;
12. Preparation of media and methods of sterilization;
13. Operating techniques of milk driers
14. Operating techniques of Rheometer and HPLC

Note:

a. Deptt., involved in teaching: DC, DE, DM and DT
b. Dairy Chemistry department will offer the course.

Suggested Readings

- Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
- Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

PGS-506 (e-course) Disaster management 1+0

Objectives:

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I: Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.

UNIT II: Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III: Disaster Management- Efforts to mitigate natural disasters

at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

Common Compulsory Non-Credit course for Ph.D. students from all disciplines

Course No.	Course title	Credit hours	Semester
RPE 700	Research and Publication Ethics	1+1	I and II

RPE 700 Research and Publication Ethics 1+1

I. Theory

RPE 01: Philosophy and Ethics

- Introduction to philosophy: definition, nature and scope, concept, branches
- Ethics: definition, moral philosophy, nature of moral judgements and reactions

RPE 02: Scientific Conduct

- Ethics with respect to science and research
- Intellectual honesty and research integrity
- Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
- Redundant publications: duplicate and overlapping publications, salami slicing
- Selective reporting and misrepresentation of data
- Publication ethics: definition, introduction and importance
- Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc.
- Conflicts of interest

- Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
- Violation of publication ethics, authorship and contributorship
- Identification of publication misconduct, complaints and appeals
- Predatory publishers and journals

II. Practical

RPE 4: Open Access Publishing

- Open access publications and initiatives
- SHERPA/ RoMEO online resource to check publisher copyright and self-archiving policies
- Software tool to identify predatory publications developed by SPPU
- Journal finder/ journal suggestion tools, viz., JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.

RPE 05: Publication Misconduct

A. Group Discussions

- Subject specific ethical issues, FFP, authorship
- Conflicts of interest
- Complaints and appeals: examples and fraud from India and abroad

B. Software tools

- Use of plagiarism software like Tumitin, Urkund and other open source software tools

RPE 06: Databases and Research Metrics

A. Databases

- Indexing databases
- Citation databases: Web of Science, Scopus, etc.

B. **Research Metrics**

- Impact Factor of journal as per Journal Citation Report, SNIP, SIR, IPP, Cite Score
- Metrics: h-index, g index, i10 index, altmetrics

Veterinary Anatomy

DEPARTMENT OF VETERINARY ANATOMY
Course Structure for M.V.Sc. degree programme (Semester Wise)

S. No.	COURSE NO.	COURSE TITLE	CREDIT HR.	SEMESTER
1	ANA-601*	COMPARATIVE OSTEOLOGY AND ARTHROLOGY	1+2	I
2.	ANA-602*	COMPARATIVE SPLANCHNOLOGY	2+2	II
3.	ANA-603*	MYOLOGY, ANGIOLOGY, NEUROLOGY AND AESTHESIOLOGY OF OX	2+2	I
4.	ANA-604*	GROSS, HISTOLOGICAL AND HISTOCHEMICAL TECHNIQUES	1+3	II
5.	ANA-605	CLINICAL ANATOMY	0+1	II
6.	ANA-606*	GENERAL HISTOLOGY AND ULTRASTRUCTURE	1+1	I
7.	ANA-607*	SYSTEMIC HISTOLOGY AND ULTRASTRUCTURE	3+1	II
8.	ANA-608*	DEVELOPMENTAL ANATOMY	2+1	I
9.	ANA-609	WILD LIFE AND FORENSIC ANATOMY	1+0	I
10.	ANA-691*	MASTER'S SEMINAR	1+0	I and II
11.	ANA-699*	MASTER'S RESEARCH	0+30	I and II
* Compulsory courses				

DEPARTMENT OF VETERINARY ANATOMY
Course Structure for Ph. D. degree programme (Semester Wise)

Sr. No	Course No.	Course Title	Credit Hr.	Semester
1.	ANA-701*	MYOLOGY, ANGIOLOGY, NEUROLOGY AND AESTHESIOLOGY OF EQUINE, CANINE AND PORCINE	2+1	I
2.	ANA-702	PRINCIPLES AND APPLICATIONS OF BIOMECHANICS	1+0	II
3.	ANA-703*	AVIAN ANATOMY	1+1	I
4.	ANA-704*	NEUROANATOMY	2+1	II
5.	ANA-705	COMPARATIVE ENDOCRINE ANATOMY	1+1	I
6.	ANA-706*	THEORY AND APPLICATIONS OF ELECTRON-MICROSCOPY	1+1	II
7.	ANA-707*	HISTOENZYMOLOGY AND IMMUNOCYTOCHEMISTRY	2+1	II
8.	ANA-708	APPLIED EMBRYOLOGY AND TERATOLOGY	1+1	I
9.	ANA-709	FUNCTIONAL VETERINARY ANATOMY	1+0	I
10.	ANA-710	GROSS ANATOMY OF LABORATORY ANIMALS	1+1	II
11.	ANA-711	CROSS SECTIONAL ANATOMY OF OX	0+1	II
12.	ANA-712	ANIMAL ALTERNATIVES IN VETERINARY ANATOMY	1+1	I
13.	ANA-713	SPECIAL PROBLEM	0+2	I
14.	ANA-791*	DOCTORAL SEMINAR-I	1+0	I and II
15.	ANA-792*	DOCTORAL SEMINAR-II	1+0	I and II
16.	ANA-799*	DOCTORAL RESEARCH	0+75	I and II
* Compulsory courses				

Course Contents M.V.Sc. in Veterinary Anatomy

I. Course Title : Comparative Osteology and Arthrology
II. Course Code : ANA 601
III. Credit Hours : 1+2
IV. Aim of the course

To make a student well versed with the bones and joints of different domestic animals.

V. Theory

Unit I

Technical terms, structure, chemical composition and classification of bones.

Unit II

Bones of appendicular skeleton of ox as a type and their comparison with those of horse, sheep, goat, dog, pig and poultry.

Unit III

Bones of axial skeleton of ox as a type and their comparison with those of horse, sheep, goat, dog, pig and poultry.

Unit IV

Classification and detailed study of different joints of the body.

Unit V

Study the various indices for estimating race, sex and age of different animals. Basics of biomechanics of the locomotor system. Radiography of normal and developing bones.

VI. Practical

Demonstration of all bones and dissection of joints of buffalo/ Cattle. Radiographic study of bones and joints

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Technical terms, structure, chemical and physical composition and classification of bones	1
2.	Study on scapula and humerus of ox, horse, dog, pig, sheep, goat and poultry (including clavicle and coracoid).	1
3.	Study on radius andulna of ox, horse, dog, pig, sheep, goat and poultry.	1
4.	Study on carpals of ox, horse, dog, pig, sheep, goat and poultry.	1
5.	Study on metacarpals and digits including sesamoids of ox, horse, dog, pig, sheep, goat and poultry.	1
	Comparative study on os-coxae including pelvimetry and femur of ox, horse, dog, pig, sheep, goat and poultry.	1
6.	Comparative study on tibia and fibula of ox, horse, dog,	

	pig, sheep, goat and poultry.	1
7.	Comparative study on tarsal and metatarsal of ox, horse, dog, pig, sheep, goat and poultry.	1
8.	Study on the ethmoid, occipital and sphenoid bone of ox, horse, dog, pig, sheep, goat and poultry.	1
10	Study on the frontal, parietal, interparietal and temporal bones of ox, horse, dog, pig, sheep, goat and poultry.	1
11	Study on the maxilla, premaxilla, palatine, pterygoid, nasal, lacrimal and malar bones of ox, horse, dog, pig, sheep, goat and poultry.	1
12	Study on vomer, hyoid and mandible bones of ox, horse, dog, pig, sheep, goat and poultry	1
13	Study on cervical, thoracic, lumbar, sacral and coccygeal vertebrae of ox, horse, dog, pig, sheep, goat and poultry	1
14	Study on ribs and sternum of ox, horse, dog, pig, sheep, goat and poultry. 1	
15	Detailed study of different joints of the body	2
16	Biomechanics of the locomotor system	1
17	Radiographic anatomy	1
	Total	18

Practical

1	Topographic terms.	1
2	Classification of bones	1
3-4	Comparative study on scapula and humerus	2
5-6	Comparative study on radius and ulna	2
7-8	Comparative study on carpals	2
9-10	Comparative study on metacarpals and digits	2
11	Comparative study on os-coxae and femur	1
12-13	Comparative study on tibia and fibula	2
14	Comparative study on tarsal and metatarsal	2
15-16	Comparative study on the ethmoid, occipital and sphenoid bone	3
17-18	Comparative study on the frontal, parietal, interparietal And temporal bones	2
19-20	Comparative study on the maxilla, premaxilla, palatine pterygoid, nasal, lacrimal and malar bones	2
21-22	Comparative study on vomer, hyoid and mandible bones	2
23-24	Comparative study on cervical and thoracic vertebrae	2
25-27	Comparative study on bones of lumbar, sacral and coccygeal vertebrae.	2
28-30	Comparative study on ribs and sternum	2
31-32	Classification and detailed study of different joints of the body.	2

33-34	Biomechanics of the locomotor system	2
35-36	Radiographic anatomy	2
	Total	36

I. Course Title : Comparative Splanchnology
II. Course Code : ANA 602
III. Credit Hours : 2+2
IV. Aim of the course

To give a detailed overview of different systems constituting splanchnology.

V Theoy

Unit I

Overview of different systems constituting descriptive anatomy of various organs of digestive system and associated glands of ox and their comparison with those of horse, sheep, goat, dog, pig and poultry. Study of formation of thoracic, abdominal and pelvic cavities; reflection of these cavities.

Unit II

Study of various organs/ structures and associated glands constituting the respiratory system of ox and their comparison with those of horse, sheep, goat, dog, pig and poultry.

Unit III

Detailed study of organs and associated glands comprising the urinary system of ox as a type and their comparison with those of horse, sheep, goat, dog, pig and poultry.

Unit IV

Complete study of various organs and associated glands of male and female genital systems.

Unit V

Surgical sites for various operations and clinically significant areas for performing auscultation, percussion and for carrying out surgical procedures such as laryngotomy, oesophagotomy, gastrotomy, rumenotomy, cystotomy, urethrotomy, Caesarian section laparotomy, mammectomy, thoracotomy, thoracocentesis, etc.

Unit VI

Study of various endocrine organs of ox and their comparison with horse, sheep, goat, dog, pig and poultry

V. Practical

Demonstration of structure and placement of organs in body cavities of all the animals. Sonographic appearance of different organs.

S. No.	Topic	No. of Lectures/Practicals
	Theory	
1.	Introduction	1
2.	Study of topographic anatomy and reflection of thoracic, Abdominal and pelvic cavities in ox, horse, dog, pig, sheep, goat and poultry	2
3.	Comparative anatomy of oral cavity in ox, horse, dog, sheep, goatand pig.	2
4.	Comparative anatomy of dentition in ox, horse, dog, sheep, Goat and pig,	1
5.	Comparative anatomy of tongue in ox, horse, dog, sheep, Goat and pig.	1
6.	Comparative anatomy of esophagus in different species	1
7.	Study of the salivary glands of various species	1
8.	Study of ruminant stomach along with omentum	2
9.	Study of monogastric stomach and omentum of various species	2
10.	Comparative anatomy of small intestines of various species	1
11.	Comparative anatomy of large intestines of various species	1
12.	Study of liver and gall bladder of various species	1
13.	Study of spleen and pancreas of various species	1
14.	Study of digestive system of poultry	1
15-16.	Study of nasal cavity in ox, horse, dog, sheep, goat and pig	2
17.	Study of larynx of various species	1
18.	Study of trachea of various species	1
19.	Comparative anatomy of lungs of various species	2
20.	Study of digestive system of fowl	1
21.	Study of kidneys of various species	1
22.	Study of ureter and urinary bladder	1
23.	Study of urethra	1
24.	Study of male genital system and associated organs of various species	1
25.	Study of female genital system and associated organs of various species	2
26.	Study of male and female genital system of fowl	1
27.	Study of udder of different species of animals	1
28.	Study of body cavities	1
	Total	35
	Practical	
1.	Introduction	1

2. Study of topographic anatomy of thoracic, abdominal and pelvic cavities in different animals. 2
3. Comparative anatomy of oral cavity in ox, horse, dog, sheep, goat and pig. 2
4. Comparative anatomy of dentition in ox, horse, dog, sheep, goat and pig, 1
5. Comparative anatomy of tongue in ox, horse, dog, sheep, goat and pig. 1
6. Comparative anatomy of esophagus in different species 1
7. Study of the salivary glands of various species. 1
8. Study of ruminant stomach along with omentum 2
9. Study of monogastric stomach and omentum of various species 2
10. Comparative anatomy of small and large intestines and anus of various species 2
11. Study of liver and gall bladder, spleen, pancreas of various species 2
12. Study of larynx of various species 1
13. Comparative anatomy of lungs of various species 2
14. Study of body cavities 2

15-16. Study of urinary system and associated organs of various Species 2

17. Study of male genital system and associated organs of various species 2
18. Comparative study of accessory sex glands in different species 1
19. Study of female genital system and associated organs of various species 2
20. Study of endocrine organs of various species 2
21. Study of udder of different species of animals 1

Total 32

I. Course Title : Myology, Angiology, Neurology and Aesthesiology of Ox

II. Course Code : ANA 603

III. Credit Hours : 2 +2

IV. Aim of the course

To give a thorough knowledge about the muscles, course of blood vessels and nerves of the body in addition to various organs of circulatory, nervous and sensory systems of ox as a type animal.

V. Theory

Unit I

Classification of muscle fibres. Origin, insertion and relations of

muscles of different body parts.

Unit II

Topographic anatomy of the vascular system comprising of heart, arteries, veins and lymphatics.

Unit III

Study of various components of central nervous system, peripheral nervous system and autonomic nervous system.

Unit IV

Complete study of the gross anatomy of various sense organs.

Unit V

Study of different nerve blocks, intravenous sites and enucleation of eye ball.

VI. Practical

Dissection of heart, different vessels, brain, cranial nerves, brachial plexuses and lumbo-sacral plexus. Dissection of eye, ear, hoof and horn of buffalo/cattle.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Myology and organization of various types of muscles	2
2.	Heart and pericardium	4
3.	Muscles and blood supply to the head and neck	3
4.	Muscles and blood supply to the forelimb	3
5.	Muscles of thorax and abdomen and thoracic aorta, Abdominal aorta and its branches	2
6.	Muscles and blood supply to the hind limb	2
7	Venous system	2
8	Lymph glands and its afferent and efferent vessels	2
9	Study of brain	2
10	Study of cranial nerves	2
11	Study of spinal cord and spinal nerves	2
12	Brachial and lumbo-sacral plexus	2
13	Structure of eye ball	2
14	Structure of external, middle and internal ear of different species	2
15	Study of hoof	2
16	Study of horn	2
	Total	36
Practical		
1	Introduction to general myology	1
2	Structure of heart	2
3	Brachiocephalic trunk, course of aorta, coronary arteries	

	and pulmonary trunk 1	
4	Bicarotid trunk	1
5	Blood supply to the forelimb	1
6	Thoracic aorta and its branches abdominal aorta	1
7	Abdominal aorta and its branches	1
8	Blood supply to the hind limb	1
9	Meninges	1
10	Dorsal and ventral aspect of brain and ventricles of brain, Sagittal sections of brain of different species 1	
11	Cranial nerves,	1
12	Spinal cord and spinal nerves	1
13	Brachial plexus	1
14	Lumbo-sacral plexus	1
15	Venous drainage and lymphatic system	1
16	Blood supply to the brain	2
17	Study of eye	1
18	Study of ear	1
19	Autonomic nervous system	1
20	Muscle of face, larynx, mastication, soft palate, tongue, pharynx and ear	4
21	Muscles of neck	2
22	Muscles of fore limb	2
23	Muscles of thorax	1
24	Muscles of, abdomen	1
25	Muscles of hip and thigh	2
26	Extensors and flexors of hind limb	1
27	Muscles of tail and penis	
	Total	35

I. Course Title : Gross, Histological and Histochemical Techniques

II. Course Code : ANA 604

III. Credit Hours : 1+3

IV. Aim of the course

Hands-on training for preparation of gross anatomical specimens and processing of tissues to demonstrate structural components by different stains for research and teaching purposes.

V. Theory

Unit I

Preparation of tissues for microtomy and lightmicroscopy using different fixatives.

Unit II

Different staining methods for routine light microscopy and special

staining methods.

Unit III

Frozen sectioning techniques and staining methods for enzymes, carbohydrates, lipids, proteins, pigments, etc.

Unit IV

Silver staining techniques for nervous tissue.

Preparation of tissue for electron microscopic studies

VI. Practical

Embalming fluids, embalming of animals, maceration and preparation of skeletons. Gross staining of brain sections. Demonstration of sites of ossifications. Preparation of transparent specimens, preparation of casts of various organs, blood vessels and ducts, etc. Study of different techniques for collection, fixation and processing of animal tissues; preparation of paraffin and frozen sections; handling and care of microtomes. Demonstration of staining of carbohydrates, lipids, proteins, nucleic acids and enzymes.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1	Embalming fluid and its preparation	1
2	Embalming techniques, formalin and modified gravity feed embalming technique.	1
3	Maceration and preparation of skeletons; taxidermy, burial method, chemical method(sodium hydroxide method) gross staining of brain specimens different species; Tompsett 1955, Mulligam 1931 for gray matter, Waldman and Michaels (1954) for white matter, Hewitt method	1
4	Demonstration of sites of ossifications alizarin red technique	1
5-6	Preparation of transparent specimens of various organs, plastination	2
7	Chemical composition of a living cell	1
8	Fixation of tissue samples with different fixatives and post fixation of tissue samples	1
9	Embedding, block preparation and paraffin sectioning.	1
10	Natural and synthetic dyes	1
11	Metachromasia and supravital staining	1
12	Routine hematoxylin and eosin staining	1
13	Special staining for connective, muscular and nervous tissue.	1
14	Staining for carbohydrates and proteins and lipids.	1
15	Special stain for demonstration of nucleic acids	1
16	Special staining for cytoplasmic granules and pigments and	

	minerals	1
17	Differential staining for cell types	1
18	Demonstration of silver staining techniques	1
	Total	18

Practical

1	Embalming fluid and its preparation	2
2	Embalming techniques, formalin and modified gravity feed embalming technique.	2
3	Maceration and preparation of skeletons; taxidermy, burial method, chemical method(sodium hydroxide method) gross staining of brain specimens different species; Tompsett 1955, Mulligam 1931 for graymatter, Waldman and Michaels (1954) for white matter, Hewitt method	2
4	Demonstration of sites of ossifications alizarin red technique	2
5	Preparation of transparent specimens of various organs, plastination	2
6	Preparation of casts of various organs, vinyl acetate cast	2
7	Chemical composition of a living cell	2
8	Fixation of tissue samples with different fixatives	4
9	Post fixation of tissue samples	2
10	Embedding, block preparation and paraffin sectioning.	4
11	Natural and synthetic dyes	2
12	Metachromasia and supravital staining	2
13	Routine hematoxylin and eosin staining	2
14	Special staining for connective: elastic, reticular and collagen fibres, muscular and nervous tissue.	4
15	Staining for carbohydrates: pas, amp and proteins.	2
16	Special stain for demonstration of nucleic acids, lipids and enzymes	2
17	Special staining for cytoplasmic granules	2
18	Special staining for pigments and minerals	2
19	Differential staining for cell types	2
20	Demonstration of silver staining techniques	2
	Total	46

I. Course Title : Clinical Anatomy

II. Course Code : ANA 605

III. Credit Hours : 0+1

IV. Aim of the course

To give exposure to different clinical conditions.

V. Practicals

Clinical examination of animal in health and disease,

auscultation of different organs, different types of nerve blocks, surgical conditions of different body systems, radiographical techniques and post-mortem examination.

S. No. Topic No. of Lectures/Practicals

Practical

1. Clinical examination of animal by palpation, percussion and auscultation 1
2. Site to record temperature, pulse, palpable lymph nodes, collection of blood and pregnancy diagnosis in domestic animals 1
3. Area of auscultation for lungs and heart, passing of probang 1
4. Preferable site for injections in domestic animals (intradermal, subcutaneous, intramuscular, intravenous, intracardiac, intratracheal, subconjunctival, intra-articular, epidural) 1
5. Nerve blocks of head region (frontal, infraorbital, mandibulo-alveolar, mental, retrobulbar, Peterson, auriculopalpebral and cornual) for different surgical conditions (exraction of tooth, trephining of frontal and maxillary sinuses, extirpation of eye ball, amputation of horn, haematoma) 2
6. Surgical conditions of respiratory system (catheterization of guttural pouch, ventriculectomy in horse, tracheotomy, thoracocentesis) 1
7. Paravertebral nerve block, paracentesis, rumenocentesis. Surgical conditions of digestive system (passing of stomach tube, ligation of parotid duct, oesophagotomy, abdominocentesis, rumenotomy, laparotomy/ celiotomy, gastrotomy, splenectomy, enterotomy, extirpation of anal sacs in dog) 2
8. Surgical conditions of urinary system (urethrotomy, puncturing of urinary bladder, catheterization of urinary bladder, cystotomy) 1
9. Surgical conditions of genital system (hysterotomy/ caesarean section, ovario-hysterectomy (spaying), castration, vasectomy, caponing in fowl) 1
10. Nerve blocks of fore limb (radial, median, ulnar, volar digital nerves) for surgical affections 1
11. Nerve blocks of hind limb (tibial, peroneal, saphenous, plantar digital nerves) for surgical affections including patellar desmotomy 1
12. Nerve blocks (pudic, cranial epidural, caudal epidural) for

surgical affections including docking 1

13. Radiographical techniques, contrast radiography 1
14. Radiographic visualization of organs of thoracic and abdominal cavity 1
15. Radiographic visualization of organs of pelvic cavity 1
16. Post-mortem examination and collection of material for teaching and research 1

Total 18

I. **Course Title : General Histology and Ultrastructure**

II. **Course Code : ANA 606**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To understand basic principles of light microscopy and light and ultrastructure of four basic tissues.

V. **Theory**

Unit I

Light and ultrastructural details of animal cell.

Unit II

Light and ultrastructural details of epithelial tissue.

Unit III

Light and ultrastructural details of muscular tissue.

Unit IV

Light and ultrastructural details of connective tissue.

Unit V

Light and ultrastructural details of nervous tissue.

VI. **Practical**

Demonstration of different components of cells and intercellular substances of the above referred tissues by special staining through the use of light, phase contrast, dark field, fluorescent and electron microscopes.

S. No. Topic No. of Lectures/ Practicals

Theory

1. Introduction to animal cell and Study of plasma membrane 1
2. Study of nucleus and nuclear membrane and Study of mitochondria and endoplasmic reticulum 1
3. Study of Golgi apparatus, centriole, lysosomes, microtubules, microfilaments, etc. 1
4. Cell division and Cell wall modifications and junctional complexes 1
5. Light and ultrastructural study of different types of epithelial tissue and glands 2

6. Light and ultrastructural study of different types of muscular tissue 1
7. Introduction to different types of connective tissue and Detailed study of connective tissue fibres; collagen, reticular and elastic 1
8. Study of different cell types of connective tissue, constituents of ground substance 1
9. Study of different types of connective tissues 1
10. Light and ultrastructural details of different cartilages; hyaline, elastic and fibrous cartilage 1
11. Light and ultrastructural details of bone 1
12. Structural details of blood and its different constituents 2
13. Light and ultrastructural study of neurons and neuroglial cells of CNS and PNS, nerves, ganglion, etc. 2

Total 16

Practicals

1. Study on electron micrographs of an animal cell to distinguish different organelles 1
2. Study of electron micrographs of plasma membrane, nucleus and nuclear membrane 2
3. Study of electron micrographs of mitochondria, Golgi apparatus and endoplasmic reticulum 1
4. Study of different types of epithelial tissues by light microscope 1
5. Study of different types of epithelial tissues and glands by electron micrographs 1
6. Study of different types of Muscle tissues by light microscope 1
7. Study of different types of Muscle tissues by electron micrographs 1
8. Study of different types of connective tissue fibres and cells 1
9. Study of different types of connective tissues 3
10. Study of different types of cartilages 1
11. Study of Bone; ground bone and decalcified bone 1
12. Study of different constituents of blood 1
13. Light and ultrastructural study of nervous tissue 2

Total 17

I. **Course Title : Systemic Histology and Ultrastructure**

II. **Course Code : ANA 607**

III. **Credit Hours : 3+1**

IV. **Aim of the course**

To understand and identify arrangement of four basic tissues in organs of different body systems

V. Theory

Unit I

Light and ultrastructure of different organs of digestive system of ruminants with differential features among domestic animals.

Unit II

Light and ultrastructure of different organs of respiratory, lymphoid and cardiovascular systems.

Unit III

Light and ultrastructure of different organs of urino-genital systems.

Unit IV

Light and ultrastructure of different sense organs and nervous system.

Unit V

Light and ultrastructure of different organs of endocrine system

VI. Practical

Study of histological structure of organs of digestive, respiratory, urinary, genital and cardiovascular systems of buffalo, horse and dog/ cat.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	General organization of the wall of tubular organs	1
2.	Light microscopic and ultra structural study of tongue, lip and cheek	2
3.	Light microscopic and ultra structural study of salivary gland	2
4.	Light microscopic and ultra structural study of pharynx and oesophagus	2
5.	Light microscopic and ultra structural study of rumen, reticulum and omasum	2
6.	Light microscopic and ultra structural study of abomasum	2
7.	Light microscopic and ultra structural study of small intestine	2
8.	Light microscopic and ultra structural study of large intestine	2
9.	Light microscopic and ultra structural study of liver	2
10.	Light microscopic and ultra structural study of pancreas and gall bladder	2
11.	Light microscopic and ultra structural study of nasal cavity	1
12.	Light microscopic and ultra structural study of larynx and trachea	2
13.	Light microscopic and ultra structural study of lungs	2
14.	Light microscopic and ultra structural study of cardiovascular system including heart	2
15.	Light microscopic and ultra structural study of lymphoid organs	2

16. Light microscopic and ultra structural study of ovary 2
17. Light microscopic and ultra structural study of oviduct and uterus 2
18. Light microscopic and ultra structural study of cervix, vagina and mammary glands 2
19. Light microscopic and ultra structural study of testes 2
20. Light microscopic and ultra structural study of epididymis and vas deferens 1
21. Light microscopic and ultra structural study of urethra and accessory sex glands and penis 2
22. Light microscopic and ultra structural study of kidney 2
23. Light microscopic and ultra structural study of ureter, urinary bladder and urethra 1
24. Light microscopic and ultra structural study of endocrine glands; thyroid, pituitary, adrenal gland, parathyroid, pineal gland 2
25. Light and ultrastructural details of Spinal cord, cerebrum and cerebrum 1
26. Light microscopic and ultra structural study of integument 1
27. Light microscopic and ultra structural study of eye 2
28. Light microscopic and ultra structural study of ear 2

Total 49

Practical

1. Light microscopic and ultra structural study of lip and cheek, tongue and salivary glands 1
2. Light microscopic and ultra structural study of pharynx and oesophagus 1
3. Light microscopic and ultra structural study of rumen, reticulum, Omasum and abomasum 1
4. Light microscopic and ultra structural study of small intestine 1
5. Light microscopic and ultra structural study of large intestine 1
6. Light microscopic and ultra structural study of liver, pancreas and gall bladder 1
7. Light microscopic and ultra structural study of larynx and trachea 1
8. Light microscopic and ultra structural study of lungs 1
9. Light microscopic and ultra structural study of cardiovascular system including heart 1
10. Light microscopic and ultra structural study of lymphoid organs 1
11. Light microscopic and ultra structural study of ovary and oviduct 1

12. Light microscopic and ultra structural study of uterus, cervix, vagina and mammary glands 1
13. Light microscopic and ultra structural study of male reproductive ystem 1
14. Light microscopic and ultra structural study of kidney, ureter, urinary bladder and Urethra 1
15. Light microscopic and ultra structural study of endocrine glands; thyroid, pituitary, adrenal gland, parathyroid, pineal gland 1
16. Light and ultrastructural study of Spinal cord, cerebrum and cerebrum 1
17. Light microscopic and ultra structural study of sense organs 1

Total 17

I. **Course Title : Developmental Anatomy**
II. **Course Code : ANA 608**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To understand the developmental processes of different body systems at various stages of pregnancy.

V. **Theory**

Unit I

Gametogenesis, Classification of eggs, fertilization, cleavage and gastrulation

Development of foetal membranes and placenta in domestic animals.

Unit III

Histogenesis of nervous system, sense organs, lymphoid organs, endocrine organs and cardiovascular system

Unit IV

Embryonic development of digestive, respiratory, uro-genital and musculoskeletal system.

VI. **Practical**

Study of serial sections of the chick and pig embryos at different stages of development.

S. No. Topic No. of Lectures/Practicals

Theory

1. Introduction to Embryology, history of embryology, term used in embryology Gametogenesis; Spermatogenesis 2
2. Oogenesis; classification of eggs, structure of mammalian and avian eggs 2
3. Fertilization, Cleavage Implantation Placentation 2
4. Blastulation Gastrulation, formation of extra embryonic membranes 2

5. Formation of extra embryonic membranes 2
6. Organogenesis and histogenesis of nervous system, 2
7. Development of sense organs 2
8. Development of endocrine organs 2
9. Cardiovascular system including fetal circulation. 2
10. Embryonic development of gastro-intestinal tract 2
11. Development of liver, pancreas and gall bladder 2
12. Development of Respiratory system 2
13. Development of urinary system
14. Male reproductive system 2
15. Female reproductive system 2
16. Musculoskeletal system 2

Total 32

Practical

1. Study of sperm and ova 1
2. Cleavage, Blastulation and Gastrulation 1
3. Study of whole mount sections of chick embryo and serial sections of chick embryo 1
4. Organogenesis, Development of nervous system 1
5. Organogenesis, Development of digestive system 2
6. Organogenesis. Development of respiratory system 2
7. Organogenesis, Development of cardiovascular system 2
8. Organogenesis, Development of endocrine system 1
9. Organogenesis, Development of urinary system 2
10. Organogenesis, Development of male and female reproductive system 2
11. Determination of age of different species of embryo 1

Total 16

I. **Course Title : Wild Life and Forensic Anatomy**
II. **Course Code : ANA 609**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

To give exposure to different body systems of wild animals of local region for theforensic purpose.

V. **Theory**

Unit I

Importance of anatomy of wild animals in veterinary anatomy.

Unit II

Anatomy of different body systems of wild animals.

Unit III

Anatomy of different body systems of wild birds.

Unit IV

Application of wild life anatomy in forensic veterinary medicine

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Introduction, scope and importance of anatomy of wild animals	1
2.	Origin, evolution and classification of wild mammals and birds	1
3.	Morphological adaptations of wild mammals and birds	1
4.	Radiography and ultrasonography as a tool to study wild life anatomy	1
5.	Anatomy of skeletal system of Elephants with special emphasis on dentition and ageing and sexual dimorphism	1
6.	Anatomy of digestive, respiratory, reproductive and urinary systems of elephants	1
7.	Anatomy of skeletal system of wild carnivores including lion, tiger, leopard, cheetah, wolf and fox.	1
8.	Anatomy of digestive, respiratory, reproductive and urinary systems of wild carnivores	1
9.	Anatomy of skeletal, digestive, respiratory, reproductive and urinary systems of wild ruminants	1
10.	Anatomy of skeletal, digestive, respiratory, reproductive and urinary systems of wild primates	1
11.	Anatomy of skeletal system of Cervidae family	1
12.	Anatomy of digestive, respiratory, reproductive and urinary systems of Cervidae family	1
13.	Anatomy of cardio-vascular system of wild animals	1
14.	Anatomy of nervous system of wild animals	1
15.	Anatomy of sense organs of wild animals	1
16.	Anatomy of wild birds	1
17.	Application of wild life anatomy in forensic veterinary medicine	1
18.	Clinical anatomy of captive wild animals	1
	Total	18

Course Contents
Ph.D. in Veterinary Anatomy

I. **Course Title : Myology, Angiology, Neurology And Aesthesiology OfEquine, Canine And Porcine**

II. **Course Code : ANA 701**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To teach students about anatomy of muscles, blood vessels, nervous tissue and sense organs in equine, canine and porcine.

V. **Theory**

Unit I

Comparative study of mycology of horse, dog and pig.

Unit II

Comparative study of angiology of horse, dog and pig.

Unit III

Comparative study of neurology of horse, dog and pig.

Unit IV

Comparative study of aesthesiology of horse, dog and pig.

VI. **Practical**

Dissection of different body regions with respect to muscles, blood vessels and nerves; and see the topographic positioning of different organs in different body cavities in equine, canine and porcine.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Comparative study of muscles of head and neck of horse, dog and pig	2
2.	Comparative study of muscles of forelimb: shoulder and arm	1
3.	Comparative study of extensor and flexors of forelimb	1
5.	Comparative study of muscles of abdomen	1
7.	Comparative study of muscles of pelvic region, hind limb and tail	2
8.	Comparative study of topography and structure of heart, blood supply to heart	2
9.	Study of arterial supply to head and neck	2
10.	Comparative study of blood supply to the forelimb	1
11.	Study of the collateral and terminal branches of aorta	2
12.	Comparative study of blood supply to the hind limb	2
13.	Comparative study of venous system	1
14.	Study the lymphatic system	1
15.	Comparative study of brain and spinal cord	2
16.	Study of cranial nerves	2

17. Study of brachial plexus and its branches 1
18. Study of cervical, thoracic and lumbar nerves 1
19. Comparative study of lumbo-sacral plexus 2
20. Comparative study of eye 1
21. Comparative study of ear 1
22. Comparative study of hoof 1
23. Comparative study of gustatory and olfactory organs 1

Total 30

Practical

1. Comparative study of muscles of head and neck of horse, dog and pig 1
2. Comparative study of muscles of forelimb: shoulder, arm extensors and flexors 1
3. Comparative study of muscles of abdomen 1
4. Comparative study of muscles of pelvic region, hind limb and tail 1
5. Comparative study of topography and structure of heart, blood supply to heart 1
6. Study of arterial supply to head and neck 1
7. Comparative study of blood supply to the forelimb 1
8. Study of the collateral and terminal branches of aorta 1
9. Comparative study of blood supply to the hind limb 1
10. Comparative study of venous and lymphatic system 1
11. Comparative study of brain and spinal cord 1
12. Study of cranial nerves 1
13. Study of brachial plexus and its branches 1
14. Study of cervical, thoracic and lumbar nerves 1
15. Comparative study of lumbo-sacral plexus 1
16. Comparative study of eye and ear 1
17. Comparative study of hoof 1
18. Comparative study of gustatory and olfactory organs 1

Total 18

I. **Course Title : Principles and Applications of Biomechanics**
II. **Course Code : ANA 702**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

To sensitize the student about the importance of biomechanics.

V. **Theory**

Unit I

Biomechanics, its definition and scope with reference to anatomy and physiology of domestic animals and musculo-skeletal dynamics.

Unit II

Locomotion and clinical applications. Biomechanics of cortical and trabecular bones.

Unit III

Biomechanics of fracture fixation. Instrumentation and techniques in locomotion and their applications in lameness.

S. No.	Topic	No. of Lectures
Theory		
1.	Definition of Biomechanics and its classification.	1
2.	Scope Biomechanics of with reference to anatomy and physiology of domestic animals	1
3.	Musculo-skeletal dynamics	2
4.	Locomotion and its type in domestic animals	2
5.	Instrumentation and techniques in locomotion and their applications in lameness.	2
6.	Biomechanics of microscopic structures	1
7.	Polariscope, its principle and application	2
8.	Biomechanics of cortical and trabecular bones.	1
9.	Biomechanics of articular cartilages	2
10.	Biomechanics of mammalian body; bow and string theory	2
11.	Biomechanics of fracture fixation	1
12.	Biomechanics of heart	1
	Total	18

I. **Course Title : Avian Anatomy**

II. **Course Code : ANA 703**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To give detailed overview of poultry anatomy.

V. **Theory**

Unit I

The study of the gross features of different body systems of domestic fowl.

Unit II

The study of microscopic features of different body systems of domestic fowl.

VI. **Practical**

Dissection and demonstration of various body systems of fowl and different domestic birds. Microscopic examination of slides of various organ systems of fowl.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1	The study of gross features of axial and appendicular skeleton of domestic fowl	1
2	Study of various joints of axial and appendicular skeleton of domestic fowl	2
3	Gross and microscopic study of muscular system of domestic fowl	1
4	Gross and microscopic study of digestive system of domestic fowl.	2
5	Gross and microscopic study of respiratory organs of domestic fowl.	1
6	Gross and microscopic study of urinary organs of domestic fowl.	1
7	Gross and microscopic study of reproductive system of domestic fowl.	1
8	Study of the blood of domestic fowl.	2
9	Gross and microscopic study of circulatory system of domestic fowl.	1
10	Gross and microscopic study of nervous system of domestic fowl.	1
11	Gross and microscopic study of eye and its appendages of domestic fowl.	1
12	Gross and microscopic study of ear of domestic fowl.	1
13	Gross and microscopic study of skin and its appendages of domestic fowl.	1
14	Gross and microscopic study of lymphoid organ of domestic fowl.	1
15	Gross and microscopic study of endocrine system of domestic fowl.	1
	Total	18
Practical		
1	The study of gross features of axial and appendicular skeleton of domestic fowl and turkey	1
2	Study of various joints of axial and appendicular skeleton of domestic fowl	2
3	Gross and microscopic study of muscular system of domestic fowl	1
4	Gross and microscopic study of digestive system of domestic fowl.	2
5	Gross and microscopic study of respiratory organs of domestic fowl.	1

6	Gross and microscopic study of urinary organs of domestic fowl.	1
7	Gross and microscopic study of reproductive system of domestic fowl.	1
8	Study of the blood of domestic fowl.	2
9	Gross and microscopic study of circulatory system of domestic fowl.	1
10	Gross and microscopic study of nervous system of domestic fowl.	1
11	Gross and microscopic study of eye and its appendages of domestic fowl.	1
12	Gross and microscopic study of ear of domestic fowl.	1
13	Gross and microscopic study of skin and its appendages of domestic fowl.	1
14	Gross and microscopic study of lymphoid organ of domestic fowl.	1
15	Gross and microscopic study of endocrine system of domestic fowl.	1
	Total	18

I. **Course Title : Neuroanatomy**
II. **Course Code : ANA 704**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To provide in-depth knowledge of nervous system.

V. **Theory**

Unit I

The gross and microscopic anatomy of the brain and spinal cord.

Unit II

Study of various cranial and spinal nerves along with their associated nuclei and ganglia.

Unit III

Motor and sensory pathways, different ascending and ascending tracts of brain and spinal cord and autonomic nervous system.

VI. **Practical**

Gross dissection and microscopic examination of the brain and spinal cord; demonstration of the nerves, nerve plexuses, ganglia of cranial importance, study of the serial sections of the brain and spinal cord in domestic animals.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	The gross and microscopic study of anatomy of brain, limbic system, reticular formation, lemniscal system, pyramidal system, extrapyramidal system	5

2. Study of cranial nerves along with their associated nuclei and ganglia 5
3. The gross and microscopic study of spinal cord including tracts and pathways 4
4. Study of spinal nerves along with their associated nuclei and ganglia 4
5. Hypothalamo-hypophysial system 4
6. Brachial plexus 3
7. Lumbo-sacral plexus 3
8. Study of autonomic nervous system 5

Total 33

Practical

1. The gross and microscopic study of anatomy of brain, limbic system, reticular formation, lemniscal system, pyramidal system, extrapyramidal system 2
2. Study of cranial nerves along with their associated nuclei and ganglia 2
3. The gross and microscopic study of Spinal cord including tracts and pathways 2
4. Study of spinal nerves along with their associated nuclei and ganglia 2
5. Hypothalamo-hypophysial system 2
6. Brachial plexus 2
7. Lumbo-sacral plexus 2
8. Nerve blocks 2
9. Study of autonomic nervous system 2

Total 18

I. **Course Title : Comparative Endocrine Anatomy**
II. **Course Code : ANA 705**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To project the importance and details of endocrine glands.

V. **Theory**

Unit I

Advanced gross and microscopic anatomy of the pituitary gland.

Unit II

Advanced gross and microscopic anatomy of the thyroid, parathyroid and thymus.

Unit III

Advanced gross and microscopic anatomy of the adrenal gland, islets of Langerhans, corpus luteum, Leydig cells, pineal body and other tissues associated with endocrine secretions

VI. Practical

Demonstration of the topographic anatomy in the embalmed specimens and microscopic examination of the endocrine glands of ruminants.

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction and general characteristics of endocrine gland	2
2.	Gross, microscopic and ultra structural study of Pituitary gland	1
3.	Gross, microscopic and ultra structural study of thyroid gland	1
4.	Gross, microscopic and ultra structural study of parathyroid gland	2
5.	Gross, microscopic and ultra structural study of thymus	2
6.	Gross, microscopic and ultra structural study of adrenal gland	1
7.	Gross, microscopic and ultra structural study of hypothalamus and Pineal	1
8.	Microscopic and ultra structural study of islets of Langerhans	2
9.	Gross, microscopic and ultra structural study of endocrine glands of male reproductive system	1
10.	Gross, microscopic and ultra structural study of endocrine glands of female reproductive system including corpus luteum	2
11.	Study of paraganglia, diffused endocrine system cells, endocrine cells of heart and kidney	2
12.	Advances in gross and microscopic anatomy of endocrine glands of gastro-intestinal tract	1
	Total	18
Practical		
1.	Introduction and general characteristics of endocrine gland	1
2.	Gross, microscopic and ultra structural study of Pituitary gland	2
3.	Gross, microscopic and ultra structural study of thyroid gland	1
4.	Gross, microscopic and ultra structural study of parathyroid gland	1
5.	Gross, microscopic and ultra structural study of thymus	1
6.	Gross, microscopic and ultra structural study of adrenal gland	1
7.	Gross, microscopic and ultra structural study of hypothalamus and Pineal	2
8.	Microscopic and ultra structural study of islets of Langerhans	1
9.	Gross, microscopic and ultra structural study of endocrine glands of male reproductive system	2
10.	Gross, microscopic and ultra structural study of endocrine glands of female reproductive system including corpus luteum	2
11.	Study of paraganglia, diffused endocrine system cells, endocrine cells	

	of heart and kidney	2
12.	Advances in gross and microscopic anatomy of endocrine glands of gastro-intestinal tract	2
	Total	18

I. **Course Title : Theory and Applications of Electron Microscope**

II. **Course Code : ANA 706**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To give an overview of the electron microscope.

V. **Theory**

Unit I

Introduction and principles of electron microscopy.

Unit II

Methods for transmission electron microscopy.

Unit-III

Methods for scanning electron microscopy.

VI. **Practical**

Preparation of blocks and demonstration of various techniques used for carrying out TEM and SEM.

S. No.	Topic	No. ofLectures/Practicals
Theory		
1.	Introduction of the electron microscope	1
2.	Principles of transmission electron microscopy	1
4.	Collection and fixation of samples for electron microscopy, various fixatives used in electron microscopy	2
5.	Principles of scanning electron microscopy and processing of Samples for transmission electron microscopy	1
6.	Processing of samples for scanning electron microscopy	1
9.	Ultramicrotomy (semithin and ultra thin sections)	1
10.	Coating of grids with supportive films	1
11.	Staining of semi thin and ultra thin sections	1
12.	Negative staining	1
13.	Applications of scanning and transmission electron microscopy	1
14.	Cryo-electron microscopy	1
15.	Immuno electron microscopy	1
16.	Strategies in immunolabelling	1
17.	Applications in nano science	1
	Total	15

Practical

1.	Collection of tissue samples for em	1
2.	Fixation of samples for electron microscopy	1
3.	Processing of samples for scanning electron microscopy	2
4.	Processing of samples for transmission electron microscopy	2
5.	Ultramicrotomy (semithin and ultra thin sections)	2
6.	Coating of grids with supportive films	2
7.	Staining of semi thin and ultra thin sections	1
8.	Negative staining	1
9.	Cryo-electron microscopy	2
10.	Immunolabelling	2
11.	Atomic force microscope	1
	Total	17

I. **Course Title : Histoenzymology and Immunocytochemistry**

II. **Course Code : ANA 707**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To give a student hands-on practice for various advanced histoenzymic and histochemical techniques.

V. **Theory**

Unit I

Classification of enzymes – Principles of enzymes histochemistry methods.

Unit II

Substrates –combination–coupling azo-dye methods –capture reagents.

Unit III

Localization of enzymes and controls in enzyme histochemistry.

Unit IV

Fluorescence microscopy in enzyme histochemistry. Principles and techniques of immunohistochemistry.

VI. **Practical**

Preparation of fixatives and buffers used in histochemistry. Methods of preparations and microscopical examination of routine and special preparations showing different cell organelles and inclusions. Methods for tryptophan-SS, SH groups; Glycogen- glycoproteins; Mucopolysaccharides and lipids. Methods and identification of alkaline and acid phosphatases-succinic dehydrogenase, cytochrome-oxidase, choline-esterase, catecholamines by fluorescence microscopy. Immunohistochemistry-principles and techniques.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Classification of enzymes	3
2.	Principles of enzyme histochemistry methods	3
3.	Substrate and coenzymes	2
4.	Different methods of enzyme study	3
5.	Hydrolytic enzyme histochemistry	2
6.	Alkaline and acid phosphatase	2
7.	Oxidases and peroxidases	2
8.	Diaphorases and dehydrogenases	2
9.	Peptidases	2
10.	Fluorescence microscopy	2
11.	Principles of immunohistochemistry	3
12.	Techniques in immunohistochemistry	3
13.	Study of part different parts of cryotome and their functions	3
	Total	32
Practical		
1.	Preparation of fixatives and buffers	3
2.	Demonstration of alkaline and acid phosphatase	2
3.	Demonstration of succinic dehydrogenase	2
4.	Demonstration of cytochrome oxidase	2
5.	Localization of diaphorases and choline esterase	2
6.	Fluorescence microscopy	2
7.	Principles and techniques in immunohistochemistry	3
	Total	16

I. **Course Title : Applied Embryology and Teratology**

II. **Course Code : ANA 708**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To apprise the students about the current trends in developmental processes.

V. **Theory**

Unit I

Principles of experimental embryology and teratology.

Unit II

Factors affecting the developmental mechanisms of embryo.

Unit III

Use of organizers implants, chemical and hormonal preparations in the developmental models and available literature on teratogenic experimentation.

VI. **Practical**

Collection and study of various teratological specimens from domestic animals. Class discussions on experimental models and available literature on teratogenic experimentation. To apprise the students about the current trends in developmental processes.

S. No.	Topic	No. of Lectures/Practicals

Theory

1.	Introduction to embryology and teratology.	1
2.	Principles of experimental embryology and teratology.	2
3.	Factors affecting the developmental mechanisms of embryo.	2
4.	Developmental anomalies of cardiovascular system	2
5.	Immunodeficiency and inherited defects in natural immunity	1
6.	Developmental anomalies of brain and spinal cord	2
7.	Developmental anomalies of skeletal system	1
8.	Developmental anomalies of digestive system	2
9.	Developmental anomalies of urinary system	1
10.	Developmental anomalies of male and female reproductive system	1
11.	Congenital malformations of face and oral cavity	1
12.	Congenital and inherited defects of skin	1
13.	Genetic, chromosomal and environmental factors adversely affecting prenatal development	1
	Total	18

Practical

1.	Discussion on principles and factors affecting developmental embryology and teratology in the available literature.	2
2.	Study on different teratological models/ specimens of cardiovascular system	2
3.	Immunodeficiency and inherited defects in natural immunity	1
4.	Study on different teratological models/ specimens of brain and spinal cord	2
5.	Study on different teratological models/ specimens of skeletal system	1
6.	Study on different teratological models/ specimens of digestive system	2
7.	Study on different teratological models/ specimens of urinary system	1
8.	Study on different teratological models/ specimens of male and female reproductive system	2
9.	Congenital malformations of face and oral cavity	1
10.	Congenital and inherited defects of skin	1
11.	Study on mutations and chromosomal abnormalities	1
12.	Study of teratogenic agents	1

13. Assessing the aetiology of different congenital diseases 1

Total 18

I. **Course Title : Functional Veterinary Anatomy**

II. **Course Code : ANA 709**

III. **Credit Hours : 1+0**

IV. **Aim of the course**

To make the student understand the functional anatomy of various organs/ systems in relation to structure.

V. **Theory**

Unit I

The relationship of structure to form and function.

Unit II

The relationship of structure for adaptation and behaviour.

Unit III

Relationship of structure in relation to clinical conditions/ applications.

S. No.	Topic	No. of Lectures
Theory		
1.	Introduction to functional anatomy	1
2.	Tissue organization and function	1
3.	Functional anatomy of digestive system: mouth cavity, tongue, salivary gland, esophagus and stomach including mastication, regurgitation	2
4.	Functional anatomy of digestive system: small intestine, large intestine, liver, gall bladder and pancreas	2
5.	Study of functional anatomy of respiratory system	1
6.	Functional anatomy of urinary system	1
7.	Functional anatomy of reproductive system	1
8.	Functional anatomy of mammary gland	1
9.	Functional anatomy of cardiovascular system	1
10.	Functional anatomy of central nervous system	1
11.	Functional anatomy of peripheral and autonomic nervous system	1
12.	Functional anatomy of special senses (vision, hearing)	1
13.	Functional anatomy of skeleton system including synovial fluid	1
14.	Functional anatomy of muscular system	1
15.	Functional anatomy of endocrine system	1
16.	Functional anatomy of integumentary system	1
	Total	18

I. **Course Title : Gross Anatomy of Laboratory Animals**

II. **Course Code : ANA 710**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To give an overview of different body systems of laboratory animals.

V. **Theory**

Unit I

Study of different organs of digestive system of different laboratory animals.

Detailed study of urinary, male and female reproductive systems of different laboratory animals.

Unit III

Complete study of respiratory system of different laboratory animals.

Unit IV

Study of organs of circulation and nervous system of different laboratory animals.

Unit V

Descriptive anatomy of endocrine glands of different laboratory animals.

VI. **Practical**

Demonstration of placement and relations of different organs in the body cavities of different laboratory animals.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	An overview of skeleton of rabbit, guinea pig, mice and rat	1
2.	Digestive system of rabbit and guinea pig	1
3.	Digestive system of mice and rat	1
4.	Respiratory system of rabbit and guinea pig	1
5.	Respiratory system of mice and rat	1
6.	Urinary system of rabbit and guinea pig	1
7.	Urinary system of mice and rat	1
8.	Male reproductive system of rabbit and guinea pig	1
9.	Male reproductive system of mice and rat	1
10.	Female reproductive system of rabbit and guinea pig	1
11.	Female reproductive system of mice and rat	1
12.	Endocrine glands of rabbit and guinea pig	1
13.	Endocrine glands of mice and rat	1
14.	Circulatory system of rabbit and guinea pig	1
15.	Circulatory system of mice and rat	1

16. Nervous system of rabbit and guinea pig 1
17. Nervous system of rat and mice 1
18. Lymphoid organs of laboratory animals 1

Total 18

Practical

1. Study of skeleton of rabbit, guinea pig, mice and rat 1
2. Study of digestive system of rabbit and guinea pig 1
3. Study of digestive system of mice and rat 1
4. Study of respiratory system of rabbit and guinea pig 1
5. Study of respiratory system of mice and rat 1
6. Study of urinary system of rabbit and guinea pig 1
7. Study of urinary system of mice and rat 1
8. Study of male reproductive system of rabbit and guinea pig 1
9. Study of male reproductive system of mice and rat 1
10. Female reproductive system of rabbit and guinea pig 1
11. Study of female reproductive system of mice and rat 1
12. Study of endocrine glands of rabbit and guinea pig 1
13. Study of endocrine glands of mice and rat 1
14. Study of circulatory system of rabbit, guinea pig, rat and mice 1
15. Study of circulatory system of mice and rat 1
16. Study of nervous system of rabbit and guinea pig 1
17. Study of nervous system of rat and mice 1
18. Lymphoid organs of laboratory animals 1

Total 18

I. **Course Title : Cross Sectional Anatomy of Ox**
II. **Course Code : ANA 711**
III. **Credit Hours : 0+1**
IV. **Aim of the course**

To study Gross cross sectional profiles of various parts in ox

V. **Practical**

Demonstration and topographic anatomy of various structures and organs at different levels of cross sections of the body. Correlation of different structures in different cross sections.

S. No.	Topic	No. of Practicals

Practical

1. Cross sectional profile of head at the level of 4th incisor and first cheek tooth 1
2. Cross sectional profile of head at the level of third cheek tooth and 6th cheek tooth 1
3. Cross sectional profile of head at the level of orbit and external acoustic meatus 1
4. Cross sectional profile of the neck at the level of upper third

and middle third. 1

5. Cross sectional profile of the neck at the level of lower third 1
6. Cross sectional profile of the thoracic inlet. 1
7. Cross sectional profile of the thorax at the level of 3rd rib 1
8. Cross sectional profile of the thorax at the level of 6th rib and 12th rib 1
9. Cross sectional profile of the abdomen at the level of 2nd lumbar and 5th lumbar 1
10. Cross sectional profile of the mid pelvis and tail. 1
11. Cross sectional profile at the middle and lower level of the shoulder and middle level of the arm. 1
12. Cross sectional profile at the proximal level of forearm, lower level of the forearm and mid level of metacarpus. 1
13. Cross sectional profile at the mid level of the first phalanges and mid level of second phalanges 1
14. Cross sectional profile at the upper and middle and lower levels of the thigh 1
15. Cross sectional profile at the lower levels of the thigh 1
16. Cross sectional profile at the upper and middle levels of the leg. 1
17. Cross sectional profile at the lower level of the leg and mid level of metatarsus 1

Total 17

I. **Course Title : Animal Alternatives in Veterinary Anatomy**
II. **Course Code : ANA 712**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

Alternatives of animals in veterinary anatomy teaching to avoid usage of Animals.

V. **Theory**

Unit I

Introduction and ethical issues, scope, advantages and disadvantages of alternatives.

Unit II

Plastination, 2D and 3D Models.

Unit III

Taxidermy, computer simulations.

Unit IV

Maannequins, interactive mutimedia.

Unit V

Museum specimen preparation.

VI. Practical

Techniques of Plastination, 2D and 3D Models, Taxidermy, computer simulations Maannequins, interactive mutimedia.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Introduction to animal alternatives	1
2.	Ethical issues on alternatives used	1
3.	Necessity of animal alternatives- advantages and disadvantages of alternatives	1
4.	Scope for animal alternatives	1
5.	Plastination, basic principles	1
6.	Methodology involved in plastination	1
7.	Types of plastination- advantages, disadvantages of plastination	1
8.	Three-D, Two-D models as alternatives in veterinary anatomy: advantages/ disadvantages of models used	1
9.	Drawings, Charts, Power points as self explanatory alternatives in Veterinary anatomy-An overview	1
10.	Taxidermy in veterinary anatomy-methodology involved-limitations	1
11.	Computer simulation-screen based simulations	1
12.	Virtual lab.-E-learning as alternatives	1
13.	Interactive digital tool-multimedia and Videos as effective audio visual tools- benefits and weakness of digital alternatives	1
14.	Mannequins as alternatives in veterinary anatomy, advantages and disadvantages -scope for mannequins in veterinary anatomy	1
15.	Museum specimen preparation	1
16.	Procedures involved in museum preservation- advantages and disadvantages involved in museum specimens	1
	Total	16

S. No.	Topic	No. of Lectures/Practicals
Practical		
1	Methodology involved in plastination and preparation of plastinated specimens	3
2	Three-D, Two-D Models as alternatives in veterinary anatomy	2
3	Methodology involved taxidermy -preparation of specimens	2
4	Computer Simulation-screen based simulations	2
5	Virtual lab -E-learning as alternatives	2

6	Interactive digital tool-multimedia and Videos	1
7	Mannequins as alternatives in veterinary anatomy	2
8	Museum specimen preparation	2
	Total	16

I. Course Title : Special Problem
II. Course Code : ANA 713
III. Credit Hours : 0+2
IV. Aim of the course

To provide expertise in handling practical research problem(s).

V. Practical

S. No.	Topic	No. of Practicals
1.	Short research problem(s) involving contemporary issues and research techniques.	32

VI. Recommended list of Books

Gross Anatomy

- Dyce KM, Sack WO and Wensing CJG. 1996. *Text Book of Veterinary Anatomy*. W.B. Saunders Co.
- Konig HE and Liebich HG. 2004. *Veterinary Anatomy of Domestic Animals: Textbook and Colour Atlas.* 1st edn., Stuttgart, Schattauer Co., Germany.
- Nickel R, Schumer A, Seiferle E, Freewin J and Wills KH. 1986. *The Locomotor System of Domestic Mammals.* Verlag Paul Parey.
- Schummer A, Nickel R and Sack WO. 1979. *The Viscera of the Domestic Mammals*. Verlag Paul Parey.
- Seiferle E. 1975. *Nervous System, Sensory Organs, Endocrine Glands of DomesticMammals*. Verlag Paul Parey.
- Sisson S and Grossman JD. 1975. *The Anatomy of the Domestic Animals*. Vols. I, II. W.B. Saunders Co.

Histology

- Banks WJ. 1993. *Applied Veterinary Histology*. Mosby Year Book, USA.
- Dellmann HD. 1993. *Textbook of Histology*. Lea and Febiger, USA.
- DiFiore MS, Mancini R and Derbertis EDP. 2006. *New Atlas of Histology*. Williams and Wilkins, Lippincott, USA.
- Eurell JA and Frappier BL. 2006. *Dellmann's Textbook of Veterinary Histology*. 6th edn., Blackwell Publishing, Ames, Iowa, USA.
- Greep RO. 1977. *Histology*. McGraw-Hill Book Co., New York,

USA.
- Ham AW and Cormack DH. 1979. *Histology*. J.B. Lippincott, Philadelphia, USA.
- Stinson AW and Calhoun ML. 1993. *Text book of Veterinary Histology*. 4th edn., Lea and Febiger, Philadelphia, USA.

Embryology

- Arey LB 1965. *Developmental Anatomy*. W.B. Saunders.
- Freeman WH and Brace Girdle B. 1967. *Atlas of Embryology*. Heilemann Edu. Books Ltd.
- Langman J. 1976. *Medical Embryology*. William and Wilkin, Lippincott, USA.
- Latshaw WK. 1984. *Veterinary Developmental Anatomy; A Clinically Oriented Approach*. B.C. Decker Inc., Philadelphia, USA.
- Patten BM. 1985. *Foundation of Embryology*. Tata McGraw-Hill Book Co., USA.
- Patten BM. 2014. *Foundation of Embryology*. 6th edn., Tata McGraw-Hill Education, India.
- Tuchmann-Duplessis, MH David G, and Haegel P. 1972. *Illustrated Human Embryology*. Vol. I, II. Embryogenesis. Springer Verlag, USA.

Anatomical Techniques

- Durry RAB and Wallington EA. 1967. *Carleton's Histological Techniques*. Oxford University Press, London.
- Luna LG 1968. *Manual of Histologic Staining Methods of the Armed Forces Institute of Pathology*. McGraw-Hill Book Co., USA.
- Pearse AGE. 1968. *Histochemistry-Theoretical and Applied.* 3rd edn., Vol. I, Churchill Livingstone, London.
- Tompsett DH and Wakeley SC. 1956. *Anatomical Techniques*. E. and W. Living Stone, London.
- Bancroft JD and Stevens A. 1977. *Theory and Practice of Histological Techniques*. Churchill Livingstone.
- Thomson SW and Hunt RD. 1968. *Selected Histochemical and Histopathological Methods*. Charles C. Thomas Publication, Springfield, Illinois, USA.

List of Journals

- *Acta Anatomica*
- *American Journal of Anatomy*
- *Anatomia Histologia and Embryologia*
- *Anatomical Record*
- *Anatomy and Embryology*
- *Indian Journal of Veterinary Anatomy*

- *Journal of Anatomy*

e-Resources

- http://www.interscience.wiley.com/journal/117927935/grouphome/home. (American Journalof Anatomy)
- http://www.ovid.com/site/catalog/Journal/1057.jsp (Journal of Anatomy)
- http:http:www.interscience.wilety.com/jpages/0003-276X/(Anatomical Record)
- http://www.blackwellpublishing.com/submit.asp (Anatomia Histologia and Embryologia)

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Anatomy

Technical terms, structure, chemical composition and classification of bones. Bones of appendicular skeleton of ox as a type and their comparison with those of horse, dog and pig. Bones of axial skeleton of ox as a type and their comparison with those of horse dog and pig. Classification and detailed study of atlanto-occipital, elbow, hip, stifle and hock joints of the body. Basics of biomechanics of the locomotor system. Gross anatomy of ligamentum nuchae, sesamoidean ligaments, stay and reciprocal apparatus.

Study of formation of thoracic, abdominal and pelvic cavities; reflection of these cavities. Overview of different systems constituting descriptive anatomy of various organs/ structures and associated glands constituting the digestive, respiratory, urinary, male and female genital systems of ox and their comparisons with those of horse, dog and pig. Study of various endocrine organs of ox and their comparisons with those of horse, dog and pig.

Classification of muscle fibres. Muscles of head region, eye ball, mastication, respiration, extensors and flexors of forelimb and hind-limb, muscles of abdominal and tail region. Topographic anatomy of the vascular system comprising of heart, arteries, veins and lymphatics. Study of various components of central nervous system and peripheral nervous system. Complete study of the gross anatomy of sense organs i.e. eye, ear and hoof of horse.

Preparation of tissues for microtomy and lightmicroscopy using different fixatives. Hematoxylin and eosin staining method for routine light microscopy. Enumerate special staining methods for connective tissue and staining methods for enzymes, carbohydrates, lipids, proteins, pigments and silver staining techniques for nervous tissue. Frozen sectioning techniques. Preparation of tissue for electron microscopic studies.

Light and ultrastructural details of animal cell. Light and ultrastructural details of epithelial tissue, muscular tissue, connective tissue and nervous tissue.

Light and ultrastructure of different organs of digestive, respiratory and uro-genital systems. of ruminants with differential features among domestic animals. Light and ultrastructure of different organs of lymphoid and cardiovascular systems, different sense organs and nervous system and endocrine system.

Gametogenesis, classification of eggs, fertilization, cleavage and gastrulation. Development of foetal membranes and placenta in domestic animals. Embryology of nervous system, sense organs, lymphoid organs, endocrine organs and cardiovascular system. Embryonic development of digestive, respiratory, uro-genital and musculoskeletal systems.

Veterinary Biochemistry

DEPARTMENT OF VETERINARY PHYSIOLOGY AND BIOCHEMISTRY
Course Structure for M.V.Sc Veterinary Biochemistry degree programme

Course Code	Course Title	Credit Hours	Semester
BCT 601	BIOPHYSICAL CHEMISTRY	2 + 0	I
BCT 602*	BIOCHEMISTRY OF BIOMOLECULES	2 + 0	I
BCT 603*	ENZYMOLOGY	2 + 1	I
BCT 604*	ANALYTICAL TECHNIQUES AND INSTRUMENTATION IN BIOCHEMISTRY	1 + 1	I & II
BCT 605*	CLINICAL BIOCHEMISTRY OF ANIMALS	2 + 1	I & II
BCT 606*	INTERMEDIARY METABOLISM AND REGULATION	3 + 0	I
BCT 607*	MOLECULAR BIOCHEMISTRY	2 + 1	II
BCT 608*	NUTRITIONAL AND INDUSTRIAL BIOCHEMISTRY	2 + 0	II
BCT 609	ENDOCRINOLOGY AND REPRODUCTIVE BIOCHEMISTRY	2 + 0	II
BCT 610*	BIOCHEMISTRY OF RUMINANTS AND WILD ANIMALS	1 + 1	I
BCT 611	INTRODUCTION TO BIOINFORMATICS AND COMPUTATIONAL BIOLOGY	1 + 1	II
BCT 691	MASTER'S SEMINAR	1 + 0	I & II
BCT 699	MASTER'S RESEARCH	0+30	I & II
*Compulsory Courses			

DEPARTMENT OF VETERINARY PHYSIOLOGY AND BIOCHEMISTRY
Course Structure for Ph.D. Vetereinary Biochemistry degree programme

Course Code	Course Title	Credit Hours	Semester
BCT 701	APPLIED MOLECULAR BIOCHEMISTRY AND SYSTEMS BIOLOGY	2 + 1	I
BCT 702*	MEMBRANE BIOCHEMISTRY	2 + 0	I
BCT 703	RECENT TRENDS IN ENZYMOLOGY	2 + 1	I & II
BCT 704	DIAGNOSTIC TECHNIQUES IN CLINICAL BIOCHEMISTRY	0 + 2	I
BCT 705	RECENT TRENDS IN BIOCHEMICAL TECHNIQUES AND INSTRUMENTATION	2 + 1	I & II
BCT 706*	DEVELOPMENTAL BIOCHEMISTRY	2 + 0	I & II
BCT 707	BIOINFORMATICS TOOLS IN BIOCHEMISTRY	1 + 1	I & II
BCT 708*	ENVIRONMENTAL AND TOXICOLOGICAL BIOCHEMISTRY	2 + 0	I
BCT 709*	BIOCHEMISTRY OF DISEASES AND DISORDERS	2 + 0	I & II
BCT 710*	IMMUNO-BIOCHEMISTRY	2 + 0	I
BCT 711	SPECIAL PROBLEM	0 + 2	I & II
BCT 791	DOCTORAL SEMINAR-I	1 + 0	I & II
BCT 792	DOCTORAL SEMINAR-II	1 + 0	I & II
BCT 799	DOCTORAL RESEARCH	0+75	I & II
*Compulsory Courses			

Course Contents
M.V.Sc. in Veterinary Biochemistry

I. **Course Title : Biophysical Chemistry**
II. **Course Code : BCT 601**
III. **Credit Hours : 2 + 0**
IV. **Aim of the course**

Teaching of principles of physical chemistry as applicable to veterinary sciences.

V. **Theory Unit I**

Physical properties of water-the medium of life, Acids and bases, ionic strength and activity, Henderson-Hasselbalch equation, pH, indicators and buffers, Colloids and their properties, Mechanism of osmosis, osmotic pressure, Donnan membrane equilibrium, Viscosity, surface tension, surface forces, Adsorption and light scattering, Membrane filtration, dialysis, diffusion coefficient and partial specific volume.

Unit II

Laws of thermodynamics, Concepts of enthalpy, free energy and entropy in biochemical reactions. High energy compounds, Redox potential and free energy changes, Bioenergetics and biological oxidation, Components of mitochondrial electron transport chain. Formation of ATP and ATP cycle. Energy transformation in living cells.

Unit III

Basic Methods in Biophysical Chemistry: Basic Optical Principles, Optical Properties of Biomolecules, Optical spectroscopy, Basic Fluorescence Techniques, Chiroptical and Scattering Methods; Conventional and Confocal Fluorescence Microscopy, Basics of Super-Resolution Fluorescence Microscopy, Fluorescence spectroscopy, Patch Clamping.

VI. **Suggested Reading**

- David L Nelson and Cox Michael M. 2008. *Lehninger's Principles of Biochemistry*. 5th Ed. Freeman.
- James P Allen. 2008. *Biophysical Chemistry*. 1st Ed. Wiley-Blackwell Publication.
- Peter Jomo Walla. 2014. *Modern Biophysical Chemistry: Detection and Analysis of Biomolecules*. 2nd Ed. Wiley-VCH Publication.

Course Outline

S. No.	Topic	No. of Lectures
Theory		
1.	Physical properties of water-the medium of life, Acids and bases, ionic strength and activity	2
2.	Henderson-Hasselbalch equation, pH, indicators and buffers	2
3.	Colloids and their properties, Mechanism of osmosis, osmotic pressure, Donnan membrane equilibrium, Viscosity, surface tension, surface forces, Adsorption and light scattering	3
4.	Membrane filtration, dialysis, diffusion coefficient and partial specific volume.	2
5.	Laws of thermodynamics, Concepts of enthalpy, free energy and entropy in biochemical reactions, High energy compounds, Redox potential and free energy changes	3
6.	Bioenergetics and biological oxidation, Components of mitochondrial electron transport chain. Formation of ATP and ATP cycle. Energy transformation in living cells	4
7.	Basic Methods in Biophysical Chemistry: Basic Optical Principles, Optical Properties of Biomolecules, Optical spectroscopy	4
8.	Basic Fluorescence Techniques	2
9.	Chiroptical and Scattering Methods	2
10.	Conventional and Confocal Fluorescence Microscopy	3
11.	Basics of Super-Resolution Fluorescence Microscopy	2
12.	Fluorescence spectroscopy.	2
13.	Patch Clamping	1
	Total	32

I. **Course Title : Biochemistry of Biomolecules**

II. **Course Code : BCT 602**

III. **Credit Hours : 2 + 0**

IV. **Aim of the course**

Teaching molecular basis of structure and functional aspects of carbohydrates, lipids, amino acids and nucleic acids.

V. **Theory**

Unit I

Carbohydrates: Structure and biological significance of important monosaccharides:Ribose, Glucose, Fructose, Galactose, Mannose and Amino Sugars; Chemical reactions of monosaccharides; Isomerism of carbohydrates; Structure and biological significance of Disaccharides (Maltose, Isomaltose, Lactose, Sucrose and Cellobiose); Structure and biological

significance of polysaccharides (Starch, Dextrins, Dextrans, Glycogen, Cellulose, Inulin, Chitin), and Mucopolysaccharides including Blood group substances and Bacterial cell wall polysaccharides. Glycoconjugates in cell surface, extracellular matrix, sugar code functions, peptidoglycan–specific antibiotics; Basic principles of separation, purification and characterization of carbohydrates; Methods of structural analysis of carbohydrates.

Unit II

Lipids: Definition, Classification, Properties and Biological significance of simple, compound and derived lipids; Fat indices; Structure and functions of prostaglandins, steroids, steroid hormones and fat soluble vitamins. Basic principles of extraction and analysis of lipids; Lipid bilayers, lipid motility, integral membrane proteins, lipid linked proteins, peripheral membrane proteins, fluid mosaic model, membrane skeleton, lipid asymmetry, cardiac glycosides, abnormalities in cell membrane fluidity, signaling biomolecules.

Unit III

Proteins: Amino acids - Structure and classification. Physical and chemical properties of amino acids - amphoteric nature, acid-base property, optical activity and peptide bond formation; Structure and geometry of peptide bond. Chemical synthesis of polypeptide and oligopeptides of biological significance; Classification of proteins; Structure – primary, secondary, tertiary and quaternary; Physico- chemical, acid-base and colloidal properties of proteins; Biological significance of proteins; Denaturation, extraction and purification criteria for proteins.

Unit IV

Nucleic acids: Chemistry of purines, pyrimidines, nucleosides and nucleotides. Biological significance of nucleosides and nucleotides. Structures and functions of Watson-crick model of deoxyribonucleic acid (DNA) and a typical ribonucleic acid (RNA). Different types of DNA, acid-base properties, sedimentation behaviour, hyperchromic effect, melting of DNA, Chemical and enzymatic hydrolysis of nucleic acids. Base sequence analysis of DNA, Nucleic acid- protein interaction - histone and non-histone proteins.

VI. Suggested reading

- David L Nelson and Cox Michael M. 2017. *Lehninger's Principles of Biochemistry*. 7th Ed. Freeman.
- Voet D, Voet JG and Pratt CW. 2016. *Fundamentals of Biochemistry of Life at the Molecular Level*. 5th Ed. John Wiley and Sons.

- Berg JM, Tymoczko JL, Stryer L and Clarke ND 2015. *Biochemistry*. 8th Ed. WH Freeman and Co.
- Zubay GL. 1998. *Biochemistry*. 4th Ed. WCB London.

Course Outline

S. No.	Topic	No. of Lectures
Theory		
1	Carbohydrates: Structure and Biological Significance of Important Monosaccharides: Ribose, Glucose, Fructose, Galactose, Mannose and Amino Sugars;	1
2	Chemical reactions of monosaccharides; Isomerism of carbohydrates; Structure and Biological Significance of Disaccharides (Maltose, Isomaltose, Lactose, Sucrose and Cellobiose);	1
3	Structure and Biological Significance of Polysaccharides (Starch, Dextrins, Dextrans, Glycogen, Cellulose, Inulin, Chitin), and Mucopolysaccharides including Blood group substances and Bacterial Cell Wall polysaccharides;	1
4	Glycoconjugates in cell surface, extracellular matrix, sugar code functions, peptidoglycan-specific antibiotics;	2
5	Basic principles of separation, purification and characterization of carbohydrates;	1
6	Methods of Structural analysis of carbohydrates.	1
7	Definition, Classification, Properties and Biological Significance of simple, compound and derived lipids;	1
8	Fat indices; Structure and functions of prostaglandins, steroids, steroid hormones and fat soluble vitamins;	2
9	Basic principles of extraction and analysis of lipids;	1
10	Lipid bilayers, lipid motility, integral membrane proteins, lipid linked proteins, peripheral membrane proteins;	2
11	Fluid mosaic model, membrane skeleton, lipid asymmetry, cardiac glycosides, abnormalities in cell membrane fluidity, signaling biomolecules.	3
12	Amino acids – Structure and classification.	1
13	Physical and chemical properties of amino acids – amphoteric nature, acid-base property, optical activity and peptide bond formation.	1
14	Structure and geometry of peptide bond; Chemical synthesis of polypeptide; Oligopeptides of biological significance;	2
15	Classification of proteins; Structure – primary, secondary, tertiary and quaternary; Physico-chemical, acid-base and colloidal properties of proteins;	2

16 Biological significance of proteins; Denaturation, extraction and purification criteria for proteins. 1
17 Chemistry of purines, pyrimidines, nucleosides and nucleotides;1
18 Biological significance of nucleosides and nucleotides; 1
19 Structures and functions of Watson-crick model of deoxyribonucleic acid (DNA) and a typical ribonucleic acid (RNA). 1
20 Different types of DNA, acid-base properties, sedimentation behaviour; 2
21 Hyperchromic effect, melting of DNA; Chemical and enzymatic hydrolysis of nucleic acids; 2
22 Base sequence analysis of DNA, Nucleic acid- protein interaction – histone and non-histone proteins. 2
Total 32

I. **Course Title : Enzymology**
II. **Course Code : BCT 603**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To give thorough knowledge of molecular basis of enzyme action in relation to diagnostic importance**.**

V. **Theory**

Unit I

Introduction and historical perspective, Enzyme nomenclature and classification, enzyme compartmentalization in cell organelles, measurement of enzyme activity. ribozymes, isozymes, abzymes, restriction endonucleases.

Unit II

Enzyme structure, enzyme specificity, active site, active site mapping, mechanism of enzyme catalysis. cofactors, coenzymes- their structure and role.

Unit III

Enzyme kinetics, enzyme inhibition and activation, multienzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity. qualitative description of “concerted” and “sequential” models for allosteric enzymes. Half site reactivity, Flip-flop mechanism, positive and negative co-operativity. Monod Koshland Model. Concept of ES complex, active site, specificity derivation of Michaelis-Menten equation for uni-substrate reactions. Different plots for the determination of Km and Vmax and their physiological significances. Importance of Kcat/ Km. Kinetics of zero and first order reactions. Significance and evaluation of energy of activation.

Unit IV

Isolation, purification and characterization of enzymes, Applications of enzymes in chemical and feed industry, enzyme immobilization, biosensors, clinical and diagnostic applications of enzymes.

VI. Practical

- Enzyme assay by taking any model enzyme like alpha-amylase or alkaline phosphatase.
- Isolation, purification and characterization of any model enzyme like β-galoctosidase or acid phosphatase.
- Study of the effect of enzyme and substrate concentrations and determination of Km and Vmax.
- Determination of pH and temperature optima of alkaline phospatase.
- To study the effect of various inhibitors of enzymatic activity.
- Determination of the pH and temperature stability of alkaline phosphatase.
- Assay of Diagnostic enzymes from Clinical samples.
- Application of enzymes in ELISA and Western Blotting

VII. Suggested Reading

- Bergmeyer HU. 1983. *Methods of Enzymatic Analysis*. Vol. II. Verlag Chemie, Academic Press.
- Dixon M, Webb EC, Thorne CJR and Tipton KF. 1979. *Enzymes*. 3rd Ed. Longman.
- Maragoni AG. 2003. *Enzyme Kinetics - A Modern Approach*. John Wiley.
- Palmer T. 2001. *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry*. 5th Ed. Horwood Publ.
- Price NC and Stevens L. 2003. *Fundamentals of Enzymology*. Oxford Univ. Press.
- Wilson K and Walker J. (Eds.). 2000. *Principles and Techniques of Practical Biochemistry*. 5th Ed. Cambridge Univ. Press.
- David L Nelson and Cox Michael M. 2008. *Lehninger's Principles of Biochemistry*. 5th Ed. Freeman.
- Kaneko JJ, Harvey JH and Bruss ML. 2008. *Clinical Biochemistry of Domestic Animals*. 6th Ed. Academic Press.

Course Outline

S. No.	Topic	No. of Lectures/Practicals
Theory		
1	Introduction and historical perspective, Enzyme nomenclature and classification	2
2	Enzyme compartmentalization in cell organelles	1
3	Ribozymes, isozymes, abzymes, restriction endonucleases.	2
4	Enzyme structure	1
5	Enzyme specificity, active site, active site mapping,	2
6	Mechanism of enzyme catalysis.	2
7	Cofactors, coenzymes- their structure and role.	2
8	Enzyme kinetics	1
9	Enzyme inhibition and activation	2
10	Multienzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity.	2
11	Qualitative description of “concerted” and “sequential” models for allosteric enzymes. Half site reactivity, Flip-flop mechanism, positive and negative co-operativity. Monod Koshland Model.	3
12	Concept of ES complex, active site, specificity derivation of Michaelis- Menten equation for uni- substrate reactions.	2
13	Different plots for the determination of Km and Vmax and their physiological significances. Importance of Kcat/ Km.	2
14	Kinetics of zero and first order reactions. Significance and evaluation of energy of activation.	2
15	Isolation, purification and characterization of enzymes	2
16	Applications of enzymes in chemical and feed industry	2
17	Enzyme immobilization, biosensors, clinical and diagnostic applications of enzymes.	2
	Total	32
Practical		
1	Enzyme assay by taking any model enzyme like alpha-amylase or alkaline phosphatase.	1
2	Isolation, purification and characterization of any model enzyme like β galoctosidase or acid phosphatase.	3
3	Study of the effect of enzyme and substrate concentrations and determination of Km and Vmax.	2
4	Determination of pH and temperature optima of alkaline phosphatase.	2
5	To study the effect of various inhibitors of enzymatic activity.	2
6	Determination of the pH and temperature stability of alkaline	

	phosphatase.	2
7	Assay of Diagnostic enzymes from Clinical samples.	1
8	Application of enzymes in ELISA and Western Blotting.	3
	Total	16

I. **Course Title : Analytical Techniques and Instrumentation in Biochemistry**

II. **Course Code : BCT 604**

III. **Credit Hours : 1 + 1**

IV. **Aim of the course**

To make students well versed with certain basic methodologies used in biochemistry to carry out independent research.

V. **Theory**

Unit I

Solutions and Buffers: Units of expression of concentration of solutions - Preparation of solutions - Preparation of Buffers - Henderson-Hasselbalch equation in the preparation of buffers. Spectroscopy: Theory and applications of Colorimetry and Spectrophotometry; Major components of the following instruments and their functions: UV-Visible Spectrophotometer, Spectrofluorometer, Flame photometer, Atomic absorption spectrophotometer, Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES).

Unit II

Chromatographic Techniques: Basic principle and applications of Paper, Column and Thin layer chromatography including HPTLC; Factors affecting chromatographic resolution; Methods of preparation of biological samples for chromatographic analysis and common methods for qualitative and quantitative chromatography of amino acids, lipids and sugars including elution and densitometry. Molecular Sieving and its application in Biochemistry – General properties of dextran, acrylamide, agar and other media used for gel filtration. Principles and applications of chromatographic techniques, viz., ion-exchange, gel-filtration, affinity, hydrophobic interaction chromatography, metal chelate chromatography, planar chromatography, lateral flow immunochromatographic assays, Introduction to GLC and HPLC (Normal and Reverse Phase).

Unit III

Theory and applications of Electrophoresis: Factors affecting migration of charged particles – Moving boundary, paper and gel electrophoresis - Electrophoresis of amino acids, proteins and nucleic acids – Use of SDS-PAGE in molecular weight determination. Isoelectric focusing and Isotachophoresis - Densitometry procedures

and quantitative assays. Introduction to 2-D gel electrophoresis; Immuno- electrophoresis and other techniques like ELISA, RIA and Immuno-blotting.

Unit IV

Theory and applications of Centrifugation: Basic principle of sedimentation – Types, care and safety aspects of Centrifuges – Preparative centrifugation and Analytical centrifugation - Introduction to Ultracentrifugation - Fractionation of sub-cellular components - Density Gradient centrifugation – Determination of relative molecular mass.

N.B.: GLC and HPLC at length are to be discussed under BCT 705 (Ph.D. course); here only introduction.

VI. Practical

- Preparation of solutions and buffers; Solving problems using Henderson– Hasselbalch equation, pH, pKa and buffer concentration, normality; Verification of Beer's – Lambert's law; Estimation of glucose and total cholesterol in serum; Determination of absorption maxima and molar extinction coefficient of p-Nitrophenol from its absorption spectrum; Estimation of proteins using biuret, folin-ciocalteau methods and UV spectrophotometry; Estimation of enzyme activity by spectrophotometry (Kinetic mode).
- Separation of Lipids/ amino acids using paper chromatography and TLC; Fractionation of proteins by ammonium sulphate precipitation and desalting by dialysis; Separation of proteins using Ion-exchange chromatography, affinity chromatography and gel-filtration chromatography; Demonstration of separation of fatty acid methyl esters using GLC.
- Electrophoretic analysis of albumin using non-denaturing and denaturing conditions – Detection of molecular weight of protein by SDS-PAGE - Characterization of immunoglobulins by PAGE - Demonstration of sub-cellular fractionation by centrifugation.

VII. Suggested Reading

- David L Nelson and Cox Michael M. 2017. *Lehninger's Principles of Biochemistry*. 7th Ed. Freeman.
- Wilson K and Walker J. (Eds.). 2010. *Principles and Techniques of Biochemistry and Molecular Biology*. 7th Ed. Cambridge Univ. Press.
- Willard *et al.* 1988. *Instrumental Methods of Analysis.* 7th Ed. Wadsworth Pub Co.
- Garrity S. 1999. *Experimental Biochemistry*. 3rd Ed. Academic

Press.
- Gowenlock AH. 2002. *Varley's Practical Clinical Biochemistry*. 6th Ed. CBS.
- Holme DJ and Hazel P. 1998. *Analytical Biochemistry*. 3rd Ed. Longman.
- George W. Latimer, Jr. 2016. *Official Methods of Analysis of AOAC International*, 20th Ed. AOAC International.
- Carl A. Burtis, Edward R. Ashwood and David E. Burns, 2014. *Tietz Textbook of clinical Biochemistry and Molecular Diagnostics.* 5th Edition. Elsevier

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Concentration of Solutions and units of expression, preparation of solutions and buffers, Henderson-Hasselbalch equation and its significance in preparation of buffers	1
2	Introduction to Spectroscopy and Principle of Colorimetry and Spectrophotometry, basic components, principle and applications of UV-Visible Spectrophotometer, Reflectance Spectrophotometer and Spectro-fluorometer	1
3	Basic components, principle and applications of Flame photometer and Atomic Absorption Spectrophotometer	1
4	Basic components, principle and applications of Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES)	1
5	Introduction to Chromatography – Principle, types and applications; Theory, components and applications of Paper Chromatography, TLC and HPTLC	1
6	Theory, components and applications of Column Chromatography, factors affecting chromatographic resolution and methods of preparation of biological samples for chromatographic analysis	1
7	Methods for qualitative and quantitative chromatography of amino acids, lipids and sugars including elution and densitometry	1
8	Molecular sieving and its application in biochemistry, general properties of dextran, acrylamide, agar and other media used for gel filtration	1
9	Principles and applications of ion-exchange,gel-filtration, hydrophobic interaction, planar chromatography and lateral flow immuno-chromatographic assays	1

10 Introduction to GLC and HPLC (Normal and Reversed Phase) 1

11 Introduction to Electrophoresis - Principle, types and applications, factors affecting migration of charged particles 1

12 Principle and applications of Moving boundary, paper and gel electrophoresis, Common methods for electrophoresis of amino acids, proteins and nucleic acids with the components of electrophoretic apparatus 1

13 Use of SDS-PAGE in molecular weight determination, Isoelectric focusing, Isotachophoresis, densitometry procedures and quantitative assays applied to electrophoresis, introduction to Immuno-electrophoresis and 2-D gel electrophoresis 1

14 ELISA, RIA and Immuno-blotting 1

15 Basic principle of sedimentation – Types, care and safety aspects of Centrifuges – Preparative and Analytical; introduction to Ultracentrifugation and Fractionation of sub-cellular components 1

16 Density Gradient centrifugation and Determination of relative molecular mass 1

Total 16

Practical

1 Preparation of solutions and buffers – dil. Acids, bases, phosphate buffer, etc. 1

2 Problem solving based on Henderson-Hasselbalch equation 1

3 Verification of Beer-Lambert's Law 1

4 Estimation of glucose and total cholesterol in serum 1

5 Determination of absorption maxima and molar extinction coefficient of p-Nitrophenol from its absorption spectrum 1

6 Estimation of proteins using biuret, folin-ciocalteau methods and UV spectrophotometry 1

7 Estimation of enzyme activity by spectrophotometry – kinetic mode 1

8 Separation of amino acids by TLC/ paper chromatography 1

9 Separation of proteins by Affinity chromatography 1

10 Separation of proteins by Ion-exchange chromatography 1

11 Separation of proteins by Gel filtration chromatography 1

12 Demonstration of GLC for separation of fatty acids 1

13 Electrophoretic analysis of albumin using non-denaturing and denaturing conditions 1

14 Detection of molecular weight of protein by SDS-PAGE 1

15 Salt fractionation, dialysis and PAGE of immunoglobulins 1

16 Demonstration of sub-cellular fractionation by Ultra Centrifugation 1

Total 16

I. **Course Title : Clinical Biochemistry of Animals**
II. **Course Code : BCT 605**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To give a detailed overview of role of biomolecules in health and diseases and aid in diagnosis and prognosis of diseases in animals and poultry.

V. **Theory**

Unit I

Quality control and automation in clinical biochemistry. Disturbances in water, electrolytes and acid-base balance - electrolyte abnormalities - respiratory acidosis and alkalosis - metabolic acidosis and alkalosis – compensation – biochemical tests for diagnosis.

Unit II

Disorders of Carbohydrate metabolism: Diabetes mellitus, hyperinsulemia, galactosemia, hypoglycaemia, Glycogen storage disease and glycated proteins. Carbohydrate and protein balance for optimum rumen microflora. Ruminant ketosis, Ketosis associated with fasting, diabetes, pregnancy, lactation and post-exercise.

Unit III

Disorders of Lipid metabolism: Hypercholesterolemia, atherosclerosis, hyperlipidemia in canine, feline, equine – pathophysiology of ketonemia. Disorders of proteins, amino acids and nucleic acids metabolism: Normal and abnormal plasma proteins

– Dysproteinemia – acute phase proteins – inborn errors of amino acid metabolism– Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, Histidinemia – defect in collagen biosynthesis. Abnormalities in Nitrogen Metabolism – Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance. Composition and diagnostic significance of cerebrospinal fluid and amniotic fluid. Doping in horses.

Unit IV

Liver function tests - indications and limitations - classification of tests – Biochemical tests for liver function - serum enzyme activities to assess liver function - Hepatic encephalopathy – Hepatic photosensitivity – Ascites. Renal function: Direct and indirect test for glomerular filtration – tests for tubular function –

test for kidney damage Gastrointestinal function: Disturbances in gastrointestinal function – disturbances in rumen function.

Unit V

Clinical enzymology - functional and non-functional plasma enzymes - plasma enzymes of diagnostic importance - ALP, CK, LDH, AST, ALT, OCT - Iso-enzymes and their diagnostic importance. Oxidative Stress: Biochemical basis of disease progression and diagnostic enzymes. Biochemical markers of cardiac diseases: Hypertension, myocardial infarction and heart failure. Respiratory distress syndrome, COPD, Ischemia, shock.

Unit VI

Disorders of mineral metabolism: Hypercalcaemia, hypocalcaemia, normocalcaemia, hypophosphataemia, hyperphosphataemia. Biochemistry of tumours and various types of tumour markers for the diagnosis of prostate cancer, ovarian cancer, mammary tumour, lymphoma, bladder cancer and pancreatic cancer.

Unit VII

Biochemical basis and diagnosis of prevalent diseases and metabolic disorders in wild animals, and poultry.

VI. Practical

Urine analysis - Physical and chemical tests for normal and pathological constituents of urine. Quality Control-Precision, Accuracy, Sensitivity and Specificity; Estimation of Blood glucose - Serum biochemical parameters – Total protein, A/G ratio, Cholesterol, urea, uric acid, bilirubin, creatinine – Serum enymes – ALP, ACP, AST and ALT – Electrophoresis of plasma proteins - Separation of Iso-enzymes. Estimation of Ca, Mg, P, K, Na in serum samples. Estimation of Vit C, D and E.

VII. Suggested Reading

- David L Nelson and Cox Michael M. 2007. *Lehninger's Principles of Biochemistry*. 4th Ed. Freeman.
- Kaneko JJ, Harvey JH, Bruss ML. 2008. *Clinical Biochemistry of Domestic Animals*. 6th Ed. Academic Press.
- Racek J and Rajdl D. 2016. *Clinical Biochemistry*. 1st Ed. Karolinum Press.
- Voet D, Voet JG and Pratt CW. 2006. *Fundamentals of Biochemistry of Life at the Molecular Level*. 2nd Ed. John Wiley and Sons.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals
Theory		
1	Quality control and automation in clinical biochemistry	1
2	Disturbance in water, electrolytes and acid-base balance electrolyte abnormalities	1
3	Respiratory acidosis and alkalosis: compensation and biochemical tests for diagnosis.	1
4	Metabolic acidosis and alkalosis: compensation and biochemical tests for diagnosis.	1
5	Diabetes mellitus, classification and diagnosis	1
6	Hyperinsulemia, galactosemia, hypoglycaemia of baby pigs	1
7	Glycogen storage disease and glycated proteins	1
8	Carbohydrate balance in ruminants.	1
9	Biochemical alterations in body fluids of ruminants in hypoglycaemia	1
10	Ruminant ketosis – Ketosis associated with fasting, diabetes, pregnancy, lactation and post-exercise	1
11	Disorders of Lipid metabolism: Hypercholesterolemia, atherosclerosis, hyperlipidemia in canines, felines and equines	1
12	Pathophysiology of ketonemia.	1
13	Disorders of proteins, amino acids and nucleic acids metabolism: Normal and abnormal plasma proteins Dysproteinemias, acute phase proteins	1
14	Inborn errors of amino acid metabolism– Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, Histidinemia – defect in collagen biosynthesis	1
15	Abnormalities in Nitrogen Metabolism – Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance	1
16	Composition and diagnostic significance of cerebrospinal fluid and amniotic fluid	1
17	Doping in horses	1
18	Liver function tests - indications and limitations	1
19	Classification of tests – Biochemical tests for liver function serum enzyme activities to asses liver function	1
20	Hepatic encephalopathy – Hepatic photosensitivity – Ascites	1
21	Renal function: Direct and indirect test for glomerular filtration – tests for tubular function – test for kidney damage	1
22	Gastrointestinal function: Disturbances in gastrointestinal	

function – 1

23 Disturbances in rumen function 1

24 Clinical enzymology - functional and non-functional plasma enzymes 1

25 Plasma enzymes of diagnostic importance - ALP, CK, LDH, AST, ALT, OCT - Iso-enzymes and their diagnostic importance 1

26 Oxidative Stress: Biochemical basis of disease progression and diagnostic enzymes 1

27 Biochemical markers of cardiac diseases: Hypertension, myocardial infarction and heart failure. 1

28 Respiratory distress syndrome, COPD, Ischemia, shock 1

29 Disorders of mineral metabolism: Hypercalcaemia, hypocalcaemia, normocalcaemia, hypophosphataemia, hyperphosphataemia. 1

30 Biochemistry of tumours and various types of tumour markers 1

31 Role of tumour markers for the diagnosis of prostate cancer, ovarian cancer, mammary tumour, lymphoma, bladder cancer and pancreatic cancer 3

32 Biochemical basis and diagnosis of prevalent diseases and metabolic disorders in wild animals 1

33 Biochemical basis and diagnosis of prevalent diseases and metabolic disorders in poultry 1

Total 34

Practical

1. Urine analysis - volume, colour, acidity, pH, specific gravity normal urinary constituents - pathological constituents and sediments 2
2. Quality Control - Precision, Accuracy, Sensitivity and Specificity 1
3. Estimation of Blood glucose 1
4. Estimation of Total protein and A/G ratio 1
5. Estimation of Cholesterol from serum 1
6. Estimation of urea from serum 1
7. Estimation of uric acid from serum 1
8. Estimation of bilirubin from serum 1
9. Estimation of creatinine from serum 1
10. Estimation of serum enzymes: ALP, ACP, AST, ALT 1
11. Electrophoresis of plasma proteins 1
12. Separation of Isoenzymes 1
13. Estimation of Ca, Mg, P, K, Na in serum samples 1
14. Estimation of Vit C 1
15. Estimation of Vit D and Vit E 1
16. Estimation of total antioxidant activity 1

Total 17

I. **Course Title : Intermediary Metabolism and Regulation**
II. **Course Code : BCT 606**
III. **Credit Hours : 3 + 0**
IV. **Aim of the course**

To teach regulatory mechanisms concerned with the metabolism of carbohydrates, lipids, amino acids, proteins and nucleotides in health and diseases and to give exposure in inter-relationship of cellular metabolism of various macromolecules.

V. **TheoryUnit I**

Carbohydrate metabolism and regulation - Major pathways - Glycolysis - Reactions, functions and its control - Metabolism of other sugars - Fructose, Galactose, Mannose and Lactose - Pyruvate dehydrogenase and reactions of Citric acid cycle – Anaplerotic reactions - Energetics of glucose oxidations. Alternate pathways of glucose metabolism - HMP pathway and its importance - Glucuronic acid cycle - Gluconeogenesis - Substrates - pathway and control of amino sugar - Glycogen metabolism - Glycogenolysis and Glycogenesis reactions - Metabolic disorders - Glycogen storage diseases (GSD).

Unit II

Lipid metabolism and regulation - Lipid transport and storage - Plasma lipoproteins - Role of liver and adipose tissue in fat metabolism - Role of brown adipose tissue in thermogenesis - Catabolism of triacylglycerols – Beta oxidation of fatty acids – Ketogenesis and utilization of ketone bodies - Biosynthesis of fatty acids, triacylglycerols, phopholipids and cholesterol – Production of Bile acids - Metabolism of Eicosanoids - Lipid storage diseases.

Unit III

Amino acids metabolism - Protein turnover and regulation - amino acid pools and absorption of amino acids - catabolism of amino acids - Deamination, transamination. Ammonia carriers; Excretion of nitrogen - urea cycle. Catabolism of carbon skeletons of amino acids. Conversion of amino acids to specialized products – Heme Biosynthesis - Physiologically active amines. Biosynthesis of non-essential amino acids. Metabolic disorders.

Unit IV

Catabolism and regulation of purine and pyrimidine nucleotides/ deoxynucleotides - Biosynthesis and regulation of purine and pyrimidine nucleotides - Biosynthesis of nucleotide coenzymes and regulation - Inhibitors of purine and pyrimidine metabolism and role in cancer therapy – Metabolic disorders.

Unit V

Structural and functional relationships of specialized tissues and organs; Organ specialization in fuel metabolism: Brain, muscle, adipose tissue, liver, kidney; Inter organ metabolic pathways, hormonal control of fuel metabolism. Tracing metabolic fates, perturbing the system. Metabolic interrelationships in obesity, diabetes, cancer, aerobic and anaerobic exercise in horses, pregnancy, lactation and stress injury.

VI. Suggested Reading

- Berg JM, Tymoczko JL, Stryer L and Clarke ND 2015. *Biochemistry*. 8th Ed. WH Freeman and Co.
- David L Nelson and Cox Michael M. 2017. *Lehninger's Principles of Biochemistry*. 7th Ed. Freeman.
- Kaneko JJ, Harvey JH and Bruss ML. 2008. *Clinical Biochemistry of Domestic Animals.* 6th Ed. Academic Press.
- Metzler DE. *Biochemistry*. John Wiley.
- Swenson MJ and Reece WO.2015. *Dukes' Physiology of Domestic Animals.* 13th Ed. Panima.
- Voet D, Voet JG and Pratt CW. 2016. *Fundamentals of Biochemistry of Life at the Molecular Level*. 5th Ed. John Wiley and Sons.
- Zubay GL. 1998. *Biochemistry*. 4th Ed. WCB London.

S. No.	Topics	No. of Lectures
Theory		
1.	Glycolysis - Reactions, functions and its control	1
2.	Metabolism and regulation of other sugars – Fructose and Galactose	1
3.	Metabolism and regulation of other sugars - Mannose and Lactose	1
4.	Pyruvate dehydrogenase Complex, Reactions of Citric acid cycle and its regulation	1
5.	Anaplerotic reactions - Energetics of Glucose oxidations;Introduction to Alternate pathways of Glucose metabolism.	1
6.	Reactions of HMP pathway and its regulation	1
7.	Glucuronic acid cycle and its regulation	1
8.	Gluconeogenesis with its regulation – Substrates - Pyruvate and Lactate	1
9.	Gluconeogenesis with its regulation – Substrates - Glucogenic amino acids, Glycerol and Propionate	1

10. Glycogen metabolism – Reactions and regulation of Glycogenolysis. 1
11. Glycogen metabolism - Reactions and regulation of Glycogenesis. 1
12. Metabolic disorders – Glycogen Storage Diseases (GSD) 1
13. Lipid transport and storage – Metabolism of Plasma Lipoproteins 1
14. Role of liver and adipose tissue in fat metabolism 1
15. Role of brown adipose tissue in thermogenesis 1
16. Catabolism of Triacylglycerols and its regulation 1
17. Beta oxidation of Fatty acids and its regulation 1
18. Ketogenesis and utilization of ketone bodies 1
19. Biosynthesis of Fatty acids and its regulation 1
20. Biosynthesis of Triacylglycerols and Phopholipids and their regulation 1
21. Biosynthesis of Cholesterol and its regulation – Production of Bile acids 1
22. Metabolism of Eicosanoids 1
23. Lipid Storage Diseases 1
24. Introduction to protein turnover and amino acid pools – Meister cycle 1
25. Catabolism of amino acids - Deamination, transamination reactions and Ammonia carriers/ transport 1
26. Excretion of nitrogen - Urea cycle and its regulation 1
27. Catabolism of carbon skeletons of amino acids and its regulation 2
28. Conversion of amino acids to specialized products - Heme Biosynthesis 1
29. Conversion of amino acids to specialized products – Physiologically active amines 1
30. Biosynthesis of non-essential amino acids and its regulation 1
31. Metabolic disorders – phenylketonuria, methyl malonic aciduria, alkaptonuria, maple syrup urine disease, parkinson's disease, homocystinuria, hartnup's disease. 1
32. Catabolism and regulation of Purine nucleotides 1
33. Catabolism and regulation of Pyrimidine nucleotides 1
34. Biosynthesis and regulation of Purine nucleotides 1
35. Biosynthesis and regulation of Pyrimidine nucleotides 1
36. Biosynthesis of nucleotide coenzymes and regulation 1
37. Inhibitors of purine and pyrimidine metabolism – Role in Cancer therapy 1
38. Metabolic disorders-hyperuricemia and gout. 1

39. Structural and functional relationships of specialized tissues and organs, viz., Brain, muscle, adipose tissue, liver and kidney 2
40. Organ specialization in fuel metabolism of brain, muscle, adipose
41. tissue, liver and kidney 2
42. Inter-organ metabolic pathways 1
43. Hormonal control of fuel metabolism 1
44. Tracing metabolic fates - perturbing the system. 1
45. Metabolic interrelationships in obesity, diabetes, cancer, aerobic and anaerobic exercise in horses, pregnancy, lactation and stress injury 2

Total 48

I. **Course Title : Molecular Biochemistry**

II. **Course Code : BCT 607**

III. **Credit Hours : 2 + 1**

IV. **Aim of the course**

To provide knowledge regarding genes, their functions, expression, regulation and transfer in heterologous systems.

V. **Theory**

Unit I

Historical development of molecular biology, nucleic acids as genetic material, chemistry and structure of DNA and RNA, Genome organization in prokaryotes and eukaryotes, repetitive and non-repetitive DNA, satellite DNA; chromatin structure and function.

Unit II

DNA replication mechanisms in prokaryotes and Eukaryotes, DNA polymerases, Topoisomerases, DNA ligase, Reverse transcriptase, Transcription mechanisms in Prokaryotes and Eukaryotes, RNA polymerases, RNA editing, post transcriptional RNA processing. Recombination mechanisms, DNA repair mechanisms, Telomeres, Telomerase, Role of Telomeres in Cancer.

Unit III

Ribosomes - structure and function, organization of ribosomal proteins, genetic code, aminoacyl tRNA synthases, Inhibitors of replication, transcription and translation; Translation mechanisms in Eukaryotes and Prokaryotes and Post-translational modification; Nucleases and restriction enzymes, regulation of gene expression in prokaryotes and eukaryotes.

Unit IV

DNA sequencing techniques, Recombinant DNA technology, Plasmid

biology, Cloning Vectors, Expression vectors, selection of recombinants, Heterologous protein expression systems, Recombinant protein purification, Polymerase Chain Reaction and its variants; Site Directed Mutagenesis, *In-vitro* transcription, Gene Silencing. Transgenic Animals, Introduction to Systems Biology.

VI. Practical

Isolation and purification of DNA - Plasmid isolation- Isolation and purification of RNA – Determination of concentration of DNA and RNA by spectrophotometry - Determination of T_m of DNA by Spectrophotometry - Restriction Digestion of DNA, Agarose gel electrophoresis - RAPD analysis of DNA - cDNA synthesis using PCR

VII. Suggested Reading

- Jocelyn E Krebs *et al*. 2017. *Lewin's Genes XII*. Jones and Bartlett Publishers Inc.
- Watson JD *et al.* 2017. *Molecular Biology of the Gene.* 7th Ed. Pearson Education.
- Eberhard. O. Voit. 2017. *A First Course in Systems Biology*, 2nd Edition. Garland Science Publishers.
- *Genome Editing and Engineering*: From TALENs, ZFNs and CRISPRs to Molecular Surgery, Ed. Krishnarao Appasani, Cambridge University Press, 2018
- *Molecular Cell Biology*, 8th Ed, Lodish *et al.* WH Freeman and Co., 2016
- *Molecular Biology of the Cell*, 6th Ed. Bruce Alberts *et al*, WW Norton and Company, 2014
- *Transgenic Animal Technology: A laboratory handbook*, 3rd Edition, Ed. Carl. A. Pinkert, Academic Press, 2014.
- *Molecular Biology*, 4th Ed, Robert F. Weaver, McGraw Hill Higher Education, 2007.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Historical Development of Molecular Biology	1
2.	Nucleic acids as genetic material, Chemistry and Structure of DNA and RNA	1
3.	Genome organization in prokaryotes and eukaryotes	1
4.	Repetitive and non-repetitive DNA, Satellite DNA	1
5.	Chromatin structure and function	1
6.	DNA replication mechanisms in prokaryotes and Eukaryotes, DNA polymerases, DNA ligase	1
7.	Topoisomerases	1

8.	Transcription mechanisms in Prokaryotes and Eukaryotes, RNA Pol.	1
9.	RNA editing	1
10.	Post-transcriptional RNA processing	1
11.	Recombination mechanisms	1
12.	DNA repair mechanisms	1
13.	Reverse transcriptase	1
14.	Telomeres, Telomerase, Role of Telomeres in Cancer	1
15.	Translation mechanisms in Eukaryotes and Prokaryotes	1
16.	Post - translational modification	1
17.	Ribosomes - structure and function, organization of ribosomal proteins,	1
18.	Genetic code	1
19.	Aminoacyl tRNA synthases	1
20.	Inhibitors of replication, transcription and translation	1
21.	Regulation of gene expression in prokaryotes and eukaryotes	1
22.	Recombinant DNA technology - Introduction	1
23.	Plasmid biology, Cloning Vectors, selection of recombinants	1
24.	Nucleases and restriction enzymes	1
25.	Polymerase Chain Reaction and its variants	1
26.	Expression vectors	1
27.	Heterologous protein expression systems	1
28.	Recombinant protein purification	1
29.	Site Directed Mutagenesis, *In-vitro* transcription,	1
30.	Gene Silencing	1
31.	Transgenic Animals	1
32.	Introduction to Systems Biology	1
	Total	32

S. No.	Topic	No. of Lectures/Practicals
Practical		
1.	Isolation and purification of DNA	2
2.	Plasmid isolation	2
3.	Isolation and purification of RNA	2
4.	Determination of concentration of DNA and RNA by spectrophotometry	1
5.	Determination of T_m of DNA by Spectrophotometry	1
6.	Polymerse chain reaction	2
7.	Restriction Digestion of DNA	2
8.	Agarose gel electrophoresis	1
9.	RAPD analysis of DNA	2
10.	cDNA synthesis using PCR	2
	Total	17

I. **Course Title : Nutritional and Industrial Biochemistry**

II. **Course Code : BCT 608**

III. **Credit Hours : 2 + 0**

IV. **Aim of the course**

To give exposure about biochemical principle as applicable to nutrition in animals and industry.

V. **Theory**

Unit I

Introduction - Nutrients and their importance in ruminants, non-ruminants and poultry - Energy value of various nutrients their importance and calorimetry - Nutrient absorption and biochemical changes involved - Introduction to BMR, SDA, PER and Biological value for protein - Requirements of different nutrients in animals - Role of nutrients in growth and production of animals – Bio-availability of nutrients in different food sources.

Unit II

Metabolic role of Nutrients - Overview of metabolism of different nutrients and regulation of nutrient absorption and utilization - Alterations that occur in nutritional requirements during diseases and biochemical reactions due to Toxic factors in feed - Biochemical role of Macro and micro minerals in animal production

- Vitamins and their role as co-enzymes in metabolism – Nutrient deficiencies and metabolic disorders in animals - Biochemical alterations occurring due to phyto-toxins in ruminants - Biochemical importance of different feed additives - Agonists and antagonists of minerals and vitamins - Nutrient control of gene expression - Clinical issues of micro mineral metabolism - Nutrients (minerals) that resist digestion process in animals - Energy releasing and hematopoietic water soluble vitamins.

Unit III

Industrial biochemistry - applications of biological molecules for medical, industrial, environmental, agricultural or analytical purposes - Generation of gene-mediated industrial/ medical products - Introduction and application of fermentation

technology for ethanol and biogas production - conversion of sunlight into biomass (bioreactors and biophotolysis) - Significance of pharmaceuticals products of animal origin (sex hormones-oestrogens, progesterone; corticosteroids) - Significance of pharmaceuticals of plant origin (alkaloids, atropine, morphine, cocaine, ergot alkaloids, flavonoids, xanthenes and terpenoids) - Physical, chemical and biological treatment of waste water, bioremediation of contaminated soils.

VI. Suggested Reading

- *Nutritional Biochemistry*, 2nd Edition, Tom Brody, Elsevier pub.2009
- *Text book of Biochemistry with clinical correlations*. 6th edition, Thomas M Devlin, Wileys- liss. Press.
- *A textbook of industrial microbiology* 2nd edition, Crueger W and Crueger A. 2000, Panima Publishing Corp.
- *Principle of fermentation technology*, 1997, Stanbury PF, Ethitaker H, Hall S, Aditya Books (P) Ltd.
- *Bioprocess Engineering: Basic Concepts*. Shuler M and Kargi F. Second Edition. Pearson Education. 2002
- *Nutritional Biochemistry of the vitamins*, by David a Bender, 2nd Edition, Cambridge University Press.

Course Outline

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Nutrients and their importance in ruminants.	1
2.	Nutrients and their importance in Non ruminants and poultry	1
3.	Energy value of various nutrients their importance and calorimetry.	1
4.	Nutrient absorption and biochemical changes involved.	1
5.	Introduction to BMR, SDA, PER and Biological value for protein.	1
6.	Requirements of different nutrients in animals	1
7.	Role of nutrients in growth and production of animals	1
8.	Bio-availability of nutrients in different food sources	1
9.	An overview of metabolism of different nutrients.	1
10.	An overview of regulation of nutrient absorption and utilization.	1
11.	Alterations that occur in nutritional requirements during diseases.	1
12.	Alterations in biochemical reactions due to Toxic factors in feed.	1
13.	Biochemical role of Macro minerals in animal production	1
14.	Biochemical role of Micro minerals in animal production.	1
15.	Vitamins and their role as co enzymes in metabolism	1
16.	Deficiencies of nutrients that cause metabolic disorders in animals	1
17.	Biochemical alterations occurring due to phyto-toxins in ruminants	1

18. Biochemical importance of different feed additives 1
19. Agonists and antagonists of minerals. 1
20. Agonists and antagonists of vitamins. 1
21. Nutrient control of gene expression 1
22. Clinical issues of micro mineral metabolism. 1
23. Nutrients (minerals) that resist digestion process in animals.1
24. Energy releasing and hematopoietic water soluble vitamins.1
25. Industrial biochemistry- applications of biological molecules for medical, industrial, environmental, agricultural or analytical purposes. 1
26. Generation of gene-mediated industrial/ medical products. 1
27. Introduction and application of fermentation technology for ethanol and biogas production. 1
28. Introduction to industrial microorganisms and products, growth and product formation in biocatalysis. 1
29. Conversion of sunlight into biomass (bioreactors and bio-photolysis) 1
30. Significance of pharmaceuticals products of animal origin, sex hormones, oestrogens, progesterone, corticosteroids. 1
31. Significance of pharmaceuticals of plant origin, Alkaloids, atropine, morphine, cocaine, ergot alkaloids, flavonoids, xanthenes and terpenoids; 1
32. Physical, chemical and biological treatment of waste water, bioremediation of contaminated soils. 1

Total 32

I. **Course Title : Endocrinology and Reproductive Biochemistry**

II. **Course Code : BCT 609**

III. **Credit Hours : 2 + 0**

IV. **Aim of the course**

To impart knowledge on the role of hormones in signalling and their biochemical role in reproduction of animals.

V. **Theory**

Unit I

Endocrinology - Classification, secretion, transport and regulation of hormones - Mechanism of hormone action and intracellular signalling after receptor activation

- Releasing factors from hypothalamus and their effects on pituitary gland and metabolism - Synthesis, secretion, regulation, metabolic functions and physio- pathology of Hormones from Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal and Pineal Glands.

Unit II

Endocrinology of Gonads and Reproductive Biochemistry - Female

hormonal system Synthesis, secretion, regulation, functions, and physio-pathology of ovarian hormones and male sex hormones - Prostaglandins: chemistry, functions and clinical importance - Endocrine aspects of reproduction status in domestic animals - Endocrine aspects of reproduction in poultry - Hormones involved in the development of ductal and lobule-alveolar system of mammary gland - Endocrine control of biosynthesis of milk.

VI. Suggested Reading

- *Dukes' Physiology of Domestic Animals*, 13th edition/ editor, William O Reece, Wiley Blackwell.
- Guyton and Hall *Textbook of Medical Physiology*, 13th edition/ editor, John E Hall, Elsevier.
- *Applied Animal Endocrinology*, E. James Squires, CABI
- *Endocrinology: An Integrated Approach*, by SS Nussey, SA Whitehead, 1st edition, CRC Press.
- *Biochemistry of Lactation*, TB Mepham, Elsevier

Course Outline

S. No.	Topics	No. of Lectures

Theory

1. Classification, secretion, transport and regulation of hormones. 2
2. Mechanism of hormone action and intracellular signalling after receptor activation. 2
3. Releasing factors from hypothalamus and their effects on pituitary gland and metabolism. 2
4. Hormones from Pituitary, secretion, regulation, metabolic functions and physio-pathology. 2
5. Synthesis, secretion, regulation, metabolic functions and physio-pathology of Thyroid hormones. 1
6. Parathyroid gland, its hormone and effect on calcium and phosphate concentrations in the extracellular fluid 2
7. Endocrine Pancreas: Hormone synthesis, secretion, regulation, metabolic functions and physio-pathology. 2
8. Endocrine Adrenal: Hormone synthesis, secretion, regulation, metabolic functions and physio-pathology. 2
9. The Pineal Gland and Melatonin secretion, regulation and function. 1
10. Female hormonal system - Effect on ovaries - Synthesis, secretion, regulation, functions, and physio-pathology of ovarian hormones. 2
11. Synthesis, secretion, regulation, metabolic functions and physio-pathology of male sex hormones. 2

12. Prostaglandins: Chemistry, Functions and Clinical Importance 2
13. Hormones concerned with animal production. 2
14. Endocrine aspects in reproduction status in domestic animals 2
15. Hormones concerned with poultry production. 2
16. Endocrine aspects of reproduction in poultry 2
17. Hormones involved in development of Ductal and Lobule-Alveolar System of mammary gland - Endocrine control of milk secretion and its biosynthesis 2

Total 32

I. **Course Title : Biochemistry of Ruminants and Wild Animals**

II. **Course Code : BCT 610**

III. **Credit Hours : 1 + 1**

IV. **Aim of the course**

To acquaint the students about comparative metabolism in ruminant species and the common metabolic disorders in ruminants; to impart a basic knowledge about biochemistry of wild animals.

V. **Theory**

Unit I

Biochemistry of Ruminants - An overview of metabolism of carbohydrates, proteins and lipids in ruminants-Metabolism of nutrients by rumen microflora - Blood biochemistry of ruminants - Disorders associated with carbohydrates, proteins and lipid metabolism in ruminants - Liver and Kidney function tests - Diseases associated with major and trace elements in ruminants.

Unit II

Biochemistry of Wild Animals-Blood biochemistry and blood typing of wild animals

- Fluid balance and electrolyte maintenance in wild animals - Biomarkers for assessment of diseases in wild animals - Diabetes mellitus in primates - Neurological diseases in cheetah

VI. **Practical**

Methods of examining fluids and tissue in wild animals, Pancreatic function test, Estimation of Serum amylase, Estimation of Serum Bilirubin, Estimation of serum Inorganic Phosphate, Estimation of serum Calcium, Estimation of serum Magnesium, Estimation of Vitamin A, Estimation of serum LDH, Estimation of rumen volatile fatty acids, Estimation of rumen lactic acid, Estimation of Cellulolytic activity, Estimation of milk ketone bodies (acetone) by microdiffusion method, Estimation of milk lactose

VII. **Suggested reading**

- Dvorak AM and Harris W. 1991. *Blood Cell Biochemistry*. 2nd

Ed. Plenum.

- *Clinical Biochemistry of Domestic Animals*, 6th Edition/ Editors: Jiro Kaneko John Harvey Michael Bruss, Elsevier.
- *Lipid Metabolism in Ruminant Animals*, 1st Edition/ Editors: William W Christie, Elsevier.
- *Digestive Physiology and Metabolism in Ruminants*, Editors: Ruckebusch Y, Thivend.
- *Energy Nutrition in Ruminants*, Editors: Orskov ER.
- *Zoo and Wild Animal Medicine (Current Therapy 3) by Murray E Fowler, 5th edition.*
- *Textbook of Veterinary Biochemistry*, by RS Dhanotiya, JAYPEE.

Course Outline

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Comparative metabolism of carbohydrates, proteins and lipids in ruminants	2
2.	Metabolism of nutrients by rumen microflora	1
3.	Blood biochemistry of ruminants	1
4.	Disorders associated with carbohydrate, protein and lipid metabolism	2
5.	Liver dysfunction and tests	1
6.	Kidney dysfunction and tests	1
7.	Diseases associated with major and trace elements	2
8.	Blood biochemistry and blood typing of wild animals	1
9.	Fluid balance and electrolyte maintenance in wild animals	2
10.	Biomarkers for assessment of diseases in wild animals	1
11.	Diabetes in primates	1
12.	Neurological diseases in cheetah	1
	Total	16
Practical		
1.	Methods of examining fluids and tissue in wild animals	1
2.	Pancreatic function test	1
3.	Estimation of Serum amylase	1
4.	Estimation of Serum Bilirubin	1
5.	Estimation of serum Inorganic Phosphate	1
6.	Estimation of serum Calcium	1
7.	Estimation of serum Magnesium	1
8.	Estimation of Vitamin A	1
9.	Estimation of serum LDH	1
10.	Estimation of rumen volatile fatty acids	1
11.	Estimation of rumen lactic acid	1
12.	Estimation of Cellulolytic activity	1
13.	Estimation of milk ketone bodies (acetone) by microdiffusion	

	method	1
14.	Estimation of milk lactose	1
	Total	14

I. **Course Title : Introduction to Bioinformatics and Computational Biology**

II. **Course Code : BCT 611**

III. **Credit Hours : 1 + 1**

IV. **Aim of the course**

To impart an introductory knowledge of Bioinformatics and Computational biology to postgraduate students studying any discipline of veterinary/ agricultural science.

V. **Theory**

Unit I

Introduction to bioinformatics, scope and applications of bioinformatics; biological databases: primary, secondary and structural; basic concept of Protein and Gene Information Resources-PIR, SWISS-PROT, PDB, GenBank, DDBJ; Basic concept of computational biology, applications in different subfields of biology, software tools.

Unit II

Basic concept of sequence search algorithm and alignment tools: BLAST and FASTA; DNA and protein sequence analysis, local and global alignment; Algorithms: Dot Matrix method, dynamic programming methods; Pairwise and multiple sequence alignment and its application; Tools of Multiple sequence alignment: ClustalW.

Unit III

Basic concept of Phylogeny study; cDNA libraries and EST, EST analysis; database search engines: introduction and application; Commercial databases and software packages, GPL software for Bioinformatics.

Unit IV

Computer aided drug design: basic principles, docking; QSAR, 2DQSAR, 3DQSAR, their basic concept and applications, machine learning tools for QSAR.

VI. **Practical**

- Basic computing: Introduction to LINUX and Windows
- Nucleotide information resource: EMBL, GenBank, DDBJ
- Protein information resource: SwissProt, TrEMBL, Uniprot
- Structure databases: PDB, MMDB
- Search Engines: Entrez, ARSA, SRS
- Usage of NCBI resources
- Retrieval of sequence/ structure from databases

- Database searching
- Visualization of structures of DNA and Proteins using Rasmol
- Sequence similarity search using BLAST
- Multiple sequence alignment
- Primer designing

VII. Suggested Reading

- *Introduction to Bioinformatics* 2003. Attwood TK and Parry-Smith DJ, Pearson Education.
- *Essential bioinformatics* 2006. Xin Xiong. Cambridge University Press.
- *Bioinformatics: Concepts, Skills and Applications* 2004. Rastogi SC, Mendiratta N and Rastogi P. CBS.
- *Principles of Genome Analysis and Genomics* 2003. SB Primrose and RM Twyman, Blackwell Publishing.
- *Molecular Analysis and Genome Discovery* 2004. Ralph Rapley and Stuart Harbron (Eds.), John Wiley and Sons.
- *BioInformatics* 2001. Andreas D Baxevanis and BF Francis Ouellette (Eds.)
- *Wiley Interscience Proteins and Proteomics* 2003. Richard J. Simpson, Cold Spring Harbor Laboratory.

Course Outline

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Introduction to bioinformatics - Scope and applications of bioinformatics	1
2.	Introduction to biological databases: primary, secondary and structural databases	1
3.	Basic concept of Protein and Gene Information Resources-PIR, SWISS-PROT, PDB, GenBank, DDBJ	1
4.	Basic concept of computational biology, applications in different subfields of biology	1
5.	Basic concept of sequence search algorithm and alignment tools: BLAST and FASTA; DNA and protein sequence analysis, local and global alignment	1
6.	Dot Matrix method, dynamic programming methods	1
7.	Pairwise and multiple sequence alignment and its application	1
8.	Tools of Multiple sequence alignment: ClustalW	1
9.	Basic concept of Phylogeny study	1
10.	cDNA libraries and EST, EST analysis	1
11.	Database search engines-introduction and application	1
12.	Commercial databases and software packages, GPL software	

for Bioinformatics	1
13. Computer aided drug design-basic principles	1
14. Introduction of Molecular docking and QSAR	1
15. 2DQSAR, 3DQSAR, their basic concept and applications	1
16. Machine learning tools for QSAR	1
Total	16

Practical

1. Basic concept of computer hardware and software, computer operating systems: Linux and windows	2
2. Nucleotide information resource: EMBL, GenBank, DDBJ	1
3. Protein information resource: SwissProt, TrEMBL, Uniprot	1
4. Structure databases: PDB, MMDB	1
5. Basic concept of molecular search Engines: Entrez, ARSA, SRS	1
6. Usage of NCBI resources	2
7. Retrieval of sequence/ structure from databases	1
8. Database searching	1
9. Visualization of structures of DNA and Proteins using Rasmol	1
10. Sequence similarity search using BLAST	1
11. Multiple sequence alignment tools: ClustalW, Bioedit, etc.	2
12. Phylogeny study using different software tools	1
13. Primer designing using different software tools	1
Total	16

Course Contents
Ph.D. in Veterinary Biochemistry

I. **Course Title : Applied Molecular Biochemistry and Systems Biology**

II. **Course Code : BCT 701**

III. **Credit Hours : 2 + 1**

IV. **Pre-requisite**

Should have studied BCT-607: Molecular Biochemistry (2+1) or other equivalent courses with similar syllabi/ content at Master's level.

V. **Aim of the course**

To impart latest information on the molecular biochemistry of isolation, transfer and expression of genes and biochemical approaches employed in gene therapy and computational approaches to biology/ synthetic biology.

VI. **Theory**

Unit I

Organization of prokaryotic genome, nuclear and organelle genes, concept of genome mapping and Organization, Molecular evolution, Prokaryotic and Eukaryotic gene regulation, RNA editing.

Unit II

Comparative genomics, functional genomics, transcriptomics and transcriptional network, Application of genomics, Livestock genomics, Buffalo Genome Inititative, Dog genome projects, Role of genomics in Wild life conservation and Reconstruction of species, Bioethics and biosafety guidelines and IPR in recombinant DNA research.

Unit III

Transgenics, Gene Knock–out technology, Site specific nucleases, Zinc–Fingers, TALENS and CRISPR–Cas 9, Applications of Gene knock out, Development of Knock-out Animal models, Gene silencing, Antisense oligos, Ribozymes, RNAi, 3'UTR and miRNA, Applications of gene silencing, Site directed mutagenesis, gene targeting and gene therapy.

Unit IV

Nucleic acid sequencing: Various methods of sequencing including automated sequencing and Microarrays, Whole Genome Sequencing, epigenetic regulation, Protein sequencing, Peptide synthesis, Peptide arrays, protein engineering, Directed evolution of proteins.

Unit V

Mathematical modelling, Static Network models, Mathematics of Biological systems, Parameter estimation, Gene systems, Gene regulation models, Protein systems, Metabolic systems, Signalling systems, Population systems, Physiological modelling, Systems biology in Medicine and Drug development, Basic design of biological systems, Introduction to nutrigenomics and pharmacogenomics, Applications in Veterinary Science.

VII. Practical

DNA methylation protocols, Genome Editing protocols, *in-vitro* Site Directed Mutagenesis, Gene silencing protocols, Next Generation sequencing platforms, Quantitative PCR, SAGE, Massively Parallel Signature Sequencing (MPSS), Oligonucleotide synthesis and quality control, Cap Analysis of Gene Expression (CAGE)/ deep CAGE, Chip-Chip assay Proteomics - 2D-PAGE, MSMS, MALDI- TOF, and Protein-protein interaction (Hybrid assay, DNA-Protein interaction and gene regulation (EMSA and Chip assay), DNA Microarrays, Protein sequencing protocols.

VIII. Suggested Reading

- *Molecular Biology of the Gene*, 7th Ed. JD Watson *et al*., Pearson Education, 2017
- *Lewin's Genes XII*, Jocelyn E Krebs *et al*., Jones and Bartlett Publishers Inc., 2017
- *A First Course in Systems Biology*, 2nd Edition, Eberhard. OVoit, Garland Science publishers 2017
- *Directed Enzyme Evolution: Advances and Applications*, Ed. Miguel Alcalde, Springer International Publishing, 2017
- *Genome Editing in Animals: Methods and Protocols*, Ed. Izuho Hatada, Springer Protocols, 2017
- *Genome Editing and Engineering*: From TALENs, ZFNs and CRISPRs to Molecular Surgery, Ed. Krishnarao Appasani, Cambridge University Press, 2018
- *Molecular Cell Biology*, 8th Ed, Lodish *et al*., WH Freeman and Co., 2016
- *Nutrigenomics*, Eds. Carsten Carlberg, Stine Marie Ulven and Ferdinand Molnar, Springer Intl. Pub, 2016
- *CRISPR: Methods and Protocols*, Eds. Magnus Lundgren, Emmanuelle Charpentier, Peter C Fineran, Humana Press, 2015
- *Genome Analysis: Current Procedures and Applications*, Ed Maria S Poptsava, Caister Academic Press, 2014
- *Transgenic Animal Technology: A laboratory handbook*, 3rd

Edition, Ed. Carl A Pinkert, Academic Press, 2014
- *Molecular Biology of the Cell*, 6th Ed. Bruce Alberts *et al*, WW Norton and Company, 2014
- *Bovine Genomics*, Ed. James E Womack, Wiley Blackwell, 2012
- *The Genetics of the Dog*, Eds. Elaine A Ostrander and Anatoly Ruvinsky, CABI press, 2012
- *An Introduction to Systems Biology*. Ed. Sangdun Choi, Humana Press, 2010
- *Genome Mapping and Genomics in Domestic Animals*, Eds. Noelle E Cockett, Chittaranjan Kole, Springer Verlag, 2009.
- *Gene Knockout protocols*, Eds. Ralf Kuhn, Wolfgang Wurst, 2009, Springer
- *Molecular Biology*, 4th Ed, Robert F. Weaver, McGraw Hill Higher Education, 2007
- *Comparative Genomics*, Ed. Nicholas H Bergman, Humana press, 2007
- *Molecular Biology and Genomics*, Cornel Mulhardt, Academic Press, 2007
- *The Dog and Its Genome*, Eds. Elaine A. Ostrander, Urs Giger, Kerstin Lindblad-Toh, CSHL press, 2006
- *Life: An Introduction to Complex Systems Biology*, Springer, 2006
- *An Introduction to Systems Biology: Design principles of Biological circuits*, Uri Alon, 2006, Chapman and Hall/ CRC
- *Directed molecular Evolution of Proteins: or How to improve Enzymes for Biocatalysis*, Eds. Susanne Brakmann, Kai Johnsson, Wiley VCH Verlag GmbH, 2003
- *Directed Evolution Library Creation*, Eds. Frances H Arnold, George Georgiou, Humana Press, 2003.
- Selected articles from journals.

Course Outline

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Organization of prokaryotic genome	1
2.	Nuclear and organelle genes.	1
3.	Concept of genome mapping and Organization	1
4.	Molecular evolution	1
5.	Prokaryotic and Eukaryotic gene regulation	1
6.	RNA editing	1
7.	Comparative genomics	1
8.	Functional genomics	1

9. Transcriptomics and transcriptional network 1
10. Application of genomics, Livestock genomics, Buffalo Genome Initiative, Dog genome projects, Role of genomics in Wild life conservation and Reconstruction of species 1
11. Bioethics and biosafety guidelines and IPR in recombinant DNA research 1
12. Transgenics, Gene Knock-out technology. 1
13. Site specific nucleases, Zinc-Fingers, TALENS and CRISPR – Cas 9, 1
14. Applications of Gene knock out, Development of Knock-out Animal models 1
15. Gene silencing, Applications of gene silencing 1
16. Antisense oligos, Ribozymes 1
17. RNAi, 3'UTR and miRNA, Site directed mutagenesis 1
18. gene targeting and gene therapy 1
19. Nucleic acid sequencing: Various methods of sequencing Including automated sequencing and Microarrays 1
20. Whole Genome Sequencing, epigenetic regulation 1
21. Protein sequencing, Peptide synthesis 1
22. Peptide arrays 1
23. Protein engineering 1
24. Directed evolution of proteins 1
25. Mathematical modelling, Static Network models 1
26. Mathematics of Biological systems, Parameter estimation 1
27. Gene systems, Gene regulation models 1
28. Protein systems, Metabolic systems 1
29. Signalling systems, Population systems 1
30. Physiological modelling 1
31. Systems biology in Medicine and Drug development 1
32. Basic design of biological systems 1
33. Introduction to Nutrigenomics - Applications in Veterinary Science 1
34. Pharmacogenomics - Applications in Veterinary Science 1

Total 34

Practical

1. DNA methylation protocols 2
2. Genome Editing protocols, *In-vitro* Site Directed Mutagenesis 2
3. Gene silencing protocols 2
4. Next Generation sequencing platforms 1
5. Quantitative PCR, SAGE, Massively Parallel Signature Sequencing (MPSS) 1
6. Oligonucleotide synthesis and quality control 2

7. Cap Analysis of Gene Expression (CAGE)/ deep CAGE 2
8. Chip-Chip assay Proteomics 1
9. 2D-PAGE, MSMS, MALDI-TOF 2
10. Protein-protein interaction (Hybrid assay, DNA-Protein interaction and gene regulation (EMSA and Chip assay), DNA Microarrays,
Protein sequencing protocols 2
Total 17

I. **Course Title : Membrane Biochemistry**
II. **Course Code : BCT 702**
III. **Credit Hours : 2 + 0**
IV. **Pre-requisite**

Should have studied BCT -602: Biochemistry of Biomolecules (3+0) or other equivalent courses with similar syllabi/ content at Master's level.

V. **Aim of the course**

To teach structure and functions of biomembranes, structure-function relationships, membrane biogenesis.

VI. **Theory**

Unit I

Concept of biomembranes and their classification based on cellular organelles; physico-chemical properties of different biological and artificial membranes, Membrane biogenesis and differentiation, Trafficking of Membrane Components - lipids, carbohydrates and proteins, cell surface receptors and antigen.

Unit II

Distribution and organization of membrane components-lipids; proteins- intrinsic and extrinsic: their arrangement; carbohydrates in membranes and their function. Cell membrane structure and the Fluid-mosaic model. Restoration and maintenance of cell membrane integrity and permeability. Methods for analysis of plasma membrane integrity. Separation of different membrane components.

Unit III

Molecular basis of biochemical behaviours of membranes, Various membrane movements; transport across membrane-Active transport, passive transport, diffusion, osmosis, exocytosis and endocytosis, Fick's law of diffusion and its physiological importance, energy transduction.

Unit IV

Role of membrane in cellular metabolism, cell recognition and cell –to –cell interaction; signal transduction, Molecular mechanisms,

ion translocating antibiotics, valinomycin, gramicidin, ouabain, group translocation, ionophores, electrical gradient, energy coupling mechanism, recent trends and tools in membrane research.

VII. Suggested Reading

- Alberts B, Johnson A, Lewis J, Raff M, Roberts HK and Walter P. *Molecular Biology of the Cell. Garland Science*, Taylor and Fransis Group.
- Cooper GM and Hausam RE. 2015. *The Cell: A Molecular Approach*. Oxford University Press. ISBN: 9781605352909
- Lodish H, Berk A, Zipursky SA, Matsudaira P, Baltimore D and Darnel J. 1999. *Molecular Cell Biology*. WH Freeman.
- Nelson DL and Cox MM. 2000. *Lehninger Principles of Biochemistry.* 3rd Ed. Replika Press Pvt. Ltd., New Delhi for Worth Publ., New York.
- Selected articles from journals.

Course Outline

S. No.	Topics	No. of Lectures
Theory		
1.	Concepts of bio membranes and their classification based on cellular organelles	2
2.	Physico-chemical properties of different biological and artificial membranes	1
3.	Membrane biogenesis and differentiation	2
4.	Trafficking of Membrane Components - lipids, carbohydrates and proteins	2
5.	Cell surface receptors and antigen	1
6.	Distribution and organization of membrane components-lipids; proteins, intrinsic and extrinsic: their arrangement	2
7.	Cell membrane structure and the Fluid-mosaic model	1
8.	Restoration and maintenance of cell membrane integrity and permeability	1
9.	Methods for analysis of plasma membrane integrity.	2
10.	Separation of different membrane components.	1
11.	Molecular basis of biochemical behaviours of membranes	2
12.	Various membrane movements	1
13.	Transport across membrane-Active transport, passive transport, diffusion, osmosis, exocytosis and endocytosis	2
14.	Fick's law of diffusion and its physiological importance	1
15.	Energy transduction	1
16.	Role of membrane in cellular metabolism	1

17. Role of membrane in cell recognition 1
18. Cell to cell interaction 2
19. Signal transduction 2
20. Molecular mechanisms, ion translocating antibiotics, valinomycin, gramicidin, ouabain, group translocation, ionophores, electrical gradient, energy coupling mechanism. 2
21. Recent trends and tools in membrane research 3

Total 33

I. **Course Title : Recent Trends in Enzymology**

II. **Course Code : BCT 703**

III. **Credit Hours : 2 + 1**

IV. **Pre-requisite**

Should have studied BCT-603: Enzymology (2+1) or other equivalent courses with similar syllabi/ content at Master's level.

V. **Aim of the course**

To teach current developments in actions of enzymes and their applications.

VI. **Theory**

Unit I

Enzyme: Structure, mechanism, and Regulation. Three dimensional structure of enzyme, flexibility and conformational mobility of enzymes, enzyme families, dehydrogenase and dinucleotide fold, Multienzyme complexes, features and mapping of active site of enzymes, methods of examining enzyme-substrate complexes, reaction mechanism of lysozyme, chymotrypsin, carboxypeptidase A and ribonuclease

A. Regulation of enzyme activity by zymogen activation, covalent modification and feed back inhibition. Allosteric enzyme with special reference to aspartate trans carbomylase. Concerted and sequential models of allosteric enzymes.

Unit II

Enzyme catalysis: general acid-base, covalent electrostatic and metal ion catalysis, orbital steering, principles of kinetic equivalence and kinetic isotopic effects, transition state theory-application and significance of enzyme catalysis. Hammond postulate

Enzyme kinetics and inhibition: factors influencing enzyme reaction velocity, steady- state kinetic of enzyme catalyzed reaction, significance of Michacelis-Menten parameters, Extension and modification of the Michaelis-Menten mechanism. K_{cat}/ K_m and kinetic perfection in enzyme catalysis, kinetics of multi-substrate system- random, sequential, ordered, Theorell-chance and the

ping-pong mechanisms. Competitive, non-compititive enzyme inhibition, suicide substrates and anti- metabolites.

Unit III

Recent developments: Industrial application of Enzymes, Enzyme immobilization methods and application. Restriction endonucleases, enzyme engineering, use of site-directed mutagenesis for detection of enzyme mechanisms, Abzymes and ribozymes, Enzyme linkering. Biosensors.

Unit IV

Diagnostic enzymology: Assay of enzymes in clinical cases, Enzymes in Pathogenesis, Enzyme histochemistry and cytochemistry, Application of microscopy in enzymology, Enzyme immuno diagnostics, Cholinesterase, lipase, amylase, GGT, GPx, arginase, AST, ALT and SDH in diagnosis of diseases of animals. Therapeutic Enzymes.

VII. Practical

- Estimation of Antioxidant Enzymes (Superoxide dismutase, Glutathione Peroxidase, Catalase, Glutathione S-transferase) from tissue samples.
- Isolation, purification and characterization of enzymes from biological samples.
- Application of enzymes in competitive bioassays (ELISA, RIA)
- Determination of Enzyme activity in Native Gel Electrophoresis.
- Estimation of Diagnostic enzymes from Clinical samples.
- Application of Restriction enzymes in cloning experiments.

VIII. Suggested Reading

- David L Nelson and Cox Michael M. 2008. *Lehninger's Principles of Biochemistry*. 5th Ed. Freeman.
- Kaneko JJ, Harvey JH and Bruss ML. 2008. *Clinical Biochemistry of Domestic Animals*. 6th Ed. Academic Press.
- Maragoni AG. 2003. *Enzyme Kinetics - A Modern Approach*. John Wiley.
- Palmer T. 2001. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry. 5th Ed. Horwood Publ.
- Price NC and Stevens L. 2003. *Fundamentals of Enzymology*. Oxford Univ. Press.
- Voet D, Voet JG and Pratt CW. 2006. *Fundamentals of Biochemistry of Life at the Molecular Level*. 2nd Ed. John Wiley and Sons.
- Wilson K and Walker J. (Eds.). 2000. *Principles and Techniques of Practical Biochemistry*. 5th Ed. Cambridge Univ. Press.

- Selected articles from standard journals.

Course Outline

S. No.	Topic	No. of Lectures/Practicals

Theory

1. Enzyme: Structure, mechanism, and regulation. 3
2. Three dimensional structure of enzyme, flexibility and Conformational mobility of enzymes 2
3. enzyme families, dehydrogenase and dinucleotide fold, Multienzyme complexes 1
4. Features and mapping of active site of enzymes, methods of examining enzyme-substrate complexes 2
5. reaction mechanism of lysozyme, chymotrypsin, carboxypeptidase A and ribonuclease A. 1
6. Regulation of enzyme activity by zymogen activation, covalent modification and feedback inhibition. 1
7. Allosteric enzyme with special reference to aspartate trans carbomylase. Concerted and sequential models of allosteric enzymes. 2
8. Enzyme catalysis: general acid-base, covalent electrostatic and metal ion catalysis, orbital steering. 2
9. Principles of kinetic equivalence and kinetic isotopic effects, transition state theory-application and significance of enzyme catalysis. Hammond postulate 2
10. Enzyme kinetics and inhibition: factors influencing enzyme reaction velocity, steady-state kinetic of enzyme catalyzed reaction, significance of Michacelis-Menten parameters 2
11. Extension and modification of the Michacelis-Menten mechanism. Kcat/ Km and kinetic perfection in enzyme catalysis 2
12. Kinetics of multi-substrate system-random, sequential, ordered Theorell-chance and the ping-pong mechanisms. 2
13. Competitive, non-compititive enzyme inhibition, suicide substrates and anti-metabolites. 1
14. Recent developments: Industrial application of Enzymes 1
15. Enzyme immobilization methods and application. 1
16. Restriction endonucleases 1
17. Enzyme engineering, use of site-directed mutagenesis for detection of enzyme mechanisms 1
18. Abzymes and ribozymes, Enzyme linkering. Biosensors. 1
19. Diagnostic enzymology: Assay of enzymes in clinical cases 1
20. Enzymes in Pathogenesis, Enzyme histochemistry and Cytochemistry 1

21. Application of microscopy in enzymology 1
22. Enzyme immuno diagnostics, Cholinesterase, lipase, amylase, GGT, GPx, arginase, AST, ALT and SDH in diagnosis of diseases of animals, Therapeutic Enzymes. 2

Total 33

Practical

1. Estimation of Antioxidant Enzymes (Superoxide dismutase, Glutathione Peroxidase, Catalase, Glutathione S transferase) from tissue samples 3
2. Isolation, purification and characterization of enzymes from biological samples. 4
3. Application of enzymes in competitive bioassays (ELISA, RIA) 2
4. Determination of Enzyme activity in Native Gel Electrophoresis. 2
5. Estimation of Diagnostic enzymes from Clinical samples. 2
6. Application of Restriction enzymes in cloning experiments.3

Total 16

I. **Course Title : Diagnostic Techniques in Clinical Biochemistry**

II. **Course Code : BCT 704**

III. **Credit Hours : 0 + 2**

IV. **Pre-requisite**

Should have studied BCT-605: Clinical Biochemistry of Animals (2+1) or other equivalent courses with similar syllabi/ content at Master's level.

V. **Aim of the course**

To give exposure about biochemical changes in diseases of animals and current developments of diagnostic techniques in clinical biochemistry.

VI. **Practical**

Unit I

Scope of diagnostic techniques in disease diagnosis. Fractionation of cell organelles. Molecular basis of cell injury and diseases; Molecular basis of autoimmunity, immunodeficiency, Immunochemical techniques: Immunochemical protein analysis: immunoelectrophoresis, tumour markers.

Unit II

Comparative ruminant metabolism, metabolism of various nutrients by micro flora. Postruminal digestion of dietary and microbial biomolecules. Metabolic disorders of rumen and recent development in disorders of ruminants associated with protein, carbohydrate, fat (LDL, HDL, VLDL, apoproteins, etc. and

triglycerides), mineral and electrolyte metabolism.

Unit III

Photometric methods: spectrophotometry (UV, visible) atomic reflectometry, turbidimetry, nephelometry, spectrofluorometry, atomic emission, etc. Spectrometric methods: AAS, mass spectrometry, nuclear magnetic resonance (NMR), infra-red (IR) spectroscopy.

Unit IV

Functional tests: Nucleic acid extraction, DNA finger printing, micro and mini satellites, PCR, RT-PCR, RFLP, Fluorescent In-situ hybridization (FISH), genome mapping, DNA microarrays, biomolecular prospecting and molecular designing in clinical biochemistry.

Unit V

Tests for cardiovascular diseases: Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin. Myocardial infarction and shock; enzyme patterns and marker proteins.

Unit VI

Diagnostic use of serum enzyme assays and radioactive isotopes. LFT, KFT and tests for drugs of abuse.

Unit VII

Case Based Learning and selected articles from journals pertaining to disease diagnosis.

VII. Suggested Reading

- Bishop ML, Fody EP and Schoeff LE. 2004. *Clinical Chemistry: Principles, Procedures, Correlations* 5th edition, Lippincott Williams and Wilkins Press
- Nelson DL and Cox MM. 2007. *Lehninger's Principles of Biochemistry*. 4th Ed. Freeman.
- Kaneko JJ, Harvey JH and Bruss ML. 2008. *Clinical Biochemistry of Domestic Animals*. 6th Ed. Academic Press.
- Voet D, Voet JG and Pratt CW. 2006. *Fundamentals of Biochemistry of Life at the Molecular Level*. 2nd Ed. John Wiley and Sons.
- Racek J and Rajdl D. 2016. *Clinical Biochemistry*. 1st Ed. Karolinum Press.

Course Outline

Sl. No.	Topics	No. of Practical

Practical

1. Scope of diagnostic techniques in disease diagnosis. Fractionation of cell organelles 2

2. Molecular basis of cell injury and diseases 1
3. Molecular basis of autoimmunity, immunodeficiency, Immunochemical techniques -Immunochemical protein analysis-immunoelectrophoresis, immunofixation and immunoassays 3
4. Oncogenesis and tumour markers 2
5. Comparative ruminant metabolism, metabolism of various Nutrients by micro flora 1
6. Postruminal digestion of dietary and microbial biomolecules.1
7. Metabolic disorders of rumen and recent development in disorders of ruminants associated with protein 1
8. Metabolic disorders of rumen and recent development in disorders of ruminants associated with carbohydrates 2
9. Metabolic disorders of rumen and recent development in disorders of ruminants associated with fat, mineral and electrolyte metabolism. 2
10. Photometric methods: spectrophotometry (UV, visible) atomic reflectometry, turbidimetry, nephelometry, spectrofluorimetry, atomic emission, etc. 1
11. Spectrometric methods: AAS, mass spectrometry, nuclear Magnetic resonance (NMR), infra-red (IR) spectroscopy. 1
    Functional tests: Nucleic acid extraction, DNA finger printing, micro and mini satellites 1
12. PCR, RT-PCR, RFLP, Fluorescent In-situ hybridization (FISH) 1
13. Genome mapping, DNA microarrays 1
14. Biomolecular prospecting and molecular designing in clinical biochemistry 1
15. Tests for cardiovascular diseases: Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin 2
16. Myocardial infarction and shock; enzyme patterns and marker proteins. 1
17. Diagnostic use of serum enzyme assays 1
18. Radioactive isotopes in radiodiagnosis 1
19. Liver function tests (LFT) 1
20. Liver function tests (KFT) 1
21. Tests for drugs of abuse 1
22. Case Based Learning and selected articles from journals pertaining to disease diagnosis 1
    Total 30

I. **Course Title : Recent Trends In Biochemical Techniques And Instrumentation**

II. **Course Code : BCT 705**

III. **Credit Hours : 2 + 1**

IV. **Pre-requisite**

Should have studied VBC-604: Analytical Techniques and Instrumentation in Biochemistry (2+1) or other equivalent courses with similar syllabi/ content at Master's level.

V. **Aim of the course**

To expose students about current developments in techniques used in animal biochemistry.

VI. **Theory**

Basic components of the Instrument, principle and applications of the following analytical techniques:

Unit I

Separation, purification and quantification of biomolecules:
Gas Chromatography (GC) and High performance liquid chromatography (HPLC)

- Types of pumping systems and their essential features; Column packing; Normal and modified stationary phases; Detection systems;

Blotting techniques (Western), 2-D gel electrophoresis – IPG-DALT, IEF-SDS PAGE

Unit II

Structural elucidation of biomolecules and quantification:
NMR spectrometry, X-ray crystallography, ESR Spectroscopy, CD Spectroscopy and Mass Spectrometry (LC/ MS, GC/ MS, MALDI-TOF, SELDI-TOF).

Microscopy – Electron microscopy – SEM/ TEM/ STEM; Atomic force microscopy (AFM) or scanning force microscopy (SFM); Scanning Tunnelling Microscope (STM).

Unit III

Other Analytical techniques: Radiotracer techniques:
Radiotracers in study of biological processes.

Tissue Culture: Setting up a cell culture laboratory; Principles of aseptic handling;, Cell line derivation; Cell freezing and quantitation; Contamination control; Cell freezing and thawing; Cell culture media constituents and their functions; Designing serum-free medium. Techniques for short-term and long-term culture of organs. Any other current technique with relevance to biochemistry.

VII. **Practical**

Demonstration of feasible techniques available at the

department/ institute/ other institutes.

VIII. Suggested Reading

- Burtis CA, Ashwood ER and Burns DE. 2014. *Tietz Textbook of clinical Biochemistry and Molecular Diagnostics.* 5th Edition. Elsevier
- Nelson DL and Cox MM. 2017. *Lehninger's Principles of Biochemistry*. 7th Ed. Freeman.
- Garrity S. 1999. *Experimental Biochemistry*. 3rd Ed. Academic Press.
- Gowenlock AH. 2002. *Varley's Practical Clinical Biochemistry*. 6th Ed. CBS.
- George W Latimer Jr. 2016. *Official Methods of Analysis of AOAC International*, 20th Ed. AOAC International.
- Holme DJ and Hazel P. 1998. *Analytical Biochemistry*. 3rd Ed. Longman.
- Wilson K and Walker J. (Eds.). 2010. *Principles and Techniques of Biochemistry and Molecular Biology*. 7th Ed. Cambridge Univ. Press.
- Willard *et al*. 1988. *Instrumental Methods of Analysis.* 7th Ed. Wadsworth Pub Co.
- Selected articles from standard journals.

Course Outline

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Gas Chromatography (GC) - Types of pumping systems and their essential features;S Column packing; Normal and modified stationary phases; Detection systems	4
2.	High performance liquid chromatography (HPLC) - Types of pumping systems and their essential features; Column packing; Normal and modified stationary phases; Detection systems	4
3.	Western blotting of proteins	1
4.	2-D gel electrophoresis of proteins – IPG-DALT, IEF-SDS PAGE	1
5.	NMR spectrometry	2
6.	X-ray crystallography	2
7.	ESR Spectroscopy	2
8.	CD Spectroscopy	2
9.	Mass Spectrometry (LC/ MS, GC/ MS, MALDI-TOF, SELDI-TOF)	3
10.	Electron microscopy – SEM/ TEM/ STEM	3

11.	Atomic force microscopy (AFM)	1
12.	Scanning Tunneling Microscopy (STM)	1
13.	Radiotracers in study of biological processes	2
14.	Tissue Culture: Setting up a cell culture laboratory; Principles of aseptic handling;, Cell line derivation; Cell freezing and quantitation; Contamination control; Cell freezing and thawing; Cell culture mediaconstituents and their functions; Designing serum-free medium. Techniques for short-term and long-term culture of organs, etc.	3
15.	Any other current technique	1
	Total	32

Practical

1.	Gas Chromatography (GC)	1
2.	High performance liquid chromatography (HPLC)	1
3.	Western blotting of proteins	1
4.	2-D gel electrophoresis of proteins	1
5.	NMR spectrometry	1
6.	X-ray crystallography	1
7.	ESR Spectroscopy	1
8.	CD Spectroscopy	1
9.	Mass Spectrometry (LC/ MS, GC/ MS, MALDI-TOF, SELDI-TOF).	1
10.	Electron microscopy – SEM/ TEM/ STEM	1
11.	Atomic force microscopy (AFM)	1
12.	Scanning Tunneling Microscopy (STM)	1
13.	Radiotracers	1
14-16.	Tissue Culture	3
	Total	16

I. **Course Title : Developmental Biochemistry**

II. **Course Code : BCT 706**

III. **Credit Hours : 2 + 0**

IV. **Pre-requisite**

Should have studied VBC-609: Endocrinology and Reproductive Biochemistry or other equivalent courses with similar syllabi/ content at Master's level.

V. **Aim of the course**

To understand the developmental processes in embryogenesis and its gene expression.

VI. **Theory**

Unit I

Biochemistry of fertilization - Sperm-egg structure - Acrosome reaction and capacitation, Sperm-egg interaction –receptors

involved; sperm entry into egg; zygote formation. Formation of multicellular and multi-layered embryo: factors affecting cleavage of zygote; Types of cleavage; blastula formation; gastrulation; neurulation; somite formation and cell migration; factors affecting cell migration; cell-cell interactions and their expression; involvement of extracellular matrix during development(cell movement and regulation of shape); growth factors and their role; organogenesis-biochemistry and molecular biology. Application of "OMICS" techniques in developmental biology.

Unit II

Development and differentiation: Genes involved in the development of Drosophilla and C. elegans and their regulation. Expression of genes during differentiation of anterior and posterior and dorsal and ventral halves, head; thorax and abdomen. Pattern formation and positional information: Inductive interaction in the development of epithelia and body parts.

VII. Suggested Reading

- Scott F Gilbert. 2010. *Developmental Biology*, 9th edition. Sunderland (MA): Sinauer Associates.
- Scott Freeman 2014. *Biological Science*, 5th edition. Publisher: Benjamin-Cummings Publishing Co.
- Selected articles from standard journals.

Course Outline

S. No.	Title	No. of Lectures
Theory		
1.	Biochemistry of fertilization.	1
2.	Sperm-egg structure. Acrosome reaction and capacitation	3
3.	Sperm-egg interaction –receptors involved; sperm entry into egg; zygote formation.	3
4.	Formation of multicellular and multi-layered embryo: factors Affecting cleavage of zygote; Types of cleavage	3
5.	Blastula formation; gasrulation; neurulation; somite formation and cell migration; factors affecting cell migration; cell-cell interactions and their expression; involvement of extracellular matrix during development(cell movement and regulation of shape); growth factors and their role;	5
6.	Organogenesis-biochemistry and molecular biology.	3
7.	Application of "OMICS" techniques in developmental biology.	3
8.	Development and differentiation: Genes involved in the Development of Drosophilla and C. elegans and their regulation	4
9.	Expression of genes during differentiation of anterior and	

Posterior and dorsal and ventral halves, head; thorax and abdomen. 4

10. Pattern formation and positional information: Inductive Interaction in the development of epithelia and body parts. 3

Total 32

I. **Course Title : Bioinformatics Tools in Biochemistry**

II. **Course Code : BCT 707**

III. **Credit Hours : 1 + 1**

IV. **Pre-requisite**

Should have studied VBC-611: Introduction to Bioinformatics and Computational Biology or other equivalent courses with similar syllabi/ content at Master's level.

V. **Aim of the course**

To impart knowledge of Bioinformatics applicable to biochemistry

VI. **Theory**

Unit I

Biological databases, nucleic acid and protein sequence databases; Pair wise sequence alignment; global and local alignments, matrices, gap penalties; Multiple sequence alignment and phylogenetic analysis-methods and programs

Unit II

Genome sequencing using next generation sequencing (NGS) technologies, sequence assembly and comparison, human genome, livestock, bacterial and viral genomes, Computational gene discovery; Gene and promoter prediction; Microarray technology: basic concept and application

Unit III

Protein structure- secondary and tertiary structure prediction; Homology and ab- initio based tertiary structure prediction; Structure validation tools, Ramachandran Map; protein motifs and domain prediction; RNA folding and secondary structure predictions

Unit IV

Metabolomics: concepts and principles; Nutrigenomics: bioinformatics in nutrition and health; Pharmacogenomics: introduction, applications, current and future perspectives

VII. **Practical**

- Practical application of NCBI resources
- Web based tools: Expasy, SwissProt, EBI
- Perform local alignment using different BLAST variants
- Multiple sequence alignment using ClustalW, T Coffee
- Analysis packages-commercial databases and packages,

GPL software for Bioinformatics

- Database searching
- Phylogenetic analysis by PHYLIP and MEGA tools
- Protein structure visualization tools: RASMOL, SWISSPDB viewer,
- Homology modelling and structure validation of protein structures
- Tools for protein secondary and tertiary structure prediction- SANJIVNI, BHAGIRATH, SWISS Model, MODELLER, ROSETTA, I-TASSER, etc.
- Biomolecule chemical structure creation and modification using ChemSketch

VIII. Suggested Reading

- *Essential bioinformatics* 2006. Xin Xiong. Cambridge University Press
- *Discovering Genomics, Proteomics and Bioinformatics* 2007. A. Malcolm Campbell and Laurie J Heyer. Benjamin Cummings.
- *Proteins: Structures and Molecular Properties* 1993. Creighton TE. W.H. Freeman.
- *Bioinformatics: Sequence and Genome Analysis* 2001. Mount DW. Cold Spring Harbor.
- *Introduction to Computational Molecular Biology* 1997. Setubal Joao and Meidanis Joao. PWS Publishing Company.
- *Bioinformatics: Concepts, Skills and Applications* 2004. Rastogi SC, Mendiratta N and Rastogi P. CBS.
- *Principles of Genome Analysis and Genomics* 2003. SB. Primrose and R.M. Twyman, Blackwell Publishing.
- *Molecular Analysis and Genome Discovery* 2004. Ralph Rapley and Stuart Harbron (Eds.), John Wiley and Sons.
- *BioInformatics* 2001. Andreas D. Baxevanis and B. F. Francis Ouellette (Eds.).
- Online Resources available on Internet and Selected articles from standard journals.

Course Outline

S. No.	Topic	No. of Lectures/ Practicals

Theory

1. Biological databases: nucleic acid and protein sequence databases 1
2. Pair wise sequence alignment, global and local alignments, matrices, gap penalties 1
3. Multiple sequence alignment: methods and programs 1
4. Phylogenetic analysis: methods and applications 1

5. Genome sequencing technologies-traditional and next generation sequencing (NGS) 1
6. Assembly and comparison of genome: Human genome, livestock and bacterial genomes 1
7. Computational gene discovery, Gene and promoter prediction 1
8. Microarray technology: basic concept and application 1
9. Protein structure- secondary and tertiary structure prediction 1
10. Homology and ab-initio based tertiary structure prediction 1
11. Protein structure validation tools, Ramachandran Map 1
12. Protein motifs and domain prediction 1
13. RNA folding and secondary structure predictions 1
14. Metabolomics: concepts and principles 1
15. Nutrigenomics: bioinformatics in nutrition and health 1
16. Pharmacogenomics: introduction, applications, current and future perspectives 1

Total 16

Practical

1. Practical application of NCBI resources 3
2. Web based tools: Expasy, SwissProt, EBI 1
3. Local alignment using different BLAST variants 2
4. Multiple sequence alignment using ClustalW, T Coffee 1
5. Commercial bioinformatics databases and packages, GPL Software for Bioinformatics 2
6. Database searching 1
7. Phylogenetic analysis by PHYLIP and MEGA tools 1
8. Protein structure visualization tools: RASMOL, SWISSPDB viewer, UCSF ChimeraX 1
9. Homology modelling and structure validation of protein structures 1
10. Practice on tools for protein secondary and tertiary structure prediction: SANJIVNI, BHAGIRATH, SWISS Model, MODELLER, ROSETTA, I-TASSER, etc. 2
11. Biomolecule chemical structure creation and modification using ChemSketch 1

Total 16

I. **Course Title : Environmental and Toxicological Biochemistry**
II. **Course Code : BCT 708**
III. **Credit Hours : 2 + 0**
IV. **Aim of the course**

To impart awareness on environmental pollutants and toxicants affecting livestock and poultry; Clinical Biochemistry in Toxicology.

V. **Theory**

Unit I

Introduction to environmental pollutants and toxicants, their classification, sources and impact on animal health including poultry. Effect of various pollutants on animal and microbial metabolism; their detoxification mechanism in animals and birds, Biochemical basis of pollutant tolerance. Soil enzymes, their source and role in environment, methods for measurement of pollution, Pesticide residues and its effect on animal health. environmental chemo-dynamics. Heavy metals and metalloids, industrial chemicals and biotoxins on animal health and productivity.

Unit II

Water pollution, biochemical basis for measuring water pollution, chemical properties of water-physical, chemical and biological treatment process. Biochemical oxygen demand and water quality assessment. Biochemical aspects of water quality.

Unit III

Global environmental issues in the light of biochemistry, methanogenesis and role of ruminants, global warming, green house gases, acid rain and their effects on animal health and productivity.

Unit IV

Distribution and storage of toxicants in animal body, target organ toxicity, biotransformation and elimination of toxicants, methods for measurement of toxin level in animals.

Unit V

Clinical Biochemistry in Toxicology- Hepatotoxicity and biochemical changes due to hepatotoxicity, Nephrotoxicity and its effect, Effects of toxins on lungs, respiratory tract, endocrine system, nervous system, erythrocyte and haematopoietic system. Toxins affecting haemoglobin and oxidative metabolism.

VI. Suggested Reading

- Casarett, Louis J.; Doull, John. *Casarett and Doull's Toxicology: The Basic Science of Poisons* 8th ed.: New York: McGraw-Hill, 2013. ISBN:9780071769235
- Hayes AW, Kruger CL. *Hayes' principles and methods of toxicology* 6th ed. ISBN:9781842145364
- Kaneko JJ, Harvey JW and Bruss ML. *Clinical Biochemistry of Domestic Animals, Academic* press, ISBN 13:978-0-12-370491-7.
- Selected articles from journals.

Course Outline

S. No.	Topic	No. of Lectures
Theory		
1	Introduction to environmental pollutants and toxicants, their classification	2
2	Sources and impact of pollutants and toxicants on animal Health including poultry	2
3	Effect of various pollutants on animal and microbial metabolism	2
4	Detoxification mechanism in animals and birds	2
5	Biochemical basis of pollutant tolerance	1
6	Soil enzymes, their source and role in environment	1
7	Methods for measurement of pollution	1
8	Pesticide residues and its effect on animal health	1
9	Environmental chemo-dynamics	1
11	Heavy metals and metalloids, industrial chemicals and biotoxins on animal health and productivity.	2
12	Water pollution, biochemical basis for measuring water pollution	1
13	Chemical properties of water-physical, chemical and biological Treatment process	1
14	Biochemical oxygen demand and water quality assessment	1
15	Biochemical aspects of water quality	1
16	Distribution and storage of toxicants in animal body	1
17	Target organ toxicity	1
18	Introduction to environmental pollutants and toxicology	1
19	Biotransformation and elimination of toxicants	2
20	Methods for measurement of toxin level in animals	1
21	Clinical Biochemistry in Toxicology	1
22	Hepatotoxicity and biochemical changes due to hepatotoxicity	1
23	Nephrotoxicity and its effect	1
24	Effects of toxins on lungs, respiratory tract, endocrine system, Nervous system, erythrocyte and haematopoietic system	2
25	Toxins affecting haemoglobin and oxidative metabolism.	2
	Total	32

I. **Course Title : Biochemistry of Diseases and Disorders**

II. **Course Code : BCT 709**

III. **Credit Hours : 2 + 0**

IV. **Pre-requisite**

Should have studied BCT-605:Clinical Biochemistry of Animals (2+1) or other equivalent courses with similar syllabi/ content at Master's level.

V. Aim of the course

To update general biochemical concepts for an understanding of biological and chemical principles underlying health, disease and disorders of animals and poultry.

VI. Theory

Unit I

Scope of biochemistry and its applications in understanding the development of diseases and their control.

Biochemical basis of Immunological diseases: Equine immuno-deficiency, neutrophil function defects and its testing, Autoimmune Diseases, Primary Immune Deficiency Diseases, Secondary Immunodeficiency, Hypersensitivity Diseases.

Endocrine diseases arising from over or under production of hormones or from resistance to a particular hormone; Thyroid disorders; Pancreatic disorders; Cushings disease. Hemostatic diseases: Role of Vascular Endothelium, Platelets, Coagulation Proteins, Complexes, and Thrombin Activation; Fibrinolysis, Hereditary and Acquired disorders of hemostasis.

Unit II

Nutritional diseases arising from over or under-nutrition of fat and water soluble vitamins and minerals: Night blindness, pernicious anaemia, iron overload, metabolic disorders of iron metabolism, rickets, osteomalacia, milk fever, swayback, anaemia of Inflammatory disease. Toxic diseases: Hepatotoxicity, Nephrotoxicity; Toxins affecting: Skeletal and Cardiac muscle; Lung and Respiratory tract; Gastrointestinal tract; Erythrocytes, Haematopoietic system, Hemoglobin and oxidative metabolism; Endocrine system, Nervous system and neuromuscular disorders.

Unit III

Neoplastic diseases: Biochemical changes in development of various neoplasms, Deranged glucose metabolism in cancerous tissue, oncogenesis. Degenerative diseases: *Neurodegenerative diseases* – including amyotrophic lateral sclerosis, Parkinson's *disease*, Alzheimer's *disease*, and Huntington's *disease*. Molecular basis of cell injury and diseases by Free Radicals.

Unit IV

Biochemical basis of cardiomyopathies in dogs and birds, Prion disease (Scrapie), Bovine spongiform encephalopathy, Reticuloendotheliosis in poultry, Avian Influenza; Retinitis pigmentosa, retinal degeneration and Lysosomal storage diseases in animals. Comparative medical genetics: Genome sequences, Disease Gene Mapping, Genetic diseases, Gene

therapy

VII. Suggested Reading

- Charles A Janeway Jr, Paul Travers, Mark Walport and Mark J Shlomchik. 2001. *Immunobiology, The Immune System in Health and Disease*, 5th edition, New York.
- David L Nelson and Cox Michael M. 2017. *Lehninger's Principles of Biochemistry*. 7th Ed. Freeman.
- Kaneko JJ, Harvey JW and Bruss ML. *Clinical Biochemistry of Domestic Animals*, Academic press, ISBN 13:978-0-12-370491-7.
- Kenneth M Murphy and Casey Weaver 2016. *Janeway's Immunobiology*, 9th Edition ISBN: 978-0-815-34505-3.
- Thomas M. Devlin (Ed) 2011. *Textbook of Biochemistry with Clinical Correlations*, John Wiley and Sons.
- Voet D, Voet JG and Pratt CW. 2016. *Fundamentals of Biochemistry of Life at the Molecular Level*. 5th Ed. John Wiley and Sons.
- Selected articles from standard journals.

Course Outline

S. No. Topic No. of Lectures

Theory

1. Scope of biochemistry and its applications in understanding the development of diseases and their control 1
2. Biochemical basis of Immunological diseases: Equine immuno-deficiency, neutrophil function defects and its testing, Autoimmune Diseases, Primary Immune Deficiency Diseases, Secondary Immuno eficiency, Hypersensitivity Diseases 3
3. Endocrine diseases arising from over or underproduction of hormones or from resistance to a particular hormone; Thyroid disorders;Pancreatic disorders; Cushings disease. 2
4. Hemostatic diseases: Role of Vascular Endothelium,Platelets, Coagulation Proteins, Complexes, and Thrombin Activation; Fibrinolysis, Hereditary and Acquired disorders of hemostasis. 2
5. Nutritional diseases arising from over or under-nutrition of fat and water soluble vitamins and minerals: Night blindness, pernicious anaemia, iron overload, metabolic disorders of iron metabolism, rickets, osteomalacia, milk fever, swayback, anaemia of Inflammatory disease. 4
6. Toxic diseases: Hepatotoxicity, Nephrotoxicity; Toxins affecting: Skeletal and Cardiac muscle; Lung and Respiratory tract;

Gastrointestinal tract; Erythrocytes, Haematopoietic system, Hemoglobin and oxidative metabolism; Endocrine system, Nervous system and neuromuscular disorders. 4

7. Neoplastic diseases: Biochemical changes in development of various neoplasms, Deranged glucose metabolism in cancerous tissue, oncogenesis. 4
8. Degenerative diseases: Neurodegenerative diseases – including amyotrophic lateral sclerosis, Parkinson's disease, Alzheimer's disease, and Huntington's disease; Molecular basis of cell injury and diseases by Free Radicals. 4
9. Biochemical basis of cardiomyopathies in dogs and birds, Prion disease (Scrapie), Bovine spongiform encephalopathy, Reticuloendotheliosis in poultry, Avian Influenza; Retinitis pigmentosa, retinal degeneration and Lysosomal storage diseases in animals. 5
10. Comparative medical genetics: Genome sequences, Disease Gene Mapping, Genetic diseases, Gene therapy. 3

Total 32

I. **Course Title : Immuno-biochemistry**
II. **Course Code : BCT 710**
III. **Credit Hours : 2 + 0**
IV. **Aim of the course**

To impart knowledge about fundamental principles and applications of immunology and immunochemical research techniques.

V. **Theory**

Unit I

History and scope of immunology, Cellular basis of immunity- adaptive and non- adaptive immunity, Memory, Specificity and Diversity, Self and non self discrimination, Immune system, Organs, tissues and cells, Cell mediated vs Humoral immunity, Immunoglobulins, Concept of antigen, Immunogen, Adjuvant, Hapten

Unit II

Classes of antibodies, Antibody diversity, Theories of generation of antibody diversity, Monoclonal antibodies, Polyclonal antibodies, Hybridoma, Recombinant antibodies, Single chain and single domain antibodies in immunodiagnostics and immunotherapy, Phage display library, complement system- classical and alternate.

Unit III

Cellular interactions in the immune response, affinity, avidity, B-cell and T-cell response, major histocompatibility complex, cell mediated immune response, cytokines, Vaccine.

Nanoparticles in vaccine development and delivery, Nanomedicine in immunodiagnostics and immunotherapy, Immunoregulation, immunological tolerance, hypersensitivity, innate resistance and specific immunity.

Unit IV

Current immunological techniques: Raising of antisera and antibody purification, Immunodiffusion, Immunoelectrophoresis, immunofluoresence, rocket electrophoresis, Immunological markers and fluorescence-activated cell sorting, Radioimmuno assay (RIA) and different types of ELISA, Immunohistochemistry, Immunoinformatics techniques.

VI. Suggested Reading

- Abbas AK and Lichtman AH. 2003. *Cellular and Molecular Immunology.* 5th Ed. WB Saunders.
- David J Dabbs. 2018. *Diagnostic Immunohistochemistry*. 5th Ed. Elsevier.
- Goldsby RA, Kindt TJ and Osborne BA. 2003. *Immunology*. 4th Ed. WH Freeman.
- Harlow and Lane D. (Eds.). 1988. *Antibodies: A Laboratory Manual*. Cold Spring Harbor Laboratory.
- *Immunochemistry*: Edited by CJ van Oss and MHV van Reganmortel. pp 1069. Marcel Dekker, New York. 1994. ISBN 0 8247 9123 1; TR O'Brien.
- Ivan Roitt (Eds.). 1997. *Essential Immunology* Publisher - Blackwell Scientific Publication, Oxford.
- Kuby J. 1996. *Immunology*. 3rd edition WH Freeman.
- Male D, Brostoff J, Roth DB and Roitt I. 2006. *Immunology*. 7th Ed. Elsevier.
- Manson MM. (Eds.). 1992. *Immunochemical Protocols: Methods in Molecular Biology* Vol. 10- Humana Press Totowa NJ.
- Mariusz Skwarczynski, Istvan Toth. 2017. *Micro and Nanotechnology in Vaccine Development.* 1st ed. Elsevier.
- Mathew Sebastian, Neethu Ninan AK. Haghi. 2012. *Nanomedicine and Drug Delivery*. 1st Ed. Apple Academic Press.
- Selected articles from standard journals.

Course Outline

S. No.	Title	No. of Lectures
Theory		
1.	History and scope of immunology, cellular basis of immunity-adaptive and non-adaptive immunity, memory, specificity and diversity, self and non self-discrimination,	2

2. Immune system, organs, tissues and cells, cell mediated vs humoral immunity, immunoglobulins 3
3. Concept of antigen, immunogen, adjuvant, hapten 1
4. Classes of antibodies, Antibody diversity, theories of generation of antibody diversity, 3
5. Monoclonal antibodies, polyclonal antibodies, Hybridoma, Recombinant antibodies, Single chain and single domain antibodies in immunodiagnostics and immunotherapy, Phage display library 4
6. Complement system- classical and alternate. 2
7. Cellular interactions in the immune response, affinity, avidity, B-cell and T-cell response, major histocompatibility complex, cell mediated immune response, cytokines. 4
8. Vaccine Nanoparticles in vaccine development and delivery, Nanomedicine in immunodiagnostics and immunotherapy, 3
9. Immunoregulation, immunological tolerance, hypersensitivity, Innate resistance and specific immunity. 2
10. Current immunological techniques: Raising of antisera and antibody purification, 1
11. Immunodiffusion, Immunoelectrophoresis, immunofluoresence, rocket electrophoresis 2
12. Immunological markers and fluorescence-activated cell sorting. 1
13. Radioimmuno assay (RIA) and different types of ELISA. 2
14. Immunohistochemistry. 1
15. Immunoinformatics techniques. 1

Total 32

I. **Course Title : Special Problem**
II. **Course Code : BCT 711**
III. **Credit Hours : 0+2**
IV. **Aim of the course**

To provide expertise in handling practical research problem(s).

V. **Practical**

Short research problem(s) involving contemporary issues and research techniques.

VI. **List of Journals**

- *Indian Journal of Chemical Technology*
- *Indian Journal of Biochemistry and Biophysics*
- *Indian Journal of Chemistry - Section B*
- *Indian Veterinary Journal*
- *Journal of Chemical Sciences*
- *Journal of Indian Chemical Society*

- *Meat Science - An International Journal*
- *The EMBO Journal*
- *Theriogenology*
- *Trends in Biochemical Sciences*

e-Resources

- www.niscair.res.in/ScienceCommunication (Indian Journal of Biochemistry)
- www.medind.nic.in/iaf/iafm.shtml (Indian Journal of Clinical Biochemistry)
- www.ijcb.co.in (Indian Journal of Clinical Biochemistry)
- www.mcponline.org (Molecular and Cellular Proteomics)
- www.elsevier.com/vj/proteomics (Proteomics Virtual Journal)
- www.elsevier.com (Journal of Proteomics)
- www.elsevier.com (Clinical Biochemistry)
- www.sciencedirect.com/science/journal (Science Direct – Clinical Biochemistry)
- www.jbc.org (Journal of Biological Chemistry)

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Biochemistry

Acids and bases, ionic strength and activity, Henderson-Hasselbalch equation, pH, indicators and buffers, Colloids and their properties, Mechanism of osmosis, osmotic pressure, Donnan membrane equilibrium, Viscosity, surface tension, surface forces, Adsorption and light scattering, Membrane filtration, dialysis, diffusion coefficient and partial specific volume.

Carbohydrates: Structure and biological significance of important monosaccharides, disaccharides and polysaccharides, Chemical reactions of monosaccharides. Basic principles of separation, purification and characterization of carbohydrates.

Lipids: Definition, Classification, Properties and Biological significance of simple, compound and derived lipids; Basic principles of extraction and analysis of lipids; fluid mosaic model of membrane skeleton, lipid asymmetry, cardiac glycosides,

Proteins: Amino acids - Structure and classification. Physical and chemical properties of amino acids - acid-base property, optical activity and peptide bond formation; Structure and geometry of peptide bond. Chemical synthesis of polypeptide and Oligopeptides of biological significance; Classification of proteins; Structure – primary, secondary, tertiary and quaternary; Biological significance of proteins; Denaturation, extraction and purification criteria for proteins.

Nucleic acids: Chemistry of purines, pyrimidines, nucleosides and nucleotides. Biological significance of nucleosides and nucleotides. Structures and functions of Watson-crick model of deoxyribonucleic acid (DNA) and a typical ribonucleic acid (RNA). Different types of DNA, acid-base properties, Base sequence analysis of DNA,

Enzyme nomenclature and classification, enzyme compartmentalization in cell organelles, measurement of enzyme activity. ribozymes, isozymes, abzymes, restriction endonucleases.

Enzyme structure, enzyme specificity, active site, active site mapping, mechanism of enzyme catalysis. cofactors, coenzymes- their structure and role.

Enzyme kinetics, enzyme inhibition and activation, multienzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity. qualitative description of “concerted” and “sequential” models for allosteric enzymes.

Concept of ES complex, active site, specificity derivation of Michaelis-Menten equation for uni- substrate reactions. Different plots for the determination of Km and Vmax and their physiological significances. Importance of Kcat/ Km. Kinetics of zero and first order reactions.

Theory and applications of Colorimetry and Spectrophotometry; Basic principle and applications of Paper, Column and Thin layer chromatography including HPTLC; Theory and applications of Electrophoresis: Theory and applications of Centrifugation:

–Disturbance in water, electrolytes and acid-base balance - electrolyte abnormalities - respiratory acidosis and alkalosis - metabolic acidosis and alkalosis – compensation – biochemical tests for diagnosis. Disorders of Carbohydrate metabolism, Disorders of Lipid metabolism: Disorders of proteins, amino acids and nucleic acids metabolism

Liver function tests , Renal function tests, tests for Gastrointestinal function:

Functional and non-functional plasma enzymes, plasma enzymes of diagnostic importance Oxidative Stress, Ischemia, shock.

Disorders of mineral metabolism. Structure and biological significance of vitamins. Disorders related to vitamin metabolism.

Carbohydrate metabolism and regulation - Major pathways, Lipid metabolism and regulation, Amino acids metabolism, Biosynthesis of non-essential amino acids. Metabolic disorders.

Catabolism and regulation of purine and pyrimidine nucleotides/ deoxynucleotides

- Biosynthesis and regulation of purine and pyrimidine nucleotides - Biosynthesis of nucleotide coenzymes and regulation - Inhibitors of purine and pyrimidine metabolism and role in cancer therapy – Metabolic disorders.

Structural and functional relationships of specialized tissues and organs; Organ specialization in fuel metabolism: Brain, muscle, adipose tissue, liver, kidney; Inter organ metabolic pathways, hormonal control of fuel metabolism.

Chemistry and structure of DNA and RNA, Genome organization in prokaryotes and eukaryotes.

DNA replication mechanisms in prokaryotes and Eukaryotes. Transcription mechanisms in Prokaryotes and Eukaryotes. Translation mechanisms in Eukaryotes and Prokaryotes and Post - translational modification;

Mechanism of hormone action and intracellular signalling after receptor activation -Releasing factors from hypothalamus and their effects on pituitary gland and metabolism - Synthesis, secretion, regulation, metabolic functions and physio-pathology of Hormones from Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal and Pineal Glands.

Endocrinology of Gonads and Reproductive Biochemistry

Biochemistry of Ruminants - An overview of metabolism of carbohydrates, proteins and lipids in ruminants.

Veterinary Biotechnology

DEPARTMENT OF ANIMAL BIOTECHNOLGY
Course Structure for M.V.Sc degree programme (Semester Wise)

Sr. No.	Course No.	Course Title	Cr. Hrs.	Semester
1	BTY-602*	FUNDAMENTALS OF CELL BIOLOGY	2+0	I
2	BTY-603*	MOLECULAR BIOLOGY AND GENETIC ENGINEERING	2+0	I
3	BTY-604*	ANIMAL CELL CULTURE– PRINCIPLES AND APPLICATIONS	2+1	I
4	BTY-608*	ANIMAL GENOMICS	2+1	I
5	BTY-610*	REPRODUCTIVE BIOTECHNOLOGY	2+1	I
6	BTY-601	BASIC AND APPLIED BIOTECHNOLOGY	2+0	II
7	BTY-605*	MOLECULAR DIAGNOSTICS	2+1	II
8	BTY-606*	IMMUNOLOGY APPLIED TO BIOTECHNOLOGY	2+1	II
9	BTY-607*	INTRODUCTION TO BIOINFORMATICS	2+1	II
10	BTY-609*	TECHNIQUES IN MOLECULAR BIOLOGY AND GENETIC ENGINEERING	0+2	II
11	BTY-691	MASTER'S SEMINAR	1+0	I & II
12	BTY-699	MASTER'S RESEARCH	0+30	I & II
*Compulsory Courses				

DEPARTMENT OF ANIMAL BIOTECHNOLGY
Course Structure for Ph.D. degree programme (Semester Wise)

Sr. No.	Course No.	Course Title	Cr. Hrs.	Semester
1	BTY 702*	FUNCTIONAL GENOMICS AND PROTEOMICS	3+0	I
2	BTY 703	ADVANCES IN CELL AND MOLECULAR BIOLOGY	2+0	I
3	BTY 705	GENE MANIPULATION AND GENOME EDITING	2+0	I
4	BTY 708*	ADVANCES IN REPRODUCTIVE BIOTECHNOLOGY	2+1	I
5	BTY 709*	ADVANCES IN ANIMAL CELL CULTURE	2+1	I
6	BTY 701*	GENETIC ENGINEERING	1+2	II
7	BTY 704	DIAGNOSTIC PLATFORM	1+1	II
8	BTY 706*	TRENDS IN VACCINOLOGY	2+1	II
9	BTY 707	ADVANCES IN BIOINFORMATICS	1+1	II
10	BTY 710	INDUSTRIAL BIOTECHNOLOGY	2+1	II
11	BTY 711	RUMEN AND FEED BIOTECHNOLOGY	2+1	II
12	BTY 791	DOCTORATE SEMINAR-I	1+0	I & II
13	BTY 792	DOCTORATE SEMINAR-II	1+0	I & II
14	BTY 799	DOCTORATE RESEARCH	0+70	I & II
*Compulsory Courses				

Course Contents
M.V.Sc. in Veterinary Biotechnology

I. **Course Title : Basic and Applied Biotechnology**
II. **Course Code : BTY 601**
III. **Credit Hours : 2+0**
IV. **Theory**

Unit I

History and scope of Biotechnology, Application of Biotechnology in Agriculture, Veterinary Sciences, diagnostics and therapeutics, pharmaceutical industry, food industry, chemical industry and environment, plant tissue culture and its applications

Unit II

Biofermentation, Fermentation technology, aerobic and anaerobic fermentation, Different types of fermentations, Basic design and construction of fermenter, Media sterilization, Upstream and Downstream processing, Microbes and enzymes of industrial importance, Microbial growth kinetics, Immobilized enzymes and cells and immobilization process.

Unit III

Vaccines and their immune response, Types of vaccines: Conventional and new generation vaccine, Subunit vaccine, recombinant vaccines, Vectored vaccines, DNA vaccine, edible vaccine, DIVA strategy and reverse vaccinology

Unit IV

Biodiversity, genetic diversity, molecular taxonomy, species and population biodiversity, quantifying biodiversity, maintenance of ecological diversity, conservation of biodiversity and conservation of animal genetic resources.

V. **Suggested Readings**

- Becker JM, Cold Well GA and Zachgo EA. 2007. *Biotechnology a Laboratory Course*. Academic Press.
- Brown CM, Campbell I and Priest FG. 2005. *Introduction to Biotechnology*. Panima.
- Singh BD. 2006. *Biotechnology Expanding Horiozon*. Kalyani

S No.	Topics	No. of Lectures
1.	History and scope of Biotechnology, Application of Biotechnology in agriculture, veterinary sciences, diagnostics and therapeutics, pharmaceutical industry, food industry, chemical industry and environment, plant tissue culture and its applications	1-3
2.	Biofermentation	4

3. Fermentation technology, aerobic and anaerobic fermentation 5
4. Different types of fermentations 6
5. Basic design and construction of fermenter 7
6. Upstream processing- Media sterilization, inoculum preparation and and Downstream processing 8
7. Microbes and enzymes of industrial importance, Microbial Growth kinetics and products. 9
8. Immobilized enzymes and cells and immobilization process 10
9. Vaccines and their immune response 11
10. Types of vaccines -Conventional and new generation vaccine 12-14
11. Subunit vaccine, recombinant vaccines 15
12. Vectored vaccines and DNA vaccine and their immune response 16
13. Edible vaccine, DIVA strategy and reverse vaccinology 17-20
14. Biodiversity, genetic diversity, molecular taxonomy, species And population biodiversity 21-22
15. Quantifying biodiversity, maintenance of ecological diversity 23-25
16. Conservation of biodiversity and conservation of animal genetic resources 26-28

I. **Course Title : Fundamentals of Cell Biology**
II. **Course Code : BTY602**
III. **Credit Hours : 2 + 0**
IV. **Aim of the course**

Understanding the functions of cell components and cell signal pathways

V. **Theory**

Unit I

Origin and evolution of cells – from molecules to first cell – from prokaryotes to eukaryotes – from single to multi cellular organisms – Chemical components of a cell – catalysis and use of energy by cells – techniques used to study cells – microscopy – light microscopy – fluorescent microscopy – electron microscopy – confocal microscopy – cell and cell parts separation techniques – ultracentrifugation

– flow cytometry – detection of cell parts - antibodies

Unit II

Structure of cell – Plasma membrane – cytoskeleton – Nucleus – Chromosome- Chromosomal DNA packaging and its implications - endoplasmic reticulum – ribosome - mitochondria –Mitochondrial DNA organization - golgi peroxisome – lysosome

Unit III

Cell Membrane transport – transport of small molecules - macromolecules and particles- exocytosis and endocytosis – Nuclear transport –protein synthesis and sorting – endoplasmic reticulum – golgi complex – peroxisomes – lysomes – lipid synthesis and sorting – Electron transport chain – chemiosmotic coupling - Transport of metabolites across the inner mitochondrial membrane – Mechanism of muscle contraction – cell crawling – functions of keratin and neurofilaments – organelle transport and separation of mitotic chromosome

Unit IV

Cell signaling – modes of cell-cell signaling- steroid hormones and the steroid receptor super family – Neurotransmitters - Peptide Hormones and Growth Factors

- G Protein-Coupled Receptors - Receptor Protein-Tyrosine Kinases - Cytokine Receptors and Non receptor Protein-Tyrosine Kinases - The cAMP Pathway: Second Messengers and Protein Phosphorylation - Cyclic GMP - Phospholipids and Ca^{2+} - Ras, Raf, and the MAP Kinase Pathway - The JAK/ STAT Pathway - Integrins and Signal Transduction - Regulation of the Actin Cytoskeleton - Hedgehog and Wingless

- Notch Signaling – Cell signal network - Feedback and crosstalk and networks of cellular signal transduction – cell cycle – regulators of cell cycle – events of M phase

VI. Suggested Readings

- Lewin B. 2008. *Gene IX*. Jones and Bartlett.
- Primrose SB. 2001. *Molecular Biotechnology*. Panima.
- Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific

S. No.	Topic	No. of Lectures
1.	Origin and evolution of cells from molecules to first cell from prokaryotes to eukaryotes from single to multicellular organisms	1
2.	Chemical components of a cell Catalysis and use of energy by cells	2
3.	Techniques used to study cells Principles and applications of microscopy, light microscopy, fluorescent microscopy, electron microscopy and confocal microscopy, Cell and cell parts separation techniques Principles and applications of ultracentrifugation and flow cytometry Detection of cell parts Primary and secondary antibodies used to detect cell parts	3-4
4.	Structure of cell, Plasma membrane, Cytoskeleton	5
5.	Structure of cell, Nucleus, Chromosome Chromosomal DNA Packaging and its implications	6

6. Structure of cell, Endoplasmic reticulum, Ribosome Mitochondria 7
7. Structure of cell, Mitochondrial organization, Golgi complex Peroxisome, Lysosome 8
8. Cell Membrane transport, Transport of small molecules, Macromolecules and particles 9
9. Cell Membrane transport, Exocytosis and endocytosis Nuclear transport 10
10. Cell Membrane transport, Protein synthesis and sorting into Endoplasmic reticulum Golgi complex 11
11. Cell Membrane transport, Protein synthesis and sorting into Peroxisomes, Lysomes
    Lipid synthesis and sorting 12-13
12. Cell Membrane transport, Electron transport chain Chemiosmotic coupling 14
13. Transport of metabolites across the inner mitochondrial membrane 15
14. Mechanism of muscle contraction, cell crawling functions of keratin and neurofilaments 16
15. Cell Membrane transport, organelle transport separation of mitotic chromosome 17
16. Cell signaling, Modes of cell-cell signaling Steroid hormones and the steroid receptor super family 18
17. Cell signaling, Neurotransmitters, Peptide Hormones and Growth Factors 19
18. Cell signaling, G Protein-Coupled Receptors Receptor Protein-Tyrosine Kinases 20
19. Cell signaling, Cytokine Receptors Non receptor Protein-Tyrosine Kinases 21
20. Cell signaling, The cAMP Pathway Second Messengers and Protein Phosphorylation 22
21. Cell signaling, Cyclic GMP Phospholipids and Ca^{2+} 23
22. Cell signaling Ras, Raf, and the MAP Kinase Pathway The JAK/ STAT Pathway
    Integrins and Signal Transduction 24
23. Cell signaling, Regulation of the Actin Cytoskeleton Hedgehog and Wingless Notch Signaling 25-26
24. Cell signaling, Cell signal network, Feedback and crosstalk Networks of cellular signal transduction 27
25. Cell cycle, Regulators of cell cycle Events of M phase 28

I. **Course Title : Molecular Biology and Genetic Engineering**
II. **Course Code : BTY 603**

III. Credit Hours : 2+0

IV. Aim of the course

Understanding the principles of molecular biology and genetic engineering.

Unit I

History and scope of molecular biology – Discovery of DNA and evidence for DNA as the genetic material - structure of DNA, RNA and proteins – Organization of prokaryotic and eukaryotic genome – Gene transfer in micro organisms like conjugation, transformation, transduction and protoplastic fusion – DNA replication

- genetic code - transcription, RNA processing and alternative splicing - Translation in prokaryotes and eukaryotes - Regulation of gene expression.

Unit II

Enzymes used in molecular biology and recombinant DNA research - Cloning vectors

– plasmids, phages, phagemids, cosmids, BAC, YAC - Expression vector – bacterial, viral, baculo and yeast vectors, shuttle vectors - Polymerase chain reaction and different types of PCR - Probes – Synthesis and types, Nucleic acid hybridization and blotting - Construction of gene libraries and cDNA library - Gene mapping and DNA structure analysis.

Unit III

Cloning in bacteria, yeast, plant and animal cells – identification of gene of interest and synthesis of double stranded DNA and complementary DNA - Restriction enzyme digestion – ligation - methods for transfer of cloned DNA - identification and enrichment of recombinant clones - expression of recombinant DNA in prokaryotic and eukaryotic vectors - strategies for purification of expressed protein.

Unit IV

Molecular mechanism of mutation – DNA repair - site directed DNA alterations and gene manipulations - Gene editing techniques - Methods of DNA sequencing - Genetics of tumorigenic region of agrobacteria - Applications of genetic engineering in veterinary science- Ethics, legal issues and safety aspects of genetic manipulation.

V. Suggested Readings

- Kun LY. 2006. *Microbial Biotechnology*. World Scientific.
- Sambrook J and Russel DW. 2001. *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbour Lab. Press.
- Twyman RM. 2003. *Advanced Molecular Biology*. Bios

Scientific.

S. No.	Topic	No. of Lectures
1	History and scope of molecular biology – Discovery of DNA And evidence for DNA as the genetic material	1
2	Structure of DNA, RNA and proteins – Organization of prokaryotic and eukaryotic genome	2
3	Gene transfer in micro organisms like conjugation, transformation, transduction and protoplastic fusion	3
4	DNA replication - genetic code - transcription, RNA processing and alternative splicing	4-5
5	Translation in prokaryotes and eukaryotes - Regulation of gene expression	6-7
6	Enzymes used in molecular biology and recombinant DNA research	8-9
7	Cloning vectors – plasmids, phages, phagemids, cosmids, BAC, YAC	10-11
8	Expression vector – bacterial, viral, baculo and yeast vectors, shuttle vectors	12-13
9	Polymerase chain reaction and different types of PCR	14-15
10	Probes – Synthesis and types, Nucleic acid hybridization and blotting	16-17
11	Construction of gene libraries and cDNA library - Gene mapping and DNA structure analysis	18
12	Cloning in bacteria, yeast, plant and animal cells – identification of gene of interest and synthesis of double stranded DNA and complementary DNA	19-21
13	Restriction enzyme digestion – ligation - methods for transfer of cloned DNA - identification and enrichment of recombinant clones	22-24
14	Expression of recombinant DNA in prokaryotic and eukaryotic vectors - strategies for purification of expressed protein	25
15	Molecular mechanism of mutation – DNA repair - site directed DNA alterations and gene manipulations	26
16	Gene editing techniques and Methods of DNA sequencing	27-28
17	Genetics of tumorigenic region of agrobacteria	29
18	Applications of genetic engineering in veterinary sciences	30
19	Ethics, legal issues and safety aspects of genetic manipulation.	31

I. Course Title : Animal Cell Culture–Principles and Applications

II. Course Code : BTY 604

III. Credit Hours : 2+1

IV. Aim of the course

Understanding the principles and applications of animal cell culture

V. Theory

Unit I

Introduction, History of cell culture development, Methods of sterilization, Different tissue culture techniques including primary culture, Continuous cell lines- anchorage dependent and independent cell lines, Organ culture, Cell bank.

Unit-II

Different types of cell culture media, Serum, growth supplements, Balanced salt solution, Serum free media, Enzymes used in cell culture, Factors that affecting the growth of cells.

Unit III

Cell culture contaminants, Cryopreservation of primary culture and cell line, Cell cloning, Types of cell culture bioreactor, Cell counting and cytotoxic assays.

Unit IV

Applications of animal cell culture, Hybridoma technology and monoclonal antibody production, Applications of monoclonal antibodies in diagnostic and cancer research, Isolation and culturing of adult and embryonic stem cells, Therapeutic applications of adult stem cells.

VII. Practicals

- Packaging and sterilization of glass and plastic ware for cell culture
- Preparation of reagents and media for cell culture
- Primary chicken embryo fibroblast
- Primary sheep/ goat kidney culture
- Cultivation of continuous cell lines
- Quantification of cells by trypan blue exclusion dye
- Isolation of lymphocytes and cultivation
- Study of effect of toxic chemicals on cultured mammalian cells
- Study of cytopathic effect of virus on mammalian cells
- Cryopreservation of primary cultures and cell lines
- Isolation and culture of stem cells from bone marrow

VIII. Suggested Readings

- Freshney: *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*, 6th Edition.
- Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.

S. No.	Topic	No. of Lectures/Practicals

Theory

1.	Introduction, History of cell culture development	1-2
2.	Methods of sterilization	3
3.	Tissue culture techniques- primary culture using various methods	4-5
4.	Continuous cell lines- anchorage dependent and independent cell lines	6
5.	Organ culture	7
6.	Cell bank and role of cell bank.	8
7.	Different types of cell culture media, Serum, growth supplements, balanced salt solution, Serum free media	9-12
8.	Enzymes used in cell culture, Factors that affecting the growth of cells	13
9.	Cell culture contaminants	14
10.	Cryopreservation of primary culture and cell line	15
11.	Cell cloning	16
12.	Types of cell culture bioreactor	17-18
13.	Cell counting and cytotoxic assays	19-21
14.	Applications of animal cell culture	22-24
15.	Hybridoma technology and monoclonal antibody production,	25-26
16.	Applications of monoclonal antibodies in diagnostic and cancer research	27
17.	Isolation and culturing of adult and embryonic stem cells and therapeutic applications of adult stem cells	28

Practical

1.	Packaging and sterilization of glass and plastic ware for cell culture	1
2.	Preparation of reagents and media for cell culture	2
3.	Primary chicken embryo fibroblast	3
4.	Primary sheep/ goat kidney culture	4
5.	Cultivation of continuous cell lines	5
6.	Quantification of cells by trypan blue exclusion dye	6
7.	Isolation of lymphocytes and cultivation	7
8.	Study of effect of toxic chemicals on cultured mammalian cells	8
9.	Study of cytopathic effect of virus on mammalian cells	9
10.	Cryopreservation of primary cultures and cell lines	10
11.	Isolation and culture of stem cells from bone marrow	11

I. **Course Title : Molecular Diagnostics**

II. **Course Code : BTY 605**

III. **Credit Hours : 2+1**

IV. **Aim of the courses**

Understanding the various diagnostics methods using molecular techniques.

V. **Theory**

Unit I

Introduction, Importance and historical perspective of development of molecular diagnostic technology, Development and optimisation of Nucleic acid detection assays: OIE guidelines, Concept of development of group specific and strain specific nucleic acid-based diagnostics, Basis for selection of gene/ nucleotide sequence of pathogenic organism to target for detection.

Unit II

Types and application of different molecular diagnostic assays. Restriction endonuclease analysis for identification of pathogens, Principle of development of pathogen specific DNA probes, Blotting techniques e.g. Southern and Northern hybridization.

Unit III

Signal, target and probe based amplification techniques, Transcription based amplification (TBA)/ Nucleic Acid Sequence Based Amplification (NASBA)/ Self- Sustaining Sequence Replication (SSSR/ 3SR), Strand Displacement Amplification (SDA), LAMP, Ligase Chain Reaction (LCR)-Prospects and Applications, History of PCR, principle, Cyclic and thermal parameters in PCR, Real time PCR, Variations in PCR, Applications of PCR for diagnosis of infectious diseases of animals and poultry.

Unit IV

Advancements in diagnostic technology platforms including DNA array technology, biosensors, Nanodiagnostics, Mass spectrometry, Molecular cloning, DNA sequencing including Next generation sequencing, Bead based assays and lateral-flow device technology.

VI. **Practicals**

- Preparations of buffers and reagents.
- Collection of clinical and environmental samples from animal and poultry farmsfor molecular detection of pathogens.
- Extraction of nucleic acids from clinical specimens.
- Qualitative and quantitative analysis of extracted nucleic acid.

- Agarose gel electrophoresis of extracted nucleic acids.
- Restriction endonuclease digestion and analysis in agarose electrophoresis.
- Polymerase chain reaction for detection of pathogens in blood and other animal tissues.
- RT-PCR for detection of RNA viruses
- PCR-RFLP for detection and typing of pathogens
- Real time PCR for detection of pathogens in semen and other animal tissues
- DNA fingerprinting for identification of genetic diseases
- PCR based detection of potential pathogens in milk, eggs and meat
- Sanger sequencing using capillary electrophoresis

Suggested Readings

- Elles R and Mountford R. 2004. *Molecular Diagnosis of Genetic Disease*. Humana Press.
- Rao JR, Fleming CC and Moore JE. 2006. *Molecular Diagnostics. Horizon Bioscience in seed lot systems*.

S. No.	Topic	No. of Lectures/Practicals

Theory

1. Introduction, importance and historical perspective of development of molecular diagnostic technology 1-2
2. Development and optimization of nucleic acid detection assays: OIE guidelines 3-4
3. Concept of development of group specific and strain specific nucleic acid based diagnostics, basis for selection of gene/ nucleotide sequence of pathogenic organism to target for detection 5-6
4. Types and application of different molecular diagnostic assays 7-8
5. Restriction endonuclease analysis for identification of pathogens 9-10
6. Principle of development of pathogen specific DNA probes Blotting techniques e.g. Southern and Northern hybridization 11
7. Nucleic Acid Sequence Based Amplification (NASBA)- Prospects and Applications 12-13
8. Historical background of development of PCR and other diagnostic assays, Signal, target and probe based amplification techniques, Transcription based amplification (TBA)/ Nucleic Acid Sequence Based amplification (NASBA)/ Self-Sustaining Sequence Replication (SSSR/ 3SR), Strand Displacement Amplification (SDA), LAMP, Ligase chain reaction (LCR) -

Prospects And ApplicationsPCR principle, cyclic and thermal parameters in PCR, Real time PCR, Variations in PCR, application ofPCR for diagnosis of infectious diseases of animals and poultry 14-17

9. Real-time PCR and its application in diagnosis 18-19
10. Advancements in diagnostic technology platforms 20
11. DNA array technology 21
12. Nano-diagnostics 22-23
13. Biosensors 24
14. Mass spectrometry in disease diagnosis. 25
15. Molecular cloning 26
16. Bead based assays 27
17. DNA sequencing including Next generation sequencing 28-29
18. Lateral-flow devices and its applications in diagnosis 30

Practical

1. Preparation of buffers and reagents 1
2. Extraction of nucleic acids and qualitative and quantitative analysis of Nucleic acid 2-3
3. Agarose gel electrophoresis of Nucleic acids. 4
4. Amplification of pathogen specific gene using PCR. 5-6
5. Different types of PCR including RT-PCR, nested PCR, etc. 7-9
6. Real-time PCR 10
7. PCR-RFLP 11-12
8. DNA fingerprinting for identification of genetic diseases 13
9. Sanger sequencing using capillary electrophoresis 14-16

I. **Course Title : Immunology Applied to Biotechnology**
II. **Course Code : BTY 606**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

Understanding the basic immunology and various immunoassays

V. **Theory**

Unit I

Introduction, Principles of immunology, Immune system, Immune response, Major histocompatibility complex: Structure, Functions and gene organization and its association with disease and resistance; Immunity against infectious agents of animals; Immunological tolerance; Autoimmunity; Techniques used in biotechnology.

Unit II

Immunoglobulins: Isotype, Allotype and Idiotype; Antibody production and purification; Application of antibodies in purification,

Immunoblotting; Expression of immunoglobulin genes in plants and production of antibodies; Cytokines: classification, Structure, Functions; Industrial production of cytokines and interferon.

Unit III

Application of antibodies in chemiluminescence and florescence assay used for identification of recombinant genes; Antibody based nucleic acid probes and their applications; Immunoinformatics; Transgenic animals and cellular chimeras; Immunodiagnostic tests: Agar gel precipitation, Agglutination reaction based tests, various types of immunoassays, immunofiltration tests, flow cytometry in disease diagnosis.

Unit IV

Chimeric and humanized monoclonal antibodies, Recombinant antibodies; Modern uses of antibody: Biosensors, Catalysis, *in vivo* imaging, Microarrays, Proteomics; Cancer immunity and its immunotherapy.

VI. Practicals

- Agar gel immunodiffusion test; latex agglutination test
- Immunofiltration assay
- Immunodiffusion assays
- Flow cytometry
- Immunoelectrophoresis.
- Fluorescent antibody test.
- Enzyme immunoassays including various types of ELISA & Immunoblotting.
- Affinity chromatography
- Lymphocyte proliferation assay
- Cultivation of normal lymphocytes and myeloma cell line.
- Somatic cell hybridization and production of hybridoma.
- Screening of hybrids for production of monoclonal antibodies
- Bioinformatics tools for immunological research

VII. Suggested Readings

- Kindt TJ, Goldsby RA and Osbrne BA. 2007. *Kuby Immunology*. WH Freeman.
- Male D, Brostoff J, Roth DB and Roitt I. 2006. *Immunology*. Elsevier.
- Spinger TA. 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Introduction to principles of immunology, immune system and immune response	1
2.	Major histocompatibility complex: its structure, functions and	

Gene organization 2
3. MHC and its association with disease and resistance 3
4. Immunity against infectious agents of animals 4
5. Immunological tolerance 5
6. Autoimmunity: mechanism and control 6
7. Techniques used in biotechnology 7
8. Immunoglobulins and its type: Isotype, Allotype and Idioty 8
9. Antibody production and purification 9
10. Application of antibodies in purification 10
11. Immunoblotting: principle and applications 11
12. Expression of immunoglobulin genes in plants and production of antibodies 12
13. Cytokines: classification, structure, functions 13
14. Industrial production of cytokines and interferon 14
15. Application of antibodies in chemiluminescence and florescence assay for identification of recombinant genes 15
16. Antibody based nucleic acid probes and their applications 16
17. Immunoinformatics: concept and application 17
18. Transgenic animals and cellular chimeras 18
19. Immunodiagnostic tests: agar gel precipitation, agglutination Reaction based assays 19
20. Various types of Immunoassays, immunofiltration tests, flow Cytometry in disease diagnosis 20
21. Chimeric and humanized monoclonal antibodies 21
22. Recombinant antibodies: production and application 22
23. Modern uses of antibody: biosensors, catalysis, *in vivo* imaging, microarrays, proteomics 23
24. Cancer immunity and its immunotherapy 24

Practical

1. Agar gel immunodiffusion test; latex agglutination 1
2. Immunofiltration assay 2
3. Flow cytometry 3
4. Immunoelectrophoresis 4
5. Fluorescent antibody test 5
6. Enzyme immunoassays including various types of ELISA 6
7. Immunoblotting 7
8. Affinity chromatography 8
9. Lymphocyte proliferation assay 9
10. Cultivation of normal lymphocytes and myeloma cell line 10
11. Somatic cell hybridization and production of Hybridoma 11
12. Screening of hybrids for production of monoclonal antibodies 12
13. Bioinformatics tools for immunological research 13

I. **Course Title : Introduction to Bioinformatics**

II. **Course Code : BTY 607**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

Understanding the various databases and packages used in Bioinformatics.

V. **Theory**

Unit I

Introduction, Database searching - Biological Data Acquisition, Retrieval methods for DNA sequence, protein sequence and protein structure information, General Introduction of Biological Databases;Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum) Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Data – Access, Retrieval and Submission: Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches.

Unit II

DNA sequence analysis, Progressive and hierarchical algorithms for MSA multiple sequence alignment, Local versus global. Distance metrics. Similarity and homology. Scoring matrices. Dynamic programming algorithms, Needleman-wunsch and Smith- waterman. Heuristic Methods of sequence alignment, FASTA, BLAST and PSI BLAST. Multiple Sequence Alignment and software tools for pairwise and multiple sequence alignment; Genome Analysis: Whole genome analysis, Viral vector resources, cDNA libraries and EST, EST analysis, EST contings resources, Phylogeny: Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, Method of construction of Phylogenetic trees [distance based method (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method], Comparative genomics, orthologs, paralogs.

Unit III

Secondary database searching, Introduction to concept of secondary data bases and their applications, Genome databases at NCBI, SANGER, TIGR, EBI, AGD and T (Animal genome database and tool), Introduction to animal genome research, RNA databases, protein structural databases, Building search protocol, Introduction to concept chemoinformatics computer aided drug Design–basic principles, Docking, QSAR.

Unit IV

Analysis packages–commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

VI. Practicals

- Usage of NCBI resources
- Retrieval of sequence/ structure from databases
- Visualization of protein structures
- Protein structure modeling/ predictions
- Protein antigenicity predictions
- Docking of ligand receptors
- BLAST exercises.
- Multiple sequence alignment and construction of phylogenetic tree

VII. Suggested Readings

- Attwood TK and Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Education.
- Rastogi SC, Mendiratta N and Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Introduction to bioinformatics, concept and history of databases, various primary databases resources	1-4
2.	Nucleic acid databases and their variants	5
3.	Protein databases and its variants	6
4.	Specialized genomic resources	7
5.	DNA sequence analysis, introduction to concept indel, identity, mutations, gaps and penalties	8-9
6.	cDNA library, its applications, EST, gene contings, EST databases, EST analysis tools, sequence assembly tools and clustering EST libraries	10-12
7.	Gene cloning vectors, their databases, tools and resources	13
8.	Similarity vs homology, local and global alignments	14
9.	Introduction to the concept of pair wise sequence alignment and multiple sequence alignment, difference between pair wise sequence alignment and multiple sequence alignment, introduction to various algorithms used in pair wise sequence alignment and multiplesequence alignments	15-16
10.	Applications of phylogenetic analysis, type of phylogenetic trees	17-18
11.	Introduction to methods/ matrixes used for construction of Phylogenetic trees use of concept bootstrap value	19
12.	Introduction to concept secondary database, their applications	20

Practical

I. **Course Title : Animal Genomics**

II. **Course Code : BTY 608**

III. **Credit Hours : 2 + 1**

IV. **Aim of the course**

Understanding the gene mapping and DNA markers in livestock improvement

V. **Theory**

Unit I

Historical perspective, Genome organization in eukaryotes- Chromosome numbers in farm animals – Physical and molecular structure of chromosomes -Chromosome abnormalities– High order structures, Cohesions and condensins in chromosome structure. SMC proteins –Importance of repetitive DNA –Classical satellites, microsatellites and mini satellites- SINES and LINES- Minisatellite and microsatellite based fingerprinting techniques.

Unit II

Importance of gene mapping in livestock, Methods and techniques used for gene mapping, Physical mapping, Linkage analysis, Cytogenetic techniques, FISH technique in gene mapping, Somatic cell hybridization, Radiation hybrid maps, *in-situ* hybridization, Comparative gene mapping.

Unit III

DNA markers – Properties of DNA markers- RFLPs – Minisatellite and Microsatellite markers –PCR based markers- RAPD, PCR-RFLPs, Allele specific – PCR, SSCP, STMS markers, DAMD-PCR, ARMS PCR, AP-PCR, RAMPO, AFLP,

SNP, EST, etc. Genetic characterization based on DNA markers, Genetic distance analysis, Quantitative Trait Loci (QTL), Applications of DNA markers in livestock improvement- Marker Assisted Selection (MAS) – Marker Assisted Introgression – Parentage determination – SNP chips - Genomic selection based on SNP typing – Methods of genome editing –ZFN, TALENS, Meganucleases and CRISPR –Cas. Role of genome editing in livestock improvement.

Unit IV

Genome sequencing- Next Generation Sequencing – Metagenomics –RNASeq analysis-Exome sequencing and ddRAD sequencing for genome wide SNP detection- Current status of whole genome sequencing and gene maps of livestock, Role of MHC in disease resistance, Genes influencing production traits, Mitochondrial DNA of farm animals, Evolutionary significance, Applications of genome analysis in animal breeding.

VI. Practicals

- Chromosome preparation (normal karyotyping, different types of banding) in farm animals
- Isolation and purification of animal genomic DNA from blood lymphocytes
- Analysis of DNA by agarose or polyacrylamide gel electrophoresis
- Checking the quality and quantity of genomic DNA
- Restriction digestion and analysis
- Southern hybridization
- DNA testing by microsatellite markers
- Techniques for revealing polymorphism- RFLP, SSCP, AFLP, Microsatellites, SNP chips
- Genomic DNA cloning or cDNA cloning
- Differentiation of tissues of different species by mitochondrial genome analysis.
- NGS data analysis- metagenome, RNASeq, exome and ddRAD sequence data by bioinformatics software

VII. Suggested Readings

- Gibson G and Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.
- Primrose SB and Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell.
- Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II.Wiley- CVH.

S. No.	Topic	No. of Lectures/Practicals
History		
1.	Historical perspective, Genome organization in eukaryotes- Chromosome numbers in farm animals – Physical and molecular structure of chromosomes -Chromosome abnormalities in farm animals	1-2
2.	High order structures, Role of cohesions and condensins in chromosome structure- SMC proteins	3-4
3.	Importance of repetitive DNA –Classical satellites, microsatellites and mini satellites-SINES and LINES Minisatellite and microsatellite based fingerprinting techniques	5-6
4.	Importance of gene mapping in livestock, methods and techniques used for gene mapping	7
5.	Physical mapping- cytogenetic techniques, FISH technique in gene mapping,	8
6.	Gene mapping by somatic cell hybridization.	9
7.	Radiation hybrid maps for gene mapping	10

Practical

8. DNA testing by microsatellite markers 9
9. Techniques for revealing polymorphism- PCR-RFLP 10
10. Single Strand Conformational Polymorphism (SSCP) analysis 11
11. AFLP, SNP chips 12
12. Genomic DNA cloning or cDNA cloning 13
13. Differentiation of tissues of different species by mitochondrial genome analysis 14
14. NGS data analysis-metagenome, RNASeq, exome and ddRAD sequence data by bioinformatics software 15-16

I. **Course Title : Techniques in Molecular Biology and Genetic Engineering**

II. **Course Code : BTY 609**

III. **Credit Hours : 0+2**

IV. **Aim of the course**

To develop skill in various molecular biology and genetic engineering techniques

- Isolation of DNA from mammalian cells
- Isolation of bacterial plasmids
- Restriction endonuclease digestion of plasmid and chromosomal DNA
- Agarose gel electrophoresis of RE digested DNA
- PCR using random primers as well as specific primers
- Different types of PCR
- Isolation of mRNA/ RNA, Quantification of nucleic acids
- cDNA synthesis
- Real time polymerase chain reaction
- Synthesis of nucleic acid probes
- Nucleic acid hybridization
- Cloning of bacterial and viral genes into plasmid vectors
- DNA ligation and transformation and confirmation of recombinants
- Purification of recombinant protein
- Polyacrylamide gel electrophoresis (PAGE)
- Western blot analysis

Suggested Readings

- Kun LY. 2006. *Microbial Biotechnology*. World Scientific.
- Sambrook J and Russel DW. 2001. *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbour Lab. Press.
- Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

S. No.	Topic	No. of Lectures/Practicals
1.	Isolation of DNA from blood and mammalian cells	1-2
2.	Isolation of bacterial plasmids	3-4
3.	Restriction endonuclease digestion of plasmid and chromosomal DNA	5-6
4.	Agarose gel electrophoresis of RE digested DNA	7
5.	Polymerase Chain Reaction using random primers as well as specific primers	8-9
6.	Different types of PCR	10-12
7.	Isolation of mRNA/ RNA, Quantization of nucleic acids	13-14
8.	cDNA synthesis	15
9.	Real time polymerase chain reaction	16-17
10.	Synthesis of nucleic acid probes and hybridization	18
11.	Cloning of bacterial and viral genes into plasmid vectors	19-20
12.	DNA ligation and transformation and confirmation of recombinants	21-23
13.	Purification of recombinant proteins	24-25
14.	Polyacrylamide gel electrophoresis (PAGE)	26-27
15.	Western blot analysis	28-29

I. **Course Title : Reproductive Biotechnology**

II. **Course Code : BTY 610**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

Understanding the concept of assisted reproductive technology

V. **Theory**

Unit I

Assisted Reproductive Technology (ART), History, Role of biotechnology in ART, importance of assisted reproductive technology in human and animals

Unit II

Multiple Ovulation Embryo Transfer (MOET), *in-vitro* fertilization, Micro assisted fertilization, Embryo culture, Micromanipulation of gametes and embryos, preservation of embryos and oocytes

Unit III

Semen sexing technology, Embryo splitting, Different methods of embryo sexing, Transgenic animal production, Application, Limitation and regulatory issues

Unit IV

Somatic cell nuclear transfer of domestic animals and application. Isolation and characterization of embryonic stem cells. Different applications of embryonic stem cells

VI. **Practicals**

- MOET protocols for domestic animals
- Oocyte and embryo freezing protocol
- Oocyte collection and evaluation from live and slaughter house animals
- *In-vitro* embryo production
- Embryo quality analysis
- Embryo biopsy and embryo sexing

VII. Suggested Reading

- Ball PJH and Peter AR. 2004. *Reproduction in Cattle*. Blackwell.
- Gordon I. 2003. *Laboratory Production of Cattle Embryos*. CABI.
- Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	History, role of biotechnology in Assisted reproductive technology(ART)	1-2
2.	Application of ART in human and animals	3-4
3.	Multiple ovulation embryo transfer (MOET)- donor and recipient selection- synchronization-super ovulation-artificial insemination-embryo flushing- embryo evaluation- recipient management	5-6
4.	Oocyte recovery from slaughter house ovaries and live animals, oocytes evaluation and *in-vitro* maturation	7-8
5	*In-vitro* fertilization of oocytes, *In-vitro* culture and assessment of embryonic developmental stages	9-11
6.	Micro assisted fertilization	12-13
7.	Micromanipulation of gametes and embryos	14
8.	Preservation of embryos and oocytes	15
9.	Semen sexing technology and semen analysis	16
10.	Embryo splitting	17
11.	Different methods of embryo sexing	
12.	Transgenic animal production, application, limitation and regulatory issues	20-22
13.	Somatic cell nuclear transfer of domestic animals and application	23-25
14.	Isolation and characterization of embryonic stem cells	26-27
15.	Different applications of embryonic stem cells	28
Practicals		
1.	MOET protocols for domestic animals	1-2
2.	Oocyte and embryo freezing protocol	3-5
3.	Oocyte collection and evaluation from live and slaughter	

Course Contents
Ph.D. in Veterinary Biotechnology

I. **Course Title : Genetic Engineering**
II. **Course Code : BTY 701**
III. **Credit Hours : 1+2**
IV. **Aim of the course**

Understanding the concept of gene cloning and expression.

V. **Theory**

Unit I

Cloning vectors- plasmids, Phages, Cosmids, BAC, YAC, Expression vectors-viral, baculo and yeast vectors, Shuttle vectors.

Unit II

Restriction, ligation, Transformation and recombinant selection methods, Construction of genomic and cDNA library, Construction of full length cDNA, Preparation of probe, Nick translation, Random hexamer and nick translation.

Unit III

Linkers, Adapters and cassettes, Screening the library.

Unit IV

Expression of genes, Prokaryotic and eukaryotic expression, Identification of recombinant proteins, Purification of expressed protein.

VI. **Practicals**

- Preparation of vector
- Restriction enzyme digestion of vector
- Preparation of target DNA and Purification of DNA
- DNA ligation
- Preparation of electro competent cells
- Transformation
- Calculation of transformation efficiency
- Screening by colony PCR
- Selection of recombinant by insert release
- Induction of expressed protein
- Purification of expressed protein
- SDS-PAGE
- Western blotting.

VII. **Suggested Readings**

- Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA and Struhl K. 2002.
  Short Protocols in Molecular Biology. Wiley

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Cloning vectors- plasmids, phages, cosmids, BAC, YAC	1-2
2.	Expression vectors- viral, baculo and yeast vectors, shuttle vectors.	3-4
3.	Restriction, ligation, transformation	5-6
4.	Recombinant selection methods	7
5.	Construction of genomic and cDNA library	8
6.	Construction of full length cDNA	9
7.	Preparation of probe	10
8.	Nick translation random hexamer and nick translation	11
9.	Linkers, adapters, Cassettes,	12
10.	Screening the library	13
11.	Expressions of genes, prokaryotic and eukaryotic expression	14-15
12.	Identification of protein, Purification of expressed protein	16
Practical		
1.	Preparation of vector	1-2
2.	Restriction enzyme digestion of vector	3
3.	Preparation of target DNA and Purification of DNA	4-5
4.	DNA ligation	6
5.	Preparation of electro competent cell	7-8
6.	Transformation	9
7.	Calculation of transformation efficiency	10
8.	Screening by colony PCR	11-12
9.	Selection of recombinant by insert release	13-14
10.	Induction of expressed protein	15-16
11.	Purification of expressed protein	17-19
12.	SDS-PAGE	20-21
13.	Western blotting	22-23

I. **Course Title : Functional Genomics and Proteomics**

II. **Course Code : BTY 702**

III. **Credit Hours : 3+0**

IV. **Aim of the course**

Understanding the principles of functional genomics and proteomics

V. **Theory**

Unit I

Overview of Mammalian Genome: Mitochondrial genome, Protein coding genes, RNA genes and repeat sequences, Variations in the mammalian genome, Expression of mammalian genome.

Unit II

Overview of Mammalian Transcriptome: Different methods to study gene expression, Single gene analysis, Northern blots, Quantitative PCR, SAGE, MPSS and SSH,

Introduction to basic microarray technology, Design of microarray.

Unit III experiments,Types of Methods to study the mammalian Genome: Chromosome number evolution in mammalian species, Chromosome territory, Karyotyping, FISH and Spectral karyotyping, Next Generation sequencing platforms chemistries and their applications, Mutation detection methods for single gene and genome wide scale.

Unit IV

Databases such as NCBI, EBI, Nucleotide, Genome, SNP, Gene, Unigene, Homologene, Protein, etc. under NCBI. Service databases under EBI. Genome browsers, The concept of Comparative genomics, Genome BLAST and BLAT. Proteomics technology, Identification and analysis of proteins by 2D analysis, Mass spectrophotometery, Circular Dischorism, Fluorescence Spectroscopy, NMR and X- ray crystallography, MALDI-TOF, Differential display proteomics, Protein -protein interaction, Yeast two hybrid system and phage display.

VI. Suggested Reading

- Gibson G and Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.
- Primrose SB and Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell.
- Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II Wiley- CVH.

S. No.	Topic	No. of Lectures
1.	Overview of Mammalian Genome: Mitochondrial genome	1
2.	Protein coding genes	2
3.	RNA genes and repeat sequences	3
4.	Variations in the mammalian genome	4
5.	Expression of mammalian genome	5
6.	Overview of Mammalian Transcriptome	6
7.	Different methods to study gene expression	7-8
8.	Single gene analysis, Northern blots, Quantitative PCR	9-10
9.	SAGE, MPSS and SSH	11-12
10.	Introduction to basic microarray technology, Design of experiments	13-14
11.	Types of microarray	15-16
12.	Mammalian Genome- Chromosome number, evolution in	

I. **Course Title : Advances in Cell and Molecular Biology**
II. **Course Code : BTY 703**
III. **Credit Hours : 2 + 0**
IV. **Aim of the course**

Understanding the latest development in cell and molecular biology

V. **Theory**

Unit I

Cell chemistry and Biosynthesis pathways – Molecular motors of cell biology – Cell signalling – Signal Transduction – Chemotropic Energy Metabolism – Apoptosis pathways.

Unit II

Structure and functions of Prokaryotic and Eukaryotic Operons – Recombination and Genetic variability – Regulation of Gene Expression – Strategies of nuclear Transport – Carrier Proteins and active membrane transport methodologies.

Unit III

Protein Biosynthesis and Transportation – Protein sorting - Enzymes in Molecular Biology – Post transcriptional control strategies – Plasmids in recombinant DNA technology.

Unit IV

RNA interference technology – Insights into Nanobiology – Biosensors – DNA Microarray – Peptide Synthesis – Reverse Genetics.

VI. **Suggested Readings**

- Lewin B. 2008. *Gene IX*. Jones and Bartlett.
- Primrose SB. 2001. *Molecular Biotechnology*. Panima.
- Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific

S. No.	Topic	No. of Lectures
1.	Cell chemistry and biosynthesis pathway	1
2.	Molecular motors of cell biology	2
3.	Cell signalling	3
4.	Signal transduction	4
5.	Chemotropic energy metabolism	5
6.	Apoptosis pathways	6

I. **Course Title : Diagnostic Platform**

II. **Course Code : BTY 704**

III. **Credit Hours : 1 + 1**

IV. **Aim of the course**

Understanding the concept of various diagnostic platforms.

V. **Theory**

Unit I

History and evolution of diagnostic platforms- Methods for identifying agents for infection or disease- Point-of-care assays- Point-of-care assays based on proteins- point-of-care assays based on nucleic acids, Principles for specific identification of the analytes or clinical parameters - Various assays for different platform.

Unit II

Catridges- Polymer catridges- Catridge based *in-vitro* diagnostics- Microfluidics/ nanotechnology sensors- Complexity and diversity of samples- Sample preparation- extraction of DNA/ RNA- PCR for marker DNA sequence- POC based on microfluidic chips.

Unit III

Detection principles- Colorimetric- Optical, Electrochemical, Magnetic, Mechanical protein detection methods- Sensitive sensing principles- NASBA- RPA- LAMP with QUASR- Integrated microfluidic system.

Unit IV

Instrumentation for point of care diagnostic platform- Blood protein

analyses, the Afinion platform from Axis-Shield- The Verigene ® System by Nanosphere- Cepheid's GeneXpert cassette- NorChip- use of smart phone apps for real time monitoring and analysis.

VI. Practicals

- DNA/ protein extraction
- RNA extraction
- Polymerase chain reaction
- NASBA
- RPA
- LAMP
- Microfluidic assay

VII. Suggested Readings

- *Diagnostic Devices with Microfluidics*. 1st Edition. Francesco Piraino, Šeila Selimoviæ. CRC Press
- *Point-of-Care Diagnostics on a Chip*. David Issadore Robert M. Westervelt

S.No.	Topic	No. of Lectures/Practicals
Theory		
1.	History and evolution of diagnostic platforms	1
2.	Methods for identifying agents for infection or disease, point-of-care assays	2
3.	Point-of-care assays	3
4.	Principles for specific identification of the analytes or clinical parameters, various assays for different platform	4
5.	Catridges, polymer catridges- catridge based *in-vitro* diagnostics	5
6.	Microfluidics/ nanotechnology sensors, complexity and diversity of samples	6
7.	sample preparation, extraction of DNA/ RNA, PCR for marker DNA sequence	7
8.	POC based on microfluidic chips	8
9.	Detection principles- colorimetric- optical, electrochemical, magnetic	9
10.	Detection principles- colorimetric- optical, electrochemical, magnetic, mechanical protein detection methods	10
11.	Sensitive sensing principles- NASBA- RPA- LAMP with QUASR	11
12.	Integrated microfluidic system	12
13.	Instrumentation for point of care diagnostic platform	13
14.	Blood protein analyses, the Afinion platform from Axis-Shield	14
15.	The Verigene ® System by Nanosphere- Cepheid's	

GeneXpert cassette 15

16. NorChip, use of smart phone apps for real time monitoring and analysis 16-17

Practical

1. DNA/ protein extraction 1-2
2. RNA extraction 3-4
3. Polymerase chain reaction 5-7
4. NASBA 8
5. RPA 9
6. LAMP 10-11
7. Microfluidic assay 12-13

I. **Course Title : Gene Manipulation and Genome Editing**

II. **Course Code : BTY 705**

III. **Credit Hours : 2 + 0**

IV. **Aim of the course**

Understanding the various method of gene manipulation and genome editing.

V. **Theory**

Unit I

Genome Overview: Genetic architectures of model organisms: yeast, *C. elegans*, Drosophila, Mouse, Human, Chromosomal and Genomic overviews of cattle, buffalo, sheep, goat, pigs and poultry.

Unit II

Tools to characterize transgene: Identification and characterization of suitable transgene. Vectors used to clone and expression of foreign gene in prokaryotic and eukaryotic systems. Different types of promoters for tissue specific expression of transgene. Detection of transgene in the new-born.

Unit III

Methods of gene transfer: Microinjection of recombinant DNA into fertilized eggs/ stem cells, Transfection of DNA totipotent kerato-carcinoma cells, Electroporation, gene transfer into cultured cells.

Unit IV

Genome editing tools: Zinc finger, TALEN and CRISPR: Their discovery, Types and their mechanism. Applications of these tools for *in vivo* genome engineering. Mono allelic and biallelic gene editing. Screening for genome editing process in cells/ animals. Applications of these tools in animal science for genetic studies, therapeutic potential and transgenic animal as bioreactors. Recent examples of genome edited animals and their applications in animal science.

VI. Suggested reading

- *Human genome editing science, ethics and governance*

S. No.	Topic	No. of Lectures
1.	Genetic architectures of model organisms: yeast, *C. elegans*, *Drosophila*, Mouse, human	1-2
2.	Chromosomal and Genomic overviews of cattle, buffalo, yak, Mithun, sheep and goat	3-4
3.	Chromosomal and Genomic overviews of pigs and poultry genome	5
4.	Identification and characterization of suitable transgene	6
5.	Vectors used to clone and expression of foreign gene in prokaryotic systems.	7-8
6.	Vectors used to clone and expression of foreign gene in eukaryotic systems.	9-10
7.	Different types of promoters in prokaryotes and eukaryaotes for tissue specific expression of transgene	11-12
8.	Detection of transgene in the new-born	13
9.	Microinjection of recombinant DNA into fertilized eggs/ stem cells	14-16
10.	Transfection of DNA totipotent/ ES cells and kerato-carcinoma cells,	17-18
11.	Electroporation, gene transfer into cultured mammalian cells.	19-21
12.	Zinc finger and TALEN types and their mechanism	22
13.	CRISPR types and their mechanism	23-24
14.	Applications of these tools for *in vivo* genome engineering.	25
15.	Mono allelic and biallelic gene editing	26
16.	Screening for genome editing process in cells/ animals.	27
17.	Applications of these tools in animal science for genetic studies, therapeutic potential and transgenic animal as bioreactors.	28
18.	Recent examples of genome edited animals and their applications in animal science	29-30

I. Course Title : Trends in Vaccinology

II. Course Code : BTY 706

III. Credit Hours : 2+1

IV. Aim of the course

Understanding the current trends in vaccine production technologies.

V. Theory

Unit I

Immunity against veterinary infectious agents: Bacteria, Virus, fungi and parasites; Immunoinformatics and its application to epitope mapping of pathogens, etc.; Advancement in vaccinology: Vaccinomics, Adversomics, Systems Vaccinology, reverse vaccinology, Structural Vaccinology and computational vaccinology and its applications.

Unit II

Current trends in vaccine development against animal pathogens; Molecular approaches for vaccine development including: recombinant peptide vaccines, vectored vaccines, Marker vaccines, DNA vaccines, genetically manipulated live vaccines, etc.; Plant expression system based vaccines, idiotype and synthetic peptide based vaccines.

Unit III

Vaccines and Immunotherapeutic for Treating Non-Infectious Diseases: Cancer; obesity, neurodegenerative diseases, addictions, atherosclerosis, etc.; DIVA Vaccines for animal disease; Vaccines for emerging human and animal diseases; Novel immunomodulators and vaccine delivery systems: Immunomodulators including cytokines and new adjuvants; delivery of immunogens through liposomes, microspheres, ISCOMS, nanotechnology based vaccine delivery, etc.

Unit IV

Vaccine formulation: pharmacopeia requirements; Vaccine qualities and its control; Large scale vaccine production technology: cost effectiveness of preventive immunization programmes; Stages of development of vaccine; Clinical trials of vaccine and its regulation; Commercial vaccines available against animal pathogens, its characteristics and immunization schedule; Vaccine stability, Preservation and vaccination failure; Environmental concerns with the use of recombinant vaccines.

VI. Practicals

- Purification of immunoglobulins: gel filtration and ion exchange chromatography
- Hybridoma technique for monoclonal antibody production
- Preparation of gene construct for recombinant and nucleic acid vaccine
- Expression of gene encoding immunogenic protein in prokaryotic/ yeast/ animal cell culture system
- Study of immune response against recombinant vaccine
- Use of modern adjuvants in vaccines
- Isolation and characterization of antigens from viruses, bacteria
- Immunoassays: ELISA, FAT, RIA

VII. Suggested Reading

- Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthc.

S. No.	Topic	No. of Lectures/ Practicals
1	Immunity against veterinary infectious agents: bacteria, virus, fungi and parasites	1-3
2	Immunoinformatics and its application to epitope mapping of pathogens, etc.	4
3	Advancement in vaccinology: Vaccinomics and Adversomics	5
4	Systems Vaccinology and Reverse vaccinology	6-7
5	Structural Vaccinology, computational vaccinology and its applications	8
6	Current trends in vaccine development against animal pathogens	9
7	Molecular approaches for vaccine development including: recombinant peptide vaccines, vectored vaccines, Marker vaccines, DNA vaccines, genetically manipulated live vaccines, etc.	10-12
8	Plant expression system based vaccines	13
9.	Idiotype and synthetic peptide based vaccines	14
10.	Vaccines and Immunotherapeutic for treating non-infectious Diseases: Cancer; obesity, neurodegenerative diseases, addictions, atherosclerosis, etc.	15-16
11.	DIVA Vaccines for animal disease	17
12.	Vaccines for emerging human and animal diseases	18
13.	Novel immunomodulators: Immunomodulators including cytokines and new adjuvants	19-20
14.	Novel vaccine delivery systems: delivery of immunogens through liposomes, microspheres, ISCOMS, nanotechnology basedvaccine delivery, etc.	21-23
15.	Vaccine formulation: pharmacopeia requirements	24
16.	Vaccine qualities and its control	25
17.	Large scale vaccine production technology: cost effectiveness Of preventive immunization programmes	26
18.	Stages of development of vaccine, clinical trials of vaccine and its regulation	27
19.	Commercial vaccines available against animal pathogens, its characteristics and immunization schedule	28-29
20.	Vaccine stability, preservation and vaccination failure	30-31
21.	Environmental concerns with the use of recombinant vaccines	32

Practical

1. Purification of immunoglobulins: gel filtration and ion exchange

chromatography 1-2
2. Hybridoma technique for monoclonal antibody production 3-4
3. Preparation of gene construct for recombinant and nucleic acid vaccine. 5
4. Expression of gene encoding immunogenic protein in prokaryotic/ yeast/animal cell culture system. 6
5. Study of immune response against recombinant vaccine. 7-8
6. Use of modern adjuvants in vaccines 9
7. Isolation and characterization of antigens from viruses, bacteria, 10
8. Immunoassays: ELISA, FAT, RIA 11

I. **Course Title : Advances in Bioinformatics**
II. **Course Code : BTY 707**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To impart an introductory knowledge about the subject of Bioinformatics to the students studying any discipline of science.

V. **Theory**

Unit I

Introduction to Computational Gene Prediction and Genome annotation Basic concepts in Computational Phylogenetic Analysis, Super trees, consensus trees, tree compatibility. Algorithms for evaluating the tree space; Markov Chain Monte Carlo, genetic algorithms. Evaluation of results from phylogentic analyses, phylogenetic dating Genome annotation; Gene networks (basic concepts). Completed genomes and bioinformatics approaches to analyze the genomes of Viruses, Bacteria and animals.

Unit II

DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools (especially clustering approaches). Methods of Genome sequencing, EST, STS, GSS database and their generation, Whole Genome comparison, RNA folding, RNA loops, conformational study, Whole genome analysis, Whole genome regression and prediction methods, Trasncriptome analysis and its applications, Animal QTL databases and SIGENAE analysis of breeding animals genome.

Unit III

Transcriptome and Proteome- General Account; Tools of proteome analysis, Motifs and Folds; Protein structure related databases, Protein Data Bank format, Concepts of B-factor and R-

factor, Protein Structural Alignment and Superposition, Structure visualization of proteins. Protein Fold Classification, Protein structure comparison, CATH and SCOP Databases. Protein structure prediction methods. Homology modeling. Molecular Docking and Drug design (Basic concepts) Molecular dynamics and simulation study of protein, Force field concepts.

Unit IV

Protein identification and characterization:- AA CompIdent, TagIdent, PepIdent and MultiIdent, PROSEARCH, PepSea, PepMAPPER, FindPept, introduction to the concept of chemoinfromatics, metabolomics and immunoinfromatics.

VI. Practicals

- Gene annotation
- Phylogenetic tree construction
- RNA folding
- Genome database searching
- Protein folding and structure predictions
- Analysis of 3D structure of protein using RasMol through command line.
- Molecular Docking of protein and ligand by HEX.
- Analysis of 3D structure of protein and nucleic acid using Cn3D.
- QTL databases

VII. Suggested Readings

- Attwood TK and Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Education.
- Rastogi SC, Mendiratta N and Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Introduction to Computational Gene Prediction and Genome annotation	1
2.	Basic concepts in Computational Phylogenetic Analysis, Phylogenetic dating genome annotation; Gene networks	2
3.	Completed genomes and bioinformatics approaches to analyze the genomes of Viruses, Bacteria and Animals	3-4
4.	Understanding of microarray data and correlation of gene Expression data to biological processes and computational analysis tools	5
5.	Methods of Genome sequencing, EST, STS, GSS database Whole Genome comparison	6-7
6.	RNA folding, RNA loops, conformational study and specialized RNA databases	8

7. Whole genome analysis, whole genome regression and prediction methods 9
8. Trasncriptome analysis and its applications, Animal QTL databases and SIGENAE analysis of breeding animals genome 10
9. Tools of proteome analysis, Motifs and Folds; Protein structure related databases, Protein Data Bank format, Concepts of B-factor and R-factor, 11
10. Protein Structural Alignment and Superposition, Structure visualization of proteins. Protein Fold Classification, Protein structure comparison, CATH and SCOP Databases. Protein structure prediction methods. Homology modeling 12-13
11. Molecular Docking and Drug design (Basic concepts) Molecular dynamics and simulation study of protein, Force field concepts 14
12. Protein identification and characterization 15
13. Introduction to the concept of chemoinformatics, metabolomics and immunoinformatics 16

Practical

1. Gene annotation, sequence retrieval specialized searches 1-3
2. Phylogenetic tree construction and phylogenetic dating 4-5
3. RNA folding, RNA secondary structure prediction, DNA Secondary structure prediction 5-6
4. Genome database searching, conting preparation 7
5. Protein folding and structure predictions 8
6. Analysis of 3D structure of protein using RasMol through command line 9
7. Molecular Docking of protein and ligand by HEX 10
8. Analysis of 3D structure of protein and nucleic acid using Cn3D 11
9. QTL databases 12

I. **Course Title : Advances in Reproductive Biotechnology**
II. **Course Code : BTY 708**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

Understanding the reproductive techniques in farm animals

V. **Theory**

Unit I

Micromanipulation of embryos and gametes, Somatic Cell Nuclear Transfer(SCNT),
nuclear reprogramming, Transgenic animal production, Combining Transgenic and SCNT, Gene targeting, Genome editing and

disease modeling.

Unit II

In vivo Vs *in-vitro* production of embryos, Embryos quality, Transcriptomics, Metabolomic approach, Sperm sexing technologies and their application, Preimplantation genetic diagnosis and screening, Epigenetic reprogramming, Large offspring syndrome.

Unit III

Sources of stem cells, Embryonic stem cells, Spermatogonial stem cells, Induced pluripotent stem cells, Stem cells application in regenerative medicine and disease therapeutics.

Unit IV

Social, Ethical, Religious and regulatory issues related to assisted reproductive technology, Transgenic and stem cells therapy.

VI. Practicals

- Micro assisted fertilization- ICSI
- Embryo biopsy for PGD and sexing
- Sperm quality analysis by flow cytometry
- Embryo quality analysis
- SCNT protocol
- Isolation and characterization of embryonic stem cells
- Gene expression in sperm and embryos

VII. Suggested Reading

- Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Micromanipulation of embryos and gametes, Somatic cell nuclear transfer (SCNT) and Nuclear reprogramming	1-3
2.	Transgenic animal production and SCNT	4-5
3.	Gene targeting	6
4.	Gene editing and disease modelling	7-8
5.	*In vivo vs in-vitro* embryos	9-10
6.	Embryos quality – Transcriptomics, Metabolomic approach	11-13
7.	Sperm sexing technologies and their applications	14-15
8.	Pre implantation genetic diagnosis and screening	16-17
9.	Epigenetic reprogramming	18
10.	Large offspring syndrome	19-20
11.	Source of stem cells, embryonic stem cells, spermatogonial stem cells	21-23
12.	Induced pluripotent stem cells	24-25

13. Stem cells application in regenerative medicine and diseases therapeutics 26
14. Social, ethical, religious and regulatory issues related to assisted reproductive technology 27
15. Transgenic and stems cells therapy 28

Practical

1. Micromanipulator, micro assisted fertilization, ICSI protocol 1-2
2. Embryo biopsy- sexing 3-4
3. Sperm preparation and sperm quality analysis by flow cytometry 5-6
4. Embryo quality analysis- Morphological assessment and Staining technique 7-8
5. SCNT protocol- enucleation, somatic cell injection, fusion Activation and embryo culture 9-10
6. Isolation of inner cell mass from blastocyst, culture and characterisation of embryonic stem cells 11
7. Gene expression in sperm and embryos 12

I. **Course Title : Advances in Animal Cell Culture**
II. **Course Code : BTY 709**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

Understanding the latest development in animal cell culture

V. **Theory**

Unit I

Development of cell lines using various methods, Characterization of cell lines by morphology, Chromosome analysis, DNA content, Isoenzyme analysis and antigenic markers, DNA fingerprinting.

Unit II

Setting of new cell culture lab, Detection methods for cell culture contaminants, Three dimensional culture- classification of 3D culture methods and microfluidics, Tissue engineering- types of cells, Scaffold materials, Bioprinting, Bioartificial organs, Flow Cytometry and its applications in cell culture.

Unit III

DNA transfer by viral and non viral methods, Expression of recombinant proteins in mammalian and avian cell lines.

Unit IV

Monoclonal antibody production and characterization, Up-stream and downstream processing of cell culture based vaccines, Diagnostic antigens and other pharmaceutical agents, Cell culture fermentors.

VI. Practicals

- Primary and secondary mammalian cell culture
- Development of transformed cells
- Characterization of cell lines by karyotyping
- Transfection of cells with recombinant DNA
- Expression of recombinant proteins
- Scaling-up of cultures
- Flow Cytometry
- Immunization of mice
- Maintenance of myeloma cell lines
- Fusion
- Characterization of mAbs

VII. Suggested Readings

- Freshney RI. 2005. *Culture of Animal Cells*. Wiley Liss.
- Portner R. 2007. *Animal Cell Biotechnology*. Humana Press

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Development of cell lines using various methods	1-2
2.	Characterisation of cell lines by morphology	3
3.	Characterisation of cell lines by chromosome analysis	4
4.	Characterisation of cell lines by DNA content, isoenzyme analysis and antigenic markers	5-6
5.	Characterisation of cell lines DNA fingerprinting	7
6.	Setting of new culture lab	8
7.	Detection methods for cell culture contaminants	9-10
8.	Classification of 3D culture methods and micro fluidics	11-12
9.	Tissue engineering- types of cells, scaffold materials, bio printing, bio artificial organs,	13-14
10.	Flow Cytometry and its applications in cell culture	15
11.	DNA transfer by viral and non viral methods	16
12.	Expression of recombinant proteins in mammalian and avian cell lines	17-18
13.	Monoclonal antibody production and characterisation	19-20
14.	Upstream and downstream processing of cell culture based vaccines, diagnostic antigens and other pharmaceutical agents	21-23
15.	Cell culture fermentors	24
Practical		
1.	Primary and secondary mammalian cell culture	1
2.	Development of transformed cells	2
3.	Characterization of cell lines by karyotyping	3

4. Transfection of cells with recombinant DNA 4
5. Expression of recombinant proteins 5
6. Scaling-up of cultures 6
7. Flow Cytometry 7
8. Immunization of mice 8
9. Maintenance of myeloma cell lines 9
10. Fusion 10
11. Characterisation of Mabs 11

I. **Course Title : Industrial Biotechnology**
II. **Course Code : BTY 710**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

Understanding the fermentation process and Bioenergy system.

V. **Theory**

Unit I

Introduction to fermentation process- Microbes and enzymes of industrial importance- screening and genetic improvement of industrially important microorganisms, Microbial metabolites- Microbial growth, Substrate degradation and product formation – Recombinant products.

Unit II

Fermentation systems -Batch culture, Continuous culture, Fed-batch culture, Kinetics of growth and product formation, Design of a fermenter, Basic functions of a fermenter for microbial or animal cell culture, Aseptic operation and containment, Construction and components, Types of fermenters, Fermenters for animal cell culture, Sterilization of reactor.

Unit III

Media for industrial fermentations: Typical media, Medium formulation, Precursors and metabolic regulators, Antifoams. Upstream and Downstream processing- Filtration, Centrifugation, Cell disruption, Liquid-liquid extraction, Chromatography, membrane processes, Drying, Crystallization, Whole broth processing.

Unit IV

Bioenergy- Gaseous fuels: Biohydrogen, Biomethane and Microbial fuel cell; Liquid fuels: Bioethanol, Biodiesel and Biobutanol, Aerobic and Anaerobic wastewater treatment processes—Single cell protein production -Metal leaching- Industrial chemicals- Food additives –Food supplements -Health care products.

VI. **Practicals**

- Isolation of Industrially important enzyme producing

microorganisms
- Strain improvement
- Bioreactor operation
- Production of Industrial compounds, enzymes
- Downstream processing- Filtration, Centrifugation, Cell disruption,
- Liquid-liquid extraction, Chromatography- HPLC
- Microbial fuel cell design and operation for waste water treatment

VII. Suggested Readings

- Alberghina L. 2000. *Protein Engineering for Industrial Biotechnology*. Routledge.
- Kun LY. 2006. *Microbial Biotechnology*. World Scientific.
- Singh, R and Ghosh SK. 2004. *Industrial Biotechnology*. Global Vision Publ. House.
- Thomson J. 2006. *Your Guide to Industrial Biotechnology*. Abhishek Publ.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Introduction to fermentation process, history of fermentation process	1
2.	Enzymes of industrial importance, Microbes producing Industrially important enzymes	2
3.	Screening of microbes for enzyme production	3
4.	Genetic improvement of microorganism for improved production	4-5
5.	Microbial growth studies and their metabolites-primary and secondary	6
6.	Product formation by substrate degradation	7
7.	production of recombinant products	8
8.	Batch, continuous and fed batch fermentation	9-10
9.	Kinetics of growth and product formation	11-12
10.	Design of a fermenter, basic functions, types of fermente	13
11.	Animal cell culture by using bioreactors, Fermenters for Animal cell culture	14
12.	Aseptic operation, Containment, Sterilization	15-16
13.	Medium formulation, precursors, metabolic regulators, antifoams	17-18
14.	Upstream and down stream processing	19
15.	Filteration, Centrifugation	20
16.	Extraction, Chromatography, membrane process	21-22
17.	Drying crystallization, whole broth processing	23-24

18. Bioenergy production 25
19. Biohydrogen, biomethane, biodiesel and biobutanol production 26
20. Microbial fuel cells 27
21. Aerobic treatment of waste water 28
22. Anaerobic waste water treatment 29
22. Singel cell protein production, Metal leaching 30
23. Food additives 31
24. Food supplements and health care products 32

Practical

1. Isolation of industrially important enzyme producing microorganism 1
2. Screening for enzyme production 2
3. Extraction and characterization of enzymes 3
4. Enzyme kinetics 4
5. Strain improvement by different methods 5
6. Bioreactor operation 6
7. Optimiisation of enzyme and industrial compounds production using bioreactor 7
8. Filteration 8
9. Cell disruption 9
10. Chromatography 10-12
11. Microbial fuel cell design 13
12. Optimisation of electrodes, catholyte 14
13. Waste water treatment 15-16

I. **Course Title : Rumen and Feed Biotechnology**
II. **Course Code : BTY 711**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

Understanding the rumen ecosystem and manipulation of rumen microbes.

V. **Theory**

Unit I

Rumen ecosystem – Classification of rumen microbes – Isolation – Cultural characters – Rumen fermentation – Techniques to increase production of rumen microbes – Metabolic inter-relationship between rumen microbes.

Feed processing and preservation, Microbial bioconversion of lignin and cellulose rich feeds -Factors affecting delignification, Large scale bioconversion of substrates, Pretreatment of feeds, Chemical vs microbial treatment of feeds, Anti-nutritional factors

present in feeds, Microbial detoxification of aflatoxins, Mimosine and other anti-metabolites present.

Unit III

Manipulation of rumen methane production – Addition of methane inhibitors.– Non-genetic manipulation of rumen microbes – Addition of antibiotics, Selective defaunation, Addition of fats, Addition of protein degradation protectans, Addition of buffer substances – Rumen escape proteins.

Unit IV

Genetic manipulation of rumen microflora to improve feed utilization -Manipulation of rumen microbes by recombinant DNA technology – Inter species H_2 transfer and its importance –Single cell protein (SCP) as animal feed-Rumen metagenomics- Methods of studying rumen metagenome-Conventional cloning and sequencing of metagenomic DNA-NGS based shot gun sequencing – Amplicon sequencing of 16 S/ 18S rRNA hyper variable regions – Bioinformatics analysis of metagenomic sequence data Use of probiotics-Microorganisms and proteins used as probiotics, Mechanism of action of probiotics, Immune response to probiotics, Anti-mutagenicand anti-tumour activities of probiotics.

VI. Practicals

- Introduction to feeds and fodders for ruminants
- Estimation of proximate principles, Fibre fractions in concentrates and roughages
- Methods for evaluating rumen fermentation parameters
- Sampling of rumen contents – Microbial and protozoal count – Fixing and stainingof rumen protozoa and bacteria
- Estimation of rumen fermentation parameters-pH, Rumen NH3-N, Lactic acid
- *In-vitro* Gas Production Test -(IVGPT)
- Rumen liquor analysis – Total volatile fatty acids – Individual volatile fatty acids- Ammonia Nitrogen
- TCA precipitable Nitrogen-Methane production
- Rumen microbial enzyme assay
- Isolation of DNA from rumen samples
- Rumen metagenome and Bioinformatics analysis of metagenomic sequence data

VII. Suggested Readings

- Huffnagle GB and Wernick S. 2007. *The Probiotics Revolution: The Definitive Guide to Safe, Natural Health*. Bantam Books.
- Kalidas S, Paliyath G, Pometto A and Levin RE. 2004. *Functional Foods and Biotechnology*.
  CRC Press.

- Roger A. 1989. *Food Biotechnology*. Cambridge Univ. Press.
- Hobson PN and Stewart CS. 1997. *The Rumen Microbial Ecosystem*.

S. No.	Topic	No. of Lectures/Practicals

Theory

1. Rumen ecosystem – Classification of rumen microbes 1-2
2. Isolation and Cultural characters of rumen microbes 3-4
3. Rumen fermentation – Techniques to increase production of rumen microbes 5-6
4. Metabolic inter-relationship between rumen microbes 7
5. Feed processing and preservation, microbial bioconversion of lignin and cellulose rich feeds -Factors affecting delignification, large scale bioconversion of substrates 8-9
6. Pretreatment of feeds, chemical vs microbial treatment of feeds, anti-nutritional factors present in feeds 10-11
7. Microbial detoxification of aflatoxins, mimosine and other anti-metabolites present. 12-13
8. Manipulation of rumen methane production – addition of Methane inhibitors 14-15
9. Non-genetic manipulation of rumen microbes – addition of antibiotics, selective defaunation, addition of fats, addition of protein degradation protectans, addition of buffer substances – Rumen escape proteins. 16-17
10. Genetic manipulation of rumen microflora to improve feed utilization -Manipulation of rumen microbes by recombinant DNA technology 18-19
11. Inter species H_2 transfer and its importance –Single cell protein (SCP) as animal feed 20
12. Rumen metagenomics-Methods of studying rumen metagenome-conventional cloning and sequencing of metagenomic DNA 21-22
13. NGS based shot gun sequencing – amplicon sequencing of 16S/ 18S rRNA hyper variable regions 23-24
14. Bioinformatics analysis of metagenomic sequence data 25-26
15. Use of probiotics-Microorganisms and proteins used as probiotics 27-28
16. Mechanism of action of probiotics, immune response to probiotics. 29-30
17. Anti-mutagenic and anti-tumour activities of probiotics. 31-32

Practical

1. Introduction to feeds and fodders for ruminants 1
2. Estimation of proximate principles in concentrates and roughages 2

3. Estimation of fibre fractions in concentrates and roughages 3
4. Methods for evaluating rumen fermentation parameters 4
5. Sampling of rumen contents – Microbial and protozoal count 5
6. Fixing and staining of rumen protozoa and bacteria 6
7. Estimation of rumen fermentation parameters-pH, Rumen NH3-N, Lactic acid 7
8. *In-vitro* Gas Production Test (IVGPT) 8
9. Rumen liquor analysis – Total volatile fatty acids – Individual volatile fatty acids – Ammonia Nitrogen 9
10. TCA precipitable Nitrogen-Methane production 10
11. Rumen microbial enzyme assay 11
12. Collection,isolation and quality check of DNA from rumen samples 12
13. Rumen metagenome and Bioinformatics analysis of metagenomic sequence data 13

List of Journals

- *Animal Biotechnology*
- *Animal Genetics*
- *Animal Reproduction*
- *Cellular and Molecular Probe*
- *Current Science*
- *Genome Research*
- *Indian journal of Microbiology*
- *Journal of Clinical Microbiology*
- *Journal of Dairy Science*
- *Journal of Reproduction and Fertility*
- *Methods in Virus Research*
- *Nature*
- *Nature Biotechnology*
- *Nature Genetics*
- *Nucleic Acid Research*
- *PNAS*
- *Reproduction in Domestic Animals Science*
- *Theriogenology*
- *Trends in Biotechnology*
- *Trends in Genetics*
- *Viral Research*

e-Resources

www.cls.casa.colostate.edu/TransgenicCrops/teacherlinks www.hpc.unm.edu/~aroberts/main/top5%25.htm www.isaaa.org www.ciat.cgiar.org/biotechnology/cbn/gines_mera_fund.htm www.scidev.net/en/agriculture-and-environment/agri-biotech/links/publications- andinformation-services

www.biotechinstitute.org/programs/t_leader_program.html
www.sci-ed-ga.org/modules/dna/analogies.html
www.accessexcellence.org/AE/AEPC/WWC/1993
www.atschool.eduweb.co.uk/trinity/bio2.html
www.pub.ac.za/resources/teach.html
www.bio-link.org/biomaterial.htm
www.biotechnology.gov.au/index.cfm?event=object.showContent B35A914C-DE3D-1A59-79F89FAA26F54E44and objectID=
www.monsanto.com/products/techandsafety/technicalpubs/eduwebsites.asp
www.ejbiotechnology.info/content/vol5/issue3/teaching/01/index.html
www.ncbiotech.org/resource_center/for_educators/online_teaching_resources.html www.ias.ac.in/currsci/dec252006/1594
www.cccoe.k12.ca.us/stsvcs/newteacher/rop/curr_rop_links2.html
www.scielo.cl/scielo.php?pid=S0717-34582003000100004 and script=sci_arttext
www.sunysb.edu/ligase/Forstudents/BiotechTeachingCenter/biotechcenter.html www.ca.uky.edu/agc/pubs/brei/brei3tg/brei3tg.htm
www.aggie-horticulture.tamu.edu/tisscult/biotech/biotechteach.html
www.ejbiotechnology.info/content/vol6/issue2/issues/2/index.html
http://science.nhmccd.edu/biol/bio1int.htm#dna
http://nhscience.lonestar.edu/biol/bio1int.htm
www.ingentaconnect.com/content/tandf/tsed/2000/00000022/00000009/art00007 www.buildingbiotechnology.com/free.php
www.biotechnologist2020.com/2008/04/teaching-jobs-in-bioinformatics.html
www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ613711
www.uq.edu.au/teaching-learning/index.html?page=61920
www.nature.com/nbt/journal/v18/n9/full/nbt0900_913b.html
www.fotodyne.com/literature/datasheets/E10700
www.biotethics.org/conferences/maastricht/partecipants.html
www.brookes.ac.uk/studying/courses/postgraduate/2008/biotech
www.bioweb.usc.edu/courses/2003-spring/documents/bisc406-notes_011603
www.agen.ufl.edu/~chyn/age2062/lect/lect_09/lect_09.htm
www.bioinformaticscourses.com/BIOL358/lectures.html
www.isis.vt.edu/~nstone/LifeSci/lect5.html
www.nwo.nl/nwohome.nsf/pages/NWOA_6Y2LGH_Eng
www.soi.wide.ad.jp/class/20040016
www.sciencetech.technomuses.ca/english/schoolzone/biotech.cfm
www.freevideolectures.com/biotech.html
www.agen.ufl.edu/~chyn/age4660/lect/lect_07/lect_07.htm

www.web.mit.edu/cheme/news/frontiers_2005.html

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Biotechnology

- Origin and evolution of cells, Chemical components of a cell, Structural organization and different organelles of the cell, various techniques used to study cells. Cell Membrane transport, Nuclear transport, protein synthesis and sorting to different cellular destinations, lipid synthesis and sorting, catalysis and use of energy by cells, Electron transport chain, chemiosmotic coupling, Transport of metabolites across the inner mitochondrial membrane, mechanism of muscle contraction, cell crawling, functions of keratin and neurofilaments, organelle transport and separation of mitotic chromosome.
- Cell signaling, Feedback, crosstalk and networks of cellular signal transduction, steroid hormones and the steroid receptor super family, Gated ion channels, Neurotransmitters, Receptor Protein Kinases, Cytokine Receptors and Non receptor Protein Kinases, The JAK/ STAT Pathway, G Protein-Coupled Receptors, Second Messengers and Protein Phosphorylation – cyclic AMP, Cyclic GMP, Phospholipids and Ca^{2+}, Integrins and Signal Transduction, Regulation of the Actin Cytoskeleton, Hedgehog and Wingless Notch Signaling, cell cycle, regulators of cell cycle, events of M phase
- History, scope and Applications of molecular biology, Discovery and structure of DNA, RNA and proteins, Organization of prokaryotic and eukaryotic genome, Gene transfer in microorganisms, DNA replication, transcription, RNA processing, genetic code, translation in prokaryotes and eukaryotes, Regulation of gene expression. Enzymes used in molecular biology and recombinant DNA research - Cloning and Expression vector, shuttle vectors, Polymerase chain reaction and different types of PCR, Synthesis and types of Probes, Nucleic acid hybridization and blotting, Construction of gene libraries and cDNA library, Gene mapping.
- Cloning in bacteria, yeast, plant and animal cells, identification and synthesis of gene of interest, Restriction enzyme digestion, ligation, transformation, identification and enrichment of recombinant clones, expression of recombinant DNA in prokaryotic and eukaryotic vectors, strategies for purification of expressed protein. Molecular mechanism of mutation, DNA repair, site directed DNA alterations and gene manipulations, Gene editing techniques, Methods of DNA sequencing, Genetics of tumorigenic region of agrobacteria, Ethics, legal issues and safety aspects of genetic manipulation.
- History of cell culture development, Methods of sterilization, Different tissue culture techniques including primary culture, Continuous cell lines, Organ culture, Cell bank. Different types of cell culture media, Serum, growth supplements, Balanced salt solution, Serum free media, Enzymes used in cell culture, Factors affecting the growth of cells.
- Cell culture contaminants, Cryopreservation of primary culture and cell line, Cell cloning, Isolation and culturing of adult and embryonic stem cells, Types of cell culture bioreactor, Cell counting and cytotoxic assays. Hybridoma

technology and monoclonal antibody production, Applications of animal cell culture and monoclonal antibodies, Therapeutic applications of adult stem cells.

- Historical perspective of development of molecular diagnostic technology, Development and optimisation of Nucleic acid detection assays, Concept of development of group and strain specific diagnostics, Basis for selection of gene/ nucleotide sequence of pathogenic organism to target for detection, Principle of development of pathogen specific DNA probes,
- Types and applications of molecular diagnostic assays, Restriction endonuclease analysis for identification of pathogens, Blotting techniques. Signal, target and probe based amplification techniques, TBA NASBA, SSSR/ 3SR, SDA, LAMP, LCR, History, principle and Applications of PCR, Cyclic parameters in PCR, Real time PCR, Variations in PCR. Advancements in diagnostic technology platforms including DNA array technology, biosensors, Nanodiagnostics, Mass spectrometry, Molecular cloning, DNA sequencing, Bead based assays and lateral-flow device technology.

Veterinary Extension Education

DEPARTMENT OF VETERINARY AND ANIMAL HUSBANDRY EXTENSION EDUCATION

Course structure for M.V.Sc. degree programme (Semester wise)

Course no.	Course Title	Credit	Semester
EXT 601*	DEVELOPMENT PERSPECTIVES OF EXTENSION EDUCATION	2+1	II
EXT 602*	COMMUNICATION FOR LIVESTOCK DEVELOPMENT	1+1	I
EXT 603*	DIFFUSION AND ADOPTION OF INNOVATIONS	2+1	I
EXT 604	PROGRAMME PLANNING AND EVALUATION	1+1	II
EXT 605*	RESEARCH METHODOLOGY	2+1	I
EXT 606	SOCIAL PSYCHOLOGY AND GROUP DYNAMICS	1+1	II
EXT 607*	LIVESTOCK ENTREPRENEURSHIP	1+2	I
EXT 608*	HUMAN RESOURCE MANAGEMENT IN ANIMAL HUSBANDRY SECTOR	1+1	II
EXT 609	GENDER EMPOWERMENT AND LIVESTOCK DEVELOPMENT	1+0	II
EXT 610	FARM JOURNALISM	1+1	I
SSS 600*	STATISTICS FOR SOCIAL SCIENCES	2+1	I
EXT 691	MASTERS SEMINAR	1+0	I and II
EXT 699	MASTERS RESEARCH	0+30	I and II
*Compulsory Courses			

Department of Veterinary and Animal Husbandry Extension Education
Course structure for Ph.D degree programme (Semester wise)

Course no.	Course Title	Credit	Semester
EXT 701	ORGANIZATIONAL LEADERSHIP AND MANAGEMENT	2+0	II
EXT 702*	RECENT TRENDS IN RESEARCH TECHNIQUES IN SOCIAL SCIENCES	2+1	I
EXT 703*	TRAINING FOR DEVELOPMENT	1+1	I
EXT 704*	POLICIES AND REGULATIONS IN LIVESTOCK SECTOR	1+0	I
EXT 705	EDUCATIONAL TECHNOLOGY	2+1	II
EXT 706*	DYNAMICS OF SOCIAL CHANGE	2+0	I
EXT 707	MONITORING AND EVALUATION OF LIVESTOCK DEVELOPMENT PROGRAMMES	2+1	II
EXT 708	THEORY CONSTRUCTIONS IN SOCIAL SCIENCES	1+0	I
EXT 709	FACILITATION FOR DEVELOPMENT	2+1	I
EXT 710	MANAGING EXTENSION ORGANIZATIONS	2+1	II
EXT 791	DOCTORAL SEMINAR-I	1+0	I and II
EXT 792	DOCTORAL SEMINAR-II	1+0	I and II
EXT 799	DOCTORAL RESEARCH	0+75	I and II
*Compulsory Courses			

Course Contents
M.V.Sc. in Veterinary Extension Education

I. **Course Title : Development Perspectives of Extension Education**
II. **Course Code : EXT 601**
III. **Credit Hours : (2 +1)**
IV. **Aim of the courses**

- To acquaint the students with different extension approaches and their implications in animal husbandry.
- To make students realise the importance of linkages among departments and various institutions.
- To acquaint the students with the recent development in extension.

V. **Theory**

Unit I

Important concepts in extension science; various schools of thought; Critical review and reflections on the philosophy and principles of extension.

Unit II

Implications of earlier extension efforts. Emerging issues, problems and challenges of animal husbandry extension education.

Unit III

Changing approaches – ToT approach, Education Approach, Farmer Participatory Approaches (PRA, RRA, PLA, PTD, PCD, etc.), Demand Driven approach, Market led extension, FSA, Commodity Specific Approach, Market led Extension; Classification of PRA, Differences between PRA and RRA; Global concepts of extension (SAARC, BRICS, US, Japan, UK, Philippines and Israel) and its application to Indian context. Privatization of extension. Public Private Partnership.

Unit IV

Extension approaches of State and Central Governments, ICAR, SVUs/ SAUs, NGOs, corporate and other organizations. Extension Advisory Services - Meaning, Concept - Challenges in Animal Husbandry Extension Advisory Services. Extension approaches followed in current livestock development programmes, viz., Rashtriya Gokul Mission, National Livestock Mission, Rashtriya Krishi Vikas Yojana, Livestock Insurance Scheme, Livestock Health and Disease Control, Pashu Sanjivini, National Programme for Dairy Development, National Programme for Bovine Breeding, Aatmanirbhar Bharat Abhiyaan and digital

initiatives such as E-Pashudhan Haat, National Animal Disease Reporting System for livestock development, etc. Linkages between researcher-extension agent - livestock farmer-industry in the generation, Dissemination and commercialization of animal husbandry practices/ technologies.

VI. Practical

Study of the extension approaches, functions, roles, responsibilities, organizational set-up of State Animal Husbandry Department/ Livestock Development Agency/ Dairy Federation/ Rural Development agencies, Study of selected FPOs, CIGs, NGOs, SHGs, etc. Critical analysis of cases on linkage between different actors of animal husbandry sector.

VII. Suggested Reading

- Anandajayasekeram P, Puskur R, Sindu Workneh and Hoekstra D. 2008. *Concepts and practices in agricultural extension in developing countries:* A source book. IFPRI (International Food Policy Research Institute), Washington, DC, USA, and ILRI (International Livestock Research Institute), Nairobi, Kenya. 275 pp. https://cgspace.cgiar.org/bitstream/handle/10568/99/Source_book.pdf
- Ashok G, Sharma P, Anisha S and Prerna T. 2018. *Agriculture Extension System in India*
  Review of Current Status, Trends and the Way Forward, Indian Council for Research on International Economic Relations (ICRIER).
  http://icrier.org/pdf/Agriculture-Extension-System-in-India-2018.pdf
- Bitzer V, Wongtschowski M, Hani M and Blum M. 2016. *New directions for inclusive Pluralistic Service Systems. In New Directions for Inclusive Pluralistic Service Systems* Rome (Italy). FAO. http://www.fao.org/3/a-i6104e.pdf
- Burton ES and Kristin D. 2014. *Status of Agricultural Extension and Rural Advisory Services*
  Worldwide. GFRAS: Lindau, Switzerland.
  http://www.g-fras.org/en/knowledge/gfras-publications.html?download=391:status-of- agricultural-extension-and-rural-advisory-services-worldwide
- Burton ES, Robert PB and Andrew JS. 1997. *Improving agricultural extension A reference*
  manual, FAO Rome
  https://www.oerafrica.org/FTPFolder/Website%20Materials/Agriculture/haramaya/
  Perspective_Agricultural_Extension/Attachment/Improving%20AgE

x.-FAO.pdf
- Dahama OP and Bhatnagar OP. 1987. *Education and Communication for Development*. Cambridge Univ. Press.
- Davis K and Sulaiman RV. 2016. *Extension Methods and Tools*. Module 2 NELK. GFRAS. https://www.g-fras.org/en/component/phocadownload/category/70-new-extensionist-learning- kit-nelk.html?download=560:nelk-module-2-extension-methods-and-tools-textbook
- Dharma OP. 2017. *Development Perspectives in Extension Education* Agro Tech Publishing Academy, Udiapur
- FAO. 2016. *New directions for inclusive Pluralistic Service Systems*. Report of FAO Expert Consultation. Food and Agriculture Organization of the United Nations and Royal Tropical Institute, Rome. http://www.fao.org/3/ai6103e.pdf
- GFRAS. 2016. *The New Extensionist Learning Kit*. http://g-fras.org/en/knowledge/new-extensionist-learningkit-nelk.html#module-1- introduction-to-the-new-extensionist
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- *Practices*. Food and Agriculture Organization of the United Nations. Rome. http://www.fao.org/docrep/pdf/011/i0261e/i0261e00.pdf
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Course outlines

S. No.	Topic	No. of Lectures/Practicals

Theory

1.	Important concepts in extension science	1
2.	Various schools of thought in extension	2
3.	Critical review and reflections on the philosophy of extension	2
4.	Critical review and reflections on the principles of extension	1
5.	Implications of earlier extension efforts.	1
6.	Emerging issues, problems and challenges of animal husbandry extension education	2
7.	Changing approaches – ToT approach, Education Approach, Demand Driven approach, Market led extension, FSA, Commodity SpecificApproach, Market led Extension	3
8.	Farmer participatory approaches (PRA, RRA, PLA, PTD, PCD, etc Classification of PRA, Differences between PRA and RRA;	3
9.	Global concepts of extension (SAARC, BRICS, US, Japan, UK, Philippines and Israel) and its application to Indian context	3
10.	Systems Concepts - FSA, Commodity Specific Approach, Market led Extension, Privatization of extension. Public Private Partnership	3
11.	Extension approaches of State and Central Governments, ICAR, SVUs/ SAUs, NGOs, corporate and other organizations	4
12.	Extension Advisory Services - Meaning, Concept - Challenges in Animal Husbandry Extension Advisory Services	2
13.	Extension approaches followed in current livestock evelopment programmes, viz., Rashtriya Gokul Mission, NationalLivestock Mission, Rashtriya Krishi Vikas Yojna, Livestock Insurance Scheme, Livestock Health and Disease Control, Pashu Sanjivini, National Programme for Dairy Development, National Programme for Bovine Breeding, Aatmanirbhar Bharat Abhiyaan and digital initiatives such as E-Pashudhan Haat,National Animal Disease Reporting System for livestock development, etc.	2
14.	Linkages between researcher-extension agent - livestock farmer-industry in the generation of animal husbandry practices/ technologies	1
15.	Linkages between researcher-extension agent livestock farmer- industry in the dissemination and commercialization of animal husbandry practices/ technologies	1
	Total	32

Practicals

1. Study of the extension approaches, functions, roles, responsibilities 1
2. Organizational set-up of State Animal Husbandry Department 1
3. Organizational set-up dairy/ rural development agencies 2
4. Organizational set-up of ICAR institutions 2
5. Study on the formation of FPOs – principles, practices, requirements, procedures 2
6. Study on the formation of CIGs - principles, practices, requirements, procedures 2
7. Study on the formation of SHGs principles, practices, requirements, procedures 1
8. Role of NGOs in developmental perspectives 1
9. Critical analysis of cases on linkage between different actors of animal husbandry sector. 2
10. Critical analysis of livestock development programmes 2

Total 16

I. **Course Title : Communication for Livestock Development**

II. **Course Code : EXT 602**

III. **Credit Hours : (1+1)**

IV. **Aim of the course**

To acquaint students with dynamics of communication and apply in developmentof livestock sector.

V. **Theory**

Unit I

Communication- meaning, concept, purpose and process of communication- Models and theories of communication: Aristotle, Berlo, Osgood Schramm, Shanon and Weaver, Johari window, New Comb, Westley and McLean, etc. Critical analysis of models and theories of communication. Recent developments in communication theories and models.

Unit II

Types of communication-intrapersonal, interpersonal, verbal and non-verbal; Criteria of effective communication, Determinants of communication- Empathy, credibility, fidelity, distortion, feedback and barriers to effective communication; Group and mass communication. Key communicators and their role in livestock development. Organizational Communication - formal- informal; downward-upward- horizontal; Problems in organizational communication.

Unit III

Business Communication: Relevance and importance in livestock business development. Features of business communication,

Guidelines for business communication, formal and informal business communication, Various types of business communication (Letters, Reports, Proposals, Manuals, Outreach writing (Advertisements, Pamphlets, Signs, Press Release, etc.). Effective business communication.

Unit IV

ICT-concept, importance and types of tools and applications; Role and significance of ICT tools in Animal Husbandry Development - Use and importance of Social Media in livestock development. Overview of emerging technologies.

VI. Practical

Exercises in improving communication skills (Speaking skill – Public speaking, Persuasive speech, Informative speech, etc.) Exercises on Listening, Exercises on Reading, Exercises on Non-verbal communication, Writing of Business Communication, Identification of key communicators, Communication barriers, distortion and fidelity in livestock development. Identification of different social media tools used for livestock development; Comparative study of different tools and their areas of applications in animal husbandry sector; Hands on experience in writing blogs; ICT tools in Animal Husbandry Extension delivery system; Analysis of web portals – KVK portals, Knowledge portal, ICAR, SAUs, etc.

VII. Suggested Reading

- Bhagat Amit K. *Communication as a Management Tool: Principles and Practices*. Akhand Publishing House, New Delhi. 2012
- Cragan FJ and Wright WD. 1999. *Communication in Small Groups – Theory, Process, Skills*. Wadsworth Publ.
- Mcquail D and Windahl S. 1993. *Communication Models for the Study of Mass Communications*. Longman Publ.
- Ray GL. 2011. *Extension, Communication and Management*. Kalyani Publishers, Ludhiana.
- Rogers EM and Shoemaker FF. 1971. *Communication of Innovations: A Cross – Cultural Approach*. The Free Press.
- Roloft Michael F. 1981. *Interpersonal Communication*. Sage Publ.
- Ruben Brent D. *Communication and Human Behaviour*. McMillan Publishing Company. New York. 1984.
- Sehgal MK and Khetrapal V. 2008. *Business Communication*. Excel Books. New Delhi.
- Srinivasa Raju Melkote and H Leslie Steeves. 2001. *Communication for Development Theory and Practice for empowerment and social justice*. Sage Publications

- Andres D and Woodard J. 2013. *Social media handbook for agricultural development practitioners*. Publication by FHI360 of USAID. http://ictforag.org/toolkits/social/SocialMedia 4AgHandbook.pdf
- Barber J, Mangnus E and Bitzer V. 2016. *Harnessing ICT for agricultural extension.* KIT Working Paper 2016: 4. https://213ou636sh0ptphd141fqei1-wpengine.netdna-ssl.com/sed/wp-content/uploads/sites/ 2/2016/11/KIT_WP2016-4_Harnessing-ICT-for-agricultural-extension.pdf
- Bheenick K and Bionyi I. 2017. *Effective Tools for Knowledge Management and Learning in Agriculture and Rural Development*. CTA Working paper. https://publications.cta.int/media/publications/downloads/1986_PDF.pdf
- FAO 2011. *E-learning methodologies a guide for designing and developing e-learning courses.* Food and Agriculture Organization of the United Nations. http://www.fao.org/docrep/015/i2516e/i2516e.pdf
- George T, Bagazonzya H, BallantyneP, Belden C, Birner R, Del CR and Treinen S. 2017. *ICT in agriculture: connecting smallholders to knowledge, networks, and institutions*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/12613 16
- Mayer RE. 2005. *The Cambridge handbook of multimedia learning*. New York: University of Cambridge.
- Mittal N, Surabhi, Gandhi, Sanjay and Gaurav T. 2010. *Socio-Economic Impact of Mobile Phones on Indian Agriculture*. ICRIER Working Paper No. 246, Indian Council for Research on International Economic Relations (ICRIER), New Delhi.
- Saravanan R and Suchiradipta B. 2016. *Social media policy guidelines for agricultural extension and advisory services*, *GFRAS interest group on ICT4RAS, GFRAS*: Lindau, Switzerland. www.g-fras.org/en/knowledge/gfras-publications.html?download=415:social-media-policy- guidelines-for-agricultural-extension-and-advisory-services
- Saravanan R. 2010. (Ed.) ICTs for Agricultural Extension: Global Experiments, Innovations and Experiences, New India Publishing Agency (NIPA), New Delhi. http://www.saravananraj. net/wp-content/uploads/2014/12/32_India_ICTs-for-Agricultural-Extension_Saravanan.pdf
- World Bank. 2017. *ICT in Agriculture (Updated Edition):*

Connecting Smallholders to Knowledge, Networks, and Institutions. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/27526

Course Outline

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Communication – meaning, concept, purpose of communication	1
2.	Models and theories of communication: Aristotle, Berlo, Osgood Schramm, Shanon and Weaver, Johari window, New Comb, Westley and McLean, etc.	1
3.	Critical analysis of models and theories of communication.	1
4.	Recent developments in communication theories and models	1
5.	Types of communication-intrapersonal, interpersonal, verbal and non-verbal;	1
6.	Criteria of effective communication, Determinants of communication-Empathy, credibility, fidelity, distortion, feedback	1
7.	Barriers for effective communication	1
8.	Group and mass communication. Key communicators and their role in livestock development	1
9.	Organizational Communication - formal- informal; downward-upward- horizontal; Problems in organizational communication	
10.	Key communicators and their role in livestock development	1
11.	Business Communication: Relevance and importance in Livestock business development	1
12.	Features and guidelines for business communication, Formal and informal business communication	1
13.	Various types of business communication (Letters, Reports, Proposals, Manuals, Outreach writing (Advertisements, Pamphlets, Signs, Press Release, etc.) Effective business communication	1
14.	ICT-concept, importance and types of tools and applications; Role and significance of ICT tools in Animal Husbandry Development	1
15.	Use and importance of Social Media in livestock development.	1
16.	Overview of emerging technologies	1
	Total	16
Practicals		
1.	Exercises in improving communication skills – Oral Communication	1
2.	Exercises in improving communication skills – Public speaking	1

3. Exercises in improving communication skills – Persuasive speech 1
4. Exercises in improving communication skills –Informative speech 1
5. Exercises on Listening skills 1
6. Exercise on Reading skills 1
7. Exercise on Non-verbal communication 1
8. Writing of Business Communications 1
9. Identification of key communicators 1
10. Role of key communicators 1
11. Communication barriers 1
12. Distortion and Fidelity of communication in livestock development. 1
13. Importance of feedback in communication 1
14. Identification of different social media tools used for livestock development 1
15. Comparative study of different tools and their areas of applications
16. in animal husbandry sector 1
17. ICT tools in Animal Husbandry Extension delivery system-analysis of
18. web portals – KVK portals, Knowledge portal, ICAR, SAUs, etc. 1

Total 16

I. **Course Title : Diffusion and Adoption of Innovations**
II. **Course Code : EXT 603**
III. **Credit Hours : (2+1)**
IV. **Aim of the course**

To sensitize the students to technology generation, dissemination and its adoption through effective communication

V. **Theory**

Unit I

Concept, meaning, importance of diffusion. Elements in diffusion process; Models and theories of diffusion.

Unit II

Concept, meaning, importance of adoption. Steps in adoption process. Adoption models; Stages in diffusion-adoption process; Innovation- Decision Process, Adopter categories and their characteristics. Factors influencing adoption. Attributes of innovations, Factors affecting the rate of adoption and sources of information. Consequences of innovations.

Unit III

Adopter categories and their characteristics. Identification and evaluation of innovations in livestock sector – Attributes, Reason for adoption, Non-adoption and Discontinuance, Consequences. Diffusion and adoption of livestock sectoral innovations.

Unit IV

Agricultural Innovation System – Origin of innovation system - Concepts and elements; Innovation vs Invention, Innovation and types of innovation; Innovations in livestock sector; Role of enabling environment; Methodologies for AIS Diagnosis; Capacity Development in AIS.

VI. Practical

Identification of adopter categories in the selected village, Study on attributes of innovation of selected dairy farming technologies/ sheep/ goat/ poultry farming technologies. Identification of sources of information at different stages of adoption on selected livestock technologies; Study of factors increasing or retarding the rate of adoption; Consequences of adoption of livestock technologies; Case studies in of Agricultural Innovation System, Presentation of reports on adoption and diffusion of innovations

VII. Suggested Reading

- Brown Lawrence A. 1981. *Innovation Diffusion: A New Perspective*. *Communication for Social Change*. Sage Publ.
- Cragan FJ and Wright WD. 1999. *Communication in Small Groups – Theory, Process, Skills*. Wadsworth Publ.
- Dasgupta. 1989. *Diffusion Agricultural Innovations in Village India*.
- Hall A, Sulaiman RV, Beshah T, Madzudzo E and Puskur R. 2009. *Agricultural innovation system capacity development: Tools, principles or policies*? Capacity.org (37): 16-17. http://www.capacity.org/en/journal/practice_reports/tools_principles_or_policies
- ILRI. 2014. *Innovation Platform practice briefs. International Livestock Research Institute*. https://clippings.ilri.org/2014/02/03/ipbrief1/
- Leeuwis C and van den Ban A W. 2004. *Communication for rural innovation: Rethinking agricultural extension*. John Wiley and Sons. Methuen.
- OECD. 2012. *Innovation for Development. A Discussion of the Issues and an Overview of Work of the OECD Directorate for Science, Technology and Industry*. https://www.oecd.org/innovation/inno/50586251.pdf
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- Rogers EM. 2003. *Diffusion of Innovations*. Free Press.
- Wiley Eastern. Jalihal KA and Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension*. Concept Publ. Co.
- World Bank. 2006. *Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems*. Washington, DC: World Bank. © World Bank. https://openknowledge. worldbank.org/handle/10986/7184
- World Bank. 2012. *Agricultural Innovation Systems: An Investment Source book*. Washington DC, World Bank. http://siteresources.worldbank.org/INTARD/Resources/335807-1330620492317/ 9780821386842.pdf

Course outlines

S. No.	Topic	No. of Lectures/Practicals

Theory

1.	Concept, Meaning, Importance of diffusion with special reference to Livestock Sector	1
2.	Elements in diffusion process	1
3.	Models and theories of diffusion	2
4.	Concept, meaning, importance of adoption	1
5.	Steps in adoption process. Adoption models	2
6.	Stages in diffusion-adoption process; Innovation- Decision Process	2
7.	Adopter categories and their characteristics.	1
8.	Factors influencing adoption	1
9.	Attributes of innovations	1
10.	Factors affecting the rate of adoption and sources of information.	1
11.	Consequences of innovations.	2
12.	Adopter categories and their characteristics	2
13.	Identification and evaluation of innovations in livestock sector – attributes, reason for adoption, non-adoption and discontinuance, Consequences.	3
14.	Diffusion and adoption of livestock sectoral innovations	2
15.	Agricultural Innovation System – origin of innovation system - concepts and elements	2
16.	Innovation vs Invention, Innovation and types of innovation	2
17.	Innovations in livestock sector	1
18.	Role of enabling environment; Methodologies for AIS Diagnosis	3
19.	Capacity Development in AIS	2
	Total	32

Practicals

1.	Identification of adopter categories in the selected village	2
2.	Study on the attributes of innovation of selected dairy farming technologies	2
3.	Attributes of innovation of selected sheep/ goat/ poultry farming technologies	2
4.	Identification of sources of information at different stages of adoption on a selected livestock technologies	2
5.	Study of factors increasing or retarding the rate of adoption	2
6.	Consequences of adoption of livestock technologies	2
7.	Case studies in of Agricultural Innovation System	2

8. Presentation of reports on adoption and diffusion of innovations 2
Total 16

I. **Course Title : Programme Planning and Evaluation**
II. **Course Code : EXT 604**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To expose the students to programme planning, Monitoring and evaluation of animal husbandry development programmes.

V. **Theory**

Unit I

Genesis and importance of programme planning. Objectives, principles and steps in programme planning process. Role of animal husbandry extension agencies and stakeholders in planning and implementation of Animal Husbandry programmes.

Unit II

Extension Participatory Programme planning: Meaning, Role and Benefits; Stakeholders Participation in Development - Identify Key Stakeholders, Examine Stakeholder's Interests and Impact of the Project, Assess Stakeholder Power and Interest, Outline a Stakeholder Participation Strategy.

Unit III

Meaning and Scope of Monitoring; Basic Concepts and Elements in Monitoring; Types of Monitoring; Techniques of Monitoring; What is Evaluation? Appraisal vs. Monitoring vs. Evaluation vs. Impact Assessment – Major differences; Types of Evaluation, Evaluation Designs.

Unit IV

Project Management Techniques- Gantt chart, Programme Evaluation and Review Technique (PERT). Critical Path Method (CPM). Project formulation. Project appraisal in terms of social benefit analysis, logical frame work. Various stakeholders in livestock development; stakeholder analysis, and report writing.

VI. **Practical**

Preparation of comprehensive livestock development programme for a village. Developing instruments for monitoring and evaluation of on-going development programme at village level (Logical Frame Work). Participatory techniques (RRA, PRA, Case study, etc.). SWOT analysis of a livestock development programme.

VII. **Suggested Reading**

- Bagno lB. 2014. *Conducting participatory monitoring and evaluation*. Pages 81-85 in FAO, Decision tools for family poultry

development.
- Baker H. 1984. *The program planning process*. Pages 50-64 in D. Blackburn (ed.), Extension handbook. Guelph, Ontario, Canada: University of Guelph.
- Baum WC and Tolbert SM. 1985. *Investing in Development: Lessons of the World Bank Experience*, Oxford University Press.
- Bennett CF. 1979. *Analyzing impacts of extension programs*. Washington, D.C., USA: U.S. Department of Agriculture.
- Choudhary S. 1988. *Project Management*, New Delhi: Tata McGraw Hill.
- Dale R. 2004. *Evaluating Development Programmes and Projects*, New Delhi, India: Sage Publications
- Fear FA. 1988. *Community needs assessment: A crucial tool for adult educators*. Paper presented at the MAACE Midwinter Conference, February 1988, Lansing, Michigan, USA.
- GFRAS. 2017. *The New Extensionist Learning Kit*. 13 Learning Modules for Extension Professionals. Lausanne, Switzerland, Global Forum for Rural Advisory Services GFRAS.
- Harold Kerzner. 2013. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*. Wiley
- Hoffman V, Christinck A and Lemma M. (eds.). 2009. *Rural Extension*. Margraf Publishers GmbH.
- Leagans JP. 1961. *Programme planning to meet people's needs. In: Extension education in community development, Directorate of Extension*, Ministry of Food and Agriculture, Government of India, New Delhi.
- Mukherjee N. 2002. *Participatory Learning and Action with 100 field Methods*. Concept Publishing Company, New Delhi.
- Rietbergen MJ and Narayan D. 1997. *Participatory tools and techniques: A resource kit for participation and social assessment*. Washington, D.C., USA: The World Bank. Accessed at: www.fao.org/ag/ againfo/ programmes/ en/ lead/ toolbox/ Refer/ STkHold.htm
- Roling N. 1988. *Extension science: information systems in agricultural development*, Cambridge University Press.
- Scott Bercun. 2008. *Making Things Happen – Mastering Project Management*. O'Reilly Publishers
- Somesh K. 2002. *Methods for Community Participation - A Complete Guide for Practitioners*. Vistar Publications New Delhi.
- Suvedi M and Kaplowitz MD. 2016. *Process Skills and Competency Tools – What Every Extension Worker Should Know*

– *Core Competency Handbook*. Urbana, IL, USAID-MEAS.

- Van den Ban AW and Hawkins HS. 2002. *Agricultural extension*, CBS Publishers and Distributors, New Delhi.

Course outlines

S. No.	Topic	No. of Lectures/Practicals

Theory

1. Genesis and importance of programme planning in Animal Husbandry Sector 1
2. Objectives, principles and steps in programme planning process 1
3. Role of animal husbandry extension agencies and stakeholders in planning and implementation of animal husbandry extension programmes 1
4. Participatory Programme planning – Meaning, Role and Benefits 1
5. Stakeholders Participation in Development - Identify Key Stakeholders, Examine Stakeholder's Interests and Impact of the Project 1
6. Assess Stakeholder Power and Interest, Outline a Stakeholder Participation Strategy; 1
7. Meaning and Scope of Monitoring; Basic Concepts and Elements in Monitoring; Types of Monitoring; 2
8. Techniques of Monitoring; What is Evaluation? Appraisal vs. Monitoring vs. Evaluation vs. Impact Assessment – Major differences; 1
9. Types of Evaluation, Evaluation Designs; 1
10. Project Management Techniques- Gantt chart, Programme Evaluation and Review Technique (PERT). Critical Path Method (CPM) 2
11. Project formulation, Project appraisal in terms of social benefit analysis, logical frame work 1
12. Various stakeholders in livestock development; 2
13. Stakeholder analysis, and report writing. 1

Total 16

Practicals

1. Preparation of comprehensive livestock development programme for a village 3
2. Developing instruments for monitoring and evaluation 2
3. Identification of key stakeholders in the livestock development 1
4. Application of developed instruments for monitoring and evaluation of on-going development programme at village level (Logical Frame Work) 2

5. Data collection and analysis of on-going development Programme of a village 2
6. Simulated exercises on Project Management Techniques - Gantt chart, PERT, CPM 3
7. SWOT analysis of a livestock development programmes 1
8. Report preparation and presentation 2

Total 16

I. **Course Title : Research Methodology**

II. **Course Code : EXT 605**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge and skills in formulating and conducting an independentresearch in the field of Animal Husbandry Extension.

V. **Theory**

Unit I

Concept, nature and scope of research in social sciences. Types of research- fundamental, applied and action research, experimental and non-experimental research. Identification of concepts, constructs, variables. Hypothesis– importance, selection criteria (qualities of a workable hypothesis), formulation and testing of hypothesis. Selection and formulation of research problem.

Unit II

Measurement and levels of measurement; Research designs- exploratory, experimental, and ex-post-facto research design. Sampling -Sampling methods- probability and non-probability sampling. Sources of errors.

Unit III

Methods of data collection– survey method, observation method, interview/ questionnaire method, case study, content analysis, sociometry, focus group discussion, projective techniques, Online tools of data collection, Reliability and validity of measuring instruments.

Unit IV

Social statistics – designs in data analysis, Parametric and Non-Parametric statistical methods. Data analysis and interpretation and inference, Report writing. Review of studies in social research.

VI. **Practical**

Construction of data collection tools, GPS-enabled data collection, Development of online tools of data collection (Google Forms,

Survey Monkeys, etc.) Application of statistical software for data analysis and interpretation. Creative scientific thinking, selecting a research problem and working it out with all the steps; report writing and presentation of the reports.

VII. Suggested Reading

- Arlene Fink (Ed). 2003. *The Survey Kit* (10 booklets). Sage Publ.
- Babbie E. 2008. *The basics of social research*. 4th ed. Belmont, CA, USA; Thompson Wordsworth.
- Creswell JW. 2009. *Research design: Qualitative, quantitative, and mixed methods approaches*. Third edition. Thousand Oaks: Sage Publications.
- Creswell John W. 1994. *Research Design – Qualitative and Quantitative Approaches*. University of Nebraska, Lincoln.
- Creswell JW. 2012. *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Fourth edition. Boston, MA: Pearson.
- Edwards AL. 1969. *Techniques of Attitude Scale Construction.* Vakil, Feffer and Simons
- Garrett HE. 1966. *Statistics in Psychology and Education*. International Book Bureau, Hyderabad.
- Goode WJ and Hatt PK. 1952. *Methods in Social Research*. McGraw-Hill.
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- Kerlinger FN and Lee HB. 2000. *Foundations of Behavioral Research*. Orlando, FL: Harcourt College Publishers.
- Kumar R. 2014. *Research Methodology: A Step –by - Step Guide for Beginners*. Fourth Edition. Thousand Oaks, California: Sage Publications.
- Miller Delbert C. 1991. *Handbook of Research Design and Social Measurement*. Indiana University. Sage Publ.
- NeumanWL. 2006. *Social Research Methods: Qualitative and Quantitative Approaches*. Toronto: Pearson.
- Oppenheim AN. 1979. *Questionnaire Design and Attitude Measurement*. Heinemann Educational Books.
- Sekaran U and Bougie R. 2013. *Research Methods for Business A Skill-Building Approach*. 6th Edition, Wiley, New York.
- Sivakumar PS, Sontakki BS, Sulaiman RV, Saravanan R and Mittal N. (eds). 2017. *Good Practices in Agricultural Extension*

Research. Manual on Good Practices in Extension Research and Evaluation. Agricultural Extension in South Asia. Centre for research on innovation and science and policy (CRISP), Hyderabad. India.

Course Outline

S. No.	Topic	No. of Lectures/Practicals

Theory

1. Concept, nature and scope of research in social sciences, scientific vs nonscientific approaches, 1
2. Research - Characteristics of research, Approaches of Research 1
3. Types of Research (Pure/ Basic; Evaluative, Fundamental, applied and action research) 1
4. Experimental and non-experimental research 1
5. Identification of concepts, constructs, variables 1
6. Hypothesis and its importance, Characteristics and sources and Classification of hypothesis 1
7. Selection criteria (qualities of a workable hypothesis) 1
8. Formulation and testing of hypothesis 1
9. Selection and formulation of research problem 1
10. Measurement and levels of measurement 1
11. Research Designs - Exploratory research design 1
12. Research Designs Experimental research design 1
13. Research Designs Ex-post-facto research design 1
14. Sampling– concept, meaning importance in social sciences 1
15. Sampling methods - Probability Sampling and Non-Probability sampling 1
16. Sources of errors 2
17. Methods of data collection: Over view of different tools of data collection, selection of appropriate method 1
18. Survey method – Purpose, Types, Planning a survey, advantages and limitations 1
19. Observation Method - Purpose, Types, Planning for observation, advantages and limitations 1
20. Interview/ questionnaire method - Purpose, Types, Planning an Interview/ questionnaire, advantages and limitations 1
21. Case study - Purpose, Planning a case study, advantages and limitations 1
22. Content analysis 1
23. Focus Group Discussion 1
24. Sociometry and projective techniques 1
25. Online tools of data collection – concept, meaning, importance

And types in social research 1

26. Reliability of measuring instruments – definition, importance in social sciences, Methods to test reliability 1
27. Validity of measuring instruments - definition, importance in Social sciences, Types of validity 1
28. Social statistics – designs in data analysis – criteria for choosing a right a right design and analysis 1
29. Parametric and Non-Parametric statistical methods – use and significance; types of tests used in social research with implications 1
30. Data analysis and interpretation and inference 2
31. Report writing 1
32. Review of studies in social research 1

Total 34

Practicals

1. Construction of different data collection tools relevant to livestock sector 2
2. GPS-enabled data collection 3
3. Development of online tools of data collection (Google Forms, Survey Monkeys, etc.) 2
4. Application of statistical software for data analysis and interpretation 3
5. Creative scientific thinking 1
6. Selecting a research problem and working it out with all the steps 3
7. Report writing and presentation of the report. 2

Total 16

I. **Course Title : Social Psychology and Group Dynamics**
II. **Course Code : EXT 606**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To acquaint the students with the structure and functioning of social groups and socio psychological aspects in interacting with livestock farmers.

V. **Theory**

Unit I

Concepts, scope and importance of psychology and social psychology in animal husbandry extension, Perception - nature, laws and selectivity in perception, factors in perception, importance of perception in extension work, Attitude - nature, theories, measurement and change of attitude towards livestock farming, Importance of attitude scales in livestock research and

development.

Unit II

Motivation– nature, characteristics, theories, types and techniques of motivating farmers, Learning- principles, theories of learning and experiential learning and adult learning (andragogy).

Unit III

Intelligence- nature, theories and measurement, Personality- nature, traits, types, biological and socio-cultural determinants of personality, Group and individual behaviour.

Unit IV

Concept and types of groups; Group behaviour and dynamics: structures - attraction, coalition, communication and power; group mobilisation – social capital, group decision making, Factors affecting group performance; Conflict management in groups; Group belongingness, Community Mobilization, Importance of coordination among livestock development organisations.

VI. Practical

Study of groups and group dynamics (*eg.*: Self Help Groups (SHGs), Milk Cooperative Societies, Commodity groups and Farmer producer Company/ organization (FPO),Joint Liability Group (JLG), youth clubs, etc. Motivation, perception and personality traits exercise son measurement of

Cragan FJ and Wright WD. 1999. *Communication in Small Groups – Theory, Process, Skills*.Wadsworth Publ.

- Donelson R. Forsyth, *Group Dynamics* 2018 7th Edition, Cengage Learning
- Joseph Bohac and Stan Dekoven 2013. *Group Dynamics.* Vision Publishing (Ramona, CA)
- Kagan J and Havemann E. 1980. *Psychology – An Introduction*. Harcourt Brace Javanovich Inc.
- Morgan CT, King RA and Robinson NM. 1979. *Introduction to Psychology*. Tata McGraw- Hill.
- Napier RW and Gershenfeld MK. 2006. *Groups – Theory and Experience*. AITBS Publ.
- Robert A Baron. *Social Psychology*. 2016. 13th Edition Pearson Education
- Secord PF and Backman CW. 1964. *Social Psychology*. McGraw-Hill.

Course Outline

S. No.	Topic	No. of Lectures/Practicals

Theory

1. Concepts, scope and importance of psychology and social

psychology in animal husbandry extension 1
2. Perception - nature, laws and selectivity in perception 1
3. Attitude - nature, theories, measurement and change of attitude towards livestock farming. Importance of attitude scales in livestock research and development. 1
4. Motivation– nature, characteristics, theories, types and techniques of motivating farmers. 2
5. Learning- principles, theories of learning and experiential learning and adult learning (andragogy). 2
6. Intelligence- nature, theories and measurement. 1
7. Personality- nature, traits, types, biological and socio-cultural determinants of personality. 1
8. Group and individual behaviour. 1
9. Concept and types of groups; Group behaviour and dynamics: structures - attraction, coalition, communication and power; group mobilisation – social capital, group decision making 2
10. Factors affecting group performance; 1
11. Conflict management in groups; 1
12. Group belongingness, Community Mobilization, 1

Total 16

Practicals

1. Study of Self Help Groups and their group dynamics 2
2. Study of Milk Cooperative Societies and their group dynamics 2
3. Study of Commodity Interest groups (CIGs) 2
4. Study of Farmer Producer Company/ organization (FPO) 2
5. Study of Joint Liability Group (JLG) and youth clubs, etc.2
6. Exercises on measurement of motivation 2
7. Exercises on measurement of perception 2
8. Exercises on measurement of personality traits 2

Total 16

I. **Course Title : Livestock Entrepreneurship**
II. **Course Code : EXT 607**
III. **Credit Hours : 1+2**
IV. **Aim of the courses**

- To orient the students on basic concepts of entrepreneurship and the initiatives in promoting livestock as an enterprise.
- To impart knowledge in the various facets of entrepreneurial management and consumer behaviour for establishment of livestock ventures.

V. **Theory**

Unit I

Entrepreneurship - Role of Entrepreneurship in Economic Development of the country and current scenario and future prospects; Factors influencing Entrepreneurship (Internal factors, External factors, Political factors, Socio-Cultural Environment, Legal and Technological Environment); Role of Government and Non-Government agencies in promoting entrepreneurship in India- eg: Atal Innovation Mission, Startup India, Mudra Bank Scheme, Dairy Entrepreneurship Development Scheme, Agri-Clinics and Agri-Business Centers (ACABC), Entrepreneurship Development and Employment Generation (EDEG), etc.

Unit II

Livestock -Business Plan: Business Idea Generation, Brainstorming and evaluation of ideas, Competition, Scalability of the product, Price feasibility, Distribution and logistics, Ease of technology, Opportunities and threats, Internal strengths and weaknesses (SWOT analysis) Government regulations and statutory compliances, Sources of financial assistance.

Unit III

Livestock Business Evaluation: Evaluating financial feasibility, Cost of production and marketing, Project cost determination and fund requirement, Assessing working capital requirement, Non-fund based requirements (BG, LC), Cost of capital sources and cost of finance. Technical feasibility, Patents, Make or buy decision, Plant size and location, Machinery requirement, Outsourcing requirements, Project report and appraisal techniques- Net present value, Payback period, Break even analysis, CB Ratio.

Unit IV

Consumer Behaviour: Consumer behaviour- Definition, Consumer and customers, Buyers and users, Consumer behaviour and its applications in livestock marketing; Consumer behaviour models; Consumer motivation, Consumer perception, Consumer behaviour and marketing communications, Consumer decision-making process, Organizational buying behaviour, Modern marketing information system (marketing intelligence, communicating and acting on marketing intelligence).

VI. Practical

Exposure visits to commercial livestock enterprises- Dairy, Poultry, Meat/ Dairy/ Feed Processing Units. Analysis of successful cases of livestock entrepreneurship, Development of livestock business plans, Presentation of livestock business development plans, Study of consumer behavior, Critical analysis

of livestock markets/ super markets/ malls.

VII. Suggested Reading

- Khanka SS. 1999. *Entrepreneurial Development*. S. Chand and Co.
- Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand and Sons.
- Grover I. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public
- Nandan H. 2013. *Fundamentals of Entrepreneurship*, PHI publishers
- Reading material of Course AEM-202 Agri-*Business and Entrepreneurship Development*. http://www.manage.gov.in/pgdaem/studymaterial/aem202.pdf
- Hisrich RD, Peters MP and Shepherd A. 2007. *Entrepreneurship*, 6th Edition, Tata McGraw Hill
- Singh D. 1995. *Effective Managerial Leadership*. Deep and Deep Publ.
- Tripathi PC and Reddy PN. 1991. *Principles of Management*. Tata McGraw Hill.
- Desai V. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.

Course Outline

S. No.	Topic	No. of Lectures/Practicals

Theory

1. Entrepreneurship and its role in Economic Development of the country and current scenario and future prospects 1
2. Factors influencing Entrepreneurship (Internal factors, External factors, Political factors, Socio - Cultural Environment, Legal and Technological Environment) 1
3. Role of Government and Non-Government agencies in promoting entrepreneurship in India- eg: Atal Innovation Mission, Startup India, Mudra Bank Scheme, Dairy Entrepreneurship Development Scheme, Agri-Clinics and Agri-Business Centers (ACABC), Entrepreneurship Development and Employment Generation (EDEG), etc. 1
4. Livestock -Business Plan: Business Idea Generation, Brainstorming and Evaluation of ideas, Competition, scalability of the product, Price feasibility, Distribution and Logistics Ease of Technology,Opportunities and Threats, Internal Strengths and Weaknesses (SWOT analysis) 2
5. Government Regulations and statutory compliances, Sources

of Financial Assistance 1

6. Livestock Business Evaluation: Evaluating Financial Feasibility, Cost of Production and Marketing, Project Cost Determination and Fund requirement, assessing Working Capital Requirement, Non-fund based Requirements (BG, LC), Cost of Capital Sources and Cost of Finance 2
7. Technical Feasibility, Patents, Make or Buy Decision, Plant Size and Location, Machinery Requirement, Outsourcing Requirements, 2
8. Project Report and Appraisal Techniques- Net Present Value, Payback period, Break even analysis, CB Ratio 2
9. Consumer Behaviour**:** Consumer Behaviour Definition, Consumer and Customers, Buyers and Users, Consumer Behaviour and its Applications in Livestock Marketing; 1
10. **C**onsumer behaviour models; Consumer Motivation, Consumer Perception, Consumer Behaviour and Marketing Communications, Consumer Decision-making Process, Organizational Buying Behaviour, 2
11. Modern marketing information system (marketing intelligence, communicating and acting on marketing intelligence). 1

Total 16

Practical

1. Visit to commercial livestock enterprises – Dairy, Poultry, any other economically important species of the region 5
2. Visit to Meat/ Dairy/ Feed Processing Units 5
3. Visit to any agri/ livestock start up 3
4. Analysis of successful cases of livestock entrepreneurship 4
5. Development of livestock business plans 4
6. Presentation of livestock business development plans 3
7. Study of consumer behavior 3
8. Visit to livestock markets/ super markets/ malls and analysis 5

Total 32

I. **Course Title : Human Resource Management in Animal Husbandry Sector**

II. **Course Code : EXT 608**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To make students understand human resource management techniques and deal organizational challenges effectively

V. **Theory**

Unit I

Concept, importance and functions of human resource management in animal husbandry sector. Process of management- planning, organizing, staffing, directing, coordination, reporting and budgeting. Principles, levels and types of organizations.

Unit II

Supervision- meaning, process and techniques. Work motivation. Job efficiency and job satisfaction.

Unit III

Organizational communication. Organizational climate. Conflict management.

Unit IV

Training– models, methods, Identification of training needs, Training evaluation and developing strategies for human resource development in animal husbandry sector. Capacity need assessment and personnel management in animal husbandry organizations.

VI. Practical

Training needs assessment farmers/ extension personnel, Development of training modules, Organization and evaluation of a training programme

VII. Suggested Reading

- Khanka SS. 1999. *Entrepreneurial Development*. S. Chand and Co.
- Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand and Sons.
- BJ Lathi, Parag Narkhede and Vivek Yawalkar 2015. *Human Resource Management,* Prashant Publications.
- Noe RA, Hollenbeck JR, Gerhart B and Wright PM. 1997. Human Resources Management: *Gaining a competitive advantage.*
- Grover I. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public.
- Nandan H. 2013. *Fundamentals of Entrepreneurship*, PHI publishers.
- Reading material of Course AEM-202 *Agri-Business and Entrepreneurship Development*. http://www.manage.gov.in/pgdaem/studymaterial/aem202.pdf
- Hisrich RD, Peters MP and Shepherd A. 2007. *Entrepreneurship*, 6th Edition, Tata McGraw Hill.
- Singh D. 1995. *Effective Managerial Leadership*. Deep and Deep Publ.

- Tripathi PC and Reddy PN. 1991. *Principles of Management*. Tata McGraw Hill.
- Vasanta Desai. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.

Course Outline

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Concept, importance and functions of human resource management in animal husbandry sector	1
2.	Process of management- planning, organizing, staffing, directing, coordination, reporting and budgeting	1
3.	Principles, levels and types of organizations	1
4.	Supervision- meaning, process and techniques	1
5.	Work motivation	1
6.	Job efficiency and job satisfaction	1
7.	Organizational communication	1
8.	Organizational climate	1
9.	Conflict management	1
10.	Training– concept, meaning, importance of training in Animal Husbandry	1
11.	Training models and methods	2
12.	Identification of training needs	1
13.	Training evaluation	1
14.	Capacity need assessment and Personnel management in animal husbandry organizations	1
15.	Developing strategies for human resource development in	
16.	animal husbandry sector	1
	Total	16
Practical		
1.	Training needs assessment of livestock farmers	2
2.	Training needs assessment of poultry farmers	2
3.	Training needs assessment of extension personnel	2
4.	Development of training module	2
5.	Planning for training programme	3
6.	Organization of training programme	3
7.	Evaluation of training programme	2
	Total	16

I. **Course Title : Gender Empowerment and Livestock Development**
II. **Course Code : EXT 609**
III. **Credit Hours : 1+0**

IV. Aim of the course

To acquaint students with gender perspectives, empowerment and its importance in livestock development, policies and programmes.

V. Theory

Unit I

Gender and empowerment: meaning and importance in livestock sector, Gender related concepts and importance of empowering women in livestock development; Need and focus on gender sensitization, Gender in community diversity and its implication for empowerment.

Unit II

Gender perspectives in development of women, Social characteristics, Roles, Responsibilities, Resources, Constraints, Legal issues and opportunities; Economical, educational and other parameters with special reference to livestock development.

Unit III

Gender tools and methodologies: Dimensions and methodologies for empowerment; Gender budgeting; Gender analysis framework-context, activities, Resources and programme action profile; Technologies and empowerment, Gender specific technologies, Household technology interface, Socio-cultural interface and women as consumers of technologies.

Unit IV

Policies and programmes in empowering women in general and livestock development in specific eg: UJJAWALA, Pradhan Mantri Mahila Shakti Kendra, One Stop Centre Scheme, Mahila E-haat, STEP, etc.

VI. Suggested Reading

- Grover I and Grover D. 2002. *Empowerment of Women*. Agrotech Publ. Academy.
- Porter F, Smyth I and Sweetman C. 1999. *Gender Works: Oxfarm Experience in Policy and Practice*. Oxfarm Publ.
- Raj MK. 1998. *Gender Population and Development*. Oxford Univ. Press.
- Sahoo RK and Tripathy SN. 2006. *SHG and Women Empowerment*. Anmol Publ.
- Sinha K. 2000. *Empowerment of Women in South Asia. Association of Management Development Institution in South Asia*, Hyderabad.
- Thakur Joshi S. 1999. *Women and Development*. Mittal Publ.

Vishwanathan M. 1994. Women in Agriculture and RD. Rupa Books.

- Ramkumar S, Garforth C, Rao SVN and Waldie K. (Ed). 2001. *Landless Livestock Farming- Problems and Prospects*. RAGACOVAS, Pondicherry.
- Seth Mira 2001. *Women and Development – Indian Experience*. Sage Publ.
- Samanta RK. (Ed). *Women in Agriculture – Perspectives, Issues and Experiences*. MD Publ.
- Waldie K and Ramkumar S. 2002. *Landless Women and Dairying – Opportunities for Development within a Poverty Perspective*. RAGACOVAS, Pondicherry.
- *Gender and empowerment: Definitions, approaches, and implications for policy* http://genderandenvironment.org/resource/gender-and-empowerment-definitions- approaches-and-implications-for-policy/
- Njuki, J., Waithanji, E., Bagalwa, N. and Kariuki, J. 2013. *Guidelines on integrating gender* in livestock projects and programs. Nairobi, Kenya: ILRI.
- https://cgspace.cgiar.org/bitstream/handle/10568/33425/GenderInLivestock.pdf
- http://wcd.nic.in/womendevelopment/national-policy-women-empowerment

Course Outline

S. No.	Topic	No. of Lectures
Theory		
1.	Gender and empowerment: meaning, importance in livestock sector	1
2.	Gender related concepts	1
3.	Importance of empowering women in livestock development	1
4.	Need and focus on gender sensitization,	1
5.	Gender in community diversity and its implication for empowerment	1
6.	Gender perspectives in development of women	1
7.	Gender- Social characteristics, roles, responsibilities, resources, constraints, legal issues and opportunities; economical, educational and other parameters with special reference to livestock development	2
8.	Gender tools and methodologies: Dimensions and methodologies for empowerment	1
9.	Gender budgeting	1
10.	Gender analysis framework- context, activities, resources and programme action profile	1

11. Technologies and empowerment - Gender specific technologies 1
12. Household technology interface, Socio-cultural interface 1
13. Women as consumers of technologies 1
14. Policies and programmes in empowering women in general and livestock development in specific - Eg: UJJAWALA, Pradhan Mantri Mahila Shakti Kendra, One Stop Centre Scheme, Mahila E-haat, STEP etc 2

Total 16

I. **Course Title : Farm Journalism**
II. **Course Code : EXT 610**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To sensitize students about the role of print, electronic, digital and internet media for promoting animal husbandry sector.

V. **Theory**

Unit I

Concept of farm journalism and communication. Journalism as a means of mass communication and its role in livestock development. Opportunities, strength and limitations. Ethics and principles of journalism for effective writing.

Unit II

Writing skills –Principles of writing - art of writing, News items, News stories, feature articles, Success stories, Magazines, bulletins, folders, etc. Fundamentals of lay-out in writing. Writing of research papers and popular articles in journals, Farm magazines and e-journals. Methods and techniques of broadcasting of farm programmes. Writing scripts for radio and televisions.

Unit III

Rapport building with different categories of clients involved in veterinary and animal husbandry extension programmes. Art of speaking. Importance of listening and reading. Writing for press news. Relations with press media. Event management, Organization of press meet. Qualities of a good public relations manager. Role and importance of art of speaking, listening and reading skills

Unit IV

Types of internet based media- Writing for web- concepts, Writing for social media (Blogs, etc.) – Ethics and values. Development of Multimedia Modules.

VI. **Practical**

Designing and preparation of news stories, feature articles,

success stories related to animal husbandry. Designing and preparation of Magazines, Pamphlets, folders, popular research articles, radio, T.V. scripts. Visit to Agricultural Technology Information Centre (ATIC) centre to record the activities of preparation, editing and publication of news articles and research publications.

VII. Suggested Reading

- Bhaskaran C, Prakash R and Kishore Kumar N. 2008. *Farm Journalism in Media Management*. Agro-Tech Publ. Academy.
- Chattergee PC. 1991. *Broadcasting in India*. Sage Publ.
- Chiranjeev A. 1999. *Electronic Media Management*. Authors Press.
- D'Souza YK.1998. *Principles and Ethics of Journalism and Mass Communication*. Commonwealth Publ.
- Defleur ML and Dennis EE. 2001. *Understanding Mass Communications*. Goyalsaab Publ.
- Jaico Publ. Malhan PN. 2004. *Communication Media: Yesterday, Today and Tomorrow*. Directorate of Publication Division, New Delhi.
- Jain SC. 2006. *International Marketing Management*. CBS Publ.
- Keval J Kumar. 2004. *Mass Communication in India*.
- Mehta DS. 1992. *Mass Communication and Journalism in India*. Allied Publ.
- Panigrahy D. 1993. *Media Management in India*. P. K. Biswasroy (Ed.). Kanishka Publ.
- Singh AK 2014. *Agricultural Extension and Farm Journalism*, Agrobios Publications

Course Outline

S. No.	Topic	No. of Lectures/Practicals

Theory

1. Concept of farm Journalism and communication 1
2. Journalism as a means of mass communication and its role in livestock development. 1
3. Role journalism in livestock development 1
4. Opportunities, Strength and limitations in farm journalism in livestock sector 1
5. Ethics and principles of journalism for effective writing 1
6. Writing skills –Principles of writing, art of writing, news items, news stories, feature articles, success stories, magazines, bulletins, folders, etc. 1
7. Fundamentals of lay-out in writing 1
8. Writing of research papers and popular articles in journals,

farm magazines and e-journals 1
9. Methods and techniques of broadcasting of farm programmes. 1
10. Writing scripts for radio and televisions 1
11. Writing for press news; Organization of press meet and Event management 1
12. Relations with press media Qualities of a good public relations manager 1
13. Types of internet based media- Writing for web- concepts, Writing forsocial media (Blogs, etc.) – Ethics and values. 1
14. Development of Multimedia Modules 1
15. Rapport building with different categories of clients involved in veterinary and animal husbandry extension programmes 1
16. Role and importance of art of speaking, listening and reading skills 1

Total 16

Practicals

1. Designing and preparation of news stories related to animal husbandry. 1
2. Designing and preparation of feature articles related to animal husbandry 1
3. Designing and preparation of success stories related to animal husbandry 1
4. Designing and preparation of Magazines 1
5. Designing and preparation of Pamphlet 1
6. Designing and preparation of Folders 1
7. Designing and preparation of Popular research articles 1
8. Writing of Radio script 1
9. Preparation of TV script 2
10. Development of Short film and feature film; 2
11. Visit to editor office of farm journals of State Veterinary University 1
12. Field visit to Successful Livestock farmer and documenting success story 1
13. Visit to ATIC to record the activities of preparation, editing and publication of news articles and research publications 2

Total 16

I. **Course Title : Statistics for Social Sciences**
II. **Course Code : SSS 600**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To equip the students with knowledge and skills in the applications of statistics in the field of veterinary and Animal

Husbandry Extension.

V. **Theory**

Unit 1

Descriptive statistics- measures of central tendency, Measures of dispersion, Coefficient of variance, Standard error, Skewness and kurtosis, Contingency tables, Normal distribution, Test of significance – One sample t test, Independent t test, paired t test, ANOVA and z - one tailed and two tailed tests.

Unit 2

Population versus sample, Sampling errors, Sample size determination, Survey instruments, Open ended and closed ended questions, and online survey tools.

Unit 3

Dependency among the variables, correlation- Pearson, Spearman and Kendall, point biserial correlation, Regression analysis, Assumptions, Multiple linear Regression, Regression diagnostics-outlier, Multicollinearity, Heteroscedasticity and autocorrelation, logit/ probit model.

Unit 4

Scaling Techniques: Ranking, Rating and Paired Comparison. Scaling techniques -Likert, Thurston and Guttman Scales. Construction and standardization; Knowledge test, Test of reliability and validity. Non-parametric tests- Signed Rank, Rank sum and Kruskal-Wallis tests. Test for independence and homogeneity. Multivariate techniques – cluster analysis, discriminant analysis and Factor analysis: Different rotations and interpretation of results.

VI. **Practical**

Exercises on different statistical tools and their interpretations

VII. **Suggested Reading**

- Cunningham BJ. 2012. *Using SPSS: An Interactive Hands-on approach*
- Edwards Allen L. 1969. *Techniques of Attitude Scale construction*. Vakils, Feffer and Simons Pvt. Ltd, Bombay
- Gupta SC and VK Kapoor. 2007. *Fundamentals of Mathematical Statistics*. Sultan Chand and Sons.
- Hair Joseph F, William C Black, Barry J Babin and Rolph E. Anderson. 2010. Multivariate *Data Analysis*. Pearson Pub.
- Hogg RV, AT Craig and JW. Mckean. 2005. *Introduction to Mathematical Statistics*, Pearson Education.
- Sukhatme PV, BV Sukhatme, S Sukhatme and C Ashok. 1984.

Sampling Theory of Surveys with Applications, Lowa State University Press, Lowa, USA.

Course Contents
Ph.D. in Veterinary Extension Education

I. **Course Title : Organizational Leadership and Management**
II. **Course Code : EXT 701**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To orient students with leadership and management perspectives for organizational change and development.

V. **Theory**

Unit I

Organizational Leadership – Introd uction, Definition, Importance, Distinguishing differences between leadership and management within an organization, Theories of leadership, Current trends in leadership development, Competencies needed to be an effective leader and develop strategies for improving effective leadership potential.

Unit II

Concept, Approaches and functions of management, Principles and process of organization, hierarchy of organization, departmentalisation, Authority and responsibility. Components of individual behaviour in organization, Organizational climate, Decision making by consensus and participation by subordinates, Organization development– history, nature, characteristics, assumptions and process, Organization development interventions.

Unit III

Organizational communication, Communication network, Essentials of organizational communication. Conflict – types and management, Leadership and its role in conflict resolution, Morale in organizations, organizational factors affecting morale, attitude and productivity, methods of improving moral and evaluation of morale. Performance appraisal processes.

Unit IV

Supervision– principles, techniques and functions of supervision. Qualities of supervisor, supervisor-subordinate relationship and interaction process. Changing organizational structure and system, changing organizational climate and interpersonal style, issues and choice involved in making organizational climate effective.

VI. **Suggested Reading**

- Bhattacharyya DK. 2011. *Organizational Change and Development*, Oxford University Press.

- Hellriegel D, Sloccum JW and Woodman. 2001. *Organizational Behaviour*.
- Luthans F. 2002. *Organizational Behaviour*. Tata McGraw-Hill, New York
- Newstrom JW and Davis K. *Organizational Behaviour: Human behaviour at Work*. Tata- McGraw Hill, New Delhi.
- Peter MS. 1998. *The Fifth Discipline: The Art and Practice of Learning Organization.* Random House, London.
- Pradip NK. 1992. *Organisational Designs for Excellence*. Tata McGraw Hill, New Delhi.
- Shukla Madhukar. 1996. *Understanding Organisations*. Prentice Hall of India, New Delhi.
- Thomas GC and Christopher GW. 2013. *Organizational development and change* (10th edition), South-Western college publishing.
- Wendell LF and Cecil HB. 1999. *Organisational Development: Behavioural Science Interventions for Organization Improvement*, Pearson. 368 pp.
- Gary A Yukl. 2013. *Leadership in Organizations* (8th edition), Pearson
- Anita Satterlee. 2018. *Organizational Management and Leadership* (3rd edition, Synergistics Inc.
- Patricia D Witherspoon. 1997. *Communicating Leadership: An Organizational Perspective*, Allyn and Bacon, Inc.

Course Outline

S. No.	Topic	No. of Lectures
Theory		
1	Introduction, Definition and Importanceof Organizational Leadership with special reference to Animal Husbandry Organizations	1
2	Distinguishing differences between leadership and management within an organization	1
3	Theories of leadership, Current trends in leadership development	2
4	Competencies needed to be an effective leader and develop strategies for improving effective leadership potential.	2
5	Concept, approaches and functions of management with special reference to Animal Husbandry organizations	2
6	Principles and process of organization, hierarchy of organization, departmentalisation, Authority and responsibility.	3

7	Components of individual behaviour in organization.	1
8	Organizational climate, decision making by consensus and participation by subordinates.	1
9	Organizational development – history, nature, characteristics, assumptions and process.	1
10	Organization development interventions.	2
11	Organizational communication, Communication network, Essentials of organizational communication**.**	2
12	Conflict – types and management.	2
13	Leadership and its role in conflict resolution.	1
14	Morale in organizations, organizational factors affecting morale, attitude and productivity, methods of improving morale and evaluation of morale.	2
15	Performance appraisal processes	2
16	Principles, techniques and functions of supervision.	1
17	Qualities of supervisor, supervisor-subordinate relationship and interaction process.	1
18	Changing organizational structure and system	2
19	Changing organizational climate and interpersonal style, issues and choice involved in making organizational climate.	3
	Total	32

I. **Course Title : Recent Trends in Research Techniques in Social Sciences**

II. **Course Code : EXT 702**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To train the students on research and management techniques/ methods applicable to animal husbandry research.

V. **Theory**

Unit I

Importance and relevance of scales, Tests, Index, Quotient in social science research. Techniques of attitude scale construction, viz., paired comparison, equal appearing interval, successive interval, summated ratings, scalogram analysis.

Unit II

Measurement of reliability and validity of tests and scales. Sociometry. Qualitative, quantitative and mixed methods of research. Critical incidence techniques. Q-sort technique, Observation techniques, Case studies, etc.

Unit III

Experimental and quasi experimental research designs and

randomized control trials. Delphi techniques, Propensity score matching, Content analysis and projective techniques.

Unit IV

Multivariate analysis, Systems analysis, Conjoint analysis, Panel data analysis, Principal component analysis, Discriminant analysis, Non-parametric tests and their application in extension research.

VI. Practical

Exercises on scaling techniques, attitude scale construction – Paired Comparison, Equal Appearing interval, Summated Rating Scale, Critical Incident Technique, Exercise on construction of Knowledge Test. Assessing the reliability and validity of measuring instruments Exercise on observation skills.

VII. Suggested Reading

- Babbie E. 2008. *The basics of social research* (4th Edition), Belmont, CA, USA; Thompson Wordsworth.
- Creswell JW. 2009. *Research design: Qualitative, quantitative, and mixed methods approaches*. Third edition. Thousand Oaks: Sage Publications.
- *Creswell JW. 2012. Educational research: Planning, conducting, and evaluating quantitative and qualitative research (4th edition). Boston, MA: Pearson.*
- Kerlinger FN and Lee HB. 2000. *Foundations of Behavioral Research.* Orlando, FL: Harcourt College Publishers.
- Kumar R. 2014. *Research Methodology: A Step- by- Step Guide for Beginners*. (4th Edition). Thousand Oaks, California: Sage Publications.
- Malhotra NK. 2010. *Marketing research: An applied orientation. Sixth Edition*. Upper Saddle River NJ: Prentice Hall.
- Neuman WL. 2006. *Social Research Methods: Qualitative and Quantitative Approaches.* Toronto: Pearson.
- Sekaran U and Bougie R. 2013. *Research Methods for Business A Skill-Building Approach*. (6th Edition), Wiley, New York.
- Sivakumar PS, Sontakki BS, Sulaiman RV, Saravanan R and Mittal N. (eds). 2017. Good Practices in Agricultural Extension Research. Manual on Good Practices in Extension Research and Evaluation. *Agricultural Extension in South Asia*. Centre for research on innovation and science and policy (CRISP), Hyderabad. India.

Course outlines

S. No.	Topic	No. of Lectures/Practicals

Theory

1.	Importance and relevance of scales, tests, index, quotient in Social science research.	3
2.	Techniques of attitude scale construction, viz., paired comparison, equal appearing interval, successive interval, summated ratings, scalogram analysis.	5
3.	Measurement of reliability and validity of tests and scales.	2
4.	Sociometry.	1
5.	Qualitative, quantitative and mixed methods of research.	3
6.	Critical incidence techniques, Q-sort technique, observation techniques, case studies	3
7.	Experimental and quasi experimental research designs and randomized control trials.	2
8.	Delphi techniques, propensity score matching, content analysis And projective techniques.	3
9.	Multivariate analysis	2
10.	Systems analysis	1
11.	Conjoint analysis	1
12.	Panel data analysis	1
13.	Principal component analysis	1
14.	Discriminant analysis	1
15.	Non-parametric tests and their application in extension research.	3
	Total	32

Practicals

1.	Scaling techniques	2
2.	Attitude scale construction – Paired Comparison, Equal Appearing interval, Summated Rating Scale, Critical Incident Technique	6
3.	Construction of Knowledge Test	3
4.	Assessing the reliability and validity of measuring instruments	3
5.	Exercise on observation skills	2
	Total	16

I. **Course Title : Training for Development**

II. **Course Code : EXT 703**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To impart knowledge on planning, implementation and evaluation of various training programmes.

V. Theory

Unit I

Concept of training and education. Role of institution, Organization, Trainer and participants in success of training programme. Training infrastructure for extension personnel and livestock farmers.

Unit II

Planning, Development and execution of training programmes. Concept of need Assessment; Approaches in need Analysis- Performance Analysis, Task Analysis, Competency Study; Needs Survey.

Unit III

Training curriculum design and development. Training models, Methods and methodologies and strategies - Evaluation of Training (Kirkpatric model, CIPP Model, Logic Model, etc.), and follow-up of training programmes. Training Transfer– Barriers and factors effecting transfer of training (training design, trainee characteristics, Trainer capabilities, Training environment, Organization role, etc.).

Unit IV

Training, Capacity building, Capacity development and HRD- Meaning and differences; Need and principles of capacity development; Types and levels of capacities. Approaches in Capacity Development -Informative approach, Participatory approach, Experimental approach/ Experiential, Performance based approach; Capacity Development Strategies - Academic strategy, Laboratory strategy, Activity strategy, Action strategy, Personal development strategy, Organizational development strategy.

VI. Practical

Exercise on Training Need Assessment. Development of training modules. Organization of training programmes for farmers, Evaluation of training programmes. Impact assessment of training programmes**.** Analysis of training institutions**.** Studies on training transfer.

VII. Suggested Reading

- Bentaya GM and Hoffmann V (Eds). 2011. *Rural Extension Volume 3 -Training Concepts and Tools*, Margraf Publishers GmbH, Scientific books, KanalstraBe 21; D-97990, weikersheim, 191 pp.
- DFID. 2003. *Promoting Institutional and Organisational Development. A Source Book of Tools and Techniques*, Department for International Development, United Kingdom
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Supporting Tools - Discussion Draft, Food and Agriculture Organisation of the United Nations
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- GFRAS. 2015. *The New Extensionist: Core Competencies for Individuals*, GFRAS Brief 3.
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- Pretty JN, Gujit I, Thompson J, and Scoones I. 1995. *A Trainer's Guide for Participatory Learning and Action*. IEED Participatory Methodology Series.
- Rolf PL and Udai P. 1990. *Training for Development*, (3rd edn) by (West Hartford, Kumarian Press, 1990, pp. 333.
- Rolf PL and Udai P. 1992. *Facilitating Development: Readings for Trainers, Consultants and Policy-makers*, New Delhi: Sage Publications, pp. 359

Course outlines

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Concept of training and education.	1
2.	Role of institution, organization, trainer and participants in success of training programme.	1
3.	Training infrastructure for extension personnel and livestock farmers	1
4.	Planning, development and execution of training programmes – importance, scope and relevance to animal husbandry sector	1
5.	Concept of Need Assessment – Scope and Importance in	

Animal husbandry sector 1

6. Approaches in Need Analysis- Performance Analysis, Task Analysis, Competency Study; Needs Survey. 2
7. Training curriculum design and development. 1
8. Training models, methods and methodologies and strategies 1
9. Training Evaluation (Kirkpatrick model, CIPP Model, Logic Model, etc.) and follow-up of training programmes. 2
10. Training Transfer– Barriers and Factors effecting transfer of training (training design, trainee characteristics, trainer capabilities, training environment, organization role, etc.) 1
11. Training, capacity building, capacity development and HRD – Meaning and differences; 1
12. Need and principles of capacity development; Types and levels of capacities. 1
13. Approaches in Capacity Development -Informative approach, Participatory approach, Experimental approach/ Experiential, Performance based approach; 1
14. Capacity Development Strategies - Academic strategy, Laboratory strategy, Activity strategy, Action strategy, Personal development strategy, Organizational development strategy. 1

Total 16

Practicals

1. Training Need Assessment of farmers, entrepreneurs/ AHD functionaries 3
2. Development of training modules – for farmers/ entrepreneurs 2
3. Organization of training programmes for farmers/ entrepreneurs 3
4. Evaluation of training programmes of farmers/ entrepreneurs 2
5. Impact assessment of training programmes 3
6. Analysis of training institutions 2
7. Identification of Capacity Developmentapproaches and strategies followed by Animal Husbandry Department/ other related organization 2

Total 16

I. **Course Title : Policies and Regulations in Livestock Sector**
II. **Course Code : EXT 704**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

To sensitize students on policies and regulations in animal husbandry sector.

V. Theory

Unit I

Concept, importance of development of policies and its framework. State, National and Global policies related to livestock sector. World Trade

Organization in relation to livestock sector. Impact of WTO on Indian international trade of food products of animal origin, Intellectual Property Rights in relation to animal husbandry.

Unit II

HACCP, Sanitary and phyto-sanitary measures to protect the animals' life and health, Food safety uses in relation to animal husbandry sector. Introduction to Agreement on Technical Barriers to Trade (ATBT).

Unit III

Indian livestock sector related policies, National Livestock Policy, Regional Trade Agreements (RTAs) and Indian Livestock sector; Case studies – Impact of global trade agreements on livestock sector. Food safety acts and institutional arrangements for implementation; Agriculture Produce and Livestock Marketing (APLM) Act. Livestock products pricing policy. Government of India Systems, viz., Sanitary Import Permit System for livestock products

Unit IV

Animal welfare - Philosophical bases of animal welfare; Evolution of basic animal welfare principles; Animal Welfare laws- legislations in veterinary and animal sciences.

VI. Suggested Reading

- Jessica Vapnek Megan Chapman. 2010. *Legislative and regulatory options for animal welfare* (FAO Legislative Study 104) http://www.fao.org/docrep/013/i1907e/i1907e00.pdf
- Richard A Sprenger 2018. The HACCP Handbook (7th Edition)
- Sara E Mortimore and Carol A. Wallace. 2015. HACCP: *A food industry briefing,* Second Edition Sara E. Mortimore and Carol A Wallace
- World Society for the Protection of Animals. 2007. *Universal Declaration on Animal Welfare* https://www.worldanimalprotection.ca/sites/default/files/ca_-_en_files/case_for_a_udaw_ tcm22-8305.pdf
- https://awbi.org/awbi-pdf/APL.pdf
- https://www.petaindia.com/wp-content/uploads/2017/05/Prevention-of-Cruelty-to-Animals- Dog-Breeding-and-Marketing-Rules-2017.pdf
- https://www.wto.org/

Course Outlines

S. No.	Topic	No. of Lectures

Theory

1.	Concept, importance of development of policies and its framework.	1
2.	State, National and Global policies related to livestock sector.	1
3.	World Trade Organization in relation to livestock sector.	1
4.	Impact of WTO on Indian international trade of food products of animal origin.	1
5.	Intellectual Property Rights in relation to animal husbandry.	1
6.	HACCP, Sanitary and phyto-sanitary measures to protect the animals'life and health, food safety uses in relation to animal husbandry sector.	1
7.	Introduction to Agreement on Technical Barriers to Trade (ATBT).	1
8.	Indian livestock sector related policies.	2
9.	Regional Trade Agreements (RTAs) and Indian Livestock sector	1
10.	Case studies – Impact of global trade agreements on livestock sector.	1
11.	Case studies – Food safety acts and institutional arrangements for implementation	1
12.	Agriculture Produce and Livestock Marketing (APLM) Act.	1
13.	Livestock products pricing policy.	1
14.	Animal Welfare - Philosophical bases of animal welfare; Evolution of basic animal welfare principles	1
15.	Animal Welfare laws- legislations in veterinary and animal Sciences legislations in veterinary and animal sciences	1
	Total	16

I. **Course Title : Educational Technology**

II. **Course Code : EXT 705**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To acquaint students with different concepts of education technology for the enhancement of quality of education.

V. **Theory**

Unit I

Educational Technology – Meaning, Nature, Scope Concepts and Components of Educational Technology- Basics of Teaching and Learning- Theories of teaching and learning. Curriculum development at macro and micro levels. Formulation of instructional objectives. Teaching Competencies –Need and Importance in

teaching– competency mapping and development.

Unit II

Preparation of course outline for instructions, lesson planning. Designing instructions for theory and practical, Innovative Teaching Methods/ methodologies – Student Centric and Teacher Centric; Instructional tools and devices in class room instruction, computer aided learning. Understanding learner's behaviour, learning styles, motivating learners. Measurement of learning outcomes.

Unit III

Students' counselling, guidance and mentoring – concepts, types and importance in higher education- Student evaluation – meaning and methods, construction of measuring instrument – question banking. Performance appraisal of teachers – meaning and methods, construction of assessment instruments. Use of library for effective learning.

Emerging Educational Technologies- Open and Distance Learning (ODL) for quality Veterinary Education; Concepts of ODL – Implications to Veterinary Education. Online Education - Synchronous and Asynchronous learning – models – eLearning, Massive Open Online Courses – SWAYAM, Open Education Resources (OERs), RLOs, Digital Initiatives in Education, viz., Swayam Prabha, National Digital Library, National Academic Depository, E-Shodh Sindhu, E Acharya, EVidhwaan, Agriculture Education Portal, e-KrishiShiksha, KrishiKosh, CeRA, National Educational Alliance for Technology (NEAT) etc.

VI. Practical

Preparation of lesson plans, Planning and preparation of instructional aids, Individual classroom instructional exercises, Micro Teaching Exercise, Development and testing of student evaluation instrument, Development of performance appraisal instrument for teachers., Critical analysis of different online education platforms.

VII. Suggested Reading

- Aggarwal JC. 2000. *Essential of Educational Technology: Teaching Learning Innovations in Education*. New Delhi: Vikas Publishing House.
- Alston, Antoine JW, Wade Millerand, David L Williams. 2003. *The future role of instructional technology in agricultural education in North Carolina and Virginia*. Journal of Agricultural Education, Volume 44, Number 2, 2003.
- Breslow L, Pritchard DE, DeBore J, Stump GS, Ho AD, Seaton DT. 2013. *Studying Learning in the Worldwide Classroom Research into edX's First MOOC*.
- Davies IK. 1971. *The Management of Learning*. New York:

McGraw-Hill Publications.
- Fred Percival and Phil Race. 2005. *Handbook of Educational Technology 3rd Edition*. New Jersey: Nichols Publishing Company.
- Holz-Clause MS and Guntuku D. 2010. *Global Agricultural Knowledge Initiative: Strengthening the global competence of students, faculty and extension agents.*
- Kumar KL. 2000. *Educational Technology*. New Delhi: New Age International Publishers.
- Leith GO *et al.*1966. *A Hand Book of Programmed Learning and Birmingham*.
- Mangal SK. 2002. *Foundation of Educational Technology*. Ludhiana: Tondan Publication. 137.
- Mangal SK. 2006. *Essentials of Educational Technology*. New Delhi: Prentcile-Hall Publications.
- Mithra, Shiv K. 1968. *Proceeding of Symposium on Educational Technology*. IPAL, NCERT. P.4.
- Purabi Jain. March 1968. *Educational Technology*. New Delhi: Dominant Publishers and Distributers.
- Sampath K, Panneerselvam A, Santhanam M. 2001. *Introduction to Educational Technology*. New Delhi: Sterling Publishers Pvt. Ltd.
- Sharma RA. 2007. *Educational Technology and Management*. Agra: Vinod Pustak Mandir.

Course Outlines

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Meaning, nature, Scope, Concepts and Components of Educational Technology	1
2.	Basics of Teaching and Learning	1
3.	Theories of teaching and learning	2
4.	Curriculum development at macro and micro levels	2
5.	Formulation of instructional objectives	1
6.	Teaching Competencies – Need and Importance in teaching	1
7.	Competency mapping and development	1
8.	Lesson planning – definition, importance, steps in preparation	1
9.	Preparation of course outline for instructions, Designing Instructions for theory and practical	2
10.	Innovative Teaching Methods/ methodologies – Student Centric and Teacher Centric	2
11.	Instructional tools and devices in class room instruction,	

computer aided learning 2

12. Understanding learner's behaviour, learning styles, motivating learners. 2
13. Measurement of learning outcomes 1
14. Students' counselling, guidance and mentoring – concepts, types and importance in higher education 2
15. Student evaluation – meaning and methods, construction of measuring instrument – question banking 1
16. Performance appraisal of teachers –meaning and methods, Construction of assessment instruments. 2
17. Use of library for effective learning 1
18. Emerging Educational Technologies - Open and Distance
19. Learning (ODL) for quality Veterinary Education 2
20. Concepts of ODL – Implications to Veterinary Education. 1
21. Online Education - Synchronous and Asynchronous learning – models – eLearning, 2
22. Massive Open Online Courses – SWAYAM, Open Education Resources (OERs), RLOs, Digital Education and its application in Veterinary Education 2

Total 32

Practicals

1. Preparation of lesson plans 3
2. Planning and preparation of instructional aids 3
3. Individual classroom instructional exercises 2
4. Exercise on Micro teaching 2
5. Development and testing of student evaluation instrument 2
6. Development of performance appraisal instrument for teachers. 2
7. Critical analysis of different online education platforms 2

Total 16

I. **Course Title : Dynamics of Social Change**
II. **Course Code : EXT 706**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To provide understanding on the dynamics of social change and its implications to livestock development.

V. **Theory**

Unit I

Definition of change, development, social and cultural change. Dimensions,
characteristics, Types, rate and directions of social change. General conditions of social change. New dynamics in social

change.

Unit II

Concept, importance and problems of planned change. Role of change agents. Approaches of change agents towards planned change. Acceptance and rejection to planned change in animal husbandry. Techniques for accelerating change.

Unit III

Theories of change: Darwin, Kurt, Lewin and Ogburn: Process of change, assessment of resources, fixation of change objective, evaluating change effect. Barriers to change-psychological, Social and economic, Stimulants to change: psychological, social and economic.

Unit IV

Social Change and its implication with reference to livestock development. Temporal changes in livestock development – national and global, Climate change and its impact on livestock development.

VI. Suggested Reading

- Chandra Shekhar. 2009. *Dynamics of Social Change*. Popular Prakashan.
- Johannes Dragsbaek Schmidt, Jacques Hersh. 2000. *Globalization and Social Change*, Routledge.
- John Solomos, Les Back. 1995. *Race, Politics, and Social Change*, Routledge.

Course outlines

S. No.	Topic	No. of Lectures
Theory		
1.	Definition of change, development, social and cultural change	2
2.	Dimensions, characteristics, types, rate and directions of social change	2
3.	General conditions of social change	2
4.	New dynamics in social change	1
5.	Concept, importance and problems of planned change	2
6.	Role of change agents in social change and Approaches of Change agents towards planned change	2
7.	Acceptance and rejection to planned change in animal husbandry	2
8.	Techniques for accelerating change	1
9.	Theories of change: Darwin, Kurt, Lewin and Ogburn	3
10.	Process of change	1
11.	Assessment of resources	2
12.	Fixation of change objective	1

13. Evaluating change effect 2
14. Barriers to change-psychological, social and economical 1
15. Stimulants to change: psychological, social and economic 2
16. Social Change and its implications with reference to livestock development 2
17. Temporal changes in livestock development – national and global 2
18. Climate change and its impact on livestock development 2

Total 32

I. **Course Title : Monitoring and Evaluation of Livestock Development Programmes**

II. **Course Code : EXT 707**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To appraise the students about the monitoring and evaluation of livestock development programmes.

V. **Theory**

Unit I

Monitoring, evaluation and impact assessment - Importance and scope in livestock based developmental programmes; Approaches and Types of Monitoring Indicators- Approaches to Monitoring Indicators, Types of Monitoring Indicators; Indicators of Monitoring in Development Programmes - Capability Indicators, Performance Indicators; Monitoring and Progress Reporting; Evaluation: Data Collection Methods

- Conventional Methods, Participatory Methods; Evaluation Approaches; Challenges in Programme Evaluation.

Unit II

Conceptual framework, result framework and logic models; Quantitative and qualitative indicators – characteristics and their selection criteria; indicators and information systems for sustainable livestock development - Testing and improving indicators; Integration of M and E systems into development programs.

Unit III

Difference between outcome and impact; Types of impact assessment: Climate impact assessment; Demographic impact assessment; Development impact assessment; Ecological and environmental impact assessment; Economic and fiscal impact assessment; Risk assessment; Social impact assessment; Strategic impact assessment; technology assessment, Project evaluation, Public participation and consultation.

Unit IV

Impact assessment methods: Formative and summative evaluation, Types-within- without; before-after; case study; social auditing; performance audit; quantifying the impact parameters.

VI. Practical

Development of M and E plans and procedures for livestock developmental programmes using participatory approach. Developing indicators (social and economic) and information system for sustainable livestock development; analysis of different reports, conducting impact assessmentgeneration, report writing.

VII. Suggested Reading exercises, case studies, data

- Carlson GA, Miranowski J and Zilberman D. 1998. *Agricultural and Environmental Resource Economics*. Oxford Univ. Press. 63
- Hanley N, Shogren J and White B. 2007. *Environmental Economics in Theory and Practice*. Palgrave, London.
- Kolstad C. 1999. *Environmental Economics*. Oxford Univ. Press.
- Little IMD and Mirlees JA. 1974. *Project Appraisal and Planning for Developing Countries*. Oxford and IBH Publ.
- Prato T. 1998. *Natural Resource and Environmental Economics*. Iowa State Univ. Press.
- Sterner T. 2003. *Policy Instruments for Environmental and Natural Resource Management. Resources for the Future*. The World Bank and SIDA.

Course Outines

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Monitoring, evaluation and impact assessment - importance and scope in livestock based developmental programmes	2
2.	Approaches to Monitoring Indicators	1
3.	Types of Monitoring Indicators	1
4.	Indicators of Monitoring in Development Programmes Capability Indicators, Performance Indicators	2
5.	Monitoring and Progress Reporting	1
6.	Evaluation: Data Collection Methods - Conventional Methods, Participatory Methods	3
7.	Evaluation Approaches	1
8.	Challenges in Programme Evaluation	1
9.	Conceptual framework, result framework and logic models	2
10.	Quantitative and qualitative indicators – characteristics and their selection criteria	2
11.	Indicators and information systems for sustainable livestock development - testing and improving indicators	2

12. Integration of M and E systems into development programs 1
13. Difference between outcome and impact 1
14. Types of impact assessment: climate impact assessment; demographic impact assessment; development impact; assessment; ecological and environmental impact assessment; economic and fiscal impact assessment; risk assessment; social impact assessment; strategic impact assessment; technology assessment 5
15. Project evaluation 1
16. Public participation and consultation 1
17. Impact assessment methods: Formative and summative evaluation 2
18. Types of impact assessment -within-without; before-after; case study; social auditing; performance audit 2
19. Quantifying the impact parameters 1

Total 32

Practicals

1. Development of M and E plan for livestock developmental Programmes using participatory approach. 3
2. Development of procedures for livestock developmental Programmes using participatory approach 2
3. Developing indicators (social and economic) and information System for sustainable livestock development 3
4. Analysis of different reports 2
5. Conducting impact assessment exercises 2
6. Case studies 1
7. Data generation 1
8. Report writing 2

Total 16

I. **Course Title : Theory Constructions in Social Sciences**

II. **Course Code : EXT 708**

III. **Credit Hours : 1+0**

IV. **Aim of the course**

To provide the foundation for construction of theories in social science.

V. **Theory**

Unit I

Importance of theory construction in Extension. Hypothesis, Theory, Principle and Law; Meaning, elements, Ideal Criteria, Functions, Types of theories. Definitions: Meaning, types and Rules.

Unit II

Generalizations: Meaning, Classification. Relationship: Meaning Types.

Unit III

Terminologies used in theory constructions: Axiom, Postulate, Proposition, Theorem, Fact, Concept, Construct, Probability and Measurement Basic Derived.

Unit IV

Steps in theory building - Axiomatic techniques, Historical approaches and scientific application. Theoretical concept in social sciences. Test of Theory: Applying appropriate statistical tests.

VI. Suggested Reading

- Blalock HM. 1969. *Theory Construction: Form verbal to Mathematical Formulations*. Prentice Hall.
- Dubin R. 1978. *Theory Building*. The Free Press, New York.
- Hage J. 1973. *Techniques and Problems of Theory Constructions in Sociology*. John Wiley and Sons
- Jack P Gibbs. 1972. *Sociological Theory Construction*. The Dryden Press, Illionis.
- Stinchombe AL. 1968. *Construction of Sociological Theories*. Harcourt, Brace and World.
- Wionton CA. 1974. *Theory and Measurement in Sociology*. John Wiley and Sons.

Course Outlines

S. No.	Topic	No. of Lectures
Theory		
1.	Importance of theory construction in Extension. Hypothesis, Theory, Principle and Law	2
2.	Theory construction definitions - Meaning, types and Rules.	1
3.	Theory - Meaning, elements, Ideal Criteria, Functions, Types	1
4.	Generalizations: Meaning, Classification.	2
5.	Relationship - Meaning Types.	1
6.	Terminologies used in theory constructions: Axiom, Postulate, Proposition, Theorem, Fact, Concept, Construct, Probability and Measurement Basic Derived	3
7.	Steps in theory building - Axiomatic techniques, historical approaches and scientific application.	2
8.	Theoretical concept in social sciences.	2
9.	Test of Theory: Applying appropriate statistical tests	2
	Total	16

I. Course Title : Facilitation for Development

II. Course Code : EXT 709

III. **Credit Hours : 2+1**

IV. **Aim of the courses**

- To orient students on the importance facilitation.
- To inspires students to understand facilitation tools to influence change at the individual, group and organisational levels.
- To develop capacities in multi-stakeholder engagement, facilitation and networking.

V. **Theory**

Unit I

Facilitation for development in the AIS; Understanding facilitation for development; Importance of facilitation as a core function of extension within the Agricultural Innovation Systems (AIS); Basic principles of facilitation for development; Desired attributes of facilitator for development- Cognitive attributes, Emotional attributes (Emotional intelligence), Social, behavioural and attitudinal attributes; Technical skills of a facilitator for development- Design processes, Facilitation techniques and tools, the art of questioning and probing, Process observation and documentation, Visualisation.

Unit II

Facilitating Change in Individuals, Groups And Organisations - Self-discovery to realize our potentials, Tools for self-discovery, formulating a personal vision, Taking responsibility for your own development; Understanding the dynamics of human interaction, Group dynamics and power relations, Managing relationships, Shared vision and collective action, Tools for team building; Organizational change process, Organisational learning to adapt to changing environments, Enhancing performance of organisations, Leadership development, Tools for organisational change.

Unit III

Facilitating Operational Level Multi-Stakeholder Engagements - Defining stakeholders, Development of collective and shared goals, Building trust and accountability, Tools for stakeholder identification and visioning; Visualising innovation platforms (IPs), Why are IPs important?, Different models of IPs for multi-stakeholder engagement, policy engagement platforms, Generating issues and evidence for policy action, Advocacy for responsive policy processes.

Unit IV

Brokering Strategic Partnerships, Networking And Facilitation- Brokering linkages and strategic partnerships, Identification of critical links, Knowledge brokering, Creating linkages with

markets, Learning alliances and networking, Coordination of pluralistic service provision within the AIS, The concept of action learning and reflective practitioners, Networking; Facilitating Capacity Development-Facilitate participation and learning in development programs and projects. Virtual platforms- skills for strengthening dialogue, collaboration, shared commitment amongst diverse actors and stakeholders.

Course Outlines

S. No.	Topic	No. of Lectures/Practicals

Theory

1. Facilitation for development in the AIS; Understanding Facilitation for development; 1
2. Importance of facilitation as a core function of extension within the Agricultural Innovation Systems (AIS); 1
3. Basic principles of facilitation for development; Desired Attributes of facilitator for development- Cognitive attributes, Emotional attributes (Emotional intelligence), Social, behavioural and attitudinal attributes; 2
4. Technical skills of a facilitator for development- Design processes, Facilitation techniques and tools, the art of questioning and probing, 2
5. Process observation and documentation, Visualisation 1
6. Facilitating Change In Individuals, Groups And Organisations - Self-discovery to realize our potentials, 2
7. Tools for self-discovery, formulating a personal vision, Taking responsibility for your own development; 1
8. Understanding the dynamics of human interaction, Group dynamics and power relations, Managing relationships, Shared vision and collective action, 2
9. Tools for team building; 1
10. Organizational change process, Organisational learning to adapt to changing environments, Enhancing performance of organisations, 2
11. Leadership development, Tools for organisational change 1
12. Facilitating Operational Level Multi-Stakeholder Engagements - Defining stakeholders, Development of collective and shared goals, Building trust and accountability, 2
13. Tools for stakeholder identification and visioning; 1
14. Visualising innovation platforms (IPs), Why are IPs important?, Different models of IPs for multi-stakeholder engagement 2
15. Policy engagement platforms, Generating issues and evidence For policy action, 2
16. Advocacy for responsive policy processes 1

17. Brokering Strategic Partnerships, Networking and Facilitation-Brokering linkages and strategic partnerships, Identification of critical links, Knowledge brokering, Creating linkages with markets, 2
18. Learning alliances and networking, Coordination of pluralistic Service provision within the AIS, 1
19. The concept of action learning and reflective practitioners, Networking; 1
20. Facilitating Capacity Development-Facilitate participation and learning in development programs and projects. 2
21. Virtual platforms- skills for strengthening dialogue, collaboration, shared commitment amongst diverse actors and stakeholders 2

Total 32

Practicals

1. Practicing facilitation techniques 1
2. Self discovery exercises 1
3. Working together and interaction (task based) 1
4. Arrangement for multi-stakeholder interactions 1
5. Understanding organisational change process tools and techniques 1
6. Case analysis on organisational change process 1
7. Participating with innovation platforms 1
8. Policy engagement platforms 1
9. Stakeholder analysis mapping 2
10. Exercise on networking skills 2
11. Facilitating capacity building programmes 1
12. Facilitating virtual platforms 1
13. Filed visit to multi-stakeholder partnership projects 2

Total 16

VI. Suggested Reading

- Account Ability 2005. AA 1000, *Stakeholder Engagement Standard Exposure draft*. http://www.empresa.org/doc/AA1000_STHEngagement.pdf
- Anonymous..n.d. *Facilitation Tools for Meetings and Workshops.* https://seedsforchange.org.uk/tools.pdf
- Clarke S, Blackman R and Carter I. 2004. *Facilitation skills workbook -Training material for people facilitating small group discussions and activities using PILLARS Guides*. Tearfund, England. https://www.tearfund.org/~/media/files/tilz/fac_skills_english/facilitation_e.pdf
- Davis S. 2014. Using the Socratic Method as a Learning

Facilitator https://facilitatoru.com/training/using-the-socratic-method-as-a-learning-facilitator/
- Hanson L and Hanson C. *Transforming participatory facilitation: Reflections from practice*. http://pubs.iied.org/pdfs/G01950.pdf
- Jost C, Alvarez S and Schuetz T. 2014. CCAFS *Theory of Change Facilitation Guide*. CGIAR Research Program on Climate Change, Agriculture and Food Security. https://cgspace.cgiar.org/bitstream/handle/10568/41674/CCAFS%20TOC%20facilitation%202014%20FINAL.pdf
- Kennon N, Howden P and Hartley M. 2002. *Who really matters? A stakeholder analysis tool*. Extension Farming Systems Journal volume 5 number 2. https://www.csu.edu.au/__data/assets/pdf_file/0018/109602/EFS_Journal_vol_5_no_2_02_ Kennon_et_al.pdf
- Koutsouris A. 2012. *Exploring the emerging facilitation and brokerage roles for agricultural extension education*. AUA Working Paper Series No. 2012-4. Agricultural University of Athens. Department of Agricultural Economics and Rural Development. http://aoatools.aua.gr/RePEc/aua/wpaper/files/20124_koutsouris.pdf
- Krick T, Forstater M, Monaghan P, Sillanpaa M. 2005. *The Stakeholder Engagement Manual*: Volume 2, the Practitioner's Handbook on Stakeholder Engagement. AccountAbility, United Nations Environment Programme, Stakeholder Research Associates Canada Inc.
- Linden J. 2015. *Innovation in Layer Housing: From Drawing Board to Reality.* http://www.thepoultrysite.com/articles/3494/innovation-in-layer-housing-from-drawing- board-to-reality/
- Lindynorris. *How to Develop Your Personal Vision Statement: A Step-by-Step Guide to Charting Your Future With Purpose and Passion* http://static1.squarespace.com/static/5765deb1be659449f97fcbf5/t/5770b309579fb313164a7a37/1467003657818/LINDYNORRIS.COM+-+How+to+Develop+a+Personal+Vision+Statement.pdf
- Lundy M, Gottret MV and Ashby J. *Learning alliances: An approach for building multistakeholder innovation systems*. http://documents.worldbank.org/curated/en/564521467995077219/pdf/103509-BRI-PUBLIC- ADD-series-ILAC-brief.pdf
- Makini FW, Kamau GM, Makelo MN, Adekunle W, Mburathi GK, Misiko M, PaliM, and Dixon J. 2015. *Operational Field Guide for Developing and Managing Local Agricultural Innovation*

Platforms. Australian Centre for International Agricultural Research https://www.aciar.gov.au/file/103711/download?token=EPYmwxnE

- Mind Tools. n.d. *The Role of a Facilitator-Guiding an Event through to a Successful Conclusion*. https://www.mindtools.com/pages/article/RoleofAFacilitator.htm
- Mittal N, Sulaiman RV and Prasad RM. 2016. *Assessing Capacity Needs of Extension and Advisory Services A Guide for Facilitators*. Agricultural Extension in South Asia. http://www.aesanetwork.org/assessing-capacity-needs-of-extension-and-advisory-services-a- guide-for-facilitators/
- Mulema AA. 2012. *Organisation of innovation platforms for Agricultural Research and Development in the Great Lakes Region of Africa*. Graduate Theses and Dissertations. Paper 12631. https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=3638 and context=etd
- Nederlof S, Wongtschowski M and Van der Lee (eds.). 2011. *Putting Heads Together- Agricultural Innovation Platform in Practice*. KIT Publishers.
- Ngwenya H and Kibwika P. 2016. *NELK Module 7 Introduction to Facilitation for Development, New Extensionist Learning Kit (NELK)*, Global Forum for Rural Advisory Services (GFRAS) http://www.g-fras.org/en/knowledge/new-extensionist-learning-kit-nelk.html#module-7- introduction-for-facilitation-for-development
- Otim RL. 2013. *Facilitation Skills Training Manual: A facilitator's handbook*. United States Agency for International Development (USAID). https://publiclab.org/system/images/photos/000/020/662/original/FACILITATION_SKILLS_ TRAINING_Manual.pdf
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- Steinlin M and Jenkins CW. *Knowledge Sharing for Change-Designing and Facilitating Learning Process with a Transformational Impact.Ingenious Peoples Knowledge*.

http://www.fsnnetwork.org/sites/default/files/ipk_trainingmanual_midres.pdf
- Tallia AF, Holly J, Lanham HJ, McDaniel RR Jr., and Benjamin F Crabtree BF. 2013. 7 *Characteristics of Successful Work Relationships*. https://www.aafp.org/fpm/2006/0100/p47.pdf
- Van Rooyen A, Swaans K, Cullen B, Lema Z and Mundy P. 2013. *Facilitating Innovation Platforms in: Innovations platforms practice* brief 10. https://assets.publishing.service.gov.uk/media/57a08a28ed915d3cfd000602/Brief10.pdf
- Villet VV. 2015. *Motivation Theory by David McClelland*. https://www.mindtools.com/pages/article/human-motivation-theory.htm

I. **Course Title : Managing Extension Organizations**
II. **Course Code : EXT 710**
III. **Credit Hours : 2+1**
IV. **Aim of the courses**

- To orient students on the importance of knowledge and skills on various management functions, as applicable to extension organizations
- Discuss ways of running extension services as managers of livestock -ventures
- To develop capacities for becoming effective managers of livestock -ventures

V. **Theory**

Unit I

Management- An Over view - Management and Extension management – Meaning, concept, nature and importance; Management, administration and supervision - meaning, definition and scope; Approaches to management, Principles, functions and levels of management; Qualities and skills of a manager; Interpersonal relations in the organization; Reporting and budgeting; Extension Management in public, private sector and other sectors - Extension management (POSDCORB) in public sector, Department of Agriculture, Agricultural Technology Management Agency (ATMA), Krishi Vigyan Kendra (KVK), SAUs, ICAR Institutes, Private sector, Cooperatives, NGOs, FPOs, etc. Organisational Structure, Relations between different units- Challenges in management.

Unit II

Concepts in Management - Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM

Process, Guidelines for making effective decisions; Human Resource Management: Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development; Dealing with fund and staff shortages in different extension organizations (KVK, ATMA, etc.); Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles; Authority and responsibility, Delegation and decentralization, line and staff relations.

Unit III

Challenges of co-ordination in extension organizations; Managing interdepartmental coordination and convergence between KVK, ATMA and line departments; Co- ordinating pluralism in extension services; Challenges in managing public-private partnerships (PPPs) at different levels in agricultural development in general and extension in particular; Performance appraisal – Meaning, Concept, Methods.

Unit IV

Motivation and Communication- Managing work motivation – Concept, Motivation and Performance, Approaches to motivation, team building; Organizational Communication – Concept, Process, Types, Networks, Barriers to Communication; Mentoring, Time management, Team work and team-building strategies; Modernization of information handling; Supervision and Control - Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision; Managerial Control – Nature, Process, Types, Techniques of Control, Observation, PERT and CPM, Management Information Systems (MIS): Concept, tools and techniques, MIS in extension organisations.

VI. Practicals

- Simulated exercises on techniques of decision making
- Study the structure and function of agro-enterprises, Designing organizational structure/organograms
- Group activity on leadership development skills
- Simulated exercise to understand management processes
- Field visit to extension organizations (ATARI, KVKs, NGOs), FPOs, dairy cooperatives to understand the functions of management
- Practical exercises on PERT and CPM
- Group exercise on development of short term and long term plans for agro- enterprises
- Developing model agriculture-based projects including feasibility study, financial planning and cost-benefit analysis

VII. Suggested Reading

- Bitzer V. 2016. *Incentives for enhanced performance of agricultural extension systems*, KIT Working Paper 2016-6, Royal Tropical Institute, Amsterdam https://www.kit.nl/wp-content/uploads/2018/08/Incentives-for-enhanced-performance-of- agricultural-extension-systems.pdf
- Bitzer V, Wennik B and de Steenhuijsen B. 2016. *The governance of agricultural extension systems*, KIT Working Paper 2016-1 Royal Tropical Institute, Amsterdam. https://www.kit.nl/wp-content/uploads/2018/08/The-governance-of-agricultural-extension- systems.pdf
- Chand S. *Modern Management Theory: Quantitative, System and Contingency Approaches to Management.* http://www.yourarticlelibrary.com/management/modern-management-theory-quantitative- system-and-contingency-approaches-to-management/25621
- Daniel RG, James AFS and Freeman RE. 2003. *Management* (6th Edition). Pearson India.
- Fahimifard SM and Kehkha AA. 2009. *Application of Project Scheduling in Agriculture* (Case Study: Grape Garden Stabilization) American-Eurasian *J. Agric. and Environ. Sci.*, **5**(3): 313-321. https://www.idosi.org/aejaes/jaes5(3)/3.pdf
- Gabathuler E, Bachmann F and Klay A. 2011. *Reshaping Rural Extension Learning for Sustainability: An integrated and learning based advisory approach for rural extension with small scale farmers*- Chapter 4. Margraf Publishesrs, Kanalstr.
- GFRAS 2017. Module 3: *Agricultural Extension Programme Management, The New Extensionist Learning Kit, Global Forum for Rural Advisory Services* (GFRAS) http://www.g-fras.org/fr/component/phocadownload/category/70-new-extensionist-learning- kit-nelk.html?download=564:nelk-module-3-agricultural-extension-programme- management-textbook
- Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand and Sons, New Delhi.
- Hoffmann V, Gerster BM, Christnick A and Lemma M. 2009. *Rural Extension Volume 1*- Chapter 7. Margraf Publishesrs, Kanalstr.
- HRM. 2013. *Current Trends in Human Resource Management*

https://corehr.wordpress.com/2013/08/21/current-trends-in-human-resource-management/
- Koontz H and Weihrich H. 2015. *Essentials of Management: An International, Innovation and Leadership perspective*. Mcgrow Hill Education (India) Private Ltd.
- MANAGE. 2008. *Project Management in Agricultural Extension*, AEM-203, Post Graduate Diploma in Agricultural Extension Management (PGDAEM), National Institute of Agricultural Extension Management, Hyderabad http://www.manage.gov.in/pgdaem/studymaterial/aem203.pdf
- Mind Tools. *Core Leadership Theories: Learning the Foundations of Leadership*
- *Why are some leaders successful, while others fail?* Available online https://www.mindtools.com/pages/article/leadership-theories.htm
- Qamar KM. 2005. *Modernizing National Agricultural Extension Systems: A Practical Guide for Policy-Makers of Developing Countries*, Food and Agriculture Organization of the United Nations http://www.fao.org/uploads/media/modernizing%20national.pdf
- Swanson BE, Bentz RP and Sofranko AJ. 1997. *Improving Agricultural Extension. A Reference Manual*. Food and Agriculture Organization of the United Nations, Rome.
- Van den Ban AW and Hawkins HS. 1998. *Agricultural extension*- Chapter 10, BSL, CBS Publishers and Distributors.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1	Management- An Over view - Management and Extension management – Meaning, concept, nature and importanc	1
2	Management, administration and supervision - meaning, definition and scope;	1
3	Approaches to management, Principles, functions and levels Of management;	1
4	Qualities and skills of a manager; Interpersonal relations in the organization;	1
5	Reporting and budgeting; Extension Management in public, private sector and other sectors	2
6	Extension management (POSDCORB) in public sector, Department of Agriculture, Agricultural Technology Management Agency (ATMA), Krishi Vigyan Kendra (KVK), SAUs, ICAR	

	Institutes, Private sector, Cooperatives, NGOs, FPOs, etc.	2
7	Organisational Structure, Relations between different units- Challenges in management	1
8	Concepts in Management - Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process	2
9	Guidelines for making effective decisions; Human Resource Management: Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development	2
10	Dealing with fund and staff shortages in different extension organizations (KVK, ATMA, etc.)	1
11	Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles; Authority and responsibility, Delegation and decentralization, line and staff relations	2
12	Challenges of co-ordination in extension organizations	1
13	Managing interdepartmental coordination and convergence between KVK, ATMA and line departments; Co-ordinating pluralism in extension services	2
14	Challenges in managing public-private partnerships (PPPs) at different levels in agricultural development in general and extension in particular	2
15	Performance appraisal – Meaning, Concept, Methods	2
16	Motivation and Communication- Managing work motivation – Concept, Motivation and Performance, Approaches to motivation, team building	2
17	Organizational Communication – Concept, Process, Types, Networks, Barriers to Communication; Mentoring, Time management, Team work and team-building strategies	2
18	Modernization of information handling; Supervision and Control - Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision	2
19	Managerial Control – Nature, Process, Types, Techniques of Control, Observation, PERT and CPM, Management Information Systems (MIS): Concept, tools and techniques, MIS in extension organisations	3
	Total	32

Practicals

1	Simulated exercises on techniques of decision making	2
2	Study the structure and function of agro-enterprises, Designing organizational structure/ organograms	2
3	Group activity on leadership development skills	2
4	Simulated exercise to understand management processes	1
5	Field visit to extension organizations (ATARI, KVKs, NGOs),	

	FPOs, dairy cooperatives to understand the functions of management	3
6	Practical exercises on PERT and CPM	2
7	Group exercise on development of short term and long term plans for agro-enterprises	2
8	Developing model agriculture-based projects including Feasibility study, financial planning and cost-benefit analysis	2
	Total	16

List of Journals

- *Communicator*
- *Development communication*
- *Indian Dairyman*
- *Indian journal of Adult Education*
- *Indian Journal of Dairy Science*
- *Indian Journal of Extension Education*
- *Indian Journal of Psychology*
- *Indian Journal of Public Administration*
- *Journal of Dairy Research*
- *Journal of Extension Systems*
- *Journal of Rural Development*
- *Journal of Training and Development*
- *The Indian Journal of Animal Sciences*
- *The Indian Veterinary Journal*
- *Journal of Agriculture Extension and Education*
- *Indian Journal of Animal Research*
- *Indian Journal of Gender of Studies*
- *Kurukshetra*
- *Yojana*
- *Economic and Political weekly*
- *Indian Farming*

e-Resources

- www.informaworld.com (Journal of Agricultural Education and Extension)
- www.blackwellpubllishing.co (International Journal of Training and Development)
- www.blackwellpubllishing.co Educational Measurement: Issue and Practices
- www.academicjournals.net (International Journal of Dairy Science)
- www. cipav.org.co (Livestock Research for Rural Development)
- www.joe.org Journal of Extension

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Extension Education

1. Important concepts in extension science; principles of extension, Implications of earlier extension efforts. Emerging issues, problems and challenges of animal husbandry extension education. Changing approaches – ToT approach, Education Approach, Farmer Participatory Approaches (PRA, RRA, PLA, PTD, PCD, etc.), Demand Driven approach, Market led extension, FSA, Commodity Specific Approach, Market led Extension; Classification of PRA, Differences between PRA and RRA; Global concepts of extension (SAARC, BRICS, US, Japan, UK, Philippines and Israel) and its application to Indian context. Privatization of extension. Public Private Partnership.Extension approaches of State and Central Governments, ICAR, SVUs/ SAUs, NGOs, corporate and other organizations.
2. Communication- meaning, concept, purpose and process of communication- Models and theories of communication: Aristotle, Berlo, Osgood Schramm, Shanon and Weaver, Johari window, New Comb, Westley and McLean, etc. Types of communication- intrapersonal, interpersonal,verbalandnon-verbal; Criteria of effective communication, Determinants of communication- Empathy, credibility, fidelity, distortion, feedback and barriers to effective communication; Group and mass communication. Key communicators and their role in livestock development. Organizational Communication - formal- informal; downward-upward- horizontal; Problems in organizational communication.
3. ICT-concept, importance and types of tools and applications; Role and significance of ICT tools in Animal Husbandry Development - Use and importance of Social Media inlivestock development. Overview of emerging technologies.
4. Concept, meaning, importance of diffusion. Elements in diffusion process; Models and theories of diffusion. Concept, meaning, importance of adoption. Steps in adoption process. Adoption models, Stages in diffusion-adoption process; Innovation- Decision Process, Adopter categories and their characteristics. Factors influencing adoption. Attributes of innovations, Factors affecting the rate of adoption and sources of information. Consequences of innovations. Adopter categories and their characteristics. Identification and evaluation ofinnovations in livestock sector – Attributes, Reason for adoption, Non-adoption and Discontinuance, Consequences. Diffusion and adoption of livestock sectoral innovations.
5. Genesis and importance of programme planning. Objectives, principles and steps in programme planning process. Meaning and Scope of Monitoring; Basic Concepts and Elements in Monitoring; Types of

Monitoring; Techniques of Monitoring; What is Evaluation? Project Management Techniques- Gantt chart, Programme Evaluation and Review Technique (PERT). Critical Path Method (CPM).

6. Concept, nature and scope of research in social sciences. Types of research- fundamental, applied and action research, experimental and non-experimental research. Identification of concepts, constructs, variables. Hypothesis– importance, selection criteria (qualities of a workable hypothesis), formulation and testing of hypothesis. Selection and formulation of research problem. Measurement and levels of measurement; Research designs- exploratory experimental, and ex-post-facto research design. Sampling -Sampling methods- probability and non-probability sampling. Sources of errors. Methods of data collection– survey method, observation method, interview/ questionnaire method, case study, content analysis, sociometry, focus group discussion, projective techniques, Online tools of data collection, Reliability and validity of measuring instruments.
7. Concepts, scope and importance of psychology and social psychology in animal husbandry extension. Attitude-nature, theories, measurement and change of attitude towards livestock farming, Importance of attitude scales in livestock research and development. Motivation– nature, characteristics, theories, types and techniques of motivating farmers, Learning- principles, theories of learning and experiential learning and adult learning (andragogy).
8. Entrepreneurship - Role of Entrepreneurship in Economic Development of the country and current scenario and future prospects; Factors influencing Entrepreneurship (Internalfactors, Externalfactors, Politicalfactors, Socio-Cultural Environment, Legal and Technological Environment).
9. Gender and empowerment: meaning and importance in livestock sector, Gender related concepts and importance of empowering women in livestock development; Need and focus on gender sensitization, Gender in community diversity and its implication for empowerment.
10. Concept of farm journalism and communication. Journalism as a means of mass communication and its role in livestock development. Opportunities, strength and limitations. Ethics and principles of journalism for effective writing.
11. Descriptive statistics- measures of central tendency, Measures of dispersion, Coefficient of variance, Standard error, Skewness and kurtosis, Contingency tables, Normal distribution, Test of significance – One sample t test, Independent t test, paired t test, ANOVA and z - one tailed and two tailed tests. Population versus sample, Sampling errors, Sample size determination, Survey instruments, Open ended and closed ended questions, and online survey tools. Dependency among

the variables, correlation- Pearson, Spearman and Kendall, point biserial correlation, Regression analysis, Assumptions, Multiple linear Regression, Regression diagnostics-outlier, Multicollinearity, Heteroscedasticity and autocorrelation, logit/ probit model. Scaling Techniques: Ranking, Rating and Paired Comparison. Scaling techniques - Likert, Thurston and Guttman Scales. Construction and standardization; Knowledge test, Test of reliability and validity. Non-parametric tests- Signed Rank, Rank sum and Kruskal-Wallis tests. Test for independence and homogeneity. Multivariate techniques – cluster analysis, discriminant analysis and Factor analysis: Different rotations and interpretation of results.

Veterinary Physiology

DEPARTMENT OF VETERINARY PHYSIOLOGY

Course Structure for M.V.Sc degree programme (Semester Wise)

Course Code	Course Title	Credit Hours	Semester
VPY-601*	PHYSIOLOGY OF DIGESTION	2+1	I
VPY-602*	CARDIOVASCULAR AND RESPIRATORY PHYSIOLOGY	2+1	I
VPY-603*	RENAL PHYSIOLOGY AND BODY FLUID DYNAMICS	2+1	I
VPY-604*	HAEMATOLOGY	2+1	I
VPY 605	GROWTH AND ENVIRONMENTAL PHYSIOLOGY	2+0	II
VPY 606*	PHYSIOLOGY OF ANIMAL REPRODUCTION	2+1	II
VPY 607	CLINICAL PHYSIOLOGY	1+1	II
VPY 608	NEUROMUSCULAR PHYSIOLOGY	2+0	II
VPY 609*	ENDOCRINOLOGY OF DOMESTIC ANIMALS	2+0	II
VPY 610*	INSTRUMENTATION AND RESEARCH TECHNIQUES IN VETERINARY PHYSIOLOGY	0+2	II
VPY-691	PHYSIOLOGY OF WILD LIFE	1+0	I
VPY-692	MASTERS SEMINAR	1+0	I & II
VPY 699	MASTERS RESEARCH	0+30	I & II
*Compulsory Courses			

DEPARTMENT OF VETERINARY PHYSIOLOGY

Course Structure for Ph.D degree programme (Semester Wise)

Course Code	Course Title	Credit Hours	Semester
VPY 701	APPLIED PHYSIOLOGY OF BODY FLUIDSAND ELECTROLYTES	2+1	I
VPY 702	PHYSIOLOGY OF ANIMAL BEHAVIOUR	2+0	I
VPY 703*	RECENT TRENDS IN RUMINANT DIGESTION	2+1	I
VPY 704*	RECENT TRENDS IN NEUROENDOCRINOLOGY	2+1	I
VPY 705	MYOPHYSIOLOGY AND KINESIOLOGY	2+0	I
VPY 706	AVIAN PHYSIOLOGY	2+1	I
VPY 707	PHYSIOLOGY OF LACTATION	2+1	II
VPY 708	RECENT TRENDS IN ENVIRONMENTAL PHYSIOLOGY AND GROWTH	2+1	II
VPY 709	CELLULAR AND MOLECULAR PHYSIOLOGY	2+0	II
VPY 710	RECENT TRENDS IN IMMUNO-PHYSIOLOGY	2+1	II
VPY 711*	PHYSIOLOGY OF STRESS	2+0	II
VPY 712*	RECENT TRENDS IN REPRODUCTIVE PHYSIOLOGY	2+1	II
VPY 791	DOCTORATE SEMINAR-I	1+0	I & II
VPY 792	DOCTORATE SEMINAR-II	1+0	I & II
VPY 799	DOCTORATE RESEARCH	0+75	I & II
*Compulsory Courses			

Course Contents
M.V.Sc. in Veterinary Physiology

I. **Course Title : Physiology of Digestion**
II. **Course Code : VPY 601**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To teach comparative physiology of digestive system of monogastricanimals, ruminants and birds, and basic techniques.

V. **Theory**

Unit I

Basic characteristics and comparative physiology of digestive system of monogastric and polygastric animals. Appetite andcontrol of feed intake.

Unit II

Gastro-intestinal motility, secretary functions of gastro-intestinal tract, their regulation and gastro-intestinal hormones.

Unit III

Digestion, absorption and metabolism of carbohydrate, protein and fat in simple and compound stomach. Absorption of water and electrolytes.

Unit IV

Development of ruminant stomach, rumen microbiology and rumen environment. Ruminantmicrobial digestion, its advantages and disadvantages. Fate of rumen fermentation products. Rumino-reticularmotility, its significance and control. Digestion in birds.

VI. **Suggested Reading**

- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura. 2015.
- *Cunningham's Textbook of Veterinary Physiology* 5th Edn. Bradley G. Klein 2012
- *Digestive Physiology and Nutrition of Ruminants* by D C Church, 1975
- *The Rumen Microbial. Ecosystem*. 2nd Edn. Ed. by. P.N. HOBSON and C.S Stewart 1997
- Hungate RE. 1966. *Rumen and its Microbes*. Acad. Press. N.Y.
- *Rumen Microbiology*, Burk A Dehority. 2003. Nottingham University Press

S. No. Topic No. of Lectures/Practicals

Theory

1. Basic characteristics and comparative physiology of digestive system of domestic animals. Classification of animals on the basis of feeding habits, differences in the anatomy of digestive tract 1
2. General functions of Gastrointestinal tract and its control 1
3. Functional anatomy of digestive tract of monogastric animals-structural differences among the monogastric animals 1
4. Functional anatomy of digestive tract of ruminants: Development of ruminant stomach 1
5. Structural details of rumen, reticulum, omasum and abomasum, Rumino-reticular motility, its significance and control 1
6. Pseudoruminants, reticular groove reflex, rumination process and its phases. 1
7. Prehension, prehensile organs in different animals, grazing, browsing, rooting, mastication, deglutition, feed intake, water requirements and intake, drinking habits of water in different animals 1
8. Motility of esophagus, gastro-intestinal motility, primary peristalsis and secondary peristalsis, functions and zones of stomach 1
9. Rate of gastric emptying, interdigestive motility patterns, migrating myoelectric complex, emesis or vomiting 1
10. Motility in small intestine, nervous and hormonal control, peristaltic reflex and segmentation reflex. Motility in large intestine: caecum, colon, haustral contractions, oral and aboral peristaltic contractions, antiperistaltic contractions, Rate of passage of digesta and its estimation 1
11. Appetite and control of feed intake, hunger contractions, thirst, constipation, defecation, diarrhea 1
12. Regulation of GIT functions, gastro-intestinal hormones and their functions 1
13. Salivary secretion, its composition and functions 1
14. Secretion of gastric juice, phases of gastric secretion, composition, zymogen, autocatalysis and digestion in stomach 1
15. Pancreatic juice, secretion, control and composition, 1
16. Proteases, lipases, amylases and other enzymes of pancreatic juice. 1
17. Trypsin inhibitor and end products of pancreatic digestion 1
18. Liver, structure of liver lobule: secretion of bile and its regulation bile acids, bile salts, bile pigments: functions of bile

1

19. Enterohepatic recirculation: gall bladder function and contractions. 1
20. Intestinal juices, their secretions, composition and functions 1
21. Absorption of nutrients in the digestive tract and the effect ofnutrient interactions 1
22. Bacterial fermentation in large intestine, fermentative products, absorption of end products of fermentation 1
23. Metabolism and excretion of various nutrients, 1
24. Development of ruminant system and rumen environment 1
25. Rumen microbiology, Rumen microbes: classification of rumen bacteria, protozoa, fungi 2
26. Ruminant microbial digestion, Fermentation pathways: fermentation of carbohydrates, protein and fat, microbial activities in ruminant stomach and intestine 2
27. Rumen degradable proteins, rumen undegradable proteins and urea feeding 1
28. Volatile fatty acids, Absorption of end products and place of Absorption and mechanism of absorption 1
29. Advantages and disadvantages of ruminant digestion, artificial rumen 1
30. Digestion in birds: functional anatomy of avian digestive system, swallowing, crop, proventriculus, ventriculus, caeca, nitrogenmetabolism 1

Total 32

Practicals

1. Collection of saliva and its enzymatic studies 1
2. Gastric and intestinal motility, Rate of passage of digesta andits estimation 1
3. Rumino-reticular movements
4. Activity of pepsin and trypsin enzymes 1
5. Estimation of digestive metabolites such as glucose and ketone bodies, 1
6. Estimation of triglycerides, cholesterol 1
7. Estimation of urea nitrogen and total proteins 1
8. Liver function tests 2
9. Pancreatic function tests 1
10. Methods of collection of rumen liquor, merits and demerits 1
11. Determination of pH, total volatile fatty acids in rumen liquor 1
12. Determination of ammonia-nitrogen and total-nitrogen in Strained rumen liquor 2

13. Counting of protozoa and bacteria in rumen liquor 1
14. Demonstration of fermentation of feed-stuff in artificial rumen 1
Total 16

I. **Course Title : Cardiovascular and Respiratory Physiology**
II. **Course Code : VPY 602**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To teach function and regulation of heart, recording of ECG and respiration in different animals and basic techniques.

V. **Theory**

Unit I

Functional anatomy of heart and properties of cardiac muscle, Origin and propagation of cardiac impulses. Rhythmic excitation of heart, Electrophysiology of heart, Cardiac cycle, Cardiac sounds.

Unit II

Cardiac output and its measurements, Factors affecting cardiac output. Venous return and its regulation. Regulation of the cardiac functions.

Unit III

Normal electrocardiogram, Electrocardiographic interpretation in common cardiac disorders. Cardiac murmurs and cardiac arrhythmias. Echocardiography.

Unit IV

Circulation - coronary, systemic and pulmonary circulation and their regulation. Regional circulation. Pathophysiology of circulation. Hemodynamics. Arterial pressure. Capillary exchanges. Lymphatic circulation.

Unit V

Respiration, Mechanism of ventilation, Transport and exchange of respiratory gases at alveolar and tissue level, Respiratory adjustments at high altitude, Stress and exercise. Pulmonary volumes and capacities. Neural and chemical control of respiration. Respiration in birds.

VI. **Suggested Reading**

- Guyton and Hall *Textbook of Medical Physiology* 13th Edn John E. Hall Ph.D. 2015
- *Ganong's Review of Medical Physiology*, 26th Edn Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks, 2019
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O. Reece, Howard H. Erickson, Jesse P. Goff, Etsuro E. Uemura 2015.

- *Cunningham's Textbook of Veterinary Physiology* 5th Edn. Bradley G. Klein 2012.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1	Functional anatomy of heart	1
2	Electrophysiology of heart	1
3	properties of cardiac muscle	1
4	Origin and propagation of cardiac impulses	1
5	Rhythmic excitation of heart	1
6	Cardiac cycle	1
7	Cardiac sounds	1
8	Cardiac output and its measurements	1
9	Factors affecting cardiac output	1
10	Regulation of the cardiac functions	1
11	Venous return and its regulation	1
12	Normal electrocardiogram	1
13	Electrocardiographic interpretation in common cardiac disorders.	1
14	Cardiac murmurs	1
15	Cardiac arrhythmias	1
16	Echocardiography	1
17	Hemodynamics	1
18	Blood pressure - factors affecting it and measurement	1
19	Regulation of blood pressure	1
20	Systemic circulation and pulmonary circulation	1
21	Coronary circulation	1
22	Regional circulation	1
23	Introduction to respiration	1
24	mechanism of ventilation	1
25	Pulmonary volumes and capacities	1
26	Transport and exchange of respiratory oxygen at alveolar and tissue level	1
27	Transport and exchange of respiratory carbondioxide at alveolar and tissue level	1
28	Neural and chemical control of respiration	1
29	Respiratory adjustments at high altitude	1
30	Respiratory adjustments to stress	1
31	Respiratory adjustments to exercise	1
32	Respiration in birds	1
	Total	32
Practical		
1.	Determination and recording of cardiac output	1

2.	Measurement of blood pressure by sphygmomanometer	1
3.	Recording of heart rate by physiograph	1
4.	Effect of various ions and electrolytes on heart	1
5.	Effect of hormones on heart	1
6.	Effect of temperature on heart	1
7.	Recording and interpretation of normal ECG	1
8.	Recording and interpretation of cardiac disorders by ECG	1
9.	Determination of blood volume	1
10.	Effect of exercise on heart rate, pulse rate rate	1
11.	Estimation of cardiac marker enzymes	1
12.	Determination of lung volumes and capacities by spirometry	1
13.	Estimation of blood gases	1
14.	Estimation of blood pyruvate	1
15.	Estimation of blood lactate	1
16.	Effect of exercise on respiration rate	1
	Total	16

I. Course Title : Renal Physiology and Body Fluid Dynamics

II. Course Code : VPY 603

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge regarding excretory system of mammals and birds, maintenance of body fluid homeostasis

V. Theory

Unit-I

An overview of nephron structure and function. Renal function in mammals.

Unit II

Renal haemodynamics. Glomerular filtration, Tubular reasbsorption and secretion. Urine formation- stages and factors affecting different stages.

Unit III

Role of kidney in acid-base balance, Physiology of micturition, Endocrine control of renal function- Renin angiotensin aldosterone system. Non excretory functions of kidney.

Unit IV

Excretory system in birds.

Unit V

Body fluids – various body fluid compartments, Different types of body fluids and their functions, Composition of different body fluids and their regulation.

VI. Suggested Reading

- Guyton and Hall *Textbook of Medical Physiology* 13th Edn John

E Hall Ph.D.. 2015

- *Ganong's Review of Medical Physiology*, 26th Edn Kim E Barrett, Susan M Barman, Scott Boitano, Heddwen Brooks. 2019.
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura. 2015.
- *Cunningham's Textbook of Veterinary Physiology* 5th Edn. Bradley G Klein. 2012.
- Klahar S. 1983. *The Kidney and Body Fluids in Health and Diseases*. Plenum Press.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Introduction to physiology of mammalian kidney	1
2.	Theories of renal formation and Functional anatomy of kidney	1
3.	Renal homeostatic function	1
4.	Renal circulation and Pressures in renal function	1
5.	Glomerular filtration	1
6.	Solute reabsorption	1
7.	Tubular secretion	1
8.	Water excretion	1
9.	Absorbtive capabilities of different segments of nephron	1
10.	Renal mechanism for concentration of urine	1
11.	Renal mechanism for dilution of urine	1
12.	Autoregulation of renal blood flow and GFR	1
13.	Renal function tests	1
14.	Hormonal regulation of kidney function	1
15.	Characteristics of urine in different species	1
16.	Renin-angiotensin-aldosterone system	1
17.	Micturition	1
18.	Non excretory functions of kidney	1
19.	Acids and bases in the body	1
20.	Buffers in the body	1
21.	Role of buffers in acid base balance	1
22.	Disturbances in acid base balance	1
23.	Urine formation in birds	1
24.	Characteristics of avian urine	1
25.	Body fluid compartments	1
26.	Regulation of ECF osmolality and volume	1
27.	Regulation of ECF electrolytes	1
28.	Water balance	1
29.	Measurement of body water	1

30. Water loss from routes other than kidney 1
31. Water conservation in domestic animals 1
32. Diuretics 1
33. Determining the degree of dehydration in an animal 1
34. Fluid therapy 1
Total 34

Practical

1. Collection and preservation of urine 1
2. Qualitative analysis of physiological constituents of urine 1
3. Qualitative analysis of pathological constituents of urine 1
4. Quantitative analysis of BUN in blood and urine 1
5. Quantitative analysis of creatinine in blood and urine 1
6. Quantitative analysis of phosphate and glucose in blood and urine 1
7. Determination of sodium, potassium in serum 1
8. Determination of calcium and chloride in serum 1

9-16. Demonstration of various kidney function tests- glomerular filtration rate, creatinine clearance rate, urea clearance rate and glucose tolerance test. 8
Total 16

I. **Course Title : Hematology**
II. **Course Code : VPY 604**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To acquaint the students about haematology of different animals including hands-on training.

V. **Theory**

Unit I

Hematopoietic stem cells, Blood cells and hematological indices, Anaemia, Different types of anaemia, Polycythemia and their effect on circulation in mammals and birds. Fate of erythrocytes. Porphyrias.

Unit II

Resistance of the body to infection, Leukocytes, tissue macrophage system and inflammatory response.

Unit III

Haemoglobin and its types, Iron binding proteins in blood, Haemoglobin disorders. Hemophilias. Immunity, Ommunoglobulins complement system.

Unit IV

Hemostasis and coagulation factors, Role of platelets, Fibrinolysis. Conditions causing bleeding disorders. Blood groups, transfusion

of blood.

VI. Suggested Reading

- Jain NC. 1993. *Essentials of Veterinary Hematology.* Lea and Febiger.
- *Schalm's Veterinary Hematology* 6th Ed - D Weiss J Wardrop, Wiley-Blackwell. 2010.
- *Guyton and Hall Textbook of Medical Physiology* 13th Edn John E Hall Ph.D. 2015.
- *Cunningham's Textbook of Veterinary Physiology* 5th Edn. Bradley G Klein. 2012.
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura. 2015.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Haematology- blood - composition-solutes of blood-plasma-interstitial fluid-lymph	1
2.	Functions of blood-general characteristics of blood-haematocrit-ESR- viscosity-temperature- volume-pH- colour-lifespan	1
3.	Haematocrit-methods of determination -colour index- icterus index- blood volume- methods of determination	1
4.	Plasma proteins – fractions- electrophoretic separation-general functions	1
5.	Functions of pre albumin-albumin-globulins and its fractions-	1
6.	Haematopoiesis- multipotent stem cells-definition-organs of hematopoisis- red and yellow marrow	1
7.	Multipotent lymphoid and myeloid stem cells- differentiation and maturation	1
8.	Bone marrow micro environment for haematopoiesis- stages of erythropoiesis	1
9.	Erythropoiesis- its regulation- vitamins and erythropoietin-haematinics	1
10.	Haemoglobin- stages of Hb synthesis- regulation	1
11.	Types of Hb	1
12.	Iron metabolism- Fe requirement- hepcidin	1
13.	Intravascular and extravascular haemolysis	1
14.	Catabolism of Hb	1
15.	Plasma bilirubin- types- hyperbilirubinemia	1
16.	Jaundice - types- etiology - differential diagnosis	1
17.	Anisocytosis- poikilocytosis- RBC membrane structure-Composition of RBC membrane	1

18. RBC metabolism-physiological and pathological conditions associated with polycythemia and oligocythemia 1
19. Anemias- classification- defective formation-excessive destruction-
    abnormal heme- abnormal globin chains- causes 1
20. Erythrocyte indices- cytometric classification of anemias-causes- Red cell distribution width 1
21. Leucocytopoiesis- granulocytopoiesis- lymphopoiesis 1
22. Functions of neutrophils- phagocytosis- opsonisation-eosinophils-basophils-monocytes 1
23. Conditions associated with altered number of neutrophils, eosinophils, basophils, monocytes and lymphocytes 1
24. Hemostasis- blood fluidity maintenance- injury leading to primary hemostatic plug formation 1
25. Secondary hemostatic pathways- intrinsic and extrinsic pathways- regulation-stabilisation of clot 1
26. Fibrinolysis- retraction of clot- haemostatic disorders 1
27. Types of immunity-innate-acquired- types of acquired immunity-Passive immunity-types-antibody-mechanism of actions of Ab- 1
28. NK cells-functions-T-cell lymphocytopoiesis- thymus- functions-thymosin-thymopoietin-maturation of T cells- T cell receptors-blood thymus barrier 1
29. Formation of T helper, cytotoxic and regulatory cells 1
30. Plasma cells-structure – formation and functions 1
31. Blood group antigens- cross reactivity- transfusion immunology 1
32. Rh blood group- erythroblastosisfoetalis-treatment 1

    Total 32

Practical

1. Enumeration of RBC, WBC 1
2. Enumeration of platelets 1
3. Enumeration of reticulocytes 1
4. Enumeration of differential leucocytes 1
5. Special staining techniques for leucocytes 1
6. Haemogram by automated blood cell counter 1
7. Anemic blood: Hb, PCV 1
8. Icterus index calculation using plasma and standard 1
9. Colour index calculation using plasma and standard 1
10. Band cell count and arneth count 1
11. Blood viscosity and RBC fragility determination 1
12. Activated partial thromboplastin time 1
13. Prothrombin time 1

14. Avian blood: haemogram-I (erythrocyte relates parameters using special stain) 1
15. Avian blood-haemogram-II (leucocyte relates parametersusing special stain) 1
16. Preparation of blood cells for electron microscopic analysis1

Total 16

I. **Course Title : Growth and Environmental Physiology**

II. **Course Code : VPY 605**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

To teach the Growth process and its regulation, effect of mineral and vitamins on body functions and influence of environmental conditions on homeothermy.

V. **Theory**

Unit I

Growth - Introduction and Concepts. Hormonal regulation of growth. Growth promoters.

Unit II

Minerals - Classification-functions and disorders. Chelated minerals, nanominerals.

Unit III

Vitamins - Classification-functions and disorders. Synthetic vitamins.

Unit IV

Environment - Introduction and concepts. Weather and climate. Homeothermy, Poikilothermy. Hibernation and estivation. Thermoregulation, thermal stress. Effect of environment on production and reproduction.

VI. **Suggested Reading**

- Samuel Brody. 1945. *Bioenergetics and growth*. Reinhold Publishing Corp., New York
- Hossner KL. 2005. *Hormonal Regulation of Farm Animal Growth*. CABI.
- McDowell LR. 1989. *Vitamins in Animal Nutrition*. Academic Press.
- Underwood EJ. 1977. *Trace Elements in Human and Animal Nutrition*. Academic Press.
- ESE Hafez. 1968. *Adaptation of Domestic Animals*. Lea and Febiger.
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura 2015.

S. No.	Topic	No. of Lectures/Practicals
1.	Growth - Definition, concepts, terminologies used in expression of growth	1
2.	Hormonal regulation of growth	2
3.	Commercial and synthetic hormones used in growth regulation	1
4.	Growth promoters used in livestock	1
5.	Growth promoters used in poultry	1
6.	Minerals - Introduction, Classification, sources	1
7.	Bioavailability of different minerals	1
8.	Physiological role of minerals	1
9.	Disorders of mineral metabolism in livestock	1
10.	Disorders of mineral metabolism in poultry	1
11.	Chelated minerals	1
12.	Nanotechnology in mineral supplementation	1
13.	Vitamins - Introduction, Classification, sources	1
14.	Physiological role of fat soluble vitamins	1
15.	Physiological role of water soluble vitamins	1
16.	Disorders of fat soluble vitamins	1
17.	Disorders of water soluble vitamins	1
18.	Synthetic vitamins in animal production	1
19.	Environment - Introduction, physical components	1
20.	Physical principles of heat exchange	1
21.	Weather and climate	1
22.	Homeothermy, Poikilothermy, endothermy and ectothrmy	1
23.	Hibernation and estivation	1
24.	Body temperature in different species	1
25.	Thermoregulation in livestock	1
26.	Thermoregulation in poultry	1
27.	Thermal stress	1
28.	Heat tolerance coefficient	1
29.	Effect of weather variables on production - Milk, meat, wool	2
30.	Effect of weather variables on reproduction	1
	Total	32

I. **Course Title : Physiology of Animal Reproduction**

II. **Course Code : VPY 606**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge of male and female reproductive system of different speciesof animals including birds.

V. **Theory**

Unit I

Functional histomorphology of male and female reproductive system. Development of male and female sex organs in different domestic animals. Neuro-endocrine reflexes.

Unit II

Puberty and its endocrine control. Sexual cycles and mating behaviours in females. Oogenesis, folliculogenesis and ovulation. Secretions of female reproductive tract in different species of animals. Endocrine regulation of female reproduction.

Unit III

Male mating behaviour, Spermatogenesis, Spermiogenesis, Spermatogenic cycles. Spermatozoa- structure and composition, Maturation and transportation. Secretions of male reproductive tract. Endocrine regulation of male reproduction.

Unit IV

Transport of male and female gametes, Fertilization, implantation. Early embryo development and maternal recognition of pregnancy. Hormones of pregnancy. Placentation, parturition and Uterine Involution. Avian reproduction and formation of egg.

VI. Suggested Reading

- *Reproduction in Farm Animals*, 7th Edn ESE Hafez, B Hafez. 2013.
- *McDonald's Veterinary Endocrinology*, Pineda and Doley. Iowa State University Press, Ames, 2003.
- *Physiology of Reproduction and Artificial Insemination*, Salisbury GW and Demark NL. WB Saunders, 1978.
- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura. 2015.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1	Functional histomorphology of male reproductive system	1
2	Functional histomorphology of female reproductive system	1
3	Development of male sex organs in different domestic animals	1
4	Development of female sex organs in different domestic animals	1
5	Neuro-endocrine reflexes	1
6	Puberty and its endocrine control in male domestic animals	1
7	Puberty and its endocrine control in female domestic animals	1
8	Sexual cycles in females	1
9	Mating behaviour in females	1
10	Oogenesis	1

11	Folliculogenesis	1
12	Ovulation	1
13	Secretions of female reproductive tract in different species of animals	1
14	Endocrine regulation of female reproduction in different species of animals	1
15	Spermatogenesis	1
16	Spermiogenesis	1
17	Spermatogenic cycles	1
18	Spermatozoa- structure and composition	1
19	Spermatozoa- maturation and transportation	1
20	Secretions of male reproductive tract.	1
21	Endocrine regulation of male reproduction in different species of animals	1
22	Transport of male and female gametes	1
23	Fertilization	1
24	Implantation	1
25	Early embryo development	1
26	Maternal recognition of pregnancy	1
27	Hormones of pregnancy	1
28	Placentation	1
29	Gestation	1
30	Parturition and Uterine Involution	1
31	Post-partum recovery in different species of domestic animals	1
32	Avian reproduction and formation of egg	1
	Total	32

Practical

1.	Methods of heat detection in different species of domestic animals	1
2.	Palpation of reproductive organs	1
3.	Examination of fern pattern in cervical mucus	1
4.	Semen evaluation - Gross	1
5.	Semen evaluation - Microscopical	1
6.	Semen evaluation - Biochemical	1
7.	Demonstration of preservation of semen	1
8.	Isolation of different follicles	1
9.	Collection of oocytes and their grading	1
10.	Estimation of reproductive hormones	3
11.	Demonstration of estrus behaviour	1
12.	Demonstration of mating	1
13.	Demonstration of parturition	1
14.	Demonstration of oviposition	1
	Total	16

I. **Course Code : Clinical Physiology**

II. **Course Title : VPY 607**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To teacht h e physiological basis of clinical abnormalities in body functions.

V. **Theory**

Unit-I

Introduction and basic concepts of understanding of alteration in system functions Relationship of cardiovascular, renal, respiratory systems and liver in healthy domestic animals and compensatory mechanisms during failure/ disorder of one or other systems Clinical Haematology and enzymology.

Unit II

Metabolism of carbohydrate, protein, lipid, vitamin and minerals in health and disease of various species of domestic animals and poultry.

Unit III

Evaluation of common endocrine disorders – pituitary, thyroid, parathyroid, pancreas in domestic animals (with reference to species and profile). Reproductive function alterations in male and female domestic animals during stress- productive, environmental, nutritional.

Unit IV

Clinical evaluation of Gastrointestinal tract; Clinical evaluation of Special Senses; Neuromuscular disorders and clinical correlation; Assessment of acid base and electrolyte balance.

VI. **Suggested Reading**

- *Clinical Biochemistry of Domestic Animals* 6th Edn, Jiro Jerry Kaneko, John W Harvey, Michael L Bruss, Academic Press. 2008.
- *Hawk's Physiological Chemistry*. Oser BL Tata McGraw-Hill. 1976.
- *Clinical Biochemistry: An Illustrated Colour* Text. Allan Gaw; Michael Murphy; Robert Cowan; Denis O'Reilly; Michael Stewart; James Shepherd, 2004
- *Clinical Physiology of Acid Base and Electrolyte Disorders. Rose BD. McGraw-Hill. 1989.*
- *Clinical Physiology: An Examination Primer*. 1st Edn, Ashis Banerjee, Cambridge University Press. 2005.
- *Textbook of Veterinary Physiological Chemistry* 3rd Edn, Larry R

Engelking. 2014.

- *Practical Clinical Biochemistry: Methods and Interpretations*. 4th Edn. Chawla Ranjna. 2014.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1	Introduction and basic concepts of understanding of alteration in system functions	1
2	Relationship of cardiovascular, renal, respiratory systems and liver in healthy domestic animals and compensatory mechanisms during failure/ disorder of one or other systems	2
3	Clinical Haematology	1
4	Clinical enzymology	1
5	Metabolism of Carbohydrate in health and disease of various species of domestic animals and poultry	1
6	Metabolism of protein in health and disease of various species of domestic animals and poultry	1
7	Metabolism of lipid in health and disease of various species of domestic animals and poultry	1
8	Metabolism of vitamins in health and disease of various species of domestic animals and poultry	1
9	Metabolism of minerals in health and disease of various species of domestic animals and poultry	1
10	Evaluation of common endocrine disorders – pituitary, thyroid, parathyroid, pancreas in domestic animals (with reference to species and profile)	2
11	Reproductive function alterations in male and female domestic animals during stress- productive, environmental, nutritional	1
12	Clinical evaluation of Gastrointestinal tract and special senses	1
13	Neuromuscular disorders and clinical correlation	1
14	Acid base and electrolyte balance	1
15	Biological fluid analysis	1
	Total	17
Practical		
1	Hematological analysis of clinically recovered animals	2
2	Liver function testsof clinically recovered animals	2
3	Electrocardiography and interpretations of clinically recovered animals	2
4	Sphygmomanometry of clinically recovered animals	1
5	Respiratory Function tests of clinically recovered animals	1
6	Digestive function tests of clinically recovered animals	1
7	Renal function tests of clinically recovered animals	1

8 Estimation of serum enzymes related to cardiovascular functions of clinically recovered animals 1
9 Estimation of serum enzymes related to liver functionsof clinically recovered animals 1
10 Estimation of serum enzymes related to kidney functions of clinically recovered animals 1
11 Clinical Examination of endocrinology disorder animals Bioassay of steroid hormonesof clinically recovered animals 2
12 Physiographic study of body parameters of clinically recovered animals 1
Total 16

I. **Course Title : Neuromuscular Physiology**
II. **Course Code : VPY 608**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To impart knowledge of coordination of body functions and regulation of brain functions and sense organs.

V. **Theory**

Unit I

Functional anatomy, types and classification of muscles, of muscles. Properties of skeletal muscle, Contractile elements, Membrane and action potential, Molecular mechanism of muscle contraction, Myoneuronal junction and transmission of impulse, Smooth muscle contraction.

Unit II

Length and tension relationship, Force and velocity relationship. Skeletal muscle energetics, Metabolism and lactate shuttle. Exercise, adaptation to training andperformance.

Unit III

Classification of nervous system. Neuron and its classification, Properties. Development of action potential and transmission of nerve impulse in nerve and synapse. Regulatory centres in brain. Reflexes. Functions of Cerebrum, Cerebellum, Hypothalamus, Limbic system.

Unit IV

Receptors and its types. Special senses.

VI. **Suggested Reading**

- *Guyton and Hall Textbook of Medical Physiology* 13th Edn John E Hall Ph.D. 2015.
- *Ganong's Review of Medical Physiology*, 26th Edn Kim E Barrett , Susan M Barman, Scott Boitano, Heddwen Brooks,

2019.

- *Dukes' Physiology of Domestic Animals*, 13th Edn. William O Reece, Howard H Erickson, Jesse P Goff, Etsuro E Uemura. 2015.
- *Cunningham's Textbook of Veterinary Physiology* 5th Edn. Bradley G. Klein. 2012.
- *Fundamentals of Neurophysiology*. Smith RF Springer Verlag. 1978.

S. No.	Topic	No. of Lectures
1.	Introduction, Organisation of Nervous system	1
2.	Cellular communication- concept of membrane potential	1
3.	Synapse and its properties, Synaptic transmission	1
4.	Neurotransmitters	1
5.	Sensory systems and Receptors	1
6.	Pain Physiology	1
7.	Cerebral cortex –Anatomy and Physiology	1
8.	Interbrain, thalamus and hypothalamus	1
9.	Midbrain – Physiological capability	1
10.	Brain stem – Physiological anatomy	1
11.	Sleep and EEG	1
12.	Memory and its types	1
13.	Pons and medulla – Anatomy and Physiology	1
14.	Cerebellum – Anatomy and Physiology	1
15.	Spinal cord - Anatomy and Physiology	1
16.	Spinal reflexes and properties	1
17.	Postural reflexes	1
18.	Peripheral nervous system	1
19.	Autonomic nervous system – Sympathetic nervous system	1
20.	Autonomic nervous system – Parasympathetic nervous system	1
21.	Enteric nervous system	1
22.	Overall motor control	1
23.	Sensory Physiology – Photoreception	1
24.	Sensory Physiology – Auditory and equilibrium maintenance	1
25.	Sensory transduction – Gustation and olfaction	1
26.	Muscle structure and types	1
27.	Physiological properties of muscle	1
28.	Mechanism of muscle contraction	1
29.	Properties of muscle contraction	1
30.	Muscle metabolism	1
31.	Anatomy of Neuromuscular junction	1
32.	Smooth muscle physiology	1
	Total	32

I. **Course Title : Endocrinology of Domestic Animals**

II. **Course Code : VPY 609**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

To impart knowledge of chemical integration of body functions.

V. **Theory**

Unit I

Methods of study of bioregulation including methods of endocrine analysis. Manipulation and disruption of biorhythms in homeostatic and natural ecosystem.

Unit II

Hormonal relationship in animal production. Concepts in hormone function, classification and methods of study, Hormonal assay, Mechanism of hormone synthesis, Release and transport. Mechanisms of hormone action, Target cell interactions.

Unit III

Genetic and genomic approaches in endocrinology. Animal models and alternate uses of animal model. Regulation and metabolism of hypothalamic, hypophyseal, thyroid and adrenal hormones.

Unit IV

Gonadal and placental hormones, their regulation and mechanism of action. Hormonal principles of pineal gland and its role in production.

Unit V

Endocrine control of carbohydrate and calcium homeostasis. Hormones and adaptation to environment. Hormonal regulation of gastro-intestinal activity. Prostaglandins. Hormones in fertility regulation and production augmentation. Avian endocrinology.

VI. **Suggested Reading**

- *McDonald's Veterinary Endocrinology*, Pineda and Doley. Iowa State University Press, Ames, 2003
- *General Endocrinology.* Turner CD and Bagnara JT, WB Saunders. 1976
- *Canine and Feline Endocrinology and Reproduction*, 3rd Edition, Edward C Feldman, Richard W Nelson. 2003.
- *Applied Animal Endocrinology* 2nd Edn. E James Squires. 2010

S. No.	Topic	No. of Lectures
1	Introduction to bioregulation – Scientific methods – Controlled experimental testing – Representative sampling	

- Dose response Relationship
- Biological Rhythm
- Endocrine–Nervous -Immune system interaction 1

2 Methods of endocrine secretion analysis
- Extirpation -observation: Replacement –observation
- Imaging
- Radioimmunoassay
- Enzyme immunoassay
- High Performance Liquid Chromatography/ spectroscopy
- Immunohistochemistry
- Bioassays
- Techniques for determining the number and characteristics of hormone receptor 1

3 Disruption of biorhythms in homeostatic and natural ecosystem
- Endocrine disruptors or modulators
- Assessment of endocrine disruptor activity
- Sources of endocrine disruptors
- Xenobiotics
- Environmental pollutants altering endocrine secretions 1

4 Concepts in hormone function
- Morphological functions Biological functions
- Physiological functions
- Molecular functions 1

5 Mechanism of hormone synthesis of
- Protein hormones
- Steroid hormones
- Eicosanoids
- Thyroid hormones
- Monoamines 1

6 Release and transport in blood Mechanisms for regulating release
- In response to Trophic hormone
- In response to Nervous stimuli (environmental cues)
- In response to levels of various metabolites Transport
- Carrier proteins
- Half life
- Control of hormone release
- Pulsatile release
- Sustained release
- Feed back mechanism 1

7 Mechanisms of hormone action
Extracellular receptors
- G protein coupled receptors

- Catalytic receptors

Intracellular receptors
- cytoplasmic
- Intranuclear

Target cell interactions
- Upregulation
- Down regulation 2

8 Genomic approaches in endocrinology.
- Use of transgeneic animals
- Knockout animals
- Proteomics
- Two dimensional gel electrophoresis
- X ray crystallography
- Tomography
- MRI 2

9 Animal models to study endocrine disorder
- Whole animal model
- Isolated organs or tissues
- *In vitro* models 2

10 Hypothalamic, hypophyseal hormones
- Structure
- function relationship of pituitary and hypothalamus

Anterior pituitary hormones

Growth hormone
- structure, production, biological functions, disorders of growth hormone production

Prolactin
- structure, production, biological
- functions, disorders of growth hormone production

ACTH
- structure, production, biological functions

FSH
- structure, production, biological functions

LH
- structure, production, biological functions

Posterior pituitary hormones

Oxytocin
- structure, production, biological functions

Vasopressin
- structure, production, biological functions

Hypothalamic releasing and release inhibiting hormones
- Growth hormone inhibiting hormone
- Gonadotropin releasing hormone 2

11 Thyroid hormones
- Transport
- Receptors
- Metabolism
- Metabolic effects
- Effect on growth, development, fertility and milk production 2

12. Adrenal hormones
- Structure of adrenal and synthesis of cortical hormones
- Physiological roles of
  - Glucocorticoids
  - Mineralocorticoids
- Physiological role of medullary hormones 2

13. Pineal gland and its role in production.
- Melatonin
- Photoperiodism
- Seasonal breeding
- Manipulation of breeding cycle
  - Implants
  - Sustained release bolus 1

14. Endocrine control of carbohydrate homeostasis
- Insulin
- Glucagon
- Epinephrine
- Growth hormone
- Glucocorticoids
- Thyroxine 2

15. Endocrine control of calcium homeostasis
- Parathyroid hormone
- Calcitonin
- Calcitriol (Vitamin D3)
- Estrogens/ Androgens
- Glucocorticoids
- Thyroid hormones
- Insulin like growth factors 2

16. Hormonal regulation of gastro-intestinal activity
- Gastrin
- Secretin
- Gastrin releasing peptide
- Cholecystokinin
- Gastric inhibitory peptide
- others 1

17. Prostaglandins-Synthesis, types, release and mode of action 1
18. Hormones in fertility regulation

- Manipulation of reproduction
- Regulation and manipulation of oestrous cycle
- Use of hormone agonists to control fertility
- Detection and synchronization of oestrusMethods for detection oestrus
- Strategies for synchronizing oestrusProstaglandin F_2□ based systems Progestin and other hormones based systems
- Superovulation and embryo transfer
- *In-vitro* production of embryos
- Recognition and maintenance of pregnancy
- Induction of abortion/ parturition
- Advancing cyclicity in seasonal breeders, and puberty in animals
- Immunological manipulation of reproduction 3

19. Hormones in production augmentation
    - Somatotrophin
    - Adipokines
    - Leptin
    - Anabolic steroids and Analogues –mechanism of action delivery systems and safety aspects
    - Adrenergic Agonists –mechanism of action delivery systems and safety aspects
    - Dietary supplements
      - chromium, PUFA and CLA
    - Regulation of feed intake
      - Orexigenic hypothalamic neurohormones
      - Anorexigenic hypothalamic neuropepetides
      - Hormonal regulation of mammary gland development and milk secretion Artificial induction of lactation 2

20 Avian endocrinology
- Reproductive hormones
- Hormonal manipulation of egg production
- Control of broodiness in poultry
- Manipulation of moulting 2

Total 32

I. Course Title : Instrumentation and Research Techniques in Veterinary Physiology

II. Course Code : VPY 610

III. Credit Hours : 0+2

IV. Aim of the course

Training in various techniques for application in research in AnimalPhysiology

v. Suggested Reading

- *Hawk's Physiological Chemistry*. Oser BL Tata McGraw-Hill. 1976.
- *Varley's Practical Clinical Biochemistry* Alan H Gowenlock
- *Handbook of Radioimmunoassay*. Abraham GE Marcel Dekker. 1977.
- *Electrocardiograms: A Systematic Method of Reading Them* Armstrong ML. 1978
- *Rumen Microbiology*, Burk A Dehority 2003 Nottingham University Press

S. No.	Topic	No. of Practicals
1.	Design and types of research laboratory	1
2.	Maintenance of research equipments	1
3.	Imparting knowledge about preparation of various solutions	1
4.	Basic principles and concepts of pH	1
5.	Determination of pH of various solutions and biological samples	1
6.	Basic principles and concepts of ECG	1
7.	Recording of ECG in animals	1
8.	Basic principles and concepts of physiograph and its accessories For *in-vitro* live tissue experiments	1
9.	Recording of blood pressure by physiograph and sphygmomanometer	1
10.	Recording of pulse rate by physiograph	1
11.	Recording of respiratory volumes by spirometer	1
12.	Neuro muscular experimental physiology using physiograph	1
13.	Physical and chemical principles of chromatography	1
14.	Extraction of active compounds from biological samples	1
15.	Protein separation and isolation methods – basic concepts	1
16.	Methods of protein determination	1
17.	Electrophoresis	1
18.	Thin layer chromatography	1
19.	Gas liquid chromatography	1
20.	Basic concepts of mineral estimation	1
21.	Flame photometry	1
22.	Laws of colorimetry	1
23.	Spectrophotometry	1
24.	Organ bath – Applications in experimental physiology	1
25.	Experiments using organ bath	1
26.	Enumeration of ruminal microflora	1
27.	Estimation of VFA	1
28.	Estimation of ammonia nitrogen	1

29.	Estimation of body water	1
30.	*In-vitro* rumen studies	1
31.	ELISA for estimation of various hormones	1
32.	RIA for estimation of various hormones	1
	Total	32

I. **Course Title : Physiology of Wild Life**

II. **Course Code : VPY 611**

III. **Credit Hours : 1+0**

IV. **Aim of the course**

To impart the knowledge on physiology of wild animals. The course content refers to wild animals related to Indian forests restricted to small and large animals. This course does not cover insects and other species for which veterinarian are not usually called for.

V. **Theory**

Unit I

Overview of Indian forests – Identification of sex in wild animals and birds - Blood collection methods in wild animals – Hematology - Common clinical biochemical estimations.

Unit II

Body temperature measurement techniques – Measurement of stress - Measuring senescence.

Unit III

Reproduction management in wild animals - Understanding sound mechanics and communication methods – Ethology of wild animals - Government policies for wildlife protection.

VI. **Suggested Reading**

Standard text books and Government policies pertaining to wild life.

S. No.	Topic	No. of Lectures
Theory		
1.	Animal Species Overview of Indian forests.	1
2.	How to identify the sex of wild animals and birds.	1
3.	Collection of Clinical materials for laboratory examination; methods	1
4.	Heamtology	1
5.	Common clinical biochemical estimations.	1
6.	Methods of measuring body temperature of wild animals	1
7.	Measuring capture and immobilization stress in wildlife	1
8.	Measuring senescence in wild animal populations	1
9.	Reproduction management in wild animals	2

10. Understanding sound mechanics and communication methods 1
11. Wild animal ethology 2
12. Government policies for wild life protection (respective state) 1
13. Lecture by wildlife vet or conservationist 2

Total 16

Course Contents
Ph.D. in Veterinary Physiology

I. **Course Title : Applied Physiology of Body Fluids and Electrolytes**

II. **Course Code : VPY 701**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge regarding physiology of body fluids and electrolytes in relation to homeostasis.

V. **Theory**

Unit I

Volume and composition of body fluids, Exchange of water and electrolytes between body compartments and transport mechanisms, Blood and external environment. Osmolarity and osmolality of body fluids.

Unit II

Regulation of volume and osmolarity of extracellular fluid. Regulation of pH and acid base balance. Formation and composition of cerebrospinal fluid and lymph.

Unit III

Clinical implications of change in electrolytes and body fluids. Functional consideration of plasma volume and its composition. Diuresis and endocrine control of renal functions.

Unit IV

Clinical feature in fluid and electrolyte imbalances, clinicopathological indictors of fluid and electrolyte imbalances. Physiological basis of fluid therapy.

S. No.	Topic	No. of Lectures/Practicals

Theory

1. Body fluid compartments-Extracellular and Intracellular fluid compartment (ECF and ICF), Volume of ECF and ICF. Composition of various body fluids. 1
2. Total Body water, Water requirement, daily intake and loss of water from the body. 1
3. Different transport mechanisms for exchange of water and electrolytes- Active and passive transport, filtration, diffusion and osmosis. 1
4. Exchange of nutrients and other substances between blood and interstitial fluid. Capillary pressure, interstitial fluid pressure, exchange of fluids through capillary membrane 1
5. Principles of osmosis and osmotic pressure, osmotic equilibrium

Between ICF and ECF, Tonicity of body fluids 1

6. Composition of synovial fluid and peritoneal fluid 1
7. Osmolarity and Osmolality of ICF and ECF, regulation of volume and osmolarity of ECF 1
8. Contribution of different molecules viz glucose, sodium and urea towards osmolarity of ECF 1
9. pH of different body fluids, factors affecting pH of body fluids, Physiology of acid base balance, buffer systems of ICF and ECF 1
10. Different types of Acidosis and Alkalosis, their etiology and compensation 1
11. Evaluation of acid–base status- Siggaard–Andersen alignment nomogram, Anion gap, base excess and deficit 1
12. Role of Respiratory system and Kidneys in maintenance of Acid base balance 1
13. Formation and composition of Cerebrospinal fluid and lymp 1
14. Clinical disorders resulting into loss of electrolytes from body fluids. 1
15. Changes in plasma volume and its composition under different clinical conditions-vomition and diarrhoea 1
16. hypervolemia and hypovolemia, Implications of hypovolemic and hemorrhagic shock 1
17. Dehydration - its types and causes. Water intoxication 1
18. Role of kidneys in regulation of water balance. Renin-Angiotensin system 1
19. Role of kidneys in formation and excretion of concentrated and diluted urine 1
20. Hormonal regulation of important electrolytes in plasma 1
21. Role of Hormones in renal regulation of water and electrolytes 1
22. Diuresis and pressure natriuresis, polyuria and oligouria 1
23. Clinical considerations in fluid and electrolyte imbalances 1
24. Clinicopatholiogical indicators of fluid and electrolyte imbalance 1
25. Clinical Physiology of Dehydration – Signs, symptoms, evaluation of intensity of dehydration 1
26. Clinical Physiology of vomition and diarrhoea- Signs and symptoms 1
27. Clinical Physiology of edema Signs and symptoms, causes andprevention 1
28. Role of serum sodium, hyponatremia, hypernatremia; Role of serum potassium, hypokalemia, hyperkalemia 1
29. Role of serum chloride, hypocholeremia and hypercholeremia, bicarbonate ions 1

30. Principle and indications of fluid therapy 1
31. Types of solution used for fluid therapy, role of their components and their use in different clinical conditions 1
32. Effect of adding different saline, glucose solutions to ECF-isotonic, hypertonic and hypotonic solutions 1

Total 32

Practical

1. Estimation of pH of different body fluids and evaluation of acid base status. 1
2. Determination of sodium in serum sample of farm animals (by flame photometry/ colorimetric method) 1
3. Determination of potassium in serum sample of farm animals (by flame photometry/ colorimetric method) 1
4. Determination of chloride in serum sample of farm animals
5. (by flame photometry/ colorimetric method) 1
6. Determination of bicarbonate in serum sample of farm animals 1
7. Determination of Calcium in serum sample of farm animals 1
8. Determination of Magnesium in serum sample of farm animals 1
9. Determination of phosphate in serum sample of farm animals 1
10. Determination of total body water (simulated demonstration) 1
11. Determination of blood volume (simulated demonstration) 1
12. Determination of plasma volume (simulated demonstration) 1
13. Determination of Interstitial Fluid Volume (simulated demonstration) 1
14. Estimation of osmolarity and osmolality of urine of farm animals 1
15. Estimation of osmolarity and osmolality of milk 1
16. Estimation of osmolarity and osmolality of blood of farm animals 1
17. Evaluation of dehydration in animal and choosing the fluid type, its volume and rate for fluid therapy 1

Total 16

I. **Course Title : Physiology of Animal Behaviour**
II. **Course Code : VPY 702**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To acquaint the students about physiology of animal behaviour in different species of domestic animals.

V. **Theory**

Unit I

Introduction to animal ethology. Neurophysiological basis of animal behaviour.

Unit II

Behaviour in relation to changes in the environment. Feeding, Grazing, Stall feeding and rumination behaviour.

Unit III

Sexual behaviour in female and male animals. Maternal behaviour. Milk let down.

Unit IV

Social behaviour, Communication in animals, Animal temperament. Responses of dogs and horses to training.

S. No.	Topic	No. of Lectures

Theory

1. Introduction to ethology and its importance in Veterinary Science. 1
2. Ethology-definition and its importance in animal welfare 1
3. Types of animal behaviour 2
4. Behavioural Ecology, evolutionary basis for animal behavior 2
5. Ecological pressures, ontogeny and phylogeny of behavior 1
6. Physiological concept of behaviour, neuro-endocrine integration for behavioural manifestation 2
7. The concept of instinct, Habituation, imprinting, reinforcement, conditioning, reasoning and intelligence. Temperament scoring 2
8. Ingestive/ feeding behaviour in ruminants: Prehension, grazing behaviour in cattle, sheep and goats, rumination behaviour 2
9. Ingestive behaviour in dogs 1
10. Ingestive behaviour in swine 1
11. Special feeding patterns; Abnormal feeding behaviour 2
12. Precopulatory behavior (Searching, Courtship, Sexual arousal, Erection, Penile protrusion): Species differentiation 1
13. Copulatory behaviour (Mounting, intromission and ejaculation): Species differentiation 2
14. Post copulatory behaviour (Dismounting and refractory period) 1
15. Manifestation of behavioural estrus, estrus intensity scoring 1
16. Role of pheromon in sexual behaviour manifestation 1
17. Abnormal sexual behavioural pattern 1
18. Maternal behaviour: Formation of bond between mother and fetus, concept of critical period, vocalization 1
19. Maternal behaviour in different species, abnormal maternal behaviour 1
20. Milking behaviour: Milking temperament, milk let down reflex and the factors affecting milking behaviour 1

21.	Social behaviour: Dominance, Social hierarchy	1
22.	Agonistic (combat or aggressive) behaviour, Gregarious, Peck order in chicken	1
23.	Communicating behaviour: Attraction, Repulsion and Submission	1
24.	Mode of communication (visual, auditory, chemical) in different species.	1
25.	Responses of dogs and horses to training	1
	Total	32

I. **Course Title : Recent trends in ruminant digestion**

II. **Course Code : VPY 703**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge about advances in digestion of ruminant animals.

V. **Theory**

Unit I

Introduction to rumen bacteria, protozoa and fungi. Development and natural fluctuation in rumen microbial population. Salivary secretion and its regulation.

Unit II

Microbial ecology and physiology of feed degradation within the rumen. Metabolism of nitrogen containing compounds.

Unit III

Degradation of carbohydrate, fat and protein by rumen microbes, Microbe- microbe interaction. Protected nutrients and other feed additives.

Unit IV

Genetics and biotechnology of rumen microbes, rumen anaerobic fungi, their role and interaction with other rumen microbes. Probiotics supplementation, etc. Rumen flow rate and rumen volume.

S. No.	Topic	No. of Lectures
Theory		
1.	Functional development of ruminant stomach	1
2.	Microbial ecosystem of fermentative digestion	1
3.	Fluctuation in rumen microbial population	1
4.	Substrates for fermentative digestion	1
5.	Salivary secretion and its regulation	1
6.	Role of saliva on fermentative digestion	1
7.	Rumen motility and its regulation	1

8.	Rumen bacteria	2
9.	Rumen protozoa – its importance and its interaction with other group	2
10.	Anerobic fungi	1
11.	Polysaccharide degradation by rumen microbes	2
12.	Metabolism of nitrogen containing compounds	1
13.	Lipid metabolism in rumen	1
14.	Rumen metabolites and their assimilation	1
15.	Microbe-microbe interaction	1
16.	Comparative efficiency of rumen function in different species.	2
17.	Protected nutrients	1
18.	Digestive disorders of rumen	1
19.	Nutritional toxicity and strategy to address it	1
20.	Stoichiometry of fermentative digestion	1
21.	Approaches to modification of ruminal fermentation	2
22.	Modifiers of ruminal microbial activity	1
23.	Biological models of rumen function	2
24.	Rumen simulation technique	2
25.	Rumen flow rate and rumen volume	1
	Total	32

Practical

1.	Reticulo-ruminal motility	1
2.	Total volatile fatty acids and their fractions	2
3.	Culture of rumen bacteria	3
4.	Protozoal counting	1
5.	Culture of rumen fungi	3
6.	Demonstration of effect of defaunation	2
7.	Flow rates of ruminal contents	2
8.	Artificial rumen techniques	2
	Total	16

I. **Course Title : Recent trends in Neuroendocrinology**

II. **Course Code : VPY 704**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To acquaint the students about advances in neuro-endocrinology of domestic animals.

V. **Theory**

Unit I

Neuroendocrine integrating mechanism. Structure of hypothalamus, pituitary gland, limbic and other neural pathways and endocrine functions.

Unit II

Neural control of oxytocin, adrenocorticotropic hormone, aldosterone, thyrotropic hormone, growth hormone, gonadotrophins, Hypothalamic releasing factors and the neuro-vascular link between brain and anterior pituitary.

Unit III

Role of afferent impulses from genitals and other regions in reproductive system. Influence of hormones on brain activity.

Unit IV

Effects of drugs on neuro-endocrine system. Neuro-endocrine mechanisms in birds. Interaction of nervous, endocrine and immune system in animal production and reproduction.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1	Evolution and theory of hormones	1
2	Development of endocrine glands	1
3	Neuroendocrine integrating mechanism	1
4	Homeostatic regulation by hormones; Feedback regulation of hormones	1
5	Biorhythms, manipulation and disruption of biorhythms in homeostatic and natural ecosystem	1
6	Hormones and adaptation to environment	1
7	Endocrine methodologies in study of bioregulation	1
8	Animal models and alternate uses of animal model in endocrine studies	1
9	Methods of hormonal assays - Radioimmunoassay, Immunorediometric assay, Radioceptors assay, enzyme linked immunosorbent assay, chemi-luminiscence assay	2
10	Hormone secretion, transport and clearance	1
11	Cellular receptors for hormone; Hormones and target cells	1
12	Genomic and non genomic effects of hormones	1
13	Second messenger system; Receptor signal transduction; Hormone receptor interaction – protein and peptide hormones; Hormone receptor interaction – steroid and other hormones	2
14	Half-life of hormones, pattern of hormone release;	1
15	Types and family of hormones	1
16	Hormones regulating growth	1
17	Hormones regulating energy metabolism	1
18	Hormones regulating digestion	1
19	Hormones regulating calcium and phosphorus	1
20	Hormones regulating electrolytes – Na and K	1
21	Hormones regulating hyper and hypoglycemia	1

22	Hormones regulating blood volume and blood pressure	1
23	Alleviation of stress by hormones	1
24	Endocrine role of pineal gland	1
25	Hormones and behavior	1
26	Endocrine pathophysiology	2
27	Avian endocrinology	1
28	Synthetic hormones	1
29	Application of nanotechnology in endocrine studies	1
	Total	32

Practical

1.	Extraction of hormones	1
2.	Immunohistochemistry of hormones	2
3.	Radio-immuno assay of hormones	3
4.	Enzyme linked immunosorbent assay of hormones	2
5.	Bioassy of hormones	2
6.	Induction of atherosclerosis	1
7.	Induction of hypoglycemia in laboratory models by allaxon And streptozotocin	2
8.	Induction of hyperglycemia in laboratory models by administration of epinephrine and glucagon, etc.	1
9.	*In-vitro* effects of certain hormones such as adrenaline, histamine and acetyl choline on excised intestine	1
10.	Hormone assay in fecal samples	1
	Total	16

I. **Course Title : Myophysiology and Kinesiology**

II. **Course Code : VPY 705**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

To impart knowledge to the students about myophysiology and kinesiology.

V. **Theory**

Unit I

Morphology of muscle; Chemical composition of muscle; Electrical phenomena and iron influxes; Muscle contraction and irritability; Neuromuscular transmission; Excitation contraction coupling; Mechanical properties of skeletal muscle; Types ofchemical muscle fibres; Coordination among muscles.

Unit II

Thermal properties of muscles; Chemical correlates of contraction.

Unit III

Molecular basis of muscular contraction of skeletal muscle;

Energetics of Muscle Contraction; Electromyogram; Pathophysiology of muscles; Myocardium – electrical properties; Myocardium – mechanical properties; Pacemaker tissue; Endurance of muscle.

Unit IV

Lever systems of body joints; Synovial fluid formation and its physiology; Principles of Kinesiology and its application in work physiology.

S. No.	Topic	No. of Lectures
1.	Morphology of muscle	1
2.	Chemical composition of muscle	1
3.	Electrical phenomena and iron influxes	2
4.	Muscle contraction and irritability.	2
5.	Neuromuscular transmission	2
6.	Excitation contraction coupling	2
7.	Mechanical properties of skeletal muscle	1
8.	Types of chemical muscle fibres	1
9.	Coordination among muscles.	1
10.	Thermal properties of muscles.	1
11.	Chemical correlates of contraction.	1
12.	Molecular basis of muscular contraction of skeletal muscle	2
13.	Energetics of Muscle Contraction	2
14.	Electromyogram	1
15.	Pathophysiology of muscles	1
16.	Myocardium – electrical properties	2
17.	Myocardium – mechanical properties	2
18.	Pacemaker tissue	1
19.	Endurance of muscle	1
20.	Lever systems of body joints,	2
21.	Synovial fluid formation and its physiology.	1
22.	Principles of Kinesiology and its application in work physiology	2
	Total	32

I. **Course Title : Avian Physiology**

II. **Course Code : VPY 706**

III. **Credit Hours : 2 + 1**

IV. **Aim of the course**

To teach physiology of birds.

Unit I

Digestive and urinary system.

Unit II

Blood, cardiovascular and respiratory system.

Unit III

Reproductive and endocrine system.

Unit IV

Nervous system and musculo-skeletal system.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Digestive system Comparative Functional Anatomy of the Digestive Tract -Gastrointestinal Function	1
2.	Food Intake Regulation GI Motility, Neural and Hormonal Control of Motility	1
3.	Secretions and Digestion	1
4.	Absorption - Carbohydrates, Amino Acids and Peptides, Fatty Acids and Bile Acids, Volatile Fatty Acids	1
5.	Urinary system Functional anatomy of The Kidneys- Intake of Water and Solutes	1
6.	Formation of Urine- Osmoregulation	1
7.	Postrenal Modification of Ureteral urine	1
8.	Salt Glands - Evaporative Water Loss	1
9.	Blood, Cardiovascular Blood -Components – Effects of Altitude	1
10.	Gross Structure and Function	1
11.	General Circulatory Hemodynamics	1
12.	Control of the Cardiovascular System	1
13.	Integrative Neural Control	1
14.	Respiratory system Anatomy of the Avian Respiratory	
15.	System-Air Sacs	1
16.	Ventilatory Reflexes -Respiratory System Volumes	1
17.	Gas Exchange -Ventilation and Respiratory Mechanics	1
18.	Basic Principles of Oxygen Transport - Cross-Current Gas Exchange	1
19.	High-Altitude Flight -Control of Breathing	1
20.	Reproductive system Anatomy of the Female Reproductive Breeding and Ovulation–Oviposition Cycles	1
21.	Ovarian Hormones Hormonal and Physiologic Factors Affecting Ovulation	1
22.	Effect of Light on the Ovary and Ovulation PhotorefractorinessMolt	1
23.	Incubation Physiology	1
24.	Male Reproductive Tract Anatomy Hormonal Control of Testicular Function, Spermatogenesis Extragonadal Sperm Transport and Maturation	1
25.	Endocrine system. Synthesis, Release of Hormones and	

functions of endocrine glands 1
26. Hypothalamus and Pituitary Hormones 1
27. Pancreatic and Adrenal hormones 1
28. Secretions of Thyroid gland, parathyroid gland 1
29. Nervous system and musculo-skeletal system Sensory Physiology - Uniqueness of avian brain 1
30. Functional Organization of the Spinal Cord 1
31. The Autonomic Nervous System of Avian Species 1
32. Skeletal MuscleMuscle Fiber Types, Electrical Properties of Muscle Fibers -Contractile Properties 1
33. Neurotransmission, Smooth muscle 1
Total 32

Practical

1. Collection of blood from the birds and blood processing. 1
2. Study of blood cells RBC count 1
3. WBC count 1
4. DLC 1
5. Thrombocyte count 1
6. Haemoglobin concentration 1
7. Packed cell volume (haematocrit) 1
8. Erythrocyte sedimentation rate 1
9. Determination of feed passage rate in birds 1
10. Enzymatic profile under various physiological states of birds 1
11. Collection of semen and its evaluation 1
12. Demonstration of cold shock resistant of avian spermatozoa and sperm stimulatory and inhibitory agents 1
13. Determination of glucose and calcium in blood 1
14. Determination of uric acid and urea in blood 1
15. Electrophoretic separation of plasma proteins and egg proteins 1
16. Localization of different endocrine glands 1

Total 16

I. **Course Title : Physiology of Lactation**
II. **Course Code : VPY 707**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To impart knowledge on physiology of lactation in dairy animals.

Unit I

Functional anatomy, histology and cytology of mammary gland in domestic animals.

Unit II

Development of mammary gland, Hormonal control of

mammogenesis.

Unit III

Process of lactation, Initiation of milk secretion, Hormonal control of lactation. Biochemical and histological changes in mammary gland during lactation. Mechanism of galactopoiesis.

Unit IV

Neural control of lactation, Milk let down, Milk ejection and inhibition of milk ejection. Induced lactation. Composition of milk in animals.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Introduction to the mammary gland and milk production	1
2.	Mammary gland anatomy - macrostructure	1
3.	Mammary gland anatomy - microstructure	1
4.	Mammary gland anatomy – blood supply, nerve supply and lymphatic network	1
5.	Comparative anatomy and physiology of mammary gland of Different domestic animals	1
6.	Basic histology of parenchyma and cellular organization of the mammary epithelial cell	1
7.	Mammary growth and development I: fetal through puberty	1
8.	Mammary growth and development II: Post-puberty through involution	2
9.	Hormonal control of mammogenesis	1
10.	Lactogenesis	1
11.	Lactation	2
12.	Biochemical changes in mammary gland during lactation	1
13.	Histological changes in mammary gland during lactation	1
14.	Galactopoiesis	1
15.	Neuro endocrine control of lactation	1
16.	Milk letdown and its inhibition	1
17.	Factors affecting milk yield	1
18.	Dry period – importance, different strategies and beliefs	1
19.	Mammary involution	1
20.	Milk properties and composition	1
21.	Colostrum	1
22.	Milk carbohydrate synthesis and secretion	1
23.	Milk protein synthesis and secretion	1
24.	Milk lipids synthesis and secretion	1
25.	Mammary gland immunology	1
26.	Other important milk components	1
27.	Contaminants and pollutants in milk	2
28.	Manipulation of milk production	1

29.	Diseases associated with mammary gland	1
	Total	32

Practical

1.	External structure of cow's udder	1
2.	Internal structure of cow's udder	2
3.	Histological examination of udder in cows	1
4.	Milk letdown response in dairy animals	2
5.	Composition of colostrum	1
6.	Composition of milk during different phases of lactation	2
7.	Artificial induction of lactation	3
8.	Estimation of lactogenic hormones	4
	Total	16

I. **Course Title : Recent trends in Environmental Physiology and Growth**

II. **Course Code : VPY 708**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To teach physiology of growth process in animals and effect of environmental factors on homeostasis of animals.

V. **Theory**

Unit I

Ecology of farm animals, Biological rhythms, Mammalian circadian rhythms, their regulation. Components of physical environment, Biometeorology and principles of thermoregulation in mammals and birds.

Unit II

Physiological response of farm animals to heat and cold. Effect of various climatic components on health and production (growth and egg production), reproduction and climatic adaptation.

Unit III

Concept and definitions of cellular, prenatal and postnatal growth - Patterns in animals.

Unit IV

Factors affecting growth - Nutrition, Hormones, Vitamins, Antibiotics, Environment. Ageing and senescence. Growth anomalies.

S. No.	Topic	No. of Lectures/Practicals

Theory

1	Ecology and its scope in livestock productivity;	1
2	Disciplines of ecology; fundamental principles of ecology	1
3	Biosphere and biodiversity	1

4	Ecosystem and Components of Ecosystem; Types of Species Found in Ecosystems; Principal Ways Species Interact	2
5	Adaptation, Acclimation and Acclimatization	1
6	Temperature Regulation -*Thermoregulators and Thermoconformer*	1
7	Principles of Heat gains and losses in animals	1
8	Warm-blooded versus cold-blooded animals and its relevance to survival	1
9	Heat production in birds and mammals	
10	Hibernation, Estivation and Daily Torpor; Cold Habitation	1
11	Body Temperature of Homeotherms - concept of core temperature measurements -Rectal Temperature of different animal species; Diurnal Variations	1
12	Physiological responses to heat in animals and birds	1
13	Temperature regulation in birds	1
14	Bioclimatology with respect to livestock and poultry farming	1
15	Surface temperature of earth- its measurements	1
16	earth's atmosphere-Geographic Belts, Composition of the Atmosphere	1
17	Climatic elements- components – measurements	2
18	Cold stress, Heat stress- impact on animal health and production	2
19	Adaptation to atmospheric pressure differences [altitude]-physiological changes and phenotypic characters;	1
20	Physiology of growth and its measurements	1
21	Periods of growth- prenatal and postnatal	2
22	Pattern of growth	1
23	Factors affecting growth	1
24	Recent concepts in manipulation of growth	1
25	Growth promoters	2
26	Ethical issues in use of growth promoters	2
27	Growth anomalies	1
28	Ageing and senescence	1
	Total	32

Practical

1	Atmosphere definition- understanding the globe	1
2	Temperature Recording in animal house, poultry house, and laboratory	1
3	Calculation of RH	1
4	Calculation of THI	1
5	Calculation of Heat Loading index	1
6	Measurement of sweating rate in cattle	2
7	Stress assessment- different methods and indicators	2

8	Weather forecast models followed in India	1
9	Date analysis of rain and temperature for 20 years in the Respective region	2
10	Assessing impact of different shades and houses on milk production in the college farms	1
11	Measurements of growth rate and chart of crossbred calves, native breed calf, etc.	1
12	Visit to meteorology stations	1
13	Purpose and role Satellites of ISRO related to the course (invited lecture)	1
	Total	16

I. **Course Title : Cellular and Molecular Physiology**

II. **Course Code : VPY 709**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

To impart knowledge about cellular and molecular physiology.

V. **Theory**

Unit I

Cell membrane, Organelles and their functions. DNA synthesis and replication.

Unit II

Physiology of cell signaling. Basic classification and characterization of membrane receptors. Intracellular/ nuclear receptors.

Unit III

Major signaling pathways: SPs associated with second messengers; Cell signaling and apoptosis.

Unit IV

Cell cycle and Checkpoints in Cell Cycle Regulation. Regulators of the Cell cycle, cyclin- dependent kinases (CDKs) Signaling defects. Modern methods to study signaling.

S. No.	Topic	No. of Lectures
Theory		
1.	Cell and its organelles – structure and function, difference between prokaryotic and eukaryotic cell	2
2.	Structural organization of bimembranes	1
3.	Transport of molecules through cell membrane	1
4.	Membrane proteins and their functions	1
5.	Cell adhesion molecules and their functions	1
6.	Transmembrane signalling pathways	2
7.	Cell signaling and apoptosis	1
8.	Modern methods to study signaling	1

9.	Cell cycle-stages, mitosis and meiosis and regulatory molecules	3
10.	Organization of eukaryotic and prokaryotic genome	3
11.	DNA replication in prokaryotes and eukaryotes	4
12.	Transcription in prokaryotes and eukaryotes	2
13.	Translation in prokaryotes and eukaryotes	2
14.	Techniques in molecular biology – PCR, DNA sequencing, DNA micro-array, DNA finger printing in situ hybridization	4
15.	Recombinant DNA technology and its applications	2
16.	Gene silencing by RNA interface technology	2
	Total	32

I. **Course Title : Recent trends in immune-physiology**

II. **Course Code : VPY 710**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge regarding physiology of immune system.

V. **Theory**

Unit-I

Introduction, History, Body defense, Organs of immune system, Ontogeny and phylogeny of immune system, Vertical transmission of immunity in animals.

Unit II

Immunoglobulins – Basic structure and functions, Hematopoiesis, T-cell and B- cell-evolution, Development and their functions, Cytokines-sources and actions, MHC, genetic organization of immunoglobulin, MHC and complement system.

Unit III

Immune-endocrine interactions, Immune-reproduction, Ageing, Stress and other physiological functions, Immune modulation.

Unit IV

Hypersensitivity, diseases related to immune system, dysfunction, autoimmune disorders and their genesis, immunodeficiency.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Types of immunity	1
2.	Host cell receptors of innate immunity	1
3.	Passive immunity.	1
4.	Acute phase reactant proteins (APRs) – positive APRs and negative APRs	1
5.	Significance of CRPs	1
6.	Antigen	1

7. Factors influencing immunogenicity of antigens 1
8. Heterophile antigens 1
9. Antibody 1
10. Functions of immunoglobulin 1
11. Isotypes 1
12. Hybridomas 1
13. Monoclonal antibodies (mAB) 1
14. Antigen antibody reaction 1
15. Neutralisation 1
16. Western blotting technique 1
17. Complement pathways 1
18. Leucocytopoiesis 1
19. Central lymphoid organs I 1
20. Central lymphoid organs II 1
21. Characteristics and functions of different T and B lymphocytes 1
22. NK cells 1
23. Major histocompatibility 1
24. Cytokines: interleukins, interferons, TNF, CSF 1
25. Antigen presenting cells 1
26. Cell mediated immunity 1
27. Humoral/ Ab mediated immunity 1
28. Immediate type 1
29. Hypersensitivity type III – mechanism 1
30. Autoimmunity 1
31. Immunological tolerance 1
32. Transplant immunology 1

Total 32

Practical

1. Isolation of lymphocytes from blood by density gradient centrifugation 1
2. Determination of live and dead lymphocytes in the separated sample 1
3. Estimation of CRP in serum by immunoturbidimetric assay 1
4. Hyperimmuneseum production 1
5. Haemagglutination test 1
6. Haemagglutination inhibition assay 1
7. Immunoprecipitation test 1
8. Complement fixation test 1
9. ELISA methodology 1
10. ELISA diagnostic test 1
11. RIA methodology 1
12. RIA diagnostic test 1

13. Antibody-dependent cell-mediated cytotoxicity methodology 1
14. Immunofluorescence- Immunohistochemistry 1
15. Western blotting methodology 1

Total 15

I. **Course Title : Physiology of Stress**
II. **Course Code : VPY 711**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To understand impact of various stress factors on the physiology of animals.

V. **Theory**

Unit I

Definition of stress, Various types of stresses, Their effect on animal production and reproduction.

Unit II

Physico-chemical changes of blood composition due to exercise and work. Energy utilization and requirement of muscles during work and exercise.

Unit III

Capacity of work under field and controlled laboratory conditions, Factors that regulate it.

Unit IV

Effect of various stresses on endocrine status of animals, Endurances in animals.

Unit V

Energy partitioning in lactating animals under stress, Physiological basis of ameliorative measures to combat stress in lactating animals.

S. No. Topic No. of Lectures

Theory

1. Definition of Stress, distress and eustress - Concept of Stressors
   - types of stressors – Acute and chronic stress - Broad measures of stress in animals – Behavioral, Physiological and molecular measures of stress 1
2. Neuroendocrinology of stress response - sympathetic-adrenal-medullary (SAM) pathway - the hypothalamic-pituitary adrenal (HPA) axis 1
   - Effect of stress on musculoskeletal system – Exercise and Draft associated stress - Physiological assessment and indices for evaluating work load -Concept of acceptable work

load. 1

3. Effects of stress on reproduction (including birds) – pregnancy, prenatal growth, lactation and Egg production 1
4. Effect of stress on lactation - Energy partitioning in lactating animals under stress - Physiological basis of strategies to combat stress in lactating animals 1
5. Effect of stress on immune system – altered cellular responses and cytokine production patterns and their consequences 1
6. Effect of Stress on learning and memory – Areas of brain Associated with stress induced alterations in learning and memory 1
7. Environmental characteristics affecting animals – Role of Temperature, Humidity, wind, Rainfall and solar radiation on animals 1
8. Concept of Homeothermy and Thermal stress in animals – Thermoneutral and Thermocomfort Zone – Upper and lower critical temperatures 1
9. Thermal exchanges between animal and environment – Conduction, Convection, Radiation and Evaporation 1
10. Physical and biological measures of thermal stress – Temperature Humidity Index (THI), The Livestock Weather Safety Index (LWSI), A wind chill index (WCI), Comprehensive climate index (CCI), Tunica Dartos Index (TDI), Infra-red thermography (IRT) based measures 1
11. Effect of other environmental stressors like Solar UV radiation, high altitude, pollution related stressors 1
12. Concept of Adaptation, Acclimatization, Acclimation - Types and levels of Adaptation 1
13. Morphological, Anatomical Adaptation of Animals and Birds to various kinds of environments – Theories associated with such adaptations 1
14. Physiological adaptations to heat stress – circulatory, respiratory, endocrine adjustments – Panting and Sweating in animals – 1
15. Physiological adaptations to cold stress – circulatory, respiratory, endocrine adjustments – Thermogenesis in cold – Tissues associated with thermogenesis 1
16. Cellular and Molecular adaptations to thermal stress – Heat shock response – Chaperones and their role in thermotolerance 1
17. Behavioral adaptations to thermal stress in Animals and Birds – Individual and Group adaptation behaviors 1

18. Special adaptations to Extreme environments like Deserts, polar regions Estivation, hibernation and torpor 1
19. Physiology of thermal reception and processing – Central and peripheral thermo receptors – Fever, Hyperthermia and Hypothermia 1
20. Overview of all thermal adaptation features in Farm animals including camel and donkeys, Yak 1
21. Special thermal adaptation features in birds – Thermal adaptation during flight 1
22. Measures of thermotolerance in animals – Rhoads, Gaala's, Benezra's, Iberian heat tolerance indices and cooling efficiency test of Dowling 1
23. Adaptation of animals to High Altitude Stress – Pulmonary Circulation changes adjustments in blood–O_2 affinity with change in altitude 1
24. Concept of Global warming and climate change – Approaches to alleviate the adverse effects of climate change induced heat stress. 1
25. Concept of redox biology, oxidative eustress and oxidative distress– History of oxidative stress concept 1
26. Kinds and forms of Oxidative stress – Classification of oxidative stress (Basal, low intensity, intermediate intensity and high intensity) 1
27. Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS) Different types of ROS and RNS– Sources of ROS and RNS generation – Oxidative and Nitrosative damage 1
28. Concept of Redox signaling – Role of redox signaling in physiological and pathological processes 1
29. Measuring Reactive Oxygen Species – Direct and indirect assays measuring ROS including chemiluminescence and electron spin resonance. 1
30. Antioxidant defense and their mechanism of cytoprotective actions – Enzymatic and non-enzymatic antioxidants in the body 1
31. Dietary antioxidants in livestock and poultry production Including synthetic and herbal antioxidants 1

Total 32

I. **Course Title : Recent trends in reproductive physiology**
II. **Course Code : VPY 712**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To understand recent developments in physiology of reproduction in domestic animals.

v. **Theory**

Unit I

Estrus synchronization, Superovulation and Embryo transfer in farm animals.

Unit II

Seminal plasma proteins; Sexing of spermatozoa; Cryopreservation of semen.

Unit III

Collection and grading of oocytes; IVM, IVF and IVC; Cryopreservation of embryos; sexing of embryos; Micromanipulation of gametes and embryos.

Unit IV

Transgenic animals; applications of stem cells and nano technology in reproduction.

S. No.	Topic	No. of Lectures/Practicals
Theory		
1.	Estrus synchronization in farm animals (Cattle, Buffalo, Sheep and Goat)	3
2.	Superovulation and Embryo transfer in farm animals (Cattle, Buffalo, Sheep and Goat)	3
3.	Collection of Semen in farm animals	1
4.	Seminal plasma proteins and their importance in determining male fertility	2
5.	Sexing of spermatozoa	1
6.	Cryopreservation of semen in farm animals	1
7.	Collection of oocytes from live animals and slaughter house specimens	1
8.	Grading of oocytes	1
9.	*In-vitro* maturation of oocytes	2
10.	*In-vitro* fertilization of oocytes	2
11.	*In-vitro* culture of embryos	1
12.	Cryopreservation of embryos in farm animals	2
13.	Sexing of embryos	2
14.	Micromanipulation of gametes and embryos (Intracytoplasmic Sperm injection and somatic cell nuclear transfer) and their applications	3
15.	Transgenic animal production and its importance	2
16.	Stem cell production and its clinical applications	3
17.	Nanotechnology and its use in farm animal breeding and reproduction	2

Total 32

Practical

1. Semen analysis – Fructolytic index, zona free ovum test, Acrosomal integrity test 2
2. Synchronization and superovulation protocols. 1
3. Ovum pick up from superovulated animals 1
4. Collection of oocytes from slaughter house derived ovaries, Grading and evaluation 1
5. Capacitation of spermatozoa 1
6. *In-vitro* fertilization, *In-vitro* embryo production 1
7. Collection of embryos using non-surgical procedures, Transferring embryos using non- surgical procedures. 2
8. Oocyte/ Embryo/ ovarian/ testicular tissue freezing protocols. 1
9. Demonstration on Intracytoplasmic sperm injection 1
10. Micromanipulation of early embryos. 2
11. Isolation and identification of embryonic stem cells 3

Total 16

Note: The course teachers shall conduct the above practicals by utilizing facilities from semen/ IVF lab in the university/ college, if not available in the department.

List of Journals

- *Acta Endocrinologica*
- *Advances in Clinical Chemistry*
- *Advances in Reproductive Physiology*
- *Advances in Veterinary Sciences*
- *American Journal of Clinical Nutrition*
- *American Journal of Physiology*
- *American Journal of Veterinary Research*
- *Animal Nutrition and Feed Technology*
- *Animal Reproduction Science*
- *Animal Sciences*
- *Annual Review of Physiology*
- *Buffalo Journal*
- *Domestic Animal Endocrinology*
- *Indian Journal of Animal Reproduction*
- *Indian Journal of Animal Nutrition*
- *Indian Journal of Animal Physiology*
- *Indian Journal of Animal Research*
- *Indian Journal of Animal Science*
- *Indian Veterinary Journal*
- *Journal of Endocrinology*
- *Journal of Physiology*
- *Journal of Reproduction and Fertility*

- *Neuroendocrinology*

e-Resources

- http://intl-joe, endocrinology-journals.org (Journal of Endocrinology)
- http://intl-ajpcon.physiology.org (American Journal of Physiology)
- http://arjournals.annualreviewes.org (Annual Review of Physiology)
- www.jneurosci.org (Journal of Neuroscience)
- www3.interscience.wiley.com (Journal of Physiology and Animal Nutrition)
- http://jp.physioc.org. (Journal of Physiology)

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Physiology

A: Digestive System

Development of ruminant stomach; Rumen microbiology and rumen environment Digestion, absorption and metabolism of carbohydrate, protein and fat in simple and compound stomach. Ruminant microbial digestion. Fate of rumen fermentation products

Rumino-reticular motility, its significance and control.

B: Circulatory System & Respiratory

Cardiac cycle, Cardiac sounds. Cardiac output and its measurements; Factors affecting cardiac output. Normal electrocardiogram Circulation - coronary, systemic and pulmonary circulation and their regulation. Mechanism of ventilation. Transport and exchange of respiratory gases at alveolar and tissue level. Pulmonary volumes and capacities. Stress and exercise.

C: Excretory System

Glomerular filtration, Tubular reasbsorption and secretion. Urine formation-stages and factors affecting different stages. Role of kidney in acid-base balance. Physiology of micturition. Endocrine control of renal function- Renin angiotensin aldosterone system.

D:Hematology

Blood cells and hematological indices. Anaemia; Different types and their effect on circulation. Resistance of the body to infection, Leukocytes, tissue macrophage system and inflammatory response. Haemoglobin and its types. Hemostasis and coagulation factors. Role of platelets, Fibrinolysis. Conditions causing bleeding disorders.

E: Growth and Environmental Physiology

Growth - Introduction and Concepts. Hormonal regulation of growth. Growth promoters.

Environment - Introduction and concepts. Thermoregulation. Effect of environment on production and reproduction.

F: Physiology of Animal Reproduction

Puberty and its endocrine control. Sexual cycles and mating behaviours in females, oogenesis, folliculogenesis and ovulation. .Spermatozoa- structure and composition, Spermatogenesis, Spermiogenesis, Spermatogenic cycles. Fertilization, Implantation, Early embryo development and Maternal recognition of pregnancy. Hormones of pregnancy.

G: Neuromuscular Physiology

Membrane and action potential. Molecular mechanism of muscle contraction Myoneuronal junction and transmission of impulse. Skeletal muscle energetics, Metabolism and lactate shuttle. Development of action potential and transmission of nerve impulse in nerve and synapse. Regulatory centres in brain Reflexes. Functions of Cerebrum, Cerebellum, Hypothalamus, Limbic system.

H: Endocrinology of Domestic Animals

Mechanism of hormone synthesis, Release and transport. Regulation and metabolism of different hormones and their mechanism of action . Endocrine control of carbohydrate and calcium homeostasis . Hormones in fertility regulation and production augmentation.

Animal Reproduction Gynaecology and Obstetrics

DEPARTMENT OF VETERINARY GYNAECOLOGY AND OBSTETRICS

Course Structure for M.V.Sc degree programme (Semester Wise)

COURSE NO.	TITLE	CR. HRS	Semester
VGO 601*	GENERAL GYNAECOLOGY	2+1	I
VGO 602*	FEMALE INFERTILITY IN FARM ANIMALS	2+1	II
VGO 603*	VETERINARY OBSTETRICS	2+1	I
VGO 604*	ANDROLOGY AND MALE INFERTILITY	2+1	II
VGO 605*	SEMEN PRESERVATION AND ARTIFICIAL INSEMINATION	2+1	I
VGO 606*	BASICS OF REPRODUCTIVE BIOTECHNOLOGY	2+1	II
VGO 607*	CLINICAL PRACTICE-I	0+3	I
VGO 608*	CLINICAL PRACTICE-II	0+3	II
VGO 609	CANINE AND FELINE REPRODUCTION	2+1	I
VGO 610	CAPRINE AND OVINE REPRODUCTION	2+1	II
VGO 611	EQUINE REPRODUCTION	2+1	I
VGO 612	CAMEL REPRODUCTION	2+1	II
VGO 613	ELEPHANT REPRODUCTION	2+1	I
VGO 614	WILD AND ZOO ANIMAL REPRODUCTION	2+1	II
VGO 615	PORCINE REPRODUCTION	2+1	I
VGO 616	ULTRASONOGRAPHY IN ANIMAL REPRODUCTION	1+2	II
VGO 690	SPECIAL PROBLEM	0+1	I & II
VGO 691	MASTER'S SEMINAR	1+0	I &II
VGO 699	MASTER'S RESEARCH	0+30	I & II
*Compulsory courses			

DEPARTMENT OF VETERINARY GYNAECOLOGY AND OBSTETRICS

Course Structure for Ph.D degree programme (Semester Wise)

COURSE NO.	TITLE	CR. HRS	SEMESTER
VGO 701*	ADVANCES IN GYNAECOLOGY AND INFERTILITY MANAGEMENT	2+1	I
VGO 702*	ADVANCES IN VETERINARY OBSTETRICS	1+1	II
VGO 703*	ADVANCES IN ANDROLOGY AND MALE INFERTILITY	2+1	I
VGO 704*	REPRODUCTIVE BIOTECHNOLOGY	1+1	II
VGO 705	SEMENOLOGY	1+1	I
VGO 706*	CLINICAL PRACTICE-I	0+3	I
VGO 707 *	CLINICAL PRACTICE-II	0+3	II
VGO 790	SPECIAL PROBLEM	0+2	I & II
VGO 791	DOCTORAL SEMINAR-I	1+0	I
VGO-792	DOCTORAL SEMINAR-II	1+0	II
VGO 799	DOCTORAL RESEARCH	0+75	I & II
*Compulsory courses			

Course Contents
M.V.Sc. in Animal Reproduction Gynaecology and Obstetrics

I. **Course Title : General Gynaecology**
II. **Course Code : VGO 601**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To understand the basics of physiology of female reproduction and it's hormonal regulation/ manipulation/ control.

V. **Theory**

Unit I

Functional anatomy, puberty and sexual maturity, Role of hypothalamic-pituitary- gonadal axis in attainment of puberty and sexual maturity, Endocrine regulation of estrous cycle. Role of pineal gland, endogenous opioids and neuropeptides in reproduction.

Unit II

Folliculogenesis, Oogenesis and ovulation and associated endocrine pattern, manipulation of follicular waves, Synchronization of estrus and ovulation and induction of ovarian activity.

Unit III

Gamete transport, Fertilization, Implantation and maternal recognition of pregnancy.

Unit IV

Embryonic and fetal development, Placentation, Fetal circulation and gestation, position of fetus in the uterus, age characteristics of fetus.

Unit V

Pregnancy diagnosis: Clinical, Ultrasonographic, Endocrinological and other diagnostic laboratory tests.

Unit VI

Lactation and artificial induction of lactation.

VI. **Practical**

Clinical examination of female genitalia. Biometry of female genital organs. Rectal and vaginal examination to diagnose cyclic phases of estrous cycle. Fern pattern of cervical mucus and exfoliated vaginal cytology. Pregnancy diagnosis in large and small animals by various methods. Estimation of age of the fetus. Use of ultrasound/ RIA/ ELISA in gynaecology. Synchronization of estrus and ovulation in farm animals.

VII. **Suggested Reading**

- Perry T Cupps. 2009. *Reproduction in Domestic Animals*. Academic Press.
- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*.

Wiley-Blackwell.
- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology* and Wiley-Blackwell.
- David Noakes, Timothy Parkinson and Gary England 2018. *Veterinary Reproduction and Obstetrics*. Saunders Ltd.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
-

I. **Course Title : Female Infertility in Farm Animals**

II. **Course Code : VGO 602**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge and training in diagnosis and treatment of infertility in female domestic animals.

V. **Theory**

Unit I

Introduction to infertility, classification, economic impact. Anatomical causes of infertility, congenital and hereditary causes and acquired defects.

Unit II

Nutritional causes of infertility. Importance of body condition score. Negative energy balance, its prevention and amelioration.

Unit III

Managemental and environmental causes of infertility. Out of season breeding.

Unit IV

Infectious causes of female infertility, Specific and non-specific infections; It's diagnosis, treatment, prevention and control.

Unit V

Ovarian dysfunction; Anoestrus, Cystic ovarian degeneration, Anovulation, Delayed ovulation and luteal insufficiency; causes, diagnosis and treatment.

Unit VI

Repeat breeding; its causes, diagnosis and treatment.

Unit VII

Early embryonic death (EED); it's causes, Diagnosis and therapeutic management.

Unit VIII

Abortion; causes, diagnosis and prevention of abortion.

Unit IX

Interactions in immunological mechanisms and infertility.

VI. **Practical**

Record keeping, herd fertility assessment and management,

diagnosis and treatment of infertility in female animals, use of uterine swabs for bacterial and fungal culture, histo-pathological evaluation of uterine biopsy, white side test, endometrial cytology and hormone assay. Use of ultrasonography in diagnosis of infertility. Immuno- diagnostic techniques.

VII. **Suggested Reading**

- Laing JA. 1979. *Fertility and Infertility in Domestic Animals*. English Language Book Soc. and Bailliere Tindall.
- Morrow DA. 1986. Current Therapy in Theriogenology. WB Saunders.
- David Noakes. Timothy Parkinson and Gary England 2018. *Veterinary Reproduction and Obstetrics*. Saunders Ltd.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
-

I. **Course Title : Veterinary Obstetrics**

II. **Course Code : VGO 603**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge and training on problems of pregnancy and parturition and their management in domestic animals.

V. **Theory**

Unit I

Parturition; stages of parturition, Mechanism of initiation of parturition, Hormonal profiles associated with parturition, Transition cow, Onset of postpartum ovarian activity.

Unit II

Principles of handling of dystocia, Obstetrical procedures: Mutations, Fetotomy, caesarean section. Obstetrical anaesthesia and analgesia, epidural anesthesia.

Unit III

Fetal and maternal dystocia; causes, diagnosis and management.

Unit IV

Uterine torsion; causes, diagnosis and its correction. Caesarean section, anaesthesia for caesarean section, ovariohysterectomy.

Unit V

Diseases and accidents during gestation and around parturition.

Unit VI

Etiology, diagnosis and treatment of ante-partum and post-partum uterine and vaginal prolapse.

Unit VII

Induction of parturition and elective termination of pregnancy.

Unit VIII

Involution of uterus following normal and abnormal parturition.

Unit IX

Care of dam and the newborn.

VI. Practical

Pelvimetry of different species of farm animals. Diagnosis and correction of abnormal fetal presentation, position and posture in phantom box. Epidural anesthesia, episiotomy, ovariohysterectomy and caesarean operation. Management of incomplete cervical dilation. Fetotomy operations. Detorsion of uterus. Management of cervico- vaginal and uterine prolapse. Handling of clinical cases of dystocia.

VII. Suggested Reading

- David Noakes, Timothy Parkinson and Gary England 2018. *Veterinary Reproduction and Obstetrics*. Saunders Ltd.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
- Sloss V and Dufty JH. 1980. *Handbook of Bovine Obstetrics*. Williams and Wilkins.

I. Course Title : Andrology and Male Infertility

II. Course Code : VGO 604

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training about male reproduction and treatment of male infertility in domestic animals.

V. Theory

Unit I

Structure and function of reproductive tract of male.

Unit II

Sexual behavior and examination of bulls for breeding soundness.

Unit III

Spermatogenesis, Seminiferous epithelial cycle, Spermatogonial wave, Structure of spermatozoa, Semen and its composition. Mechanism of sperm motility.

Unit IV

Diseases transmitted through semen. Factors affecting semen quality, semen culture, tests for assessment of sperm motility, sperm survival and fertilizing capacity of spermatozoa.

Unit V

Causes of infertility; hereditary, congenital, infectious, nutritional and hormonal. Pathological and functional disturbances of

epididymis, vas deferens and accessory sex glands.

Unit VI

Impotentia coeundi and impotentia generandi. Testicular hypoplasia and degeneration; causes and affect on semen and fertility. Coital injuries and vices of male animals.

Unit VII

Influence of seminal plasma proteins in modulating fertility. Heat stress and it's effect on sperm production.

Unit VIII

Screening of the breeding bulls to be selected for semen collection.

VI. **Practical**

General and rectal examination for biometrics of male genitalia and accessory sex glands. Breeding soundness evaluation of male animals. Semen evaluation for sperm abnormalities, fertility and determination of other biochemical constituents of seminal plasma, Microbiological load of semen. treatment of infertile male animals. Examination, diagnosis and

VII. Suggested Reading

- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- Mann T and Lutwak-Mann C. 1981. *Male Reproductive Function and Semen*. Springer-Verlag.
- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
- Salisbury GW, VanDemark NL and Lodge JR. 1978. *Physiology of Reproduction and Artificial Insemination of Cattle*. WH Freeman and Co.

I. **Course Title : Semen Preservation and Artificial Insemination**

II. **Course Code : VGO 605**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge and training about collection, evaluation and preservation of semen and artificial insemination in domestic animals.

V. **Theory**

Unit I

History of artificial insemination. Methods of semen collection.

Unit II

Semen evaluation; macroscopic, microscopic, biochemical and microbiological tests.

Unit III

Semen preservation. Extenders for preservation of semen at different temperatures. Semen additives for enhancement of motility and fertilizing capacity of spermatozoa. Dilution of semen.

Unit IV

Cryopreservation of semen. Effect of cryopreservation on spermatozoa, semen quality and fertility. Liquid Nitrogen (LN2) cylinders; it's handling, care and maintenance.

Unit V

Thawing protocols of frozen semen. Factors affecting post-thaw semen quality.

Unit VI

Ideal protocol for AI in different species of animals. Factors affecting success of AI.

Unit VII

Biosecurity and biosafety guidelines for frozen semen stations, semen processing laboratories and quarantine stations. Minimum standards and standard operating procedures for artificial insemination, Quality testing of straws and sheath for use in artificial insemination.

VI. Practical

Instrumentation in semen laboratory, Minimum standards of protocols and Standard operating procedures for semen production, Computer assisted semen analysis (CASA), Collection and evaluation of semen. Preparation of extenders. Preservation of semen; room temperature, refrigeration and cryopreservation. Handling and evaluation of processed semen. Practice of AI techniques.

VII. Suggested Reading

- Hafez ESE and B Hafez 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- Enos Johnson Perry 2013. *Artificial Insemination of Farm Animals*. Jodhpur: Axis Books (India).
- Salisbury GW, VanDemark NL and Lodge JR. 1978. *Physiology of Reproduction and Artificial Insemination of Cattle*. WH Freeman and Co.

I. Course Title : Basics of Reproductive Biotechnology

II. Course Code : VGO 606

III. Credit Hours : 2+1

IV. Aim of the course

To impart knowledge and training on biotechniques in animal

reproduction.

V. **Theory**

Unit I

Embryo transfer technology: selection of donors and recipients.

Unit II

Synchronization, super-ovulation, surgical and non-surgical collection of embryos and evaluation of embryos.

Unit III

Cryopreservation of embryos, transfer of embryos to donors. Sexed semen production, sexing of embryos. Guidelines for export and import of bovine germplasm. Guidelines and standards regarding embryo production.

Unit IV

In-vitro culture of granulosa cells, cumulus cells, luteal cells and oviductal cells. Recovery of bovine oocytes; from abattoir ovaries and live animals, *in- vitro* fertilization, *in-vitro* maturation, micromanipulation of embryos.

Unit V

Immuno-neutralization of hormones. Immunomodulation of fertility.

VI. **Practical**

Synchronization of estrus in donors and recipients, superovulation, surgical and non- surgical collection and transfer of embryos. Collection of oocytes from slaughter house genitalia. *In-vitro* fertilization, *in-vitro* maturation and cryopreservation of embryos. Sexing of embryos.

VII. **Suggested Reading**

- Ian Gordon. 2017. *Reproductive Technologies in Farm Animals*. Wallingford, Oxfordshire CABI.
- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- B Singh, SK Gautam and MS Chauhan. 2012. *Textbook of Animal Biotechnology*, Pearson Education.
- Heiner Niemann, Christine Wrenzycki. 2018. *Animal Biotechnology 1: Reproductive Biotechnologies*. Springer.
- Heiner Niemann, Christine Wrenzycki. 2018. *Animal Biotechnology 2*. Springer International Publishing AG.
- Troy L Ott, Zhihua Jiang. 2010. Reproductive Genomics in Domestic Animals. John Wiley.
- Marcelo Marcondes Seneda, Katia Cristina Silva-Santos LS Rafagnin Marinho. 2016. *Biotechnology of Animal Reproduction*, Nova Science Pub. Inc; UK Ed.
- Tacia Gomes Bergstein-Galan. 2018. *Reproduction Biotechnology in farm animals*. Avid Science.

I. **Course Title : Clinical Practice-I**
II. **Course Code : VGO 607**
III. **Credit Hours : 0+3**
IV. **Aim of the course**

Hands-on training on diagnosis and treatment of reproductive disorders in animals at VCC.

V. **Practical**

Clinical examination of animals affected with reproductive disorders, Use ofdiagnostic techniques for diagnosis and institution of required therapy. Acquaintance with different equipment used for handling reproductive disorders, Client management, Public relations, Code of conduct, Database management, Maintenance of case records.

VI. **Suggested Reading**

- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Zemjanis R 1970. *Diagnostic and Therapeutic Techniques in Animal Reproduction*. Williams and Wilkins; Second Edition.

I. **Course Title : Clinical Practice-II**
II. **Course Code : VGO 608**
III. **Credit Hours : 0+3**
IV. **Aim of the course**

Hands-on training on diagnosis and treatment of reproductive disorders in animals at VCC.

V. **Practical**

Clinical examination of animals affected with reproductive disorders, use of diagnostic techniques for diagnosis and institution of required therapy. Acquaintance with different equipment used for handling reproductive disorders, Client management, Public relations, Code of conduct, Database management, Maintenance of case records.

VI. **Suggested Reading**

- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Zemjanis R. 1970. *Diagnostic and Therapeutic Techniques in Animal Reproduction*. Williams and Wilkins; Second Edition.

I. **Course Title : Canine and Feline Reproduction**
II. **Course Code : VGO 609**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To impart knowledge and training about reproduction in canine and feline.

V. Theory

Unit I

Development of reproductive system. Anatomy of male and female reproductive system. Canine and feline estrous cycle, endocrinology of estrous cycle.

Unit II

Breeding management, pregnancy, pregnancy diagnosis; clinical, ultrasonographic, endocrinological and other diagnostic laboratory tests.

Unit III

Parturition, fetal and maternal dystocia; causes, diagnosis and management. Induction of parturition and caesarean section, periparturient disorders.

Unit IV

Medical termination of pregnancy in dogs and cats, management of psudopregnancy, pyometra and it's management. Infertility and it's management in dogs and cats.

Unit V

Postpartum care of dam and lactation. Neonatal care.

Unit VI

Population control in dogs; surgical and non surgical methods.

Unit VII

Reproductive physiology of male dogs, semen collection techniques, semen evaluation, freezing of semen, artificial insemination techniques, male reproductive disorders and it's management.

VI. Practical

Exfoliative vaginal cytology, determination of ovulation time, demonstration of semen collection and artificial insemination, predicting time of parturition using hormonal assay, management of dystocia using clinical cases, castration, ovariohystrectomy, caesarean section, surgical procedure related to reproductive disorders in both male and female dogs and cats.

VII. Suggested Reading

- Edward C Feldman, Richard William Nelson. 2003. *Canine and Feline Endocrinology and Reproduction*. Elsevier Health Sciences, Saunders.
- Shirley Dianne Johnston, Margaret V Root Kustritz, Patricia Schultz Olson. 2001. *Canine and Feline Theriogenology*. Saunders Publ.
- Margaret V, Root Kustritz. 2009. *Clinical Canine and Feline Reproduction*: Evidence-Based Answers. John Wiley and Sons.

- Phyllis A. Holst MS. 2010. *Canine Reproduction: The Breeder's Guide 3rd Edition*. DOGWISE.
- Cheryl Lopate. 2012. *Management of Pregnant and Neonatal Dogs, Cats, and Exotic Pets*. John Wiley and Sons.
- Jovi R Otite. 2015. *Reproduction in the Dog a Tropical Approach*. Xlibris Corporation.

I. **Course Title : Caprine and Ovine Reproduction**

II. **Course Code : VGO 610**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge and training about reproduction in sheep and goat.

V. **Theory**

Unit I

Caprine and ovine estrous cycle, endocrinology of estrous cycle, Seasonal breeding activity in sheep and goat, Artificial control of oestrus in sheep and goat.

Unit II

Breeding management, methods for advancing sheep breeding season, Induction of multiple births in sheep. Artificial insemination, pregnancy and parturition, Dystocia and it's management.

Unit III

Reproductive disorders and it's management.

Unit IV

Reproductive physiology of males, semen collection techniques, semen evaluation, freezing of semen, male reproductive disorders and it's management.

VI. **Practical**

Demonstration of semen collection and artificial insemination, management of dystocia using clinical cases, castration, ovariohystrectomy, caesarean section, surgical procedure related to reproductive disorders in both male and females.

VII. **Suggested Reading**

- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology and Reproduction*. Wiley-Blackwell.
- Lindsay DR and Pearce DT. 2011. *Reproduction in Sheep*, Cambridge University Press, Cambridge, London.
- Selected articles from journals.

I. **Course Title : Equine Reproduction**

II. **Course Code : VGO 611**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To encompass the fundamentals of equine reproductive anatomy and physiology. This will help in understanding the care and management of the breeding stallion and the broodmare.

V. **Theory**

Unit I

Anatomy and physiology of the mare and stallion.

Unit II

Manipulation of estrus in the mare, estrous cycle, broodmare management, Use of ultrasound in breeding management.

Unit III

Infertility and it's management.

Unit IV

Pregnancy diagnosis and management of the pregnant mare. Fetal development, abortion, induced parturition and dystocia.

Unit V

Neonatal management and common neonatal diseases, orphan foal management, foal management during the first six months.

Unit VI

Semen collection, semen preservation, artificial insemination and embryo transfer.

VI. **Practical**

Visit of equine/ stud farm, overall management of an equine breeding program, handling the cases of reproductive disorders, artificial insemination, semen collection, semen preservation, breeding record keeping and analysis.

VII. **Suggested Reading**

- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology and Reproduction*. Wiley-Blackwell.
- McKinnon, Squires, Vaala and verner. 2011. *Equine Reproduction* (2nd Ed). Wiley- Blackwell.
- Juan Samper, Jonathan Pyocock and Angus McKinnon. 2007. *Current Therapy in Equine Reproduction*. Saunders.
- Steven Brinsko Terry Blanchard Dickson Varner James Schumacher Charles Love. 2010. *Manual of Equine Reproduction* (3rd Ed). CV Mosby.
- John Dascanio and Patrick McCue. 2014. *Equine Reproductive procedures.* John Wiley and Sons, Inc.
- Selected articles from journals.

I. **Course Title : Camel Reproduction**

II. **Course Code : VGO 612**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge and training about reproduction in camels.

V. **Theory**

Unit I

Male reproductive organs, male reproductive physiology and sexual behavior, puberty and sexual maturity, seasonal changes, copulation, semen collection and it's characteristics.

Unit II

Female reproductive organs, female reproductive physiology and sexual behavior, oestrous cycle, external signs of oestrus, pregnancy and foetal development, pregnancy diagnosis and parturition.

Unit III

Age of sexual maturity, breeding season, conception rate, calving interval, reproductive longevity.

Unit IV

Early embryonic mortality, reproductive problems in the female, reproductive problems in the male.

Unit V

Artificial insemination, nutrition and reproduction, embryo transfer in camel.

VI. Practical

Management of dystocia in clinical cases, castration, ovariohystrectomy, caesarean section, surgical procedure related to reproductive disorders in both male and females.

VII. **Suggested Reading**

- H Merkt, D Rath, B Musa, MA El-Naggar. 1990. *Reproduction in Camels*. FAO.
- Muhammad Jamshed Khan. 2011. *Equine and Camel Production: An Approach towards Better Management*. LAP LAMBERT Academic Pub.
- Selected articles from journals.

I. **Course Title : Elephant Reproduction**

II. **Course Code : VGO 613**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To impart knowledge and training about reproduction in elephant.

V. **Theory**

Unit I

General introduction, Elephas maximus, domestic and wild elephants.

Unit II

Male genital system, Accessory sex glands, Hormonal control and semenology.

Unit III

Female reproductive system, Ovaries, fallopian tubes, Uterus, vagina and external genitalia. Oestrous cycle, Hormonal regulation of estrous cycle, Mating behaviour and act of copulation.

Unit IV

Pregnancy, Gestation length and parturition. Neonatal care of elephant calves.

Unit V

Musth in elephants, behavioral patterns, pre-musth, violent- musth and post-musth phases, controlling elephants in musth using drugs/ hormones, anti androgens. Artificial insemination and cryopreservation of gametes.

VI. Practical

Management of dystocia in clinical cases, surgical procedure related to reproductive disorders in both male and females.

VII. Suggested Reading

- Brown JL, Paris S, Prado-Oviedo NA, Meehan CL, Hogan JN, Morfeld KA and Carlstead KA. 2016. *Reproductive Health Assessment of Female Elephants in North American Zoos and Association of Husbandry Practices with Reproductive Dysfunction in African Elephants* (Loxodonta africana). PLOS ONE | DOI:10.1371 journal pone 014573.
- Ortolani A, Leong K, Graham L, Savage A. 2005. *Behavioral indices of estrus in a group of captive African Elephants* (Loxodonta africana). Zoo Biol. 24:311-329.
- Rasmussen LE, Schmidt MJ, Henneous R, Groves D, Daves GD. Jr. 1982. *Asian bull elephants: flehmen-like responses to extractable components in female elephant estrous urine.* Science. 217: 159-162.
- Sukumar R. 2006. *A brief review of the status, distribution and bioilogy of wild Asian elephants Elephas maximus*. Int. Zoo Yb. 40: 1-8.
- Thitaram C. 2009. Elephant reproduction: Improvement of breeding efficiency and development of a breeding strategy. Ph.D. Thesis, Utrecht University, The Netherlands
- Vidya TNC and Sukumar R. 2005. *Social and reproductive behaviour in elephants*. *Current sci*. **89**: 1200-1207.

- Selected articles from journals.

I. **Course Title : Wild and Zoo Animal Reproduction**
II. **Course Code : VGO 614**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To impart knowledge and training about reproduction in Wild and zoo animals.

V. **Theory**

Unit I

Introduction to reproduction, Pattern of estrous cycle, Optimal breeding time withemphasis on tiger, deer, monkey and crocodile.

Unit II

Gestational length, parturition and pregnancy diagnosis.

Unit III

Sexual behavior and major reproductive disorders in wild and zoo animals, contraception techniques for deer.

VI. **Practical**

Management of dystocia in clinical cases, castration, observation of estrus behavior, pregnancy diagnosis, surgical procedure related to reproductive disorders in both male and females.

VII. **Suggested Reading**

- GR Smith, JP Hearn and Wellcome Trust (London, England). 1988. *Reproduction and disease in captive and wild animals*, New York: Oxford University Press.
- Ian Gordon. 1997. *Controlled reproduction in horses, deer and camelids*. CAB International.
- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology and Reproduction.* Wiley-Blackwell.
- Paul A Rees. 2011. *An Introduction to Zoo Biology and Management*. Wiley-Blackwell.
- R Eric Miller, Murray E Fowler. 2014. *Fowler's Zoo and Wild Animal Medicine*. Saunders.
- Selected articles from journals.

I. **Course Title : Porcine Reproduction**
II. **Course Code : VGO 615**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To acquire knowledge about the fundamentals of reproductive anatomy, physiology and advances in fertility management in swine.

V. **Theory**

Unit I

Anatomy and physiology of boar and sow.

Unit II

Oestrus cycle in sow, manipulation of oestrus cycle, methods for detection of oestrus,
endocrinology of pregnancy and parturition.

Unit III

Infertility in sow and its management.

Unit IV

Pregnancy diagnosis and management of pregnant sow.

Unit V

Fetal development, abortion, induced parturition, dystocia, stages of parturition and mastitis-metritis complex in sow.

Unit VI

Neonatal management and common neonatal diseases, care of piglets.

Unit VII

Breeding boar selection and management, semen collection, semen preservation, natural service, artificial insemination, embryo transfer and IVF.

VI. Practical

Visit of swine farm, breeding management in sows, handling the cases of reproductive disorders, caesarean section, castration, sexual behaviour, vaginal cytology, pregnancy diagnosis, dystocia, semen collection, semen preservation, artificial insemination, embryo transfer and record keeping.

VII. Suggested Reading

- Colin T Whittemore, Ilias Kyriazakis. 2008. *Whittemore's Science and Practice of Pig Production*. John Wiley and Sons Press.
- *Control of Pig Reproduction*. Proceedings of the Eighth International Conference on Pig Reproduction, Alberta, Canada, June 2009 by Heriberto Rodríguez Martínez, Jeff L Vallet, Adam J Ziecik, Nottingham University Press. 2009.
- DJA Cole, GR Foxcroft, Butterworth-Heinemann. 2013. *Control of Pig Reproduction*. Technology and Engineering Press.
- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology and Reproduction*. Wiley-Blackwell.
- *Pig Reproduction: Problems, Practices and Principles*. Proceedings of a Conference Held at Christ Church, Oxford University, 16-18 December, 1998.

- Sergi Bonet, Isabel Casas, William V Holt, Marc Yeste. 2013. *Boar Reproduction: Fundamentals and New Biotechnological Trends*. Springer Science and Business Media.
- Selected articles from journals.

I. **Course Title : Ultrasonography in Animal Reproduction**
II. **Course Code : VGO 616**
III. **Credit Hours : 1+2**
IV. **Aim of the course**

To impart knowledge and training about application of ultrasonography in diagnosis of conditions associated with animal reproduction.

V. **Theory**

Unit I

Basic principle of ultrasonography, physics of ultrasonography, A-mode, B-mode and M-mode ultrasonography, artifacts, principle of Doppler ultrasonography.

Unit II

Trans-abdominal ultrasonography, transrectal ultrasonography, follicular dynamics and luteal characteristics in large and small ruminants, luteal blood flow studies.

Unit III

Use of ultrasonography in pregnancy diagnosis, infertility management, uterine involution, luteal cyst and follicular cyst, blood flow studies in uterine and foetal arteries. Determination of gestational age in small animals by measuring gestational sac diameter, crown rump length and body diameter. Detection of foetal resorption and mummification. Prediction of parturition time, fetal viability by detecting fetal heart rate, foetal number and sex determination.

Unit IV

Testicular and male accessory sex gland ultrasonography.

VI. **Practical**

Use of ultrasonography in different stages of reproductive cycle. Use of ultrasonography in diagnosis of clinical cases associated with reproductive disorders in both male and females.

VII. **Suggested Reading**

- MAM Taverne and AH Willemse. 1989. *Diagnostic ultrasound and animal reproduction*. Dordrecht; Boston: Kluwer Academic.
- J Ginther. 1998. *Ultrasonic imaging and animal reproduction*. Cross Plains, Wis.: Equiservices Pub.
- Selected articles from journals.

I. **Course Title : Special Problem**
II. **Course Code : VGO 690**
III. **Credit Hours : 0+1**
IV. **Aim of the course**

To expose students to research techniques related to sub discipline of the subject and submission of written project with references.

V. **Practical**

Student will carry out research on allotted project and submit the project report.

VGO 691 Master's Seminar 1+0

VGO 699 Master's Research 0+30

Course Outline: Lecture wise

VGO 601: General Gynaecology (2+1) Theory Lectures

1. Functional anatomy reproductive organs, puberty and sexual maturity in farm animals.
2. Endocrine regulation of estrous cycle in farm animals.
3. Role of hypothalamic-pituitary-gonadal axis in attainment of puberty.
4. Role of pineal gland, endogenous opioids and neuropeptides in reproduction.
5. Folliculogenesis, follicular waves and its manipulation, oogenesis and ovulation.
6. Synchronization of estrus and ovulation in farm animals.
7. Artificial induction of ovarian activity.
8. Transport of gametes in the reproductive tract, fertilization and implantation.
9. Maternal recognition of pregnancy in farm animals.
10. Embryonic and fetal development during gestation.
11. Placentation and fetal circulation.
12. Gestational changes in the fetus w.r.t. to position in the uterus, age, etc.
13. Pregnancy diagnosis in farm animals. Pregnancy diagnosis using clinical method.
14. Pregnancy diagnosis using endocrinological and other diagnostic laboratory methods.
15. Pregnancy diagnosis using ultrasonographic method.
16. Lactation and artificial induction of lactation in cattle and buffaloes.

Practicals

1. Clinical examination of female genitalia.
2. Biometry of female genital organs using slaughter house specimen.

3. Rectal and vaginal examination to diagnose cyclic phases of estrous cycle.
4. Fern pattern of cervical mucus and exfoliated vaginal cytology.
5. Pregnancy diagnosis in large and small animals by various methods.
6. Estimation of age of the fetus.
7. Pregnancy diagnosis using Ultrasonography method.
8. Pregnancy diagnosis using endocrinological method.
9. Synchronization of estrus and ovulation in farm animals.

VGO 602: Female Infertility In Farm Animals (2+1) Theory Lectures

1. Infertility, its classification and economic impact.
2. Anatomical, congenital/ hereditary and acquired causes of infertility.
3. Nutritional causes of infertility.
4. Importance of body condition score. Negative energy balance, its prevention and amelioration.
5. Managemental and environmental causes of infertility.
6. Out of season breeding.
7. Infectious causes of female infertility, specific and non-specific infections; it's diagnosis, treatment, prevention and control.
8. Anoestrus; causes, diagnosis and treatment.
9. Cystic ovarian degeneration; causes, diagnosis and treatment.
10. Anovulation and delayed ovulation; causes, diagnosis and treatment.
11. Luteal insufficiency; causes, diagnosis and treatment.
12. Repeat breeding; its causes, diagnosis and treatment.
13. Early embryonic death (EED); it's causes, diagnosis and therapeutic management.
14. Abortion; Infectious and non infectious causes of abortion.
15. Diagnosis and prevention of abortion.
16. Immunological mechanisms leading to infertility.

Practicals

1. Record keeping w.r.t. herd fertility assessment and management.
2. Diagnosis and treatment of infertility in female animals.
3. Uterine swabbing for bacterial and fungal culture.
4. Histo-pathological evaluation of uterine biopsy.
5. White side test, endometrial cytology and hormone assay.
6. Use of ultrasonography in diagnosis of infertility.
7. Immuno- diagnostic techniques.

VOG 603: Veterinary Obstetrics (2+1)

Theory Lectures

1. Parturition; stages of parturition.
2. Mechanism of initiation of parturition, hormonal profiles associated

with parturition.

3. Transition cow, onset of postpartum ovarian activity.
4. Dystocia and principles of handling of dystocia.
5. Obstetrical procedures: mutations, fetotomy, caesarean section.
6. Obstetrical anesthesia and analgesia, epidural anesthesia.
7. Fetal dystocia; causes, diagnosis and management.
8. Maternal dystocia; causes, diagnosis and management.
9. Uterine torsion; causes, diagnosis and its correction.
10. Caesarean section and ovariohysterectomy.
11. Diseases and accidents during gestation
12. Diseases and accidents around parturition.
13. Etiology, diagnosis and treatment of ante-partum vagino-cervical prolapse.
14. Etiology, diagnosis and treatment of post-partum uterine and vaginal prolapse.
15. Induction of parturition and elective termination of pregnancy.
16. Involution of uterus following normal and abnormal parturition.
17. Care of dam and the newborn.

Practicals

1. Pelvimetry of different species of farm animals.
2. Diagnosis and correction of abnormal fetal presentation, position and posture in phantom box.
3. Epidural anesthesia, episiotomy, ovariohysterectomy.
4. Caesarean operation.
5. Management of incomplete cervical dilation.
6. Fetotomy operations.
7. Detorsion of uterus.
8. Management of cervico-vaginal and uterine prolapse.
9. Handling of clinical cases of dystocia.

VGO 604: Andrology and Male Infertility (2+1) Theory Lectures

1. Structure and function of reproductive tract of male.
2. Sexual behavior in males.
3. Examination of bulls for breeding soundness.
4. Spermatogenesis, seminiferous epithelial cycle and spermatogonial wave.
5. Structure of spermatozoa, semen and its composition.
6. Mechanism of sperm motility.
7. Diseases transmitted through semen.
8. Factors affecting semen quality.
9. Tests for assessment of sperm motility, sperm survival and fertilizing capacity of spermatozoa.
10. Causes of male infertility; hereditary, congenital, infectious, nutritional and hormonal.

11. Pathological and functional disturbances of epididymis, vas deferens and accessory sex glands.
12. Impotentia cocundi and impotentia generandi.
13. Testicular hypoplasia and degeneration; causes and affect on semen and fertility.
14. Coital injuries and vices of male animals.
15. Influence of seminal plasma proteins in modulating fertility.
16. Heat stress and its effect on sperm production.
17. Screening of the breeding bulls to be selected for semen collection.

Practicals

1. General and per-rectal examination for biometrics of male genitalia and accessory sex glands.
2. Breeding soundness evaluation of male animals.
3. Semen evaluation for sperm abnormalities, fertility.
4. Determination of biochemical constituents of seminal plasma.
5. Microbiological load assessment of semen.
6. Examination, diagnosis and treatment of infertile male animals.

VGO 605: Semen Preservation and Artificial Insemination (2+1)

Theory Lectures

1. History of artificial insemination.
2. Methods of semen collection.
3. Semen evaluation; macroscopic and microscopic examination.
4. Biochemical and microbiological tests of semen.
5. Semen dilution and preservation.
6. Extenders for preservation of semen at different temperatures.
7. Semen additives for enhancement of motility and fertilizing capacity of spermatozoa.
8. Cryopreservation of semen.
9. Effect of cryopreservation on spermatozoa, semen quality and fertility.
10. Liquid Nitrogen (LN2) cylinders; its handling, care and maintenance.
11. Thawing protocols of frozen semen.
12. Factors affecting post-thaw semen quality.
13. Ideal protocol for AI in different species of animals. Factors affecting success of AI.
14. Biosecurity and biosafety guidelines for frozen semen stations, semen processing laboratories and quarantine stations.
15. Minimum standards and standard operating procedures for artificial insemination.
16. Quality testing of straws and sheath for use in artificial insemination.

Practicals

1. Instrumentation in semen laboratory.
2. Minimum standards of protocols of semen laboratory.
3. Standard operating procedures for semen production.
4. Computer assisted semen analysis.
5. Collection and evaluation of semen for its quality.
6. Preparation of semen extenders.
7. Preservation of semen; room temperature, refrigeration and cryopreservation.
8. Handling and evaluation of processed semen.
9. Practice of AI techniques.

VGO 606: Basics of Reproductive Biotechnology (2+1)

Theory Lectures

1. Embryo transfer technology: selection of donors and recipients.
2. Synchronization of estrus in donors and recipients.
3. Super-ovulation, surgical and non-surgical collection of embryos.
4. Evaluation and cryopreservation of embryos.
5. Transfer of embryos to donors.
6. Sexed semen production.
7. Sexing of embryos.
8. Guidelines for export and import of bovine germplasm.
9. Guidelines and standards regarding embryo production.
10. *In-vitro* culture of granulosa cells, cumulus cells, luteal cells and oviductal cells.
11. Recovery of bovine oocytes; from abattoir ovaries and live animals.
12. *In-vitro* maturation, *in-vitro* fertilization and micromanipulation of embryos.
13. Immuno-neutralization and immunomodulation of fertility.

Practicals

1. Synchronization of estrus in donors and recipients.
2. Superovulation, surgical and non-surgical collection and transfer of embryos.
3. Collection of oocytes from slaughter house genitalia.
4. *In-vitro* maturation and *in-vitro* fertilization of embryos.
5. Sexing of embryos.

VGO 609: Canine and Feline Reproduction (2+1)

Theory Lectures

1. Development of reproductive system. Anatomy of male and female reproductive system.
2. Canine and feline estrous cycle, endocrinology of estrous cycle.
3. Breeding management.
4. Pregnancy and pregnancy diagnosis; clinical method of pregnancy

diagnosis.
5. Ultrasonographic, endocrinological and other diagnostic laboratory tests of pregnancy diagnosis.
6. Parturition and periparturient disorders in dogs and cats.
7. Dystocia; fetal and maternal causes, diagnosis and management.
8. Induction of parturition and caesarean section.
9. Medical termination of pregnancy in dogs and cats.
10. Management of psudopregnancy and pyometra.
11. Infertility and it's management in dogs and cats.
12. Postpartum care of dam and lactation. Neonatal care.
13. Population control in dogs; surgical and non surgical methods.
14. Reproductive physiology of male dogs.
15. Semen collection techniques and semen evaluation.
16. Freezing of semen and artificial insemination techniques.
17. Male reproductive disorders and its management.

Practicals

1. Exfoliative vaginal cytology.
2. Determination of ovulation time.
3. Demonstration of semen collection and artificial insemination.
4. Predicting time of parturition using hormonal assay.
5. Management of dystocia in clinical cases.
6. Castration, ovariohystrectomy and caesarean section.
7. Surgical procedure related to reproductive disorders in both male and female dogsand cats.

VGO 610: Caprine and Ovine Reproduction (2+1)

Theory Lectures

1. Caprine and ovine estrous cycle.
2. Endocrinology of estrous cycle.
3. Seasonal breeding activity in sheep and goat.
4. Artificial control of oestrus in sheep and goat.
5. Breeding management.
6. Methods for advancing sheep breeding season, induction of multiple births in sheep.
7. Artificial insemination.
8. Pregnancy and parturition.
9. Dystocia and its management.
10. Reproductive disorders and its management.
11. Reproductive physiology of males.
12. Semen collection techniques and semen evaluation.
13. Freezing of semen.
14. Male reproductive disorders and its management.

Practicals

1. Demonstration of semen collection.
2. Demonstration of artificial insemination.
3. Management of dystocia in clinical cases.
4. Castration.
5. Ovariohystrectomy and caesarean section.
6. Surgical procedure related to reproductive disorders in both male and females.

VGO 611: Equine Reproduction (2+1)

Theory Lectures

1. Reproductive anatomy and physiology of Mare.
2. Reproductive anatomy and physiology Stallion.
3. Estrous cycle, manipulation of estrus in Mare.
4. Broodmare management.
5. Use of ultrasound in breeding management.
6. Infertility in Mare and it's management.
7. Pregnancy diagnosis.
8. Management of the pregnant mare.
9. Fetal development.
10. Abortion.
11. Parturition, induced parturition.
12. Management of dystocia.
13. Neonatal management.
14. Common neonatal diseases, orphan foal management.
15. Foal management during the first six months.
16. Semen collection.
17. Semen preservation.
18. Artificial insemination.
19. Embryo transfer.

Practicals

1. Visit of equine/ stud farm.
2. Overall management of an equine breeding program.
3. Handling the cases of reproductive disorders.
4. Artificial insemination.
5. Semen collection.
6. Semen preservation.
7. Breeding record keeping and analysis.

VGO 612: Camel Reproduction (2+1)

Theory Lectures

1. Male reproductive organs, male reproductive physiology.
2. Sexual behavior, puberty and sexual mamturity.
3. Seasonal changes and copulation.
4. Semen collection and it's characteristics.
5. Female reproductive organs, female reproductive physiology.

6. Sexual behavior, oestrous cycle, signs of oestrus.
7. Pregnancy and foetal development.
8. Pregnancy diagnosis.
9. Parturition.
10. Age of sexual maturity, breeding season.
11. Conception rate, calving interval, reproductive longevity.
12. Early embryonic mortality, reproductive problems in the female.
13. Reproductive problems in the male.
14. Artificial insemination.
15. Nutrition and reproduction.
16. Embryo transfer in camel.

Practicals

1. Management of dystocia in clinical cases.
2. Castration and ovariohystrectomy.
3. Caesarean section.
4. Surgical procedure related to reproductive disorders in both male and females.

VGO 613: Elephant Reproduction (2+1)

Theory Lectures

1. General introduction, Elephas maximus, domestic and wild elephants.
2. Male genital system, accessory sex glands.
3. Spermatogenesis and hormonal control.
4. Semen characteristics.
5. Female reproductive system, ovaries, fallopian tubes, uterus, vagina and external genitalia.
6. Oestrous cycle, hormonal regulation of estrous cycle.
7. Mating behaviour and act of copulation.
8. Pregnancy, gestation length.
9. Parturition.
10. Neonatal care of elephant calves.
11. Musth in elephants, bahavioural patterns, pre-musth, violent-musth and post-musth phases.
12. Controlling elephants in musth using drugs/ hormones, anti androgens.
13. Artificial insemination.
14. Cryopreservation of gametes.

Practicals

1. Management of dystocia in clinical cases.
2. Surgical procedure related to reproductive disorders in both male and females.

VGO 614: Wild and Zoo Animal Reproduction (2+1)

Theory Lectures

1. Introduction to reproduction in wild animals.
2. Pattern of estrous cycle in tiger, deer, monkey and crocodile.
3. Optimal breeding time with emphasis on tiger, deer, monkey and crocodile.
4. Gestational length and pregnancy diagnosis in wild and zoo animals.
5. Parturition in wild and zoo animals.
6. Sexual behavior in wild and zoo animals.
7. Major reproductive disorders in wild and zoo animals.
8. Contraception techniques for deer.

Practicals

1. Management of dystocia in clinical cases.
2. Castration in wild and zoo animals.
3. Observation of estrus behavior.
4. Pregnancy diagnosis.
5. Surgical procedure related to reproductive disorders in both male and females.

VGO 615: Porcine Reproduction (2+1)

Theory Lectures

1. Anatomy and physiology of Boar
2. Anatomy and physiology of Sow.
3. Oestrus cycle, manipulation of oestrus cycle in sow.
4. Methods for detection of oestrus.
5. Endocrinology of pregnancy.
6. Endocrinology of parturition.
7. Infertility in sow and its management.
8. Pregnancy diagnosis and management of pregnant sow.
9. Fetal development.
10. Abortion and induced parturition.
11. Parturition and its stages.
12. Dystocia in Sow.
13. Mastitis-metritis complex in sow.
14. Neonatal management and common neonatal diseases, care of piglets.
15. Breeding boar selection and management.
16. Semen collection and preservation.
17. Natural service and artificial insemination.
18. Embryo transfer and IVF.

Practicals

1. Visit and record keeping of swine farm.
2. Breeding management in sows.
3. Handling the cases of reproductive disorders.
4. Caesarean section and castration.

5. Sexual behaviour and vaginal cytology.
6. Pregnancy diagnosis in Sow.
7. Semen collection, semen preservation and artificial insemination.
8. Embryo transfer in Sow.

VGO 616: Ultrasonography in Animal Reproduction (1+2)

Theory Lectures

1. Basic principle of ultrasonography, physics of ultrasonography, A-mode, B-mode and M-mode Ultrasonography. Artifacts and principle of Doppler ultrasonography.
2. Trans-abdominal and transrectal ultrasonography.
3. Follicular dynamics and luteal characteristics in large and small ruminants, luteal blood flow studies.
4. Use of ultrasonography in pregnancy diagnosis and infertility management.
5. Studies on uterine involution, luteal cyst and follicular cyst, blood flow studies in uterine and foetal arteries ultrasonography.
6. Determination of gestational age in small animals by measuring gestational sac diameter, crown rump length and body diameter. Detection of foetal resorption and mummification.
7. Prediction of parturition time, fetal viability by detecting fetal heart rate, foetal number and sex determination.
8. Testicular and male accessory sex gland ultrasonography.

Practicals

1. Practicing trans-abdominal and trans-rectal ultrasonography.
2. Use of ultrasonography in follicular dynamics study.
3. Use of ultrasonography in luteal characteristics study.
4. Use of ultrasonography in pregnancy diagnosis.
5. Prediction of parturition time using ultrasonography.
6. Use of ultrasonography in diagnosis of clinical cases associated with reproductive disorders in females.
7. Testicular studies using ultrasonography.
8. Male accessory sex gland studies using ultrasonography
9. Use of ultrasonography in diagnosis of clinical cases associated with reproductive disorders in male.

Course Contents
Ph.D. in Animal Reproduction Gynaecology and Obstetrics

I. **Course Title : Advances in Gynaecology and Infertility Management**

II. **Course Code : VGO 701**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To learn about advances in endocrine, ovarian and uterine functions and effect of nutrition, season and immunological factors on female fertility.

V. **Theory**

Unit I

Neuro-endocrine control of reproduction, follicular development, ovulation fertilization and implantation. Embryonic and fetal development.

Unit II

Maternal recognition of pregnancy advances in early diagnosis of pregnancy.

Unit III

Embryonic losses, abortion and their prevention.

Unit IV

Seasonal breeders, Synchronization and induction of estrus and ovulation in seasonal breeders, Assisted Reproductive Technology (ART) to increase reproductive efficiency in farm animals.

Unit V

Effect of stress, nutrition and immunological factors on fertility.

Unit VI

Onset of postpartum ovarian activity and factors affecting it.

Unit VI

Diagnostic and therapeutic approaches in infertility; principles of hormone therapy in reproductive disorders, laparoscopy, ultrasonographic diagnosis of ovarian/ uterine dysfunction, reproductive disorders, vaginal and uterine cytology.

VI. **Practical**

Clinical examination of female animals. Use of ultrasonography in ovarian function (follicular image pattern, follicular dynamics) and in early pregnancy diagnosis and infertility. Utility of uterine culture, uterine cytology and uterine biopsy (histopathological examination) in infertility investigation. Laparoscopy in diagnosis of ovarian and uterine dysfunction. ELISA/ RIA of hormones and interpretation of results. Use of assisted reproductive technology (ART) to enhance reproductive efficiency in farm animals.

VII. **Suggested Reading**

- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- Mauricio Pineda and Michael P Dooley. 2008. *McDonald's Veterinary Endocrinology* and Wiley-Blackwell.
- David Noakes, Timothy Parkinson and Gary England. 2018. *Veterinary Reproduction and Obstetrics*. Saunders Ltd.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Selected articles from journals.

I. **Course Title : Advances in Veterinary Obstetrics**

II. **Course Code : VGO 702**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To learn current developments in diagnosis and management of dystocia, accidents of gestation and peri-parturient disorders in domestic animals.

V. **Theory**

Unit I

Conceptus and its development. Factors influencing gestation period and birth weight.

Unit II

Anomalies of conceptus, teratogens and effect of stress on conceptus development.

Unit III

Mechanism of initiation of parturition. Use of tocolytic drugs.

Unit IV

Induction of parturition and termination of abnormal pregnancies. Obstetrical analgesia and anesthesia.

Unit V

Pre-treatment evaluation of the dam suffering from dystocia. Management of maternal and fetal dystocia, hydrallantois, hydramnion, fetal mummification, fetal maceration, uterine inertia and uterine torsion.

Unit VI

Fetotomy, caesarean section and ovairo-hysterectomy. Retention of fetal membranes and management.

Unit VII

Neo-natal physiology and post-natal adaptations. Assessment of

neonatal viability, care of the newborn.

Unit VIII

Involution of uterus, post-partum ovarian dysfunction and their manipulation. Care of the postpartum dam.

VI. Practical

Obstetrical operations in fetal dystocia; mutations, fetotomy, cesarean section, ovario-hysterectomy; induction of parturition, obstetrical analgesia and anaesthesia.

VII. Suggested Reading

- David Noakes, Timothy Parkinson and Gary England. 2018. *Veterinary Reproduction and Obstetrics*. Saunders Ltd.
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
- Sloss V and Dufty JH. 1980. *Handbook of Bovine Obstetrics*. Williams and Wilkins.
- Selected articles from journals.

I. Course Title : Advances in Andrology and Male Infertility

II. Course Code : VGO 703

III. Credit Hours : 2+1

IV. Aim of the course

To learn advances in male reproduction and treatment of male infertility in domestic animals.

V. Theory

Unit I

Spermatogenesis, Spermatogenic waves, Sperm passage in male genitalia, biochemical milieu of male genitalia. Correlation between motility and fertilizing capacity of spermatozoa. Seminiferous eipithelial cycle, Theory of sperm motility and ultrastructure of sperm. Sperm passage in female reproductive tract; capacitation and acrosome reaction.

Unit II

Separation of motile and immotile spermatozoa.

Unit III

Sperm plasma membrane and its permeability and binding properties: acrosome and lysosomal enzymes, sperm nucleus and nuclear proteins. Mitochondria and their role in sperm metabolism. Flagellum and the mechanochemical basis of motility and cyclic nucleotides.

Unit IV

Biochemistry of seminal plasma and accessory sex gland secretions. Electrolytes, proteins, Enzymes and amino acids in seminal plasma. Fructose and other sugars, Lipids, Cholesterol,

Steroid hormones and Prostaglandins in seminal plasma.

Unit V

Fructolysis index. Aerobic and anaerobic metabolism of spermatozoa.

Unit VI

Markers of fertility in males, sperm chromatin structure assay, Anti- sperm antibodies. Karyotyping to identify sperm defect and DNA mapping for parentage.

VI. **Practical**

Breeding soundness evaluation of bulls, biochemical tests of semen for evaluation of fertility, semen culture for diagnosis of venereal diseases, diagnosis and treatment of genital pathological condition. Computer assisted semen analysis (CASA), Semen evaluation for assessment of fertilizing capacity of spermatozoa: cervical mucus penetration test, sperm capacitation test, hypo osmotic swelling test and zona free hamster egg penetration test. Anti-sperm antibody assay. Collection of preputial washings and semen for bacterial load and venereal pathogens.

VII. **Suggested Reading**

- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- Enos Johnson Perry. 2013. *Artificial Insemination of Farm Animals*. Jodhpur: Axis Books (India).
- Roberts SJ. 2005. *Veterinary Obstetrics and Genital Diseases*. Scientific Book Agency.
- Selected articles from journals.

I. **Course Title : Reproductive Biotechnology**

II. **Course Code : VGO 704**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To learn advances and recent developments in biotechnology in reproduction forthe production of desired elite animals.

V. **Theory**

Unit I

Micromanipulation, Intracytoplasmic Sperm Injection (ICSI), Sexing of embryos.

Unit II

Stem cell biotechnology, Semen sorting for production of sexed semen.

Unit III

Cloning, Biopharming, Transgenic Animals and Chimeras.

Unit IV

Transgenic animals and chimeras. Gene expression in oocyte and embryo, Identification of cellular organelles of Gamete.

Unit V

Principle and application of PCR technique in animal reproduction.

VI. **Practical**

Micromanipulation of embryos, Sexing of embryos, Stem cell production.

VII. **Suggested Reading**

- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- B Singh, SK Gautam and MS Chauhan. 2012. *Textbook of Animal Biotechnology*, Pearson Education.
- Heiner Niemann, Christine Wrenzycki. 2018. *Animal Biotechnology 1: Reproductive Biotechnologies*. Springer.
- Heiner Niemann, Christine Wrenzycki. 2018. *Animal Biotechnology* 2. Springer International Publishing AG.
- Ian Gordon. 2017. *Reproductive Technologies in Farm Animals*. Wallingford, Oxfordshire CABI.
- Troy L Ott, Zhihua Jiang. 2010. *Reproductive Genomics in Domestic Animals*. John Wiley.
- Marcelo Marcondes Seneda, Katia Cristina Silva-Santos, LS Rafagnin Marinho. 2016. *Biotechnology of Animal Reproduction*, Nova Science Pub. Inc; UK Ed.
- Tacia Gomes Bergstein-Galan. 2018. *Reproduction Biotechnology in farm animals*. Avid Science.
- Selected articles from journals.

I. **Course Title : Semenology**

II. **Course Code : VGO 705**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To learn advances in processing and cryopreservation of semen and insemination techniques to obtain high fertility.

V. **Theory**

Unit I

Contribution of gonads and accessory sex glands to semen ejaculate. Factors affecting semen production. Morphology of sperm and their defects. Biochemical composition of semen.

Unit II

Metabolism of sperm. Role of seminal plasma proteins. Species variation in seminal characteristics. Factors affecting motility and fertilizing capacity of spermatozoa.

Unit III

Use of semen additives and activators. Sperm cryodamage, Commercial extenders used for bovine semen. Microbial contamination of semen and measures for its prevention. Transmission of venereal diseases through semen and their prevention.

Unit IV

Thawing protocols for frozen semen. Post-thaw evaluation of motility and fertilizing capacity of spermatozoa. Quality control and quality assurance of semen, antisperm antibodies. Flow cytometric assessment of sperm quality.

Unit V

Sperm vitrification, freeze drying of sperm and sperm encapsulation.

Unit VI

Criteria for gradation of semen stations.

VI. Practical

Semen evaluation. Estimation of bacterial load and enzymes in semen. Morphological defects of sperm. *In-vitro* tests for sperm function i.e. BCMPT, HOST, etc. Physical and enzymatic changes in semen following cryopreservation. Tests to assess acrosomal integrity, Mitochondrial activity, DNA damage, binding assays, etc. Fluorescent probe based assessment of sperm quality. Comet assay, Sperm chromatin structure assay, TUNEL assay.

VII. Suggested Reading

- Salisbury GW, VanDemark NL and Lodge JR. 1978. *Physiology of Reproduction and Artificial Insemination of Cattle*. WH Freeman and Co.
- Hafez ESE and B Hafez. 2013. *Reproduction in Farm Animals*. Wiley-Blackwell.
- Selected articles from journals.

I. Course Title : Clinical Practice-I

II. Course Code : VGO 706

III. Credit Hours : 0+3

IV. Aim of the course

Hands-on training on diagnosis and treatment of reproductive disorders in animals

V. Practical

Clinical examination of animals affected with reproductive disorders, use of diagnostic techniques for diagnosis and institution of required therapy. Acquaintance with different equipment used for handling reproductive disorders, client management, public relations, code of conduct, database management, Maintenance of case records.

VI. **Suggested Reading**

- Morrow DA. 1986. *Current Therapy in Theriogenology.* WB Saunders.
- Zemjanis R. 1970. *Diagnostic and Therapeutic Techniques in Animal Reproduction*. Williams and Wilkins; Second Edition.
- Selected articles from journals.

Course Title: Clinical Practice-II

I. **Course Code : VGO 707**

II. **Credit Hours : 0+3**

III. **Aim of the course**

Hands-on training on diagnosis and treatment of reproductive disorders in animals.

IV. **Practical**

Clinical examination of animals affected with reproductive disorders, use of diagnostic techniques for diagnosis and institution of required therapy. Acquaintance with different equipment used for handling reproductive disorders, client management, public relations, code of conduct, database management, Maintenance of case records.

V. **Suggested Reading**

- Morrow DA. 1986. *Current Therapy in Theriogenology*. WB Saunders.
- Zemjanis R. 1970. *Diagnostic and Therapeutic Techniques in Animal Reproduction*. Williams and Wilkins; Second Edition.
- Selected articles from journals.

I. **Course Code : VGO 790**

II. **Course Title : Special Problem**

III. **Credit Hours : 0+2**

V. **Aim of the course**

To expose students to research techniques related to sub discipline of the subject and submission of written project with references.

VI. **Practical**

Student will carry out research on allotted project and submit the project report.

VGO 791 DOCTORAL SEMINAR-I 1+0
VGO 792 DOCTORAL SEMINAR-II 1+0
VGO 799 DOCTORALRESEARCH 0+75

Course Outline: Lecture wise

VGO 701: Advances in Gynaecology and Infertility Management (2+1)
Theory Lectures

1. Neuro-endocrine control of reproduction.
2. Follicular development.
3. Ovulation, fertilization and implantation.
4. Embryonic and fetal development.
5. Maternal recognition of pregnancy.
6. Advances in early diagnosis of pregnancy.
7. Embryonic losses, abortion and their prevention.
8. Seasonal breeders, synchronization and induction of estrus and ovulation in seasonal breeders.
9. Assisted reproductive technology (ART) to increase reproductive efficiency in farm animals.
10. Effect of stress and nutritional factors on fertility.
11. Effect of immunological factors on fertility.
12. Onset of postpartum ovarian activity and factors affecting it.
13. Diagnostic and therapeutic approaches in infertility.
14. Principles of hormone therapy in reproductive disorders.
15. Laproscopy.
16. Ultrasonographic diagnosis of ovarian/ uterine dysfunction.
17. Vaginal and uterine cytology.

Practicals

1. Clinical examination of female animals for reproductive soundness.
2. Use of ultrasonography in ovarian function (follicular image pattern, follicular dynamics).
3. Use of ultrasonography in early pregnancy diagnosis.
4. Use of ultrasonography in infertility management.
5. Uterine culture, uterine cytology and uterine biopsy (histopathological examination) in infertility investigation.
6. Laparoscopy in diagnosis of ovarian and uterine dysfunction.
7. Use of ELISA/ RIA in reproductive parameters study and interpretation of results.
8. Use of Assisted reproductive technology (ART) to enhance reproductive efficiency in farm animals.

VGO 702: Advances in Veterinary Obstetrics (1+1)
Theory Lectures

1. Conceptus and its development.
2. Factors influencing gestation period and birth weight.
3. Anomalies of conceptus, teratogens and effect of stress on conceptus development.
4. Mechanism of initiation of parturition. Use of tocolytic drugs.
5. Induction of parturition and termination of abnormal pregnancies.
6. Pre-treatment evaluation of the dam suffering from dystocia. Obstetrical analgesia and anesthesia.
7. Management of maternal and fetal dystocia, hydrallantois, hydramnion, fetal mummification, fetal maceration, uterine inertia and uterine torsion.
8. Fetotomy, caesarean section and ovaro-hysterectomy.
9. Retention of fetal membranes and management.
10. Neo-natal physiology and post-natal adaptations. Assessment of neonatal viability, care of the newborn.
11. Involution of uterus, post-partum ovarian dysfunction and their manipulation. Care of the postpartum dam.

Practicals

1. Performing obstetrical operations.
2. Performing obstetrical mutations.
3. Fetotomy.
4. Cesarean section and ovario-hysterectomy.
5. Induction of parturition.
6. Obstetrical analgesia and anaesthesia.

VGO 703: Advances in Andrology and Male Infertility (2+1)

Theory Lectures

1. Spermatogenesis and spermatogenic waves.
2. Sperm passage in male genitalia, biochemical milieu of male genitalia.
3. Correlation between motility and fertilizing capacity of spermatozoa.
4. Seminiferous eipithelial cycle, theory of sperm motility and ultrastructure of sperm.
5. Sperm passage in female reproductive tract; capacitation and acrosome reaction.
6. Separation of motile and immotile spermatozoa.
7. Sperm plasma membrane and its permeability and binding properties: acrosome and lysosomal enzymes, sperm nucleus and nuclear proteins.
8. Mitochondria and their role in sperm metabolism.
9. Flagellum and the mechanochemical basis of motility and cyclic nucleotides.

10. Biochemistry of seminal plasma and accessory sex gland secretions.
11. Electrolytes, proteins, enzymes and amino acids in seminal plasma. Fructose and other sugars, lipids, cholesterol, steroid hormones and prostaglandins in seminal plasma.
12. Fructolysis index. Aerobic and anaerobic metabolism of spermatozoa.
13. Markers of fertility in males.
14. Sperm chromatin structure assay.
15. Anti-sperm antibodies.
16. Karyotyping to identify sperm defect and DNA mapping for parentage.

Practicals

1. Breeding soundness evaluation of bulls.
2. Biochemical tests of semen for evaluation of fertility.
3. Semen culture for diagnosis of venereal diseases.
4. Diagnosis and treatment of genital pathological condition.
5. Studies on sperm motility using Computer assisted semen analysis (CASA).
6. Cervical mucus penetration test, sperm capacitation test and hypo-osmotic swelling test.
7. Zona free hamster egg penetration test.
8. Anti-sperm antibody assay.
9. Collection of preputial washings and semen for bacterial load and venereal pathogens.

VGO 704: Reproductive Biotechnology (1+1)

Theory Lectures

1. Micromanipulation and Intracytoplasmic sperm injection (ICSI).
2. Sexing of embryos.
3. Stem cell biotechnology.
4. Semen sorting for production of sexed semen.
5. Cloning and biopharming.
6. Transgenic animals and chimeras.
7. Gene expression in oocyte and embryo, identification of cellular organelles of Gamete.
8. Principle and application of PCR technique in animal reproduction.

Practicals

1. Micromanipulation of embryos.
2. Sexing of embryos.
3. Stem cell production.

VGO 705: Semenology (1+1)

Theory Lectures

1. Contribution of gonads and accessory sex glands to semen

ejaculate. Factors affecting semen production.

2. Morphology of sperm and their defects. Biochemical composition of semen.
3. Metabolism of sperm. Role of seminal plasma proteins. Species variation in seminal characteristics.
4. Factors affecting motility and fertilizing capacity of spermatozoa. Commercial extenders used for bovine semen.
5. Use of semen additives and activators. Sperm cryodamage.
6. Microbial contamination of semen and measures for its prevention. Transmission of venereal diseases through semen and their prevention.
7. Thawing protocols for frozen semen. Post-thaw evaluation of motility and fertilizing capacity of spermatozoa.
8. Quality control and quality assurance of semen.
9. Antisperm antibodies assay.
10. Flow cytometric assessment of sperm quality.
11. Sperm vitrification, freeze drying of sperm and sperm encapsulation.
12. Criteria for gradation of semen stations.

Practicals

1. Semen evaluation for its quality.
2. Estimation of bacterial load in semen.
3. Estimation of enzymes in the semen.
4. *In-vitro* tests for sperm function i.e. BCMPT, HOST, etc.
5. Tests to assess acrosomal integrity, mitochondrial activity and DNA damage.
6. Tests to assess binding assays.
7. Fluorescent probe based assessment of sperm quality.
8. Comet assay, Sperm chromatin structure assay, TUNEL assay.

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Animal Reproduction Gynaecology and Obstetrics

General Gynaecology (VGO 601):

Unit I: Functional anatomy, puberty and sexual maturity, Role of hypothalamic-pituitary gonadal axis in attainment of puberty and sexual maturity, Endocrine regulation of estrous cycle. Role of pineal gland, endogenous opioids and neuropeptides in reproduction.

Unit II: Folliculogenesis, Oogenesis and ovulation and associated endocrine pattern, manipulation of follicular waves, Synchronization of estrus and ovulation and induction of ovarian activity.

Unit III: Gamete transport, Fertilization, Implantation and maternal recognition of pregnancy.

Unit IV: Embryonic and fetal development, Placentation, Fetal circulation and gestation, position of fetus in the uterus, age characteristics of fetus.

Unit V: Pregnancy diagnosis: Clinical, Ultrasonographic, Endocrinological and other diagnostic laboratory tests.

Unit VI: Lactation and artificial induction of lactation.

Female Infertility in Farm Animals (VGO 602):

Unit I: Introduction to infertility, classification, economic impact. Anatomical causes of infertility, congenital and hereditary causes and acquired defects.

Unit II: Nutritional causes of infertility. Importance of body condition score. Negative energy balance, its prevention and amelioration.

Unit III: Managemental and environmental causes of infertility. Out of season breeding.

Unit IV: Infectious causes of female infertility, Specific and non-specific infections; It's diagnosis, treatment, prevention and control.

Unit V: Ovarian dysfunction; Anoestrus, Cystic ovarian degeneration, Anovulation, Delayed ovulation and luteal insufficiency; causes, diagnosis and treatment.

Unit VI: Repeat breeding; its causes, diagnosis and treatment.

Unit VII: Early embryonic death (EED); it's causes, Diagnosis and therapeutic management.

Unit VIII: Abortion; causes, diagnosis and prevention of abortion.

Unit IX: Interactions in immunological mechanisms and infertility.

Veterinary Obstetrics (VGO 603):

Unit I: Parturition; stages of parturition, Mechanism of initiation of parturition, Hormonal profiles associated with parturition, Transition cow, Onset of postpartum ovarian activity.

Unit II: Principles of handling of dystocia, Obstetrical procedures: Mutations, Fetotomy, caesarean section. Obstetrical anaesthesia and analgesia, epidural anaesthesia.

Unit III: Fetal and maternal dystocia; causes, diagnosis and management.

Unit IV: Uterine torsion; causes, diagnosis and its correction. Caesarean section, anaesthesia for caesarean section, ovariohysterectomy.
Unit V: Diseases and accidents during gestation and around parturition.
Unit VI: Etiology, diagnosis and treatment of ante-partum and post-partum uterine and vaginal prolapse.
Unit VII: Induction of parturition and elective termination of pregnancy.
Unit VIII: Involution of uterus following normal and abnormal parturition.
Unit IX: Care of dam and the new born.

Andrology and Male Infertility (VGO 604):

Unit I: Structure and function of reproductive tract of male.
Unit II: Sexual behavior and examination of bulls for breeding soundness.
Unit III: Spermatogenesis, Seminiferous epithelial cycle, Spermatogonial wave, Structure of spermatozoa, Semen and its composition. Mechanism of sperm motility.
Unit IV: Diseases transmitted through semen. Factors affecting semen quality, semen culture, tests for assessment of sperm motility, sperm survival and fertilizing capacity of spermatozoa.
Unit V: Causes of infertility; hereditary, congenital, infectious, nutritional and hormonal. Pathological and functional disturbances of epididymis, vas deferens and accessory sex glands.
Unit VI: Impotentia coeundi and Impotentia generandi. Testicular hypoplasia and degeneration; causes and effect on semen and fertility. Coital injuries and vices of male animals.
Unit VII: Influence of seminal plasma proteins in modulating fertility. Heat stress and it's effect on sperm production.
Unit VIII: Screening of the breeding bulls to be selected for semen collection.

Semen Preservation and Artificial Insemination (VGO 605) :

Unit I: History of artificial insemination. Methods of semen collection.
Unit II: Semen evaluation; macroscopic, microscopic, biochemical and microbiological tests.
Unit III: Semen preservation. Extenders for preservation of semen at different temperatures. Semen additives for enhancement of motility and fertilizing capacity of spermatozoa. Dilution of semen.
Unit IV: Cryopreservation of semen. Effect of cryopreservation on spermatozoa, semen quality and fertility. Liquid Nitrogen (LN2) cylinders; it's handling, care and maintenance.
Unit V: Thawing protocols of frozen semen. Factors affecting post-thaw semen quality.
Unit VI: Ideal protocol for AI in different species of animals. Factors affecting success of AI.
Unit VII: Biosecurity and biosafety guidelines for frozen semen stations, semen processing laboratories and quarantine stations. Minimum standards and standard operating procedures for artificial insemination, Quality testing of straws

and sheath for use in artificial insemination.

Basics of Reproductive Biotechnology (VGO 606):

Unit I: Embryo transfer technology: selection of donors and recipients.

Unit II: Synchronization, super-ovulation, surgical and non-surgical collection of embryos and evaluation of embryos.

Unit III: Cryopreservation of embryos, transfer of embryos to donors. Sexed semen production, sexing of embryos. Guidelines for export and import of bovine germplasm. Guidelines and standards regarding embryo production.

Unit IV: In-vitro culture of granulosa cells, cumulus cells, luteal cells and oviductal cells. Recovery of bovine oocytes; from abattoir ovaries and live animals, in vitro fertilization, in-vitro maturation, micromanipulation of embryos.

Unit V: Immuno-neutralization of hormones. Immunomodulation of fertility.

Canine and Feline Reproduction (VGO 609):

Unit I: Development of reproductive system. Anatomy of male and female reproductive system. Canine and feline estrous cycle, endocrinology of estrous cycle.

Unit II: Breeding management, pregnancy, pregnancy diagnosis; clinical, ultrasonographic, endocrinological and other diagnostic laboratory tests.

Unit III: Parturition, fetal and maternal dystocia; causes, diagnosis and management. Induction of parturition and caesarean section, periparturient disorders.

Unit IV: Medical termination of pregnancy in dogs and cats, management of pseudopregnancy, pyometra and it's management. Infertility and it's management in dogs and cats.

Unit V: Postpartum care of dam and lactation. Neonatal care.

Unit VI: Population control in dogs; surgical and non-surgical methods.

Unit VII: Reproductive physiology of male dogs, semen collection techniques, semen evaluation, freezing of semen, artificial insemination techniques, male reproductive disorders and it's management.

Caprine and Ovine Reproduction (VGO 610): Estrous cycle, endocrinology of estrous cycle, Seasonal breeding activity in sheep and goat, Artificial control of oestrus in sheep and goat. Infertility and its management in small ruminants.

Equine Reproduction (VGO 611): Estrous cycle, Manipulation of estrus in the mare, Infertility and its management in mare.

Camel Reproduction (VGO 612): Female reproductive physiology and sexual behavior, oestrous cycle, external signs of oestrus

Porcine Reproduction (VGO 615): Oestrus cycle in sow, manipulation of oestrus cycle, methods for detection of oestrus, endocrinology of pregnancy and parturition. Infertility in sow and its management. Neonatal management and common neonatal diseases, care of piglets.

Ultrasonography in Animal Reproduction (VGO 616): Basic principle of ultrasonography, physics of ultrasonography, A-mode, B-mode and M-mode ultrasonography, artifacts, principle of Doppler ultrasonography Trans-abdominal

ultrasonography, transrectal ultrasonography, follicular dynamics and luteal characteristics in large and small ruminants, luteal blood flow studies. Use of ultrasonography in pregnancy diagnosis, infertility management, uterine involution, luteal cyst and follicular cyst, blood flow studies in uterine and foetal arteries. Determination of gestational age in small animals by measuring gestational sac diameter, crown rump length and body diameter. Detection of foetal resorption and mummification. Prediction of parturition time, fetal viability by detecting fetal heart rate, foetal number and sex determination.

Veterinary Surgery and Radiology

DEPARTMENT OF VETERINARY SURGERY AND RADIOLOGY
Course Structure for M.V.Sc. degree programme (Semester Wise)

Course No.	Course Title	Credit	Semester
VSR 601*	CLINICAL PRACTICE-I	0+3	I
VSR 602*	CLINICAL PRACTICE-II	0+3	II
VSR 603*	PRINCIPLES OF SURGERY	2+1	I
VSR 604*	ANAESTHESIA AND ANALGESIA	2+1	II
VSR 605*	DIAGNOSTIC IMAGING TECHNIQUES	2+1	I
VSR 606	SOFT TISSUE SURGERY	2+1	II
VSR 607*	ORTHOPAEDIC SURGERY	2+1	I
VSR 608	ANAESTHESIA OF ZOO, WILD, EXOTIC AND LABORATORY ANIMALS	1+1	II
VSR 609	UROGENITAL SURGERY	1+1	I
VSR 610	OPHTHALMOLOGY	1+1	II
VSR 611	DENTISTRY AND ORAL SURGERY	1+1	I
VSR 612	CAMEL SURGERY	1+1	II
VSR 613	ELEPHANT SURGERY	1+1	I
VSR 687*	CLINICAL CASE CONFERENCE	0+1	I and II
VSR 688	SPECIAL PROBLEM IN RADIOLOGY	0+2	I and II
VSR 689	SPECIAL PROBLEM IN ANAESTHESIA	0+2	I and II
VSR 690	SPECIAL PROBLEM IN SURGERY	0+2	I and II
VSR 691	MASTERS SEMINAR	1+0	I and II
VSR 699	MASTERS RESEARCH	0+30	I and II
*Compulsory Courses			

DEPARTMENT OF VETERINARY SURGERY AND RADIOLOGY
Course Structure for PhD degree programme (Semester Wise)

Course No.	Course Title	Credit	Semester
VSR 701*	CLINICAL PRACTICE-I	0+2	I
VSR 702*	CLINICAL PRACTICE-II	0+2	II
VSR 703*	CLINICAL PRACTICE-III	0+2	I
VSR 704	CARDIOVASCULAR SURGERY	2+1	II
VSR 705	ADVANCES IN ANAESTHESIOLOGY	2+1	I
VSR 706	ADVANCES IN RADIOLOGY	2+1	II
VSR 707	ADVANCES IN DIAGNOSTIC IMAGING TECHNIQUES	2+1	I
VSR 708	ADVANCES IN ORTHOPAEDICS	2+1	II
VSR 709	NEUROSURGERY	2+1	I
VSR 710	RECONSTRUCTIVE AND REGENERATIVE SURGERY	1+1	II
VSR 711	ADVANCES IN SOFT TISSUE SURGERY	2+1	I
VSR 712	ADVANCES IN OPHTHALMOLOGY	1+1	II
VSR 713	SURGICAL ONCOLOGY	1+1	I
VSR 787*	CLINICAL CASE CONFERENCE	0+1	I and II
VSR 788	SPECIAL PROBLEM IN DIAGNOSTIC IMAGING	0+2	I and II
VSR 789	SPECIAL PROBLEM IN ANAESTHESIA	0+2	I and II
VSR 790	SPECIAL PROBLEM IN SURGERY	0+2	I and II
VSR 791	DOCTORAL SEMINAR	1+0	I and II
VSR 792	DOCTORAL SEMINAR	1+0	I and II
VSR 799	DOCTORAL RESEARCH	0+75	I and II
* Core/ Compulsory Courses			

Course Contents
M.V.Sc. in Veterinary Surgery and Radiology

I. **Course Title : Clinical Practice-I**
II. **Course Code : VSR 601**
III. **Credit Hours : 0+3**
IV. **Aim of the course**

To learn techniques and procedures in anaesthesia, diagnostic imaging techniques and surgery

V. **Practical**

Basic requirements and designing surgical and general veterinary hospital, Developing different proformas required in hospital facility, Assessing surgical patients and documentation, Preparation of surgical team and duties of team members, Surgical suite maintenance and sterilization, Acquaintance with different equipment like inhalant anaesthesia machine, Radiography systems, Ultrasonography, Endoscopy, Electro-surgery, Cryosurgery and physiotherapy equipment, Client management, Public relations, code of conduct, Management of surgical affections, Hospital database management, Attending surgical cases, Disaster management.

I. **Course Title : Clinical Practice-II**
II. **Course Code : VSR 602**
III. **Credit Hours : 0+3**
IV. **Aim of the course**

To learn techniques and procedures in anaesthesia, diagnostic imaging techniques and surgery

V. **Practical**

Application of different equipment like inhalant anaesthesia machine, Computerized radiography system, Ultrasonography, Electro-surgery, Cryosurgery, Physiotherapy and endoscopy and Physiotherapy equipment, Client management and Counselling, public relations, Code of conduct, Management of surgical affections, Hospital management, Database management, Attending surgical cases, Disaster management.

I. **Course Title : Principles of Surgery**
II. **Course Code : VSR 603**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To learn basic and advance principles and standards of practice in

veterinary surgery

V. **Theory**

Unit I

Classification of wounds, wound healing, mechanism of wound repair, local and systemic factors affecting wound healing, current concepts of inflammation and management, thermal, electrical and chemical injuries and their management.

Unit II

Asepsis, sterilization and disinfection and principles and practice of antimicrobial therapy in surgical patients.

Unit III

Shock, classification, pathophysiology, diagnosis, treatment and monitoring, surgical stress and its systemic effects, haemorrhage and haemostasis, acid-base balance, fluid therapy and blood transfusion, metabolism of the surgical patient.

Unit IV

Principles and clinical applications of laser surgery, cryosurgery, electrosurgery, physiotherapy.

Unit V

Minimally invasive surgical procedures which includes laproscopy and endoscopy, principles of microscopic surgery-vessel and nerve anastomosis, application of computers in surgery.

VI. **Practical**

Identification and handling of surgical instruments, preparation of surgical pack, surgical team and surgical patients, surgical facilities and equipment, introduction to clinical skill laboratory, practice of different suturing patterns and repair of different wounds, using drains, bandages and bandaging techniques, monitoring of traumatized surgical patient, operation theatre conduct.

I. **Course Title : Anaesthesia And Analgesia**

II. **Course Code : VSR 604**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To gain the basic and practical knowledge of principals of companion and farm animals anaesthesia and pain management

V. **Theory**

Unit I

Introduction and history of anaesthesia, General consideration for anaesthesia in animals, Properties of ideal anaesthetic agent, Types of anaesthesia, Anaesthetic triad, Preanaesthetic evaluation of patient and selection of anaesthesia.

Unit II

Preanaesthetic medication (anticholinergics, sedatives, tranquilizers, alpha-2 agonist, narcotics), Muscle relaxants and neuromuscular blocking agents.

Unit III

General anaesthetics and factors affecting their uptake, Distribution and metabolism; Injectable anaesthetic agents (properties, dosage and usage); Combinations of injectable agents and neuroleptanalgesia, Inhalation anaesthetic agents (properties, methods of administration, dosage and usages), Inhalation anaesthesia equipment and breathing circuits, artificial ventilation.

Unit IV

Post-operative care of the surgical patient, operating room emergencies, cardio-pulmonary arrest and resuscitation, monitoring of anaesthetic recovery.

Unit V

Local anaesthetics, their mechanisms, local and regional nerve blocks, spinal analgesia, intravenous regional anaesthesia, peri-operative and post-operative pain and its management.

VI. **Practical**

Inhalation anaesthesia equipment, circuits and vaporizers, artificial ventilation, use of various pre-anaesthetic and anaesthetic agents in small and large animals, anaesthetic triad, balanced anaesthesia, total intravenous anaesthesia, regional and local nerve blocks using local anaesthetics, alpha-2 agonists and their combinations in domestic animals, monitoring of anaesthesia, reversal of sedation and analgesia induced by alpha-2 agonists, practice of anaesthesia in clinical cases; record keeping in anaesthesia and euthanaia.

I. **Course Title : Diagnostic Imaging Techniques**

II. **Course Code : VSR 605**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To learn the basic principles and gain practical knowledge of diagnostic imaging techniques and interpretation

V. **Theory**

Unit I

Regulations regarding establishment and handling of x-ray units. Requirements for establishment of x-ray units, conventional and digital x-ray machine, x-ray films, Cassettes, screen, x-ray production, Qualities of x-rays, Image formation and

dark room procedures, Image plate, Formation of radiograph technique chart, Artifacts and their prevention, Radiographic quality (Detail, Density and Contrast), radiographic accessories, radiographic positioning for different organs/ parts in small and large animals.

Unit II

Plain and contrast radiographic techniques of small and large animals, fluoroscopy/ C-arm, principles of radiographic interpretation.

Unit III

Principles of radiation therapy, medical radioisotope curves, radiation laws and regulations. Radiation hazards and monitoring of radiographic exposure to personnel and protection.

Unit IV

Basic physics of ultrasound waves and image formation, scanning principles of ultrasound, transducers, equipment controls, modes of display, terminology used for echotexture and USG artifacts, application of ultrasound in small and large animals.

Unit V

Doppler techniques echocardiography and its application, introduction to nuclear imaging techniques, computerized tomography, magnetic resonance imaging, positron emission tomography technique.

VI. **Practical**

Acquaintance with imaging equipment, computed radiography and digital radiography systems, dark room processing techniques and x-ray film handling, formulation of technique chart with fixed kVp and variable mAs, radiographic artefacts and their prevention, basics of radiographic interpretation of diseases, PACS, radiography positioning of different regions in domestic animals, contrast radiographic techniques, interpretation of radiographs, practice of ultrasonographic imaging and report writing.

I. **Course Title : Soft Tissue Surgery**

II. **Course Code : VSR 606**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To learn about soft tissue surgical skills and various surgical affections of different body systems in companion and farm animals

V. **Theory**

Unit I

Skin, adnexa, integument, appendages, horn, tail, sinus affections

of equine and bovine, teat affections, principles of plastic and reconstructive surgery, different types of skin grafts.

Unit II

Surgical approaches/ affections of ear, oral cavity, larynx and pharynx, salivary glands, oesophagus, abdomen, rumen, reticulum, omasum, abomasum, stomach, intestines, rectum, anus, liver and biliary system, pancreas and porto-systemic shunts.

Unit III

Abdominal hernia, diaphragmatic hernia, perineal hernia, ventral, femoral and umbilical hernia, ritcher hernia, hiatal hernia, omental hernia, pre-pubic tendon rupture, use of biological and synthetic grafts for hernia repair, laparoscopic repair of hernia.

Unit IV

Principles of thoracic surgery, Functional anatomy of respiratory system, diseases of upper and lower respiratory system, functional anatomy of cardiovascular system and common affections of heart.

Unit V

Affections of pituitary, adrenals, thyroid, parathyroid glands, Principles of neurosurgery and common surgical affections of nervous system and special sense organs.

Unit VI

Haemolymphatic system, bone marrow, spleen, tonsils, lymph nodes and lymphatics, thymus.

VII. Practical

Practice of various surgical techniques of skin and adnexa, alimentary system, hernias, respiratory system, affections of horn, tail and teat, endoscopy techniques, instrumentation, use of rigid/ flexible endoscopes in companion and farm animals.

I. **Course Title : Orthopaedic Surgery**

II. **Course Code : VSR 607**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To learn about various affections of bones, joints, tendons, ligaments and foot and their treatment in companion and farm animals.

V. **Theory**

Unit I

Bone structure and function, growth, Response to injury, Fractures and luxations, classification of fracture, Fracture healing.

Unit II

Biomechanics of fracture healing, Considerations for selection of

fixation techniques, Treatment of fractures of different bones in companion and farm animals, Diseases of bone.

Unit III

Various affections of the joints, ligaments and tendons and their treatment.

Unit IV

Spinal affections and injury to axial skeleton.

Unit V

Conformation of the limb, anatomy of hoof, anatomical, conformational and pathological causes of lameness and allied surgical conditions of fore and hind limbs, rehabilitation of orthopaedic patient.

VI. **Practical**

Application of Plaster of Paris cast, fiberglass cast, Roberts Jones bandage, modified Schroeder Thomas splint, Coaptation splint, sling application, practice of IM pinning, wiring, bone plating, inter locking nailing, external skeletal fixation, arthrotomy, tenotomy, examination of limbs for lameness, desmotomy, nerve blocks, injections in joints, operations for arthritis, hoof surgery and corrective shoeing.

I. **Course Title : Anaesthesia of Zoo, Wild, Exotic and Laboratory Animals**

II. **Course Code : VSR 608**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To learn about basic and practical knowledge of chemical immobilization, sedation and anaesthesia of laboratory animals, exotic, captive and free ranging wild animals.

V. **Theory**

Unit I

General consideration in chemical restraint of captive and free ranging wild animals, handling of birds with minimum stress, physical examination, blood sampling, crop washes, faecal sampling.

Unit II

Methods of administration of anaesthesia in captive, free ranging animals, birds and laboratory animals.

Unit III

Local and general anaesthesia in exotic species, wild animals, birds, zoo animals and laboratory animals.

Unit IV

Anaesthetic emergencies and complications.

Unit V

Diagnostic interpretation, haematology and biochemistry analysis, avian diagnostic endoscopy

VI. **Practical**

Familiarization with capture and anaesthetic equipments, local anaesthetic techniques, use of various preanaesthetic and anaesthetic agents in laboratory animals, birds, monitoring of patient during general anaesthesia, familiarization of various diseases in exotic birds like tumours, foreign body, crop stasis, crop tear, crop fistula, toe necrosis, feather cyst, excision of uropygieal gland, rhinolith, pharyngostomy, ingluviotomy, ventriculotomy and orthopedic injuries, visits to zoos and wild life sanctuaries for practical on wild and zoo animals.

I. **Course Title : Urogenital Surgery**

II. **Course Code : VSR 609**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To learn about various surgical affections of urinary and genital tract and their treatment in companion and farm animals.

V. **Theory**

Unit I

Surgical anatomy of urinary and reproductive tract in male and female animals, Congenital anomalies of organs of male and female urinary and reproductive system.

Unit II

Principles of urinary tract surgery, Pathophysiology, Diagnosis and surgical management of affections of kidney, ureter, urinary bladder and urethra, Medical dissolution and prevention of Canine uroliths, Feline urologic syndrome, Surgical management of urolithiais in ruminants and its prevention, management of uroperitoneum and renal failure.

Unit III

Pathogenesis, Clinical symptoms, Diagnosis and surgical management of vaginal and uterine prolapse, Rectovaginal fistula, Pneumovagina, Vaginal tumours, pyometra, Cysts of Gartner's canal and vestibular glands.

Unit IV

Surgical conditions of penis, Prepuce, Prostate and testicles, Cryptorchidism, Inguinal and scrotal hernia, Affections of teat and udder.

Unit V

Indications, Techniques and postoperative complications of episiotomy, Ovariectomy, ovariohysterectomy and caesarean

section, Pyometra and its surgical treatment.

Unit VI

Castration, Vasectomy, Cauda epididymectomy and penile deviation.

VI. **Practical**

Hands-on-training of techniques of centesis of urinary bladder in companion and farm animals, Different types of catheters used in urogenital surgery, Retrograde catheterization of urethra and urinary bladder, Normograde catheterization of urethra on clinical cases of urinary retention, Pudendal nerve block for penis examination in ruminants, Diagnostic techniques and surgical management of the affections of Kidney, Ureters, Urinary bladder, Urethra, Uro-hydropropulsion, Restraint and anaesthesia for urogenital tract surgery, Cystotomy, Tube cystostomy, Nephrotomy, Ureterocolostomy, Urethrotomy, Urethrostomy, Castration, Vasectomy, Penile deviation, Epididymectomy, Amputation of penis, Episiotomy, Ovariohysterectomy, Tubectomy, Caesarean section, Management of phimosis, Paraphimosis, Venereal granuloma, Vaginal and uterine prolapse, Rectovaginal fistula and pneumovagina, Bladder and uterine marsupialization.

I. **Course Title : Ophthalmology**

II. **Course Code : VSR 610**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To learn basic principles and gain practical knowledge of diagnosis and treatment of diseases of eye.

V. **Theory**

Unit I

Anatomy and physiology of eye and its adnexa, Ophthalmic examination and diagnosis, Diagnostic instrumentation, Anaesthesia and surgery.

Unit II

General consideration for eye surgery in companion and farm animals, Therapeutic agents for eye diseases and surgery of eye lids, lacrimal apparatus, naso-lacrimal duct.

Unit III

Diseases of conjunctiva, cornea, sclera, iris, orbit, lens, vitreous and aqueous humor, retina and optic nerve, eye tumours, enucleation, exenteration.

Unit IV

Ocular manifestations of systemic diseases.

Unit V

Neuro-ophthalmology and ocular emergencies

VI. **Practical**

Ophthalmic instrumentation, examination of the eye and its adnexa, anaesthesia, preparation of patient, suture materials for eye surgery, canthotomy, tarsorrhaphy, keratoplasty, anterior chamber paracentesis, flushing of naso-lacrimal duct, iridectomy, phacoemulsification and implantation of foldable lens, surgical treatment of entropion and ectropion, cherry eye, Schirmer tear test, use of fluorescein dye in corneal ulcer, glaucoma surgery, eye worm removal.

I. **Course Title : Dentistry and Oral Surgery**

II. **Course Code : VSR 611**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To learn the basic and practical knowledge of diagnosis and treatment of diseasesof teeth and oral cavity.

V. **Theory**

Unit I

Anatomy, development of teeth (odontogenesis), dentition and ageing of different species.

Unit II

Clinical examination of oral cavity, Dental anesthesia and pain management, Dental radiography.

Unit III

Diseases of oral cavity and teeth, Congenital and developmental anomalies of oral cavity, Abnormal tooth eruption, Irregular wear of teeth in companion and farm animals, occlusion and malocclusion, Mandibular fracture, Malformation of mandible, maxilla (cleft palate).

Unit IV

Acquired diseases of teeth (halitosis, dental caries, fracture of teeth, dental materials and dental radiography), Oronasal fistula, Maxilla and mandibular fractures repair, Orthodontics, Tumors and Other acquired condition of oral cavity.

Unit V

Exodontics, Restorative dentistry, Periodontal disease, Tooth extraction, Gum diseases. Endodontics, Pulpectomy, Root Canal therapy (RCT), Current techniques in dentistry.

VI. **Practical**

Oral examination, Modified triadian system of tooth numbering in various species, Dental chart for companion and farm animals, Dentistry instrumentation, Dental radiography procedure, Periodontal probing, Scaling/ teeth cleaning, Tooth extraction,

Malpractices in equine dentistry, Periodical maintenance of oral hygiene, Corrective procedures, Malocclusion, Treatment strategies congenital malformations of maxilla and mandible, oral surgery.

I. **Course Title : Camel Surgery**
II. **Course Code : VSR 612**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To learn the basic principles and gain practical knowledge of diagnosis and treatment of surgical diseases of camel.

V. **Theory**

Unit I

Introduction to special surgical anatomy of important parts, i.e. Mandible, Soft palate, Chest pad, saddle region, Male urinary system, tail, etc., Restraint and positioning for various surgical procedures and radiography of different parts.

Unit II

Use of local anaesthesia, Various nerve blocks and regional anaesthesia used to treat diverse surgical disorders, Preanaesthetics, Tranquilizers, Sedatives and general anaesthetics used for camel surgery.

Unit III

Surgical affections of head and neck region: Laceration and infected wounds of nostril skin, Infection of turbinate, Actinobacillosis, Dental affections, Removal of canines in furious camels, Torticollis, Fracture of mandible and maxilla, Soft palate injuries, Ophthalmic affections, Salivary fistula, Stenson's duct ligation, Oesophageal obstruction.

Unit IV

Surgical affections of thorax and abdominal region: Saddle gall, Hernia, Chest pad wounds and enlargements, Foreign bodies in compartment, Intestinal obstruction, Obstructive urolithiasis, Rupture of urethra, Subcutaneous infiltration of urine, Cystorrhexis.

Unit V

Surgical affections of musculo-skeletal system: diagnosis of lameness in camels, management of long bone and digital fractures, upward fixation of patella, sprains, arthritis.

Unit VI

Sheath abscess, Necrosis of penis, Phimosis, Paraphimosis, Preputial prolapse, Various types of tumours, Gangrene and tumours of udder, Necrosis of tail, Punctured foot, prolapse of digital cushion, Foot injuries, Kumri, Kapali, etc.

VI. **Practical**

Restraint and anaesthesia (Local, regional, sedation and general anaesthesia), Preparation of sites, Surgical anatomy of important surgical affections, Special instruments used for camel restraining and surgery, Observing and assisting in diverse surgical procedures on clinical cases in camels, Practice of interdental wiring for repair of mandibular fractures in specimen mandibles, Clinical and radiographic diagnosis of lameness, Protection of wounds of chest pad and foot using special bandages, Radiography of different part of camels and postoperative care of diverse surgical affections of camels.

I. **Course Title : Elephant Surgery**
II. **Course Code : VSR 613**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To learn the basic principles and gain practical knowledge of diagnosis and treatment of surgical diseases of elephant.

V. **Theory**

Unit I

Basic surgical anatomy of Asian elephants and comparison with other farm animals.

Unit II

Drug administration techniques in captive and wild elephants, Anaesthetic management of captive and wild elephants for various surgical and managerial conditions.

Unit III

Principles of soft tissue surgery in elephants, Cyst, Bursitis, Gall, Haematoma, Abscess, etc.

Unit IV

Management and treatment of fractures and arthritis in elephants.

Unit V

Pedicure, corrective foot care and maintenance of healthy feet of captive elephants housed in different establishments in different seasons.

Unit VI

Hoisting of recumbent elephants, Surgical methods of birth control in elephants, limitations and risks of abdominal surgery in elephants (eg. Caesarian section, Castration, Hernia, etc., Soft tissue surgery like episiotomy, vestibulotomy, etc.)

VI. **Practical**

Familiarity with clinical examination procedures, Body weight estimation, Signs of health and diseases, Signs of localized

lesions, etc., Familiarity with physical and chemical restraint procedures, Drug administrations by various routes-IM, IV, SC, sub-conjuctival, oral, per rectal, etc., foot examination and foot care procedures, visit to elephant camps and attending clinical procedures, surgeries, etc.

I. **Course Title : Clinical Case Conference**
II. **Course Code : VSR 687**
III. **Credit Hours : 0+1**
IV. **Practical**

Present seminar on unusual/ interesting clinical cases done in the semester. Compile them from presentation to follow up and also submit the write up in soft or hard copy.

I. **Course Title : Special Problem in Radiology**
II. **Course Code : VSR 688**
III. **Credit Hours : 0+2**
IV. **Practical**

Investigative radiological problems in clinical or experimental models, didactic and interpersonal learning-teaching, problem solving self-learning strategies in problems related to radiology.

I. **Course Title : Special Problem in Anaesthesia**
II. **Course Code : VSR 689**
III. **Credit Hours : 0+2**
IV. **Practical**

Investigative anesthetic problems in clinical or experimental models, Didactic and interpersonal learning-teaching, Problem solving self-learning strategies in problems related to anaesthesia.

I. **Course Title : Special Problem in Surgery**
II. **Course Code : VSR 690**
III. **Credit Hours : 0+2**
IV. **Practical**

Investigative surgical problems in clinical or experimental models, Didactic and interpersonal learning-teaching, Problem solving self-learning strategies in problems related to surgery.

VSR 691 MASTERS SEMINAR (1+0)

VSR 699 MASTERS RESEARCH (0+30)

Course Outline: Lecture wise

VSR 603: Principles of Surgery (2+1)

S. No.	Topics	No. of Lectures/Practicals
Theoy		
	Unit I	
1.	Classification of wounds	1
2.	Wound healing, mechanism of wound repair	2
3.	Local and systemic factors affecting wound healing	1
4.	Current concepts of inflammation and management	1
5.	Thermal, electrical and chemical injuries and their management	3
	Unit II	
6.	Asepsis, sterilization and disinfection	1
7.	Principles and practice of antimicrobial therapy in surgical patients	2
	Unit III	
8.	Shock, classification, pathophysiology, diagnosis, treatment and monitoring	4
9.	Surgical stress and its systemic effects	1
10.	Haemorrhage and haemostasis	1
11.	Acid-base balance	1
12.	Fluid therapy	2
13.	Blood transfusion	1
14.	Metabolism of the surgical patient	2
	Unit IV	
15.	Principles and clinical applications of laser surgery, cryosurgery, electrosurgery, physiotherapy	4
	Unit V	
16.	Minimally invasive surgical procedures which includes Laproscopy and endoscopy	2
17.	Principles of microscopic surgery-vessel and nerve anastomosis	1
18.	Application of computers in surgery	1
Practical		
1.	Identification and handling of surgical instruments	3
2.	Preparation of surgical pack	1
3.	Preparation of surgical team	1
4.	Preparation of surgical patients	1
5.	Surgical facilities and equipment	2
6.	Introduction to clinical skill laboratory	1
7.	Practice of different suturing patterns	2
8.	Repair of different wounds, using drains, bandages and bandaging techniques	2

9. Monitoring of traumatized surgical patient 2
10. Operation theatre conduct 1

Suggested Reading

- Fossum TW. (Ed.). 2018. *Small Animal Surgery*. Mosby.
- Slatter DH. 2003. 3rd ed. *Textbook of Small Animal Surgery*. WB Saunders.
- Hendrickson DA and Baird AN. 2013. *Turner and McIlwraiths Techniques in Large Animal Surgery* 4th ed. Wiley Black Well.
- Gangwar, AK, Kumar N. and Sangeeta Devi. 2010. *General Animal Surgery and Anesthesiology* (With Theory and Practicals) New India Publishing Agency, New Delhi (ISBN: 9789-38-0235-172).

VSR 604: Anaesthesia and Analgesia (2+1)

S. No.	Topics	No. of Lectures/Practicals

Theoy

Unit I

1. Introduction and history of anaesthesia 1
2. General consideration for anaesthesia in animals 1
3. Properties of ideal anaesthetic agent, types of anaesthesia 1
4. Anaesthetic triad, preanaesthetic evaluation of patient and selection of anaesthesia 1
5. Preanaesthetic evaluation of patient and selection of anaesthesia 2

Unit II

6. Preanaesthetic medication (anticholinergics, sedatives, tranquilizers, alpha-2 agonist, narcotics) 5
7. Muscle relaxants and neuromuscular blocking agents 1

Unit III

8. General anaesthetics and factors affecting their uptake, Distribution and metabolism 2
9. Injectable anaesthetic agents (properties, dosage and usage) 3
10. Combinations of injectable agents and neuroleptanalgesia 1
11. Inhalation anaesthetic agents (properties, methods of administration, dosage and usages) 2
12. Inhalation anaesthesia equipment and breathing circuits 1
13. Artificial ventilation 1

Unit IV

14. Post-operative care of the surgical patient 1
15. Operating room emergencies 1
16. Cardio-pulmonary arrest and resuscitation 1
17. Monitoring of anaesthetic recovery 1

Unit V

18. Local anaesthetics, their mechanisms 1
19. Local and regional nerve blocks 1
20. Spinal analgesia, intravenous regional anaesthesia 1
21. Peri-operative and post-operative pain and its management 2

Practical

1. Inhalation anaesthesia equipment, circuits and vaporizers 2
2. Artificial ventilation 1
3. Use of various pre-anaesthetic and anaesthetic agents in small and large animals 3
4. Anaesthetic triad 1
5. Balanced anaesthesia 1
6. Total intravenous anaesthesia 1
7. Regional and local nerve blocks using local anaesthetics 1
8. Repair of different wounds, using drains, bandages and bandaging techniques 1
9. Alpha-2 agonists and their combinations in domestic animals1
10. Monitoring of anaesthesia 1
11. Reversal of sedation and analgesia induced by alpha-2 agonists 1
12. Practice of anaesthesia in clinical cases 1
13. Record keeping in anaesthesia and euthanaia 1

Suggested Reading

- Gangwar, AK, Kumar N and Sangeeta Devi. 2010. *General Animal Surgery and Anesthesiology (With Theory and Practicals)* New India Publishing Agency, New Delhi (ISBN: 9789-38-0235-172).
- Clarke KW, Trim CM and Hall LW. 2013. *Veterinary Anaesthesia*. 11th ed. WB Saunders.
- Grim KA, Lamont LA, Tranquilli WJ, Greene SA and Robertson SA. 2015. *Veterinary Anaesthesia and Analgesia*, The 5th ed. Lumb and Jones. Wiley Blackwell.
- Grim KA, Tranquilli WJ and Lamont LA. 2011. *Essentials of Small Animal Anesthesia and Analgesia*. 2nd ed. Wiley Blackwell.
- Paddleford RR. 1999. *Manual of Small Animal Anesthesia*. 2nd ed. WB Saunders.

VSR 605: Diagnostic Imaging Techniques (2+1)

S. No.	Topics	No. of Lectures/Practicals

Theoy

Unit I

1. Regulations regarding establishment and handling of x-ray units, requirements for establishment of x-ray units 1
2. Conventional and digital X-ray machine 1
3. X-ray films, cassettes, screen 1
4. X-ray production, qualities of x-rays 1
5. Image formation and dark room procedures 1
6. Image plate, formation of radiograph technique chart, artifacts and their prevention 1
7. Radiographic quality (Detail, Density and Contrast) 1
8. Radiographic accessories 1
9. Radiographic positioning for different organs/ parts in small and large animals 1

Unit II

10. Plain and contrast radiographic techniques of small and large animals 3
11. Fluoroscopy/ C-arm 1
12. Principles of radiographic interpretation 1

Unit III

13. Principles of radiation therapy, medical radioisotope curves, Radiation laws and regulations 2
14. Radiation hazards and monitoring of radiographic exposure to personnel and protection. 2

Unit IV

15. Basic physics of ultrasound waves and image formation 2
16. Scanning principles of ultrasound 1
17. Transducers, equipment controls, modes of display 1
18. Terminology used for echotexture and USG artifacts 4

Unit V

19. Doppler techniques echocardiography and its application 2
20. Introduction to nuclear imaging techniques, computerized tomography, magnetic resonance imaging, positron emission tomography techniques 3

Practical

1. Acquaintance with imaging equipment, computed radiography and digital radiography systems 3
2. Dark room processing techniques and X-ray film handling 1
3. Formulation of technique chart with fixed kVp and variable mAs 1
4. Radiographic artefacts and their prevention 1

5. Basics of radiographic interpretation of diseases 2
6. Radiography positioning of different regions in domestic animals 1
7. Contrast radiographic techniques 2
8. Interpretation of radiographs 2
9. PACS, Practice of ultrasonographic imaging and report writing 3

Suggested Reading

- Gangwar, AK, Kumar N and Sangeeta Devi. 2010. *General Animal Surgery and Anesthesiology (With Theory and Practicals)* New India Publishing Agency, New Delhi (ISBN: 9789-38-0235-172).
- Barr FJ and Gaschen L. 2011. *BSAVA Manual of Canine and Feline Ultrasonography*. British Small Animal Veterinary Association
- Boon JA. 2011. *Veterinary Echocardiography*. 2nd ed. Wiley-Blackwell.
- Bushong SC. 2017. *Radiologic Science for Technologists*. 11th ed. CV Mosby.
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- Goddard PJ. 1995. *Veterinary Ultrasonography*. CABI.
- Kealy JK, McAllister H and Graham JP. (Eds.). 2011. *Diagnostic Radiology and Ultrasonography of the Dog and Cat*. 5th ed. WB Saunders, Philadelphia.
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- Kirberger RM and McEvoy FJ 2016. *BASAVA Manual of Canine and Feline Musculoskeltal Imaging*. 2nd BASAVA Gloucester.
- Morgan JP. 1972. *Radiology in Veterinary Orthopaedics*. Lea and Febiger.
- Nyland TG and Mattoon JS. 2002. *Small Animal Diagnostic Ultrasound*. WB Saunders.
- Thrall DE. 2017. *Textbook of Veterinary Diagnostic Radiology*. 7th ed. Saunders, Philadelphia.
- Bargai U, Pharr, JW and Morgan JP. 1989. *Bovine Radiology*. Iowa State University Press, Ames.

VSR 606: Soft Tissue Surgery (2+1)

S. No. Topics No. of Lectures/Practicals

Theory

Unit I

1. Skin, adnexa, integument, appendages, horn, tail, sinus affections of equine and bovine 3
2. Principles of plastic and reconstructive surgery, different types of skin grafts 2

Unit II

3. Surgical approaches/ affections of ear 1
4. Surgical approaches/ affections of oral cavity 1
5. Surgical approaches/ affections of larynx, pharynx, salivary glands and oesophagus 1
6. Surgical approaches/ affections of abdomen 1
7. Surgical approaches/ affections of rumen and reticulum 1
8. Surgical approaches/ affections of omasum and abomasum 1
9. Surgical approaches/ affections of stomach, intestines,rectum, anus 3
10. Surgical approaches/ affections of liver and biliary system, pancreas and porto-systemic shunts 1

Unit III

11. Abdominal hernia 1
12. Diaphragmatic hernia 1
13. Perineal hernia, ventral, femoral and umbilical hernia 1
14. Ritcher hernia, hiatal hernia, omental hernia, pre-pubic tendon rupture 1
15. Use of biological and synthetic grafts for hernia repair,
16. Laparoscopic repair of hernia 1

Unit IV

17. Principles of thoracic surgery, functional anatomy of respiratory system 1
18. Diseases of upper and lower respiratory system 4
19. Functional anatomy of cardiovascular system and common Affections of heart 3

Unit V

20. Affections of pituitary, adrenals, thyroid, parathyroid glands 1
21. Principles of neurosurgery and common surgical affections of Nervous system and special sense organs 1

Unit VI

22. Haemolymphatic system, bone marrow, spleen, tonsils, lymph Nodes and lymphatics, thymus 2

Practical

1. Practice of various surgical techniques of skin and adnexa 2
2. Practice of various surgical techniques of alimentary system 5
3. Practice of various surgical techniques of hernias 2
4. Practice of various surgical techniques of respiratory system 2
5. Affections of horn, tail and teat 2

6. Endoscopy techniques, instrumentation, use of rigid/ flexible Endoscopes in companion and farm animals 1
7. Use of rigid/ flexible endoscopes in companion animals 1
8. Use of rigid/ flexible endoscopes in farm animals 1

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.
- Yool DA. 2012. *Small Animal Soft Tissue Surgery*. CABI.
- Tobia KM. 2010. *Manual of Small Animal Soft Tissue Surgery*. Wiley Black Well.

VSR 607: Orthopaedic Surgery (2+1)

S. No. Topics No. of Lectures/Practicals

Theory

Unit I

1. Bone structure and function, growth, response to injury, fractures and luxations 1
2. Classification of fracture 1
3. Fracture healing, Biological osteosynthesis 1

Unit II

4. Biomechanics of fracture healing 1
5. Considerations for selection of fixation techniques 1
6. Current trends in treatment of fractures of different bones in Companion and farm animals 4
7. Diseases of bone 2

Unit III

8. Various affections of the joints and their treatment 3
9. Various affections of the ligaments and tendons and their treatment 3

Unit IV

10. Spinal affections and injury to axial skeleton 3

Unit V

11. Conformation of the limb 3
12. Anatomy of hoof 1
13. Anatomical, conformational and pathological causes of lameness and allied surgical conditions of fore and hind limbs 6

Practical

1. Application of Plaster of Paris cast 1

2. Application of fiberglass cast 1
3. Application of Roberts Jones bandage 1
4. Application of modified Schroeder Thomas splint 1
5. Application of Coaptation splint, sling application 1
6. Practice of IM pinning, wiring 2
8. Practice of bone plating 1
9. Practice of inter locking nailing 1
10. Practice of external skeletal fixation 1
11. Practice of arthrotomy 1
12. Practice of tenotomy 1
13. Examination of limbs for lameness 1
14. Desmotomy, nerve blocks, injections in joints 1
15. Operations for arthritis and hoof surgery 1
16. Corrective shoeing 1

Suggested Reading

- Gangwar, AK, Khangembam SD, Singh AK and Kumar N. (2018) *Veterinary Orthopaedics and Lameness*, Kalyani Publishers, New Delhi (ISBN 978-93-272- 8837-7).
- Auer JA. 2006. *Equine Surgery*. WB Saunders.
- Baxter GM. (Ed.). 2011. *Adams and Stashak's Lameness in Horses*. 6th ed. Wiley-Blackwell.
- Decamp CE, Johnston, SA, Dejardin LM and Schaefer SL. 2016. *Handbook of Small Animal Othopaedics and Fracture Repair*, 5th ed., Elsevier.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders.
- Greenough PR. 2007. *Bovine Laminitis and Lameness*. WB Saunders.
- Millis DL and Levine D 2014. *Canine Rehabilitation and Physical Therapy*, 2nd ed., Elsevier.
- Newton CD and Nunamaker DM. (Eds.). 1985. *Textbook of Small Animal Orthopaedics*. JB Lippincott.
- Oehme FW and Prier JE. (Eds.). 1974. *Textbook of Large Animal Surgery*. Williams and Wilkins.
- Tyagi RPS and Singh J. (Eds.). 1993. *Ruminant Surgery*. CBS.
- Weaver AD, Jean GS and Steiner A. 2007. Bovine Surgery and Lameness. 2nd ed. Wiley- Blackwell.

VSR 608: Anaesthesia of Zoo, Wild, Exotic and Laboratory Animals (1+1)

S. No.	Topics	No. of Lectures/Practicals

Theory

Unit I

1. General consideration in chemical restraint of captive wild animals 1
2. General consideration in chemical restraint of free ranging wild animals 1
3. Handling of birds with minimum stress 1
4. Physical examination, blood sampling, crop washes, faecal sampling 1

Unit II

5. Methods of administration of anaesthesia in captive animals 1
6. Methods of administration of anaesthesia in free ranging animals 1
7. Methods of administration of anaesthesia in birds 1
8. Methods of administration of anaesthesia in laboratory animals 1

Unit III

9. Local and general anaesthesia in exotic species 1
10. Local and general anaesthesia in wild animals 1
11. Local and general anaesthesia in birds 1
12. Local and general anaesthesia in zoo animals 1
13. Local and general anaesthesia in laboratory animals 1

Unit IV

14. Anaesthetic emergencies and complications 1

Unit V

15. Diagnostic interpretation, haematology and biochemistry analysis 2
16. Avian diagnostic endoscopy 1

Practical

1. Familiarization with capture and anaesthetic equipments 1
2. Local anaesthetic techniques 1
3. Use of various preanaesthetic and anaesthetic agents in Laboratory animals 1
4. Use of various preanaesthetic and anaesthetic agents in birds 1
5. Monitoring of patient during general anaesthesia 1
6. Familiarization of various diseases in exotic birds like tumours, foreign body, crop stasis, crop tear, crop fistula, toe necrosis, feather cyst 2

7. Excision of uropygieal gland 1
8. Excision of rhinolith 1
9. Pharyngostomy 1
10. Ingluviotomy 1
11. Ventriculotomy 1
12. Orthopedic injuries 2
13. Visits to zoos for practical on zoo animals 1
14. Visits to wild life sanctuaries for practical on wild animals 1

Suggested Reading

- Coles BH. 2007. *Essentials of Avian Medicine and Surgery*. 3rd ed. Blackwell Publishing
- Donely B. 2010. *Avian Medicine and Surgery in Practice*. Manson Publishing Ltd.
- Grim KA, Lamont LA, Tranquilli WJ, Greene SA and Robertson SA. 2015. *Veterinary Anaesthesia and Analgesia*. 5th ed. Lumb and Jones. Wiley Blackwell.
- Mader DR. 2005. *Reptile Medicine and Surgery*. 2nd ed. WB Saunders
- Miller RE and Fowler M. 2014. *Fowler's Zoo and Wild Animal Medicine*. 1st ed. Saunders
- Wobeser GA. 2007. *Disease in Wild Animals: Investigation and Management*. 2nd ed. Springer

VSR 609: Urogenital Surgery (1+1)

S. No. Topics No. of Lectures/Practicals

Theoy

Unit I

1. Surgical anatomy of urinary tract in male and female animals 1
2. Surgical anatomy of reproductive tract in male and female animals 1
3. Congenital anomalies of organs of male and female urinary system 1
4. Congenital anomalies of organs of male and female reproductive system 1

Unit II

5. Principles of urinary tract surgery, pathophysiology, diagnosis and surgical management of affections of kidney 1
6. Pathophysiology, diagnosis and surgical management of affections of ureter and urinary bladder 2
7. Medical dissolution and prevention of canine uroliths 1
8. Feline urologic syndrome 1
9. Surgical management of urolithiais in ruminants and its

prevention 1

10. Management of uroperitoneum and renal failure 1

Unit III

11. Pathogenesis, clinical symptoms, diagnosis and surgical management of vaginal and uterine prolapse, rectovaginal fistula, pneumovagina 1
12. Pathogenesis, clinical symptoms, diagnosis and surgical management of vaginal tumours, pyometra, cysts of Gartner's canal and vestibular glands 1

Unit IV

13. Surgical conditions of penis, prepuce, prostate and testicles, cryptorchidism, inguinal and scrotal hernia 1
14. Affections of teat and udder 1

Unit V

15. Indications, techniques and postoperative complications of episiotomy, ovariectomy, ovariohysterectomy and caesarean section, pyomerta and its surgical treatment 1

Unit VI

16. Castration, vasectomy, cauda epididymectomy and penile deviation 1

Practical

1. Hand-on-training of techniques of centesis of urinary bladder in companion and farm animals 1
2. Different types of catheters used in urogenital surgery, retrograde catheterization of urethra and urinary bladder 1
3. Normograde catheterization of urethra on clinical cases of urinary retention 1
4. Pudendal nerve block for penis examination in ruminants 1
5. Diagnostic techniques and surgical management of the affections of kidney and ureters 2
6. Uro-hydropropulsion 1
7. Restraint and anaesthesia for urogenital tract surgery 1
8. Cystotomy, tube cystostomy 1
9. Nephrotomy, ureterocolostomy 1
10. Urethrotomy, urethrostomy 1
11. Castration, vasectomy, penile deviation, epididymectomy, Amputation of penis, episiotomy 1
12. Ovariohysterectomy, tubectomy 1
13. Caesarean section 1
14. Management of phimosis, paraphimosis, venereal granuloma 1
15. Vaginal and uterine prolapse, rectovaginal fistula and pneumovagina 1
16. Bladder and uterine marsupialization 1

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.
- Wolfe DF and Moll HD. *Large Animal Urogenital Surgery* 1999. 2nd ed., Williams and Wilkins, Tokyo.
- Yool DA. 2012. *Small Animal Soft Tissue Surgery*. CABI.

VSR 610: Ophthalmology (1+1)

S. No.	Topics	No. of Lectures/Practicals
Theory		
	Unit I	
1.	Anatomy and physiology of eye and its adnexa	1
2.	Ophthalmic examination and diagnosis, diagnostic instrumentation	1
3.	Anaesthesia and surgery	1
	Unit II	
4.	General consideration for eye surgery in companion and farm animals	1
5.	Therapeutic agents for eye diseases and surgery of eye lids, lacrimal apparatus, naso-lacrimal duct	1
	Unit III	
6.	Diseases of conjunctiva	1
7.	Diseases of cornea, sclera, iris, orbit	1
8.	Diseases of lens	1
9.	Diseases of vitreous and aqueous humor	1
10.	Diseases of retina and optic nerve	1
11.	Eye tumours, enucleation, exenteration	1
	Unit IV	
12.	Ocular manifestations of systemic diseases	2
	Unit V	
13.	Neuro-ophthalmology and ocular emergencies	3
Practical		
1.	Ophthalmic instrumentation	1
2.	Examination of the eye and its adnexa	2
3.	Anaesthesia, preparation of patient, suture materials for eye surgery	1
4.	Canthotomy, tarsorrhaphy	1
5.	Keratoplasty, anterior chamber paracentesis	1
6.	Flushing of naso-lacrimal duct	1
7.	Iridectomy	1

8. Phacoemulsification and implantation of foldable lens 1
9. Surgical treatment of entropion 2
10. Surgical treatment of cherry eye 1
11. Schirmer tear test 1
12. Use of fluorescein dye in corneal ulcer 1
13. Glaucoma surgery 1
14. Eye worm removal 1

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Gelatt KN. 2014. *Essentials of Veterinary Ophthalmology*. 3rd ed. Wiley Blackwell. US.
- Gilger BC. 2017. *Equine Ophthalmology*, 3rd ed. Wiley Blackwell.
- Maggs DJ, Miller PE and Ofri R. 2017. *Slatter's Fundamentals of Veterinary Ophthalmology*. 6th ed. Saunders.
- Slatter DH 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.

VSR 611: Dentistry and Oral Surgery (1+1)

S. No. Topics No. of Lectures/Practicls

Theory

Unit I

1. Anatomy, development of teeth (odontogenesis) 1
2. Dentition and ageing of different species 1

Unit II

3. Clinical examination of oral cavity, dental anesthesia and pain management 1
4. Dental anaesthesia and pain management 1
5. Dental radiography 1

Unit III

6. Diseases of oral cavity and teeth, congenital and developmental anomalies of oral cavity 1
7. Abnormal tooth eruption, irregular wear of teeth in companion and farm animals, occlusion and malocclusion 1
8. Mandibular fracture, malformation of mandible, maxilla (cleft palate) 1

Unit IV

9. Acquired diseases of teeth (halitosis, dental caries, fracture of teeth, dental materials and dental radiography), oronasal fistula 1
10. Maxilla and mandibular fractures repair 1
11. Orthodontics 1

12. Tumors and other acquired condition of oral cavity 1

Unit V

13. Exodontics, restorative dentistry 1
14. Periodontal disease, tooth extraction, gum diseases 1
15. Endodontics, pulpectomy, root canal therapy, current techniques in dentistry 2

Practical

1. Oral examination 1
2. Modified triadian system of tooth numbering in various species 1
3. Dental chart for companion and farm animals 1
4. Dentistry instrumentation 1
5. Dental radiography procedure 1
6. Periodontal probing, scaling/ teeth cleaning 1
7. Tooth extraction 1
8. Malpractices in equine dentistry 1
9. Periodical maintenance of oral hygiene 1
10. Corrective procedures, malocclusion 1
11. Treatment strategies congenital malformations of maxilla 2
12. Oral surgery 4

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Holmstrom SE. 2013. *Veterinary Dentistry - A Team Approach*. 2nd ed. Elsevier.
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.
- Soto JC. 2015. *Visual Atlas of Dental Pathologies in Dogs*. SERVET, Spain.

VSR 612: Camel Surgery (1+1)

S. No. Topics No. of Lectures/Practicals

Theory

Unit I

1. Introduction to special surgical anatomy of important parts, i.e. mandible, soft palate, chest pad, saddle region, male urinary system, tail, etc. 1
2. Restraint and positioning for various surgical procedures and radiography of different parts 1

Unit II

3. Use of local anaesthesia, various nerve blocks and regional anaesthesia used to treat diverse surgical disorders 1

4. Preanaesthetics, tranquilizers, sedatives and general Anaesthetics used for camel surgery 1

Unit III

5. Surgical affections of head and neck region: laceration and infected wounds of nostril skin, infection of turbinate, actinobacillosis, dental affections 1
6. Surgical affections of head and neck region: removal of canines in furious camels, torticollis, fracture of mandible and maxilla, soft palate injuries 1
7. Surgical affections of head and neck region: ophthalmic affections, salivary fistula, Stenson's duct ligation, oesophageal obstruction 1

Unit IV

8. Surgical affections of thorax and abdominal region: saddle gall, hernia, chest pad wounds and enlargements 1
9. Surgical affections of thorax and abdominal region: foreign bodies in compartment, intestinal obstruction 1
10. Surgical affections of thorax and abdominal region: obstructive urolithiasis, rupture of urethra, subcutaneous infiltration of urine, cystorrhexis 1

Unit V

11. Surgical affections of musculo-skeletal system: diagnosis of lameness in camels 1
12. Surgical affections of musculo-skeletal system: management of long bone and digital fractures 1
13. Surgical affections of musculo-skeletal system: upward fixation of patella, sprains, arthritis 1

Unit VI

14. Sheath abscess, necrosis of penis, phimosis, paraphimosis, preputial prolapse 1
15. Various types of tumours, gangrene and tumours of udder, necrosis of tail 1
16. Punctured foot, prolapse of digital cushion, foot injuries, Kumri, Kapali etc 1

Practical

1. Restraint and anaesthesia (Local, regional, sedation and general anaesthesia) 2
2. Preparation of sites 1
3. Surgical anatomy of important surgical affections 1
4. Special instruments used for camel restraining and surgery 1
5. Observing and assisting in diverse surgical procedures on clinical cases in camels 5
6. Practice of interdental wiring for repair of mandibular

fractures in specimen mandibles 1

7. Clinical and radiographic diagnosis of lameness 2
8. Protection of wounds of chest pad and foot using special bandages 1
9. Radiography of different part of camels 1

Suggested Reading

- *Selected Topics on Camelids*, Ed-TK Gahlot, The Camelid Publishers, Bikaner and now marketed by Camel Publishing House, Edition 2000.
- *Medicine and Surgery of Camelids*. Ed-Murray E. Fowler, Wiley-Blackwell, Edition 2010.
- *Advances in Surgery and Diagnostic Imaging of the Dromedary Camel*, Ed- RO Ramadan, King Faisal University, Edition 2016.

VSR 613: Elephant Surgery (1+1)

S. No. Topics No. of Lectures/Practicals

Theory

Unit I

1. Basic surgical anatomy of Asian elephants and comparison with other farm animals 4

Unit II

2. Drug administration techniques in captive and wild elephants, anaesthetic management of captive and wild elephants for varioussurgical and managerial conditions 1
3. Drug administration techniques in captive and wild elephants, anaesthetic management of captive and wild elephants for various surgical and managerial conditions 1

Unit III

4. Principles of soft tissue surgery in elephants, cyst, bursitis, gall, haematoma, abscess, etc. 2

Unit IV

5. Management and treatment of fractures and arthritis in elephants 2

Unit V

6. Pedicure, corrective foot care and maintenance of healthy feet of captive elephants housed in different establishments in different seasons 2

Unit VI

7. Hoisting of recumbent elephants, surgical methods of birth control in elephants 1
8. Limitations and risks of abdominal surgery in elephants (eg. caesarian section, castration, hernia, etc., soft tissue surgery like episiotomy,vestibulotomy, etc.) 2

Practical

1. Familiarity with clinical examination procedures 1
2. Body weight estimation 1
3. Signs of health and diseases 1
4. Signs of localized lesions, etc. 1
5. Familiarity with physical and chemical restraint procedures 1
6. Drug administrations by various routes-IM, IV, SC, sub-conjuctival, oral, per rectal, etc. 1
7. Foot examination and foot care procedures 1
8. Visit to elephant camps 1
9. Attending clinical procedures, surgeries etc 7

Suggested Reading

- Fowler ME and Mikota SK. 2006. *Biology, Medicine, and Surgery of Elephants*. Blackwell Publishing

Course Contents
Ph.D. in Veterinary Surgery and Radiology

I. **Course Title : Clinical Practice-I**
II. **Course Code : VSR 701**
III. **Credit Hours : 0+2**
IV. **Aim of the course**

To learn clinical techniques and procedures in anaesthesia, diagnostic imaging and surgery

V. **Practical**

Application of different equipment like inhalant anaesthesia machine, Computerized or digital radiography system, Ultrasonography, Endoscopy, Electro-surgery, Cryosurgery, Operating microscope, Phacoemulsification and physiotherapy, Client management and counseling, Treating surgical cases using advances techniques, managing surgical facilities, ICU equipment and personnel, Planning and formulating clinical research projects using the clinical data and facilities, Data analysis and writing of clinical case reports and success stories about the clinical achievements.

I. **Course Title : Clinical Practice-II**
II. **Course Code : VSR 702**
III. **Credit Hours : 0+2**
IV. **Aim of the course**

To learn clinical techniques and procedures in anaesthesia, Diagnostic imaging and surgery

V. **Practical**

Application of different equipment like inhalant anaesthesia machine, Computerized or digital Radiography system, Ultrasonography, Endoscopy, Electro-surgery, Cryosurgery, Operating microscope, Phacoemulsification and physiotherapy, Client management and counseling, Treating surgical cases using advances techniques, managing surgical facilities, ICU equipment and personnel, Planning and formulating clinical research projects using the clinical data and facilities, Data analysis and writing of clinical case reports and success stories about the clinical achievements.

I. **Course Title : Clinical Practice-III**
II. **Course Code : VSR 703**
III. **Credit Hours : 0+2**
IV. **Aim of the course**

To learn clinical techniques and procedures in anaesthesia, Diagnostic imaging and surgery

V. Practical

Application of different equipment like inhalant anaesthesia machine, Computerized or digital radiography system, Ultrasonography, Endoscopy, Electro-surgery, Cryosurgery, Operating microscope, Phacoemulsification and physiotherapy, Client management and counseling, Treating surgical cases using advances techniques, Managing surgical facilities, ICU equipment and personnel, Planning and formulating clinical research projects using the clinical data and facilities, Data analysis and writing of clinical case reports and success stories about the clinical achievements.

I. Course Title : Cardiovascular Surgery

II. Course Code : VSR 704

III. Credit Hours : 2+1

IV. Aim of the course

To learn the basic principles and and gain practical knowledge of diagnosis and treatment of diseases of cardiovascular system.

V. Theory

Unit I

Surgical anatomy, Pathophysiology, Systolic and diastolic functions, Heart failure.

Unit II

Physical examination, Electrocardiography, Cardiac catheterization.

Unit III

Special preoperative considerations for patients undergoing cardiovascular surgery, Surgical approaches to thorax, Different techniques of thoracotomy. Special instruments required in cardio-thoracic surgery, Defibrillator, Heart lung machine

Unit IV

Surgical management of congenital cardiac disorders: Malpositioning, Atrial septal defect, Endocardial cushion defect, Tricuspid valve disorder, Ventricular septal defect, Pulmonic stenosis, Teratology of fallot, Eisenmenger's complex, Anomalous pulmonary venous return, Mitral valve abnormalities, Aortic stenosis, Aortic regurgitation, transposition of the great vessels, Aortic pulmonary window, Persistent arteriosus, Patent ductus arteriosus, Coarctation of aorta, Persistent right aortic arch, Pericardial diaphragmatic hernia.

Unit V

Acquired cardiac disorders: Mitral regurgitation, Tricuspid regurgitation, Dirofilariasis, Acquired aortic regurgitation, Endocarditis, Heart block, Cardiomyopathy, Pericarditis, Heart tumours, Hypothermia, Extracorporeal circulatory support, Cardiopulmonary bypass, Artificial heart transplant, Post operative management, Basic peripheral vascular procedures arteriotomy, Venotomy, anastomosis, Portocaval shunts and anomalies

VI. **Practical**

Instrumentation and suture techniques for cardiovascular surgery, Vascular prostheses, Anticoagulants, Surgical approaches to thorax, Different techniques of thoracotomy, Hand-on-training of different techniques of centesis of thoracic cavity on cadavers, Thoracic drain placement, Demonstration of basic Cardiac procedures, Pericardiocentesis, Pericardiotomy, Cardiac catheterization, and various surgical conditions, Pericardiectomy, on cadaver and clinical cases of constructive pericarditis, Biopsy techniques, Use of IPPV in thoracic surgery.

I. **Course Title : Advances in Anaesthesiology**

II. **Course Code : VSR 705**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To learn advance concepts and techniques of veterinary anaesthesia.

V. **Theory**

Unit I

Cellular and molecular mechanisms of anaesthesia, Effects of anaesthesia on different systems.

Unit II

Drug interactions with anaesthetics, Pharmacokinetics and pharmacodynamics of anaesthetics, CRI and TCI, Computer assisted anaesthesia.

Unit III

Opioids, alpha-2 agonists and ketamine for epidural anaesthesia, Acupuncture and electroanaesthesia.

Unit IV

Critical acre in ICU, Pain transmission and processing, Methods for pain assessment in animals, Multimodal and preemptive analgesia, Techniques and drugs for pain managements.

Unit V

Anaesthesia for selected diseases (cardiovascular dysfunction,

pulmonary dysfunction, Neurologic diseases, Renal diseases, Hepatic diseases, Gastrointestinal diseases, Endocrine diseases, Airway diseases).

Unit VI

Anaesthesia for special patients (ocular patients, heart patients, caesarian section patients, trauma patients, neonatal and geriatric patients).

VI. **Practical**

Various procedures for catheterization of heart and great vessels, Central venous line, Haemodynamic changes and pulmonary function tests during trials of anaesthetics, Electrocardiographic, Encephalographic evaluation of central nervous system activity, Cybernetics, Data acquisition and retrieval, Administration and monitoring of newer anaesthetics combinations.

I. **Course Title : Advances in Radiology**

II. **Course Code : VSR 706**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To learn advance theoretical and practical knowledge in radiology.

V. **Theory**

Unit I

Biological effects of radiations (alpha, beta, X-ray and gamma rays) *in-vivo* and *in-vitro* cellular response following radiation as an immunosuppressive agent.

Unit II

Different kind of projections and positioning, Contrast material, Different contrast techniques, PACS.

Unit III

Radiography of head and neck region, Radiography of thorax, Lung patterns, Radiography of abdominal and pelvic region

Unit IV

Radiography of limbs for lameness and fracture diagnosis, Application of image intensifiers in veterinary practice, Different types of screens.

Unit V

Computerized radiography (CR), Digital radiography (DR), Contrast CT and contrast MRI, PETCT, Advances in scintigraphy.

Unit VI

Radiation therapy in cancer patients, Biological effects of radiation physics, Physics of radiation, Electromagnetic radiations, Hazards of electromagnetic Radiations and protection and bio-safety.

VI. **Practical**

Radiographic positioning, Radiation safety measures, Handling radioactive material, Clinical radiological diagnosis at Radiology Unit, Demonstration of advanced radiological techniques.

I. **Course Title : Advances in Diagnostic Imaging Techniques**

II. **Course Code : VSR 707**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To learn advance theoretical and practical knowledge of ultrasonography, Diagnostic imaging techniques and their interpretations.

V. **Theory**

Unit I

Techniques of ultrasonography for diagnosis of different affections of neck, thorax (echocardiography, Doppler techniques), Abdomen and pelvis (Urinary bladder and prostrate), Synovial joints, Muscle and tendons, Eye.

Unit II

Interpretation of ultrasonogram of different body organs/ vessels (normal and abnormal), Therapeutic applications of ultrasonography for physiotherapy.

Unit III

Imaging modalities like, MRI, CT scan, Nuclear medicine, Positron emission tomography technique, Single-photon emission computed tomography, etc.

Unit IV

Nuclear Scintigraphy-isotopes (natural and man-made); Cyclotron reactor, Half- life, decay pattern, Storage and handling of radioactive material,

Unit V

Methods in the detection of isotopes, Geiger-Mullar tubes, Photo-multiplier tube, medical use of isotope, Dosimetry, Nuclear medicine and its use in diagnosis of thyroid, Kidney, bone and liver function studies, Labelling of isotope and biological uses, Detonation and fission products, Image storage and transfer, DICOM, PACS and teleinterpretation.

VI. **Practical**

Hands-on-practice on different visceral organs collected from slaughter house for ultrasonographic scanning in water tub, dry and wet lab training, Demonstration and practice on different clinical cases reported for ultrasonography, Visit to places with facility of other alternate imaging techniques.

I. **Course Title : Advances in Orthopaedics**

II. **Course Code : VSR 708**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To learn advance concepts and techniques of treatment of various affections of bones, joints, tendons, ligaments and foot in companion and farm animals.

V. **Theory**

Unit I

Biomechanics of bone, Fracture etiology, Fracture reduction and different fracture fixation techniques like IM pinning, plating, nailing (inter locking nailing) and external skeletal fixation.

Unit II

Types, Properties, Biomechanics and use of different orthopaedic Implants, Bone grafts and their collection, Preservation, Indications and limitations, Bone graft substitutes like ceramics and composites, Their usage and limitations.

Unit III

Principles of osteogenesis, Osteoinduction and Osteoconduction.

Unit IV

Advances in internal fixation and external skeletal fixation techniques in veterinary orthopaedics.

Unit V

Metabolic bone diseases like rickets, osteomalacia, osteodystrophy and secondary hyperparathyroidism, etc. Classification, diagnosis and treatment of arthritis.

Unit VI

Advances in the management of congenital and acquired disorders of joints like traumatic dislocations, luxations and dysplasia. etiopathology and management of equine lameness including Laminitis, Navicular disease, Quitter, Canker and thrush, Sand cracks, Ring bone, Hygromas, Bursitis, Spavin and Splint.

Unit VII

Affections of muscles, tendons and ligaments, joint prosthesis and transplantation.

Unit VIII

Postoperative management of orthopaedic patients including the role of movement restriction, Weight bearing, Nutritional therapy, Physiotherapy and rehabilitation, Introduction to recovery assessment using lameness score, Gait analysis using computerized software.

VI. **Practical**

Hands on practice for different internal fixation techniques on

cadaver, Management of different types of long bone fractures in different species of domestic animals, with special reference to practice of bone plating, Interlocking nailing and external skeletal fixation, Treatment of metabolic bone diseases in growing animals, Correction of antebrachial deformities including osteotomies and limb lengthening procedures, preservation of bone grafts, practice of bone grafting and use of osteoinducers in Clinical situation, Clinical and radiographic evaluation of various joint affections, Reduction and fixation of different joint luxations like coxo-femoral, Patellar, femoro-tibial, hock, scapulo-humeral, elbow and temporomandibular, Techniques of osteotomy, arthrodesis and joint replacement, Repair of tendon and ligament injuries, Diagnosis and treatment of various conditions causing lameness in equines and bovines.

I. **Course Title : Neurosurgery**
II. **Course Code : VSR 709**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To learn principles and techniques of treatment of surgical affections of nervous system in animals

V. **Theory**

Unit I

Nervous system – Anatomy, Physiology and Pathological manifestations.

Unit II

Clinical neurology, Therapeutic Neurectomy, Nerve anastomosis, Pathogenesis of disease of the central nervous system.

Unit III

Diagnostic methods – Electrodiagnostic methods, Neuro radiology.

Unit IV

Fundamentals of neurosurgery, Surgical approaches to brain, Surgical diseases of peripheral nerves, Surgical affections and approaches to the spine, Diseases of the spinal column, Intervertebral disc diseases.

Unit V

Surgical approaches to brain and intracranial surgery.

VI. **Practical**

Methods for clinical and neurological examination including electro-encephalography, electromyography and electro-diagnostic testing, Collection of CSF and its evaluation, Techniques of myelography, Vertebral venography, Pneumoventriculography, Cerebral

arteriography and cavernus sinus venography, Management of vertebral fractures and luxations with stabilization, Treatment of spinal cord compression, *viz.,* Disc fenestration, Hemilaminectomy, Dorsal laminectomy and ventral slot, Techniques of peripheral nerve anastomosis and reconstruction of peripheral nerves.

I. **Course Title : Reconstructive and Regenerative Surgery**
II. **Course Code : VSR 710**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To learn principles and techniques of reconstructive and regenerative surgery.

V. **Theory**

Unit I

Principles of regenerative medicine, Tissue homeostasis, Tissue and organ transplantation, Histo-compatibility matching, Transplantation immunity and host graft reaction, Immunosuppression

Unit II

Classification, Isolation, Characterization, Storage and application of stem cells, Extracellular matrix, Microenvironment and growth factors for tissue repair and regeneration.

Unit III

Synthetic and biological scaffolds, Preparation of biological scaffold and its role in Tissue regeneration, Whole organ decellularization and its application, Biomimetic scaffolds.

Unit IV

Designing for 3D printing, Bio-fabrication of organ and Tissue substitutes and its applications, Ethical concerns in regenerative medicine, GMP protocols and its applications in regenerative medicine

Unit V

Current techniques in designing and clinical application of biomaterials, Mechanical and functional testing of biomaterials, Biocompatibility testing

VI. **Practical**

Collection of bone marrow derived stem cells from different species of animals, Growth and differentiation of stem cells in different lineages, Decellularization of different tissues and organs, cell growth on different scaffolds, Clinical application of stem cells.

I. **Course Title : Advances in Soft Tissue Surgery**
II. **Course Code : VSR 711**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To learn advanced concepts and practical techniques of treatment of soft tissue surgery, laparoscopic and minimally invasive surgery

V. **Theory**

Unit I

Advances in surgeries of ENT affections of small and large animals, Rhinoscopy- rhinotomy, Tumors of turbinates, Cheiloplasty, Hare lip correction, Salivary duct ligation, Parotid gland abalation, Bullaosteotomy, Buccotomy procedures, Glossophagia, Self suck correction.

Unit II

Upper respiratory tract affection in small and large animals, Barchiochephalic air way syndrome, Laryngeal paralysis, Tracheal collapse, Tracheostomy (temporary/ permanent), Chest trauma, Chest tube placement, Thoracocentesis, Pneumectomy, (partial/ unilateral), Heart lung transplant, Thoracic duct ligation, Trans tracheal intubation, Thoracoscopic procedure.

Unit III

Esophageal affections in small and large animals, Dilatation, Diverticulum, PRAA- Mullers surgery, Gastroesophageal intussception, Short bowel syndrome, Colostomy, megacolon, Rectal tube placement, Rectal diverticulum, Gastroscopy techniques

Unit IV

Pyelolithotomy, Lithotripsy, Renal transplantation, Ectopic ureter, Prostatectomy, Urinary incontinence, Penile urethosotomy, Urethroscopic retrival of urolith, Endoscopic ureter stunt placement.

Unit V

Thyroidectomy in cats, Liver lobectomy, Cholelithiasis, Cholecystectomy, Cholecystoduo denostomy, Porto caval shunt, Adrenalectomy.

Unit VI

Skin grafting, Subdermal, Axial skeletal, Omocervical axial pattern flap, Thoracodorsal axial pattern flap, Superficial brachial axial pattern flap, Caudal superficial epigastric axial pattern flap, Cranial superficial epigastric axial pattern flap, Deep circumflex iliac dorsal axial pattern flap, Deep circumflex iliac ventral axial pattern flap, Genicular axial pattern flap, Reverse saphenous conduit flap, Caudal auricular axial pattern flap, Split thickness and full thickness grafts, Reconstructive surgical procedures.

VI. **Practical**

Endoscopic surgical procedures in small and large animals, Chest tube placement, Rhinoscopy, Thoracoscopy, Broncoscopy, Gastroscopy, Colonoscopy, Urethrocystoscopy, Laproscopic surgical techniques, Skin flap and grafting techniques, Tracheaostomy, Renal graft cystoplasty.

I. **Course Title : Advances in Ophthalmology**
II. **Course Code : VSR 712**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To learn advanced concepts and practical techniques in ophthalmology.

V. **Theory**

Unit I

Embryology of the eye, study of ocular physiology and biochemistry, structure and function of eye and adenexa, Physiology of vision, Electrophysiology of visual system

Unit II

Advances in diagnosis and diseases of the eye and adnexia.

Unit III

Ocular neoplasia, advances in neuro ophthalmology, Advances in ophthalmic pharmacology, microbiology and nutrition

Unit IV

Advances in ocular imaging, Advances in ocular anaesthesia and analgesia

Unit V

Advances in ocular emergencies, Opthalmology of exotic species and lab animals, ocular toxicology

Unit VI

Corneal grafting, application of nanotechnology and stem cell therapy in veterinary ophthalmology.

VI. **Practical**

Exposure to latest ophthalmic instrumentation like phaco, ultrasound, cataract surgery and lens implantation, corneal transplantation.

I. **Course Title : Surgical Oncology**
II. **Course Code : VSR-713**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To learn about tumor genesis and treatment in animals.

V. **Theory**

Unit I

Biology of neoplastic disease: etiology, cellular mechanism, principles of surgical oncology.

Unit II

Diagnosis, classification and clinical staging of tumors and decision making for therapy, metastasis.

Unit III

Surgical management: Surgical excision of tumors, Cytoreductive surgery, Surgery for metastatic disease, Palliative surgery, Evaluation and interpretation of surgical margins.

Unit IV

Clinical signs, Diagnosis and treatment options of tumors of skin, Soft tissues, skeletal system, Head and neck, Gastro-intestinal tract, Respiratory tract, Urinary tract, Genital tract, Mammary gland, Nervous system, Endocrine system, haematopoietic system, the eye and orbit and miscellaneous tumours.

Unit V

Radiation therapy, Chemotherapy, Electrochemotherapy, Cryotherapy and targeted therapy. Side effects of radio and chemotherapy, Nutritional management of cancer patients, Basics of immunotherapy in cancer management.

VI. **Practical**

General approaches to the diagnosis of neoplasia: Fine needle aspiration biopsy, needle core biopsy, excisional and incisional biopsy, bone marrow biopsy, lymph node biopsy, percutaneous lung biopsy, bone biopsy, ultrasound/ laparoscope guided biopsy.

I. **Course Title : Clinical Case Conference**
II. **Course Code : VSR 787**
III. **Credit Hours : 0+1**
IV. **Practical**

Present seminar on unusual/ interesting clinical cases done in the semester. Compile them from presentation to follow up and also submit the write up in soft or hard copy.

I. **Course Title : Special Problem in Diagnostic Imaging**
II. **Course Code : VSR 788**
III. **Credit Hours : 0+2**
IV. **Practical**

Investigative diagnosing imaging problems in clinical models, didactic and interpersonal learning-teaching, problem solving self-learning strategies in problems related to surgery

I. **Course Title : Special Problem in Anaesthesia**
II. **Course Code : VSR 789**
III. **Credit Hours : 0+2**
IV. **Practical**

Investigative anaesthetic problems in clinical models, didactic and interpersonal learning-teaching, problem solving self-learning strategies in problems related to anaesthesia.

I. **Course Title : Special Problem in Surgery**
II. **Course Code : VSR 790**
III. **Credit Hours : 0+2**
IV. **Practical**

Investigative surgical problems in clinical models, didactic and interpersonal learning-teaching, problem solving self-learning strategies in problems related to surgery

VSR 791 Doctoral Seminar-I (1+0)
VSR 792 Doctoral Seminar-II (1+0)
VSR 799 Doctoral Research (0+75)

Course Outline: Lecture wise

VSR 704: Cardiovascular Surgery (2+1)

S. No.	Topics	No. of Lectures/Practicals
Theory		
	Unit I	
1.	Surgical anatomy, pathophysiology	1
2.	Systolic and diastolic functions	1
3.	Heart failure	1
	Unit II	
4.	Physical examination	1
5.	Electrocardiography	1
6.	Cardiac catheterization	1
	Unit III	
7.	Special preoperative considerations for patients undergoing cardiovascular surgery, surgical approaches to thorax	1
8.	Different techniques of thoracotomy	1
9.	Special instruments required in cardio-thoracic surgery, defibrillator, heart lung machine	1
	Unit IV	
10.	Surgical management of congenital cardiac disorders: malpositioning, atrial septal defect, endocardial cushion defect	1
11.	Surgical management of congenital cardiac disorders:	

tricuspid valve disorder, ventricular septal defect 1

12. Surgical management of congenital cardiac disorders: pulmonic stenosis, teratology of fallot 1
13. Surgical management of congenital cardiac disorders: eisenmenger's complex, anomalous pulmonary venous return 1
14. Surgical management of congenital cardiac disorders: mitral valve abnormalities, aortic stenosis, aortic regurgitation 1
15. Surgical management of congenital cardiac disorders: transposition of the great vessels, aortic pulmonary window, persistent arteriosus 1
16. Surgical management of congenital cardiac disorders: patent ductus arteriosus, coarctation of aorta, persistent right aortic arch 1
17. Surgical management of congenital cardiac disorders: pericardial diaphragmatic hernia 1

Unit V

18. Acquired cardiac disorders: mitral regurgitation, tricuspid regurgitation 1
19. Acquired cardiac disorders: dirofilariasis 1
20. Acquired cardiac disorders: acquired aortic regurgitation, endocarditis 1
21. Acquired cardiac disorders: heart block 1
22. Acquired cardiac disorders: cardiomyopathy, pericarditis, heart tumours 1
23. Acquired cardiac disorders: hypothermia, extracorporeal circulatory support 1
24. Acquired cardiac disorders: cardiopulmonary bypass 1
25. Acquired cardiac disorders: artificial heart transplant, post operative management 1
26. Acquired cardiac disorders: basic peripheral vascular procedures arteriotomy, venotomy, anastomosis 1
27. Acquired cardiac disorders: portocaval shunts and anomalies 1

Practical

1. Instrumentation and suture techniques for cardiovascular surgery 2
2. Vascular prostheses 1
3. Anticoagulants 1
4. Surgical approaches to thorax 1
5. Different techniques of thoracotomy 1
6. Hand-on-training of techniques of centesis of thoracic cavity on cadavers 1
7. Hand-on-training of thoracic drain placement 1
8. Demonstration of pericardiocentesis 1

9. Demonstration of pericardiotomy 1
10. Demonstration of cardiac catheterization 1
11. Demonstration of pericardiectomy on cadaver and clinical cases of constructive pericarditis 1
12. Demonstration of cardiac biopsy techniques 1
13. Demonstration of use of IPPV in thoracic surgery 1

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.

VSR 705: Advances in Anaesthesiology (2+1)

S. No. Topics No. of Lectures/Practicals

Theory

Unit I

1. Cellular and molecular mechanisms of anaesthesia 1
2. Effects of anaesthesia on different systems 3

Unit II

3. Drug interactions with anaesthetics 1
4. Pharmacokinetics and pharmacodynamics of anaesthetics 2
5. CRI and TCI, computer assisted anaesthesia 1

Unit III

6. Opioids, alpha-2 agonists and ketamine for epidural anaesthesia 2
7. Acupuncture and electroanaesthesia 1

Unit IV

8. Critical care in ICU 1
9. Pain transmission and processing, methods for pain assessment in animals 1
10. Multimodal and preemptive analgesia 1
11. Techniques and drugs for pain managements 1

Unit V

12. Anaesthesia for selected diseases (cardiovascular dysfunction) 1
13. Anaesthesia for selected diseases (pulmonary dysfunction) 1
14. Anaesthesia for selected diseases (neurologic diseases) 1
15. Anaesthesia for selected diseases (renal diseases) 1
16. Anaesthesia for selected diseases (hepatic diseases) 1
17. Anaesthesia for selected diseases (gastrointestinal diseases) 1
18. Anaesthesia for selected diseases (endocrine diseases, airway diseases) 1

Unit VI

19. Anaesthesia for special patients (ocular patients) 1
20. Anaesthesia for special patients (heart patients) 1
21. Anaesthesia for special patients (caesarian section patients) 1
22. Anaesthesia for special patients (trauma patients) 1
23. Anaesthesia for special patients (neonatal patients) 1
24. Anaesthesia for special patients (geriatric patients) 1

Practical

1. Various procedures for catheterization of heart and great vessels 2
2. Central venous line 1
3. Haemodynamic changes during trials of anaesthetics 2
4. Electrocardiography 1
5. Encephalographic evaluation of central nervous system activity 1
6. Cybernetics 1
7. Data acquisition and retrieval 1
8. Administration and monitoring of newer anaesthetics combinations 6

Suggested Reading

- Aronson LR. 2016. *Small Animal Surgical Emergencies*. Wiley Blackwell.
- Clarke KW, Trim CM and Hall LW. 2013. *Veterinary Anaesthesia*. 11th ed. WB Saunders.
- Grim KA, Lamont LA, Tranquilli WJ, Greene SA and Robertson SA. 2015. *Veterinary Anaesthesia and Analgesia*. 5th ed. Lumb and Jones. Wiley Blackwell.
- Grim KA, Tranquilli WJ and Lamont LA. 2011. *Essentials of Small Animal Anesthesia and Analgesia*. 2nd ed. Wiley Blackwell.
- Paddleford RR. 1999. *Manual of Small Animal Anesthesia*. 2nd ed. WB Saunders.

VSR 706: Advances in Radiology (2+1)

S. No. Topics No. of Lectures/Practicals

Theory

Unit I

1. Biological effects of radiations (alpha, beta, X-ray and gamma rays) *in vivo* and *in-vitro* cellular response following radiation as an immunosuppressive agent 4

Unit II

2. Different kind of projections and positioning, contrast material, different contrast techniques, PACS 4

Unit III

3. Radiography of head region 1
4. Radiography of neck region 1
5. Radiography of thorax 1
6. Lung patterns 1
7. Radiography of abdominal region 1
8. Radiography of pelvic region 1

Unit IV

9. Radiography of limbs for lameness and fracture diagnosis 1
10. Application of image intensifiers in veterinary practice 1
11. Different types of screens 1

Unit V

12. Computerized radiography (CR) 1
13. Digital radiography (DR) 1
14. Contrast CT 1
15. Contrast MRI 1
16. PETCT 1
17. Advances in scintigraphy 1
18. Radiation therapy in cancer patients 1
19. Biological effects of radiation physics 1
20. Physics of radiation, electromagnetic radiations 1
21. Hazards of electromagnetic radiations and protection and bio-safety 2

Practical

1. Radiographic positioning 3
2. Radiation safety measures 1
3. Handling radioactive material 1
4. Clinical radiological diagnosis at Radiology Unit 8
5. Demonstration of advanced radiological techniques 2

Suggested Reading

- Bargai U, Pharr, JW and Morgan JP. 1989. *Bovine Radiology*. Lowa State University Press, Ames.
- Bushong SC. 2017. *Radiologic Science for Technologists*. 11th ed. CV Mosby.
- Gillette EL, Thrall DE and Lebel JL. (Eds.). 1977. *Carlson's Veterinary Radiology*. Lea and Febiger.
- Kealy JK, McAllister H and Graham JP. (Eds.). 2011. *Diagnostic Radiology and Ultrasonography of the Dog and Cat*. 5th ed. WB Saunders, Philadelphia.
- Morgan JP. 1972. *Radiology in Veterinary Orthopaedics*. Lea and Febiger.
- Thrall DE. 2017. *Textbook of Veterinary Diagnostic Radiology*. 7th

ed. Saunders, Philadelphia.

VSR 707: Advances in Diagnostic Imaging Techniques (2+1)

S. No.	Topics	No. of Lectures/Practicals

Theory

Unit I

1. Techniques of ultrasonography for diagnosis of different affections of neck 1
2. Techniques of ultrasonography for diagnosis of different affections of thorax (echocardiography, Doppler techniques 3
3. Techniques of ultrasonography for diagnosis of different affections of abdomen and pelvis (Urinary bladder and prostrate) 1
4. Techniques of ultrasonography for diagnosis of different affections of synovial joints 1
5. Techniques of ultrasonography for diagnosis of different affections of muscle and tendons. 1
6. Techniques of ultrasonography for diagnosis of different affections of eye. 1

Unit II

7. Interpretation of ultrasonogram of different body organs/ Vessels (normal and abnormal) 3
8. Therapeutic applications of ultrasonography for physiotherapy 1

Unit III

9. Imaging modalities like, MRI, CT scan, nuclear medicine, positron emission tomography technique, single-photon emission computed tomography etc 4
10. Nuclear Scintigraphy-isotopes (natural and man-made); cyclotron reactor, half-life, decay pattern, storage and handling of radioactive material 4

Unit IV

11. Methods in the detection of isotopes, Geiger-Mullar tubes, photo-multiplier tube, medical use of isotope, dosimetry 2
12. Nuclear medicine and its use in diagnosis of thyroid 1
13. Nuclear medicine and its use in diagnosis of kidney 1
14. Nuclear medicine and its use in diagnosis of bone 1
15. Nuclear medicine and its use in diagnosis of liver function studies 1
16. Labelling of isotope and biological uses, detonation and fission products, image storage and transfer, DICOM, PACKS and teleinterpretation 3

Practical

1. Hands-on-practice on different visceral organs collected from

slaughter house for ultrasonographic scanning in water tub, dry and wet lab training 6

2. Demonstration and practice on different clinical cases reported for ultrasonography 7
3. Visit to places with facility of other alternate imaging techniques 2

Suggested Reading

- Bargai U, Pharr, JW and Morgan JP. 1989. *Bovine Radiology*. Lowa State University Press, Ames.
- Barr FJ and Gaschen L. 2011. *BSAVA Manual of Canine and Feline Ultrasonography.* British Small Animal Veterinary Association.
- Boon JA. 2011. *Veterinary Echocardiography.* 2nd ed. Wiley-Blackwell.
- Bushong SC. 2017. *Radiologic Science for Technologists*. 11th ed. CV Mosby.
- Butler JA, Colles CM, Dyson SJ, Kold SE and Poulos PW. 2017. *Clinical Radiology of the Horse*. 4th ed. Wiley Blackwell.
- Gillette EL, Thrall DE and Lebel JL. (Eds.). 1977. *Carlson's Veterinary Radiology*. Lea and Febiger.
- Goddard PJ. 1995. *Veterinary Ultrasonography*. CABI.
- Kealy JK, McAllister H and Graham JP. (Eds.). 2011. *Diagnostic Radiology and Ultrasonography of the Dog and Cat*. 5th ed. WB Saunders, Philadelphia.
- Mannion P. 2006. *Diagnostic Ultrasound in Small Animal Practice*. Blackwell Science.
- Mantis P. 2016. *Practical Small Animal Ultrasonography Abdomen*. SERVET, Spain.
- Morgan JP@. 1972. *Radiology in Veterinary Orthopaedics*. Lea and Febiger.
- Nyland TG and Mattoon JS. 2002. *Small Animal Diagnostic Ultrasound*. WB Saunders.
- Thrall DE. 2017. *Text book of Veterinary Diagnostic Radiology*. 7th ed. Saunders, Philadelphia.
- Weisse C and Berent A (Eds.) 2015. *Veterinary Image Guided Interventions*. Wiley Blackwell.

VSR 708: Advances in Orthopaedics (2+1)

S. No. Topics No. of Lectures/Practicals

Theory

Unit I

1. Biomechanics of bone, fracture etiology 1

2. Fracture reduction and different fracture fixation techniques like IM pinning 1
3. Fracture reduction and different fracture fixation techniques like plating 1
4. Fracture reduction and different fracture fixation techniques Like nailing (inter locking nailing) and external skeletal fixation 1
5. Fracture reduction and different fracture fixation techniques like external skeletal fixation 1

Unit II

6. Types, properties, biomechanics and use of different orthopaedic implants 1
7. Bone grafts and their collection, preservation, indications and limitations 1
8. Bone graft substitutes like ceramics and composites, their usage and limitations 1

Unit III

9. Principles of osteogenesis, osteoinduction and osteoconducti 2

Unit IV

10. Advances in internal fixation techniques in veterinary orthopaedics 2
11. Advances in internal fixation techniques in veterinary orthopaedics
12. Advances in external skeletal fixation techniques in veterinary orthopaedics 2
13. Metabolic bone diseases like rickets, osteomalacia, Osteodystrophy and secondary hyperparathyroidism, etc. 2
14. Classification, diagnosis and treatment of arthritis. 3
15. Advances in the management of congenital and acquired disorders of joints like traumatic dislocations, luxations and dysplasia. 2
16. Etiopathology and management of equine lameness including laminitis, navicular disease, quitter, canker and thrush, sand cracks, ring bone, hygromas, bursitis, spavin and splint. 5
17. Affections of muscles, tendons and ligaments 1
18. Joint prosthesis and transplantation 1

Unit V

19. Postoperative management of orthopaedic patients including the role of movement restriction, weight bearing, nutritional therapy, physiotherapy and rehabilitation 2
20. Introduction to recovery assessment using lameness score, gait analysis using computerized software 2

Practical

1. Hands on practice for different internal fixation techniques on cadaver 4
2. Management of different types of long bone fractures in different species of domestic animals, with special reference to practice of bone plating 1
3. Management of different types of long bone fractures in different species of domestic animals, with special reference to practice of interlocking nailing 1
4. Management of different types of long bone fractures in different species of domestic animals, with special reference to practice of external skeletal fixation 1
5. Treatment of metabolic bone diseases in growing animals 1
6. Correction of antebrachial deformities including osteotomies and limb lengthening procedures 1
7. Preservation of bone grafts 1
8. Practice of bone grafting and use of osteoinducers in clinical situation 1
9. Clinical and radiographic evaluation of various joint affections 1
10. Reduction and fixation of different joint luxations like coxo-femoral, patellar, femoro-tibial, hock, scapulo-humeral, elbow and temporomandibular 1
11. Techniques of osteotomy, arthrodesis and joint replacement 1
12. Repair of tendon and ligament injuries 1
13. Diagnosis and treatment of various conditions causing lamenessin equines 1
14. Diagnosis and treatment of various conditions causing lameness in bovines 1

Suggested Reading

- Auer JA and Stick JA. 2017. *Equine Surgery*. 4th ed. Elesvier Saunders.
- Baxter GM. (Ed.). 2011. *Adams and Stashak's Lameness in Horses*. 6th ed. Wiley-Blackwell
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders.
- Greenough PR. 2007. *Bovine Laminitis and Lameness*. WB Saunders.
- Newton CD and Nunamaber DM. (Eds.). 1985. *Textbook of Small Animal Orthopaedics*. JB Lippincott.
- Oehme FW and Prier JE. (Eds.). 1974. *Textbook of Large Animal Surgery*. Williams and Wilkins.
- Ross MW and Dyson SJ. 2011. *Diagnosis and Management of*

Lameness in the Horse. 2nd ed. Elsevier Saunders.
- Tyagi RPS and Singh J. (Eds.). 1993. *Ruminant Surgery*. CBS
- Weaver AD, Jean GS and Steiner A. 2007. *Bovine Surgery and Lameness*. 2nd ed. Wiley-Blackwell.

VSR 709: Neurosurgery (2+1)

S. No.	Topics	No. of Lectures/Practicals
Theory		
	Unit I	
1.	Nervous system – Anatomy, Physiology and Pathological manifestations	5
	Unit II	
2.	Clinical neurology	1
3.	Therapeutic neurectomy	1
4.	Nerve anastomosis	1
5.	Pathogenesis of disease of the central nervous system	1
	Unit III	
6.	Diagnostic methods – electrodiagnostic methods, neuro radiology	4
	Unit IV	
7.	Fundamentals of neurosurgery	1
8.	Surgical approaches to brain	1
9.	Surgical diseases of peripheral nerves	1
10.	Surgical approaches to brain and intracranial surgery	1
11.	Surgical affections and approaches to the spine	2
12.	Diseases of the spinal column	1
13.	Intervertebral disc diseases	1
	Unit V	
14.	Surgical approaches to brain and intracranial surgery	3
Practical		
1.	Methods for clinical and neurological examination	1
2.	Electro-encephalography	1
3.	Electromyography and electro-diagnostic testing	2
4.	Collection of CSF and its evaluation	2
5.	Techniques of myelography	1
6.	Vertebral venography	1
7.	Pneumoventriculography	1
8.	Cerebral arteriography	1
9.	Cavernus sinus venography	1
10.	Management of vertebral fractures and luxations with stabilization	1
11.	Treatment of spinal cord compression, viz., disc fenestration,	

hemilaminectomy, dorsal laminectomy and ventral slot 2

12. Techniques of peripheral nerve anastomosis and reconstructionof peripheral nerves 2

Suggested Reading

- Dewey CW and C da Costa R. 2016. *Practical Guide to Canine and Feline Neurology*, 3rd ed. Wiley Blackwell.
- Lorenz MD, Coastes JR and Kent M. 2011. *Handbook of Veterinary Neurology*, 5th ed. Elsevier.

VSR 710: Reconstructive and Regenerative Surgery (1+1)

S. No.	Topics	No. of Lectures/Practicals

Theory

Unit I

1. Principles of regenerative medicine, tissue homeostasis 1
2. Tissue and organ transplantation, histo-compatibility matching 1
3. Transplantation immunity and host graft reaction, immunosuppression 1

Unit II

4. Classification, isolation, characterization, storage and application of stem cells, extracellular matrix, 3
5. Microenvironment and growth factors for tissue repair and regeneration 1

Unit III

6. Synthetic and biological scaffolds 1
7. Preparation of biological scaffold and its role in tissue regeneration 1
8. Whole organ decellularization and its application, biomimetic scaffolds 1

Unit IV

9. Designing for 3D printing, bio-fabrication of organ and tissue Substitutes and its applications 1
10. Ethical concerns in regenerative medicine 1
11. GMP protocols and its applications in regenerative medicine 1

Unit V

12. Current techniques in designing and clinical application of biomaterials, 2
13. Mechanical and functional testing of biomaterials 1
14. Biocompatibility testing 1

Practical

1. Collection of bone marrow derived stem cells from different species of animals 3

2. Growth and differentiation of stem cells in different lineages 1
3. Decellularization of different tissues and organs 6
4. Cell growth on different scaffolds 3
5. Clinical application of stem cells 3

Suggested Reading

- Bojrab Joseph M, Monnet Eric. 2010. *Mechanisms of Disease in Small Animal Surgery*, 3rd Teton New Media, U.S.
- Griffers D and Hamaide A. (Eds.). 2016. *Complications in Small Animal Surgery*. Wiley Blackwell.
- Theoret C and Schumacher J. 2017. *Equine Wound Management*. Griffon, D and Hamaide A 2016. *Complications in Small Animal Surgery*, Wiley Blackwell.

VSR 611: Advances in Soft Tissue Surgery (2+1)

S. No. Topics No. of Lectures/Practicals

Theory

Unit I

1. Advances in surgeries of ENT affections of small and large animals- rhinoscopy, rhinotomy, tumors of turbinates 1
2. Advances in surgeries of ENT affections of small and large animals- cheiloplasty, hare lip correction, salivary duct ligation, parotid gland abalation 1
3. Advances in surgeries of ENT affections of small and large animals- bullaosteotomy, buccotomy procedures, glossoplagia, self suck correction 1

Unit II

4. Upper respiratory tract affection in small and large animals- barchiochephalic air way syndrome, laryngeal paralysis 1
5. Upper respiratory tract affection in small and large animals- Tracheal collapse, tracheostomy (temporary/ permanent) 1
6. Upper respiratory tract affection in small and large animals- chest trauma, chest tube placement, thoracocentesis 1
7. Upper respiratory tract affection in small and large animals- pneumectomy, (partial/ unilateral), heart lung transplant, thoracic duct ligation 1
8. Upper respiratory tract affection in small and large animals- thoracic duct ligation, trans tracheal intubation, thoracoscopic procedure 1

Unit III

9. Esophageal affections in small and large animals- dilatation, diverticulum, PRAA- Mullers surgery 1
10. Esophageal affections in small and large animals- gastroesophageal intussception, short bowel syndrome 1

11. Esophageal affections in small and large animals- colostomy, megacolon, rectal tube placement 1
12. Esophageal affections in small and large animals- rectal diverticulum, gastroscopy techniques 1

Unit IV

13. Pyelolithotomy, lithotripsy 1
14. Renal transplantation 1
15. Ectopic ureter, prostatectomy, urinary incontinence 1
16. Penile urethosotomy, urethroscopic retrival of urolith, endoscopic ureter stunt placement 1

Unit V

17. Thyroidectomy in cats, liver lobectomy 1
18. Cholelithiasis, cholecystectomy, cholecystoduo denostomy 1
19. Porto caval shunt, adrenalectomy 1

Unit VI

20. Skin grafting, subdermal, axial skeletal, omocervical axial pattern flap 1
21. Thoracodorsal axial pattern flap, superficial brachial axial pattern flap, caudal superficial epigastric axial pattern flap 1
22. Cranial superficial epigastric axial pattern flap, deep circumflex iliac dorsal axial pattern flap 1
23. Deep circumflex iliac ventral axial pattern flap, genicular axial pattern flap 1
24. Reverse saphenous conduit flap, caudal auricular axial pattern flap, 1
25. Split thickness and full thickness grafts 1
26. Reconstructive surgical procedures 1

Practical

1. Endoscopic surgical procedures in small and large animals 1
2. Chest tube placement 1
3. Rhinoscopy 1
4. Thoracoscopy 1
5. Bronchoscopy 1
6. Gastroscopy 1
7. Colonoscopy 1
8. Urethrocystoscopy 1
9. Laparoscopic surgical techniques 2
10. Skin flap and grafting techniques 3
11. Tracheaostomy 1
12. Renal graft cystoplasty 1

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.

- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.
- Yool DA. 2012. *Small Animal Soft Tissue Surgery*. CABI

VSR 712: Advances in Ophthalmology (1+1)

S. No.	Topics	No. of Lectures/Practicals
Theory		
	Unit I	
1.	Embryology of the eye, study of ocular physiology and biochemistry	1
2.	Structure and function of eye and adenexa, physiology of vision, electrophysiology of visual system	1
	Unit II	
3.	Advances in diagnosis and diseases of the eye and adnexia	2
	Unit III	
4.	Ocular neoplasia, advances in neuro ophthalmology	1
5.	Advances in ophthalmic pharmacology, microbiology and nutrition	1
	Unit IV	
6.	Advances in ocular imaging	1
7.	Advances in ocular anaesthesia and analgesia	1
	Unit V	
8.	Advances in ocular emergencies	1
9.	Opthalmology of exotic species	1
10.	Opthalmology of lab animals	1
11.	Ocular toxicology	1
	Unit VI	
12.	Corneal grafting	1
13.	Application of nanotechnology in veterinary ophthalmology	1
14.	Application of stem cell therapy in veterinary ophthalmology	1
Practical		
1.	Exposure to latest ophthalmic instrumentation like phaco	1
2.	Exposure to latest ophthalmic instrumentation like ultrasound	1
3.	Exposure to cataract surgery and lens implantation	10
4.	Corneal transplantation	3

Suggested Reading

- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders
- Gelatt KN. 2014. *Essentials of Veterinary Ophthalmology*. 3rd ed.

Wiley Blackwell. US.
- Gilger BC. 2017. *Equine Ophthalmology*, 3rd ed. Wiley Blackwell.
- Maggs DJ, Miller PE and Ofri R. 2017. *Slatter's Fundamentals of Veterinary Ophthalmology*. 6th ed. Saunders.
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.

VSR 713: Surgical Oncology (1+1)

S. No.	Topics	No. of Lectures/Practicals
Theory		
	Unit I	
1.	Biology of neoplastic disease: etiology, cellular mechanism	1
2.	Principles of surgical oncology	1
	Unit II	
3.	Diagnosis, classification and clinical staging of tumors and decision making for therapy, metastasis	2
	Unit III	
4.	Surgical management: surgical excision of tumors, cytoreductive surgery	1
5.	Surgical management: surgery for metastatic disease, palliative surgery, evaluation and interpretation of surgical margins	1
	Unit IV	
6.	Clinical signs, diagnosis and treatment options of tumors of skin, soft tissues	1
7.	Clinical signs, diagnosis and treatment options of tumors of skeletal system, head and neck	1
8.	Clinical signs, diagnosis and treatment options of tumors of gastro-intestinal tract, respiratory tract	1
9.	Clinical signs, diagnosis and treatment options of tumors of urinary tract, genital tract, mammary gland	1
10.	Clinical signs, diagnosis and treatment options of tumors of nervous system, endocrine system, haematopoietic system	1
11.	Clinical signs, diagnosis and treatment options of tumors of the eye and orbit and miscellaneous tumours	1
	Unit V	
12.	Radiation therapy, chemotherapy	1
13.	Electrochemotherapy, cryotherapy and targeted therapy	1
14.	Side effects of radio and chemotherapy	1
15.	Nutritional management of cancer patients, basics of Immunotherapy in cancer management	1
Practical		
1.	Fine needle aspiration biopsy	1

2. Needle core biopsy 1
3. Excisional biopsy 1
4. Incisional biopsy 1
5. Bone marrow biopsy 1
6. Lymph node biopsy 1
7. Percutaneous lung biopsy 1
8. Bone biopsy 1
9. Ultrasound guided biopsy 1
10. Laparoscope guided biopsy 1

Suggested Reading

- Kudnig ST and Sequin B. 2012. *Veterinary Surgical Oncology*, Wiley Blackwell.
- Fossum TW. 2018. *Small Animal Surgery*. 5th ed. Mosby.
- Fubini SL and Ducharme NG. 2016. *Farm Animal Surgery*. 2nd ed. Saunders.
- Maggs DJ, Miller PE and Ofri R. 2017. *Slatter's Fundamentals of Veterinary Ophthalmology*. 6th ed. Saunders.
- Slatter DH. 2003. *Textbook of Small Animal Surgery*. 3rd ed. WB Saunders.

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Surgery and Radiology

VSR 603: PRINCIPLES OF SURGERY

UNIT I

Classification of wounds, wound healing, mechanism of wound repair, local and systemic factors affecting wound healing, current concepts of inflammation and management, thermal, electrical and chemical injuries and their management.

UNIT II

Asepsis, sterilization and disinfection and principles and practice of antimicrobial therapy in surgical patients.

UNIT III

Shock, classification, pathophysiology, diagnosis, treatment and monitoring, surgical stress and its systemic effects, haemorrhage and haemostasis, acid-base balance, fluid therapy and blood transfusion, metabolism of the surgical patient.

UNIT IV

Principles and clinical applications of laser surgery, cryosurgery, electrosurgery, physiotherapy.

UNIT V

Minimally invasive surgical procedures which includes laproscopy and endoscopy, principles of microscopic surgery-vessel and nerve anastomosis, application of computers in surgery.

VSR 604: ANAESTHESIA AND ANALGESIA

UNIT I

Introduction and history of anaesthesia, general consideration for anaesthesia in animals, properties of ideal anaesthetic agent, types of anaesthesia, anaesssthetic triad, preanaesthetic evaluation of patient and selection of anaessthesia.

UNIT II

Preanaesthetic medication (anticholinergics, sedatives, tranquilizers, alpha-2 agonist, narcotics), muscle relaxants and neuromuscular blocking agents.

UNIT III

General anaesthetics and factors affecting their uptake, distribution and metabolism; injectable anaesthetic agents (properties, dosage and usage); combinations of injectable agents and neuroleptanalgesia, Inhalation anaesthetic agents (properties, methods of administration, dosage and usages), Inhalation anaesthesia equipment and breathing circuits, artificial ventilation.

UNIT IV

Post-operative care of the surgical patient, operating room emergencies, cardio-pulmonary arrest and resuscitation, monitoring of anaesthetic recovery.

UNIT V

Local anaesthetics, their mechanisms, local and regional nerve blocks, spinal

analgesia, intravenous regional anaesthesia, peri-operative and post-operative pain and its management.

VSR 605: DIAGNOSTIC IMAGING TECHNIQUES

UNIT I

Regulations regarding establishment and handling of x-ray units. Requirements for establishment of x-ray units, conventional and digital X-ray machine, x-ray films, cassettes, screen, x-ray production, qualities of x-rays, image formation and dark room procedures, Image plate, formation of radiograph technique chart, artifacts and their prevention, radiographic quality Contrast, density and details), radiographic accessories, radiographic positioning for different organs/parts in small and large animals.

UNIT II

Plain and contrast radiographic techniques of small and large animals, fluoroscopy/C-arm, principles of radiographic interpretation,

UNIT III

Principles of radiation therapy, medical radioisotope curves, radiation laws and regulations. Radiation hazards and monitoring of radiographic exposure to personnel and protection.

UNIT IV

Basic physics of ultrasound waves and image formation, scanning principles of ultrasound, transducers, equipment controls, modes of display, terminology used for echotexture and USG artifacts, application of ultrasound in small and large animals.

UNIT V

Doppler techniques echocardiography and its application, introduction to nuclear imaging techniques, computerized tomography, magnetic resonance imaging, positron emission tomography technique.

VSR 606: SOFT TISSUE SURGERY

UNIT I

Skin, adnexa, integument, appendages, horn, tail, sinus affections of equine and bovine, teat affections, principles of plastic and reconstructive surgery, different types of skin grafts.

UNIT II

Surgical approaches/affections of ear, oral cavity, larynx and pharynx, salivary glands, oesophagus, abdomen, rumen, reticulum, omasum, abomasum, stomach, intestines, rectum, anus, liver and biliary system, pancreas and porto-systemic shunts.

UNIT III

Abdominal hernia, diaphragmatic hernia, perineal hernia, ventral, femoral and umbilical hernia, ritcher hernia, hiatal hernia, omental hernia, pre-pubic tendon rupture, use of biological and synthetic grafts for hernia repair, laparoscopic repair of hernia.

UNIT IV

Principles of thoracic surgery, Functional anatomy of respiratory system, diseases of upper and lower respiratory system, functional anatomy of cardiovascular system and common affections of heart.

UNIT V

Affections of pituitary, adrenals, thyroid, parathyroid glands, Principles of neurosurgery and common surgical affections of nervous system and special sense organs.

UNIT VI

Haemolymphatic system, bone marrow, spleen, tonsils, lymph nodes and lymphatics, thymus.

VSR 607: ORTHOPAEDIC SURGERY

UNIT I

Bone structure and function, growth, response to injury, fractures and luxations, classification of fracture, fracture healing.

UNIT II

Biomechanics of fracture healing, considerations for selection of fixation techniques, treatment of fractures of different bones in companion and farm animals, diseases of bone.

UNIT III

Various affections of the joints, ligaments and tendons and their treatment.

UNIT IV

Spinal affections and injury to axial skeleton.

UNIT V

Conformation of the limb, anatomy of hoof, anatomical, conformational and pathological causes of lameness and allied surgical conditions of fore and hind limbs, rehabilitation of orthopaedic patient.

VSR 609: UROGENITAL SURGERY

UNIT I

Surgical anatomy of urinary and reproductive tract in male and female animals, congenital anomalies of organs of male and female urinary and reproductive system.

UNIT II

Principals of urinary tract surgery, pathophysiology, diagnosis and surgical management of affections of kidney, ureter, urinary bladder and urethra, medical dissolution and prevention of canine uroliths, feline urologic syndrome, surgical management of urolithiais in ruminants and its prevention, management of uroperitoneum and renal failure.

UNIT III

Pathogenesis, clinical symptoms, diagnosis and surgical management of vaginal and uterine prolapse, rectovaginal fistula, pneumovagina, vaginal tumours, pyometra, cysts of Gartner’s canal and vestibular glands.

UNIT IV

Surgical conditions of penis, prepuce, prostate and testicles, cryptorchidism,

inguinal and scrotal hernia, affections of teat and udder.

UNIT V

Indications, techniques and postoperative complications of episiotomy, ovariectomy, ovariohysterectomy and caesarean section, pyomerta and its surgical treatment.

UNIT VI

Castration, vasectomy, cauda epididymectomy and penile deviation.

VSR 610: OPHTHALMOLOGY

UNIT I

Anatomy and physiology of eye and its adnexa, ophthalmic examination and diagnosis, diagnostic instrumentation, anaesthesia and surgery.

UNIT II

General consideration for eye surgery in companion and farm animals, therapeutic agents for eye diseases and surgery of eye lids, lacrimal apparatus, naso-lacrimal duct.

UNIT III

Diseases of conjunctiva, cornea, sclera, iris, orbit, lens, vitreous and aqueous humor, retina and optic nerve, eye tumours, enucleation, exenteration.

UNIT IV

Ocular manifestations of systemic diseases.

UNIT V

Neuro-ophthalmology and ocular emergencies.

VSR 611: DENTISTRY AND ORAL SURGERY

UNIT I

Anatomy, development of teeth (odontogenesis), dentition and aging of different species.

UNIT II

Clinical examination of oral cavity, dental anesthesia and pain management, dental
radiography.

UNIT III

Diseases of oral cavity and teeth, congenital and developmental anomalies of oral cavity, abnormal tooth eruption, irregular wear of teeth in companion and farm animals, occlusion and malocclusion, mandibular fracture, malformation of mandible, maxilla (cleft palate).

UNIT IV

Acquired diseases of teeth (halitosis, dental caries, fracture of teeth, dental materials and dental radiography), oronasal fistula, maxilla and mandibular fractures repair, orthodontics, tumors and other acquired condition of oral cavity.

UNIT V

Exodontics, restorative dentistry, periodontal disease, tooth extraction, gum diseases. Endodontics, pulpectomy, root canal therapy, current techniques in dentistry.

Veterinary Medicine

DEPARTMENT OF VETERINARY MEDICINE
Course Structure for M.V.Sc degree programme (Semester Wise)

Course Code	Course Title	Credit Hours	Semester
VMD 601*	RUMINANT MEDICINE-INTERNAL	3+0	I
VMD 602*	RUMINANT MEDICINE-INFECTIOUS	3+0	II
VMD 603*	EQUINE MEDICINE	2+0	I
VMD 604*	CANINE AND FELINE MEDICINE-I	2+0	I
VMD 605*	CANINE AND FELINE MEDICINE-II	2+0	II
VMD 606*	METABOLIC AND ENDOCRINE DISEASES, NUTRITIONAL DEFICIENCIES AND DISEASES OF MAMMARY GLAND	2+0	I
VMD 607	PAEDIATRICS AND GERIATRICS	2+0	II
VMD 608	AVIAN AND SWINE MEDICINE	2+0	I
VMD 609	ZOO, WILD AND LABORATORY ANIMAL MEDICINE	1+0	II
VMD 610	TOXICOLOGY AND FORENSIC MEDICINE	1+0	I
VMD 611*	CLINICAL DIAGNOSTIC TECHNIQUES	0+2	I
VMD 612	EMERGENCY MEDICINE	0+2	II
VMD 613	DIAGNOSIS OF VETERINARY INFECTIOUS DISEASES	0+1	I
VMD 614	ONCOLOGY AND ETHNO-VETERINARY MEDICINE	1+0	II
VMD 615	ANIMAL DISEASE INVESTIGATION AND BIOSECURITY	1+1	II
VMD 616*	CLINICAL PRACTICE-I	0+3	I
VMD 617	CLINICAL PRACTICE-II	0+3	II
VMD 691*	MASTER'S SEMINAR	1+0	I & II
VMD 699	MASTER'S RESEARCH	0+30	I & II
*Compulsory courses			

DEPARTMENT OF VETERINARY MEDICINE
Course Structure for Ph.D degree programme (Semester Wise)

Course Code	Course Title	Credit Hours	Semester
VMD 701*	FARM ANIMAL GASTROENTEROLOGY	2+0	I
VMD 702	FARM ANIMAL CARDIOPULMONARY AND URINARY SYSTEM DISEASES	2+0	II
VMD 703	FARM ANIMAL NEUROLOGICAL AND MUSCULOSKELETAL SYSTEM DISEASES	1+0	I
VMD 704	FARM ANIMAL NEONATOLOGY	1+0	II
VMD 705	HERD HEALTH MANAGEMENT	2+1	I
VMD 706	CANINE AND FELINE GASTROENTEROLOGY	2+0	II
VMD 707	ADVANCES IN NEUROLOGICAL AND MUSCULOSKELETAL SYSTEM DISEASES OF CANINE AND FELINE	1+0	I
VMD 708*	CANINE AND FELINE CARDIOPULMONARY AND URINARY SYSTEM DISEASES	1+0	I
VMD 709*	DERMATOLOGY AND ENDOCRINOLOGY	1+0	II
VMD 710	CANINE AND FELINE EYE AND EAR DISEASES	1+0	II
VMD 711	VETERINARY DIAGNOSTICS	0+2	I
VMD 712	METABOLIC AND NUTRITIONAL DEFICIENCY DISEASES	2+0	I
VMD 713*	EMERGENCY AND CRITICAL CARE MEDICINE	1+1	I
VMD 714	EMERGING AND RE-EMERGING ANIMAL DISEASES	2+0	II
VMD 715*	PREVENTION AND CONTROL OF INFECTIOUS DISEASES OF RUMINANTS	2+0	II
VMD 716*	CLINICAL PRACTICE-I	0+2	I
VMD 717	CLINICAL PRACTICE-II	0+2	II
VMD 718	CLINICAL PRACTICE-III	0+2	II
VMD 791*	DOCTORAL SEMINAR-I	1+0	I & II
VMD 792*	DOCTORAL SEMINAR-II	1+0	I & II
VMD 799	DOCTORAL RESEARCH	0+75	I & II
*Compulsory courses			

Course Contents M.V.Sc. in Veterinary Medicine

I. **Course Title : Ruminant Medicine - Internal**
II. **Course Code : VMD 601**
III. **Credit Hours : 3+0**
IV. **Aim of the course**

Internal diseases of Digestive, Respiratory, Urinary, Cardiovascular, Blood and blood forming organs, Nervous, Musculoskeletal system, Skin, eye and ear of bovine, Sheep, and goat.

V. **Theory**

Unit I

Examination of alimentary tract and abdomen; Diseases of the buccal cavity and related organs including pharynx, Oesophagus. Reticulo-ruminal fermentative disorders (simple indigestion, impaction, ruminal lactic acidosis), Primary and secondary bloat, Diaphragmatic hernia, Traumatic reticulo-peritonitis and Omasal impaction.

Unit II

Diseases of abomasum (impaction, displacements, ulcers, bloat), Acute and chronic diarrhoea, Intestinal obstructive disorders (intussusception, volvulus), Peritonitis, caecal dilatation and hemorrhagic bowel syndrome.

Unit III

Manifestations of liver and biliary diseases, Focal and diffuse diseases of liver. Disease of nasal cavity, sinuses, disease of larynx and trachea, pneumonias, pleuritis, manifestations Principles of treatment in uro-genital system; Rupture, Paralysis and infections of urinary bladder, Urolithiasis, Nephritis and renal failure, Nephrosis, renal ischemia, Hemolytic uremic like syndrome, Uremia and neoplasms of urinary tract.

Unit IV

Examination of cardiac system and Special examination of heart (ECG, echocardiography, Markers for diagnosis of cardiac disorders. Principal manifestations of cardiovascular diseases, congenital cardiac diseases, myocarditis), cardiomyopathy, endocarditis, pericarditis, phelebitis, thrombosis, anemia, lymphangitis,

lymphadenopathies and thrombocytopenia.

Unit V

Principles of nervous dysfunction, Clinical manifestation and special examination, Localization of lesion in brain and spinal cord, Cortical diseases, Brain abscess, Meningitis, Diseases of brainstem, Cerebellar diseases, Spinal cord compression and peripheral nerve paralysis. Principal manifestations and special examination of musculoskeletal system, Myositis, Myopathies, Foot lameness, Arthritis, Osteodystrophies, Degenerative joint disease and nutritional deficiency diseases affecting musculoskeletal system; conjunctivitis, Keratitis, uveitis, Horner syndrome, neoplasms of eye, otits media, otitis externa; Skin diseases: folliculitis, furunculosis and skin neoplasms.

I. **Course Title : Ruminant Medicine-infectious**

II. **Course Code : VMD 602**

III. **Credit Hours : 3+0**

IV. **Aim of the course**

Bacterial, fungal, chlamydial, viral, parasitic, mycoplasmal, prions and rickettsial diseases of bovine, sheep, and goat.

V. **Theory**

Unit I

Clostridial diseases-black quarter, Botulism, Bacillary hemoglobinuria, Braxy, Enterotoxemia, Malignant edema, Pulpy kidney disease, Tetanus, Collibacilosis, Salmonellosis, Compylobacteriosis, Listeriosis, Actinobacillosis, Actinomycosis, Anthrax, Tuberculosis, Johne's disease, Leptospirosis, Pasteurellosis, Ulcerative lymphangitis, Infectious bovine keratoconjuctivitis, Chlamydiosis infections, Dermatophytosis, Cutaneous streptothricosis, Candidiasis and Rhinosporidiosis.

Unit II

Foot and mouth disease, Vesicular stomatitis, Vesicular exanthema, Rinderpest, PPR, Bovine viral diarrhea, Mucosal disease, Ephemeral fever, Bovine herpes viral diseases, Leucosis, Viral pneumonia, Pox diseases, Infectious gastroenteritis of viral etiology. Malignant catarrh fever, Rabies, Bluetongue, Louping ill, Papillomatosis, Contagious ecthyma (orf), Caprine arthritis and Encephalopathy(CAE), Contagious bovine pleuropneumonia and Contagious caprine pleuropneumonia.

Unit III

Bovine spongiform Encephalopathy, Scarpie, Bovine Anaplasmosis, Theileriasis, Babesiosis, Fascioliosis, Amphistomiosis, Gastrointestinal nematodiosis, Schistosomiosis, Lung worm infection, Echinococcosis, Coenurosis and Tapeworm infections, Coccidiosis, Thelaziasis, parasitic dermatitis (scabies, psoroptes).

I. **Course Title : Equine Medicine**
II. **Course Code : VMD 603**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

Internal and infectious diseases of Equines

V. **Theory**

Unit I

Diseases of buccal cavity (dental diseases, stomatitis), Oesophagus, Gastric dilatation, gastro-duodenal ulceration, Acute and chronic diarrhea, Colic, Acute and chronic hepatitis.

Unit II

Diseases of cardio-vascular system and blood forming organs; Manifestations and principles of treatment in respiratory disorders, Epistaxis, Ethmoidal hematoma, pharyngitis, sinusitis, Guttural pouch diseases, Tracheal collapse, Adult pneumonia, foal pneumonia, Recurrent air way obstruction, Inflammatory airway disease, Pleura-pneumonia, Pulmonary congestion and edema; Manifestations and principles of treatment of urinary system diseases, Rupture of urinary bladder, Paralysis, urolithiasis, Urinary tract infections, Acute and chronic renal failure and Neoplasms of urinary tract.

Unit III

Principal manifestations of musculoskeletal diseases, Laminitis, Inflammatory Myopathy, Exertional Myopathies, Myotonia, Hyperkalemic periodic paralysis and Nutritional deficiency diseases affecting musculoskeletal system.

Nervous diseases, Viral encephalitis, Intracarotid drug injection, Trauma to brain and cranial nerves, Brain abscess, Peripheral vestibular disease, Temporo-hyoid osteoarthropathy, Ataxia (sorghum toxicity, spinal abscesses), Peripheral facial nerve paralysis, Peripheral nerve disorders; Skin diseases, bacterial, fungal, parasitic and allergic dermatitis (culicoides hypersensitivity), Cutaneous eczema, Cutaneous acne, Cutaneous pustular

dermatitis, Candidasis, Histoplasmosis, Coccidiodomycosis and dermatophytosis.

Unit IV

Bacterial, fungal and viral keratitis, Equine recurrent uveitis, Uveitis, Ocular neoplasia. Trypanosomiasis/ dourine, Babesiosis, Parasitic pneumonia, Strangles, equine influenza, Equine herpes virus infection, Potomac horse fever, Equine infectious anaemia and setariasis.

I. **Course Title : Canine and Feline Medicine-I**
II. **Course Code : VMD 604**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

Internal (digestive, liver, pancreas, cardiovascular, blood and blood forming organs) and infectious (bacterial, parasitic and protozoal) diseases of dogs and cats.

V. **Theory**

Unit I

Diagnostic approach to common manifestations of disease: Vomiting, acute diarrhea, Chronic diarrhea, Syncope, Anemia, Jaundice, Fever, Weight loss, Edema, Dyspnoea, coughing and nasal discharge.

Unit II

Etiology, pathogenesis, clinical signs, clinical pathology, diagnosis, Differential diagnosis and treatment of diseases of the oral cavity, oesophagus, acute gastritis, chronic gastritis, Gastric dilatation, Volvulus, Tumors of the stomach, Intussusception, Acute enteritis, Chronic enteritis, Inflammatory bowel disease, Colitis, Gastric and Intestinal foreign bodies, Diseases of rectum and anal sac, Peritonitis, Acute hepatitis, Chronic hepatitis, Diseases of gall bladder, Cholangitis, Vascular liver diseases, Extra hepatic biliary system, Acute pancreatitis and Exocrine pancreatic insufficiency.

Unit III

Anemia, Lymphangitis, Lymphadinopathies, Coagulopathies, Immune mediated diseases, Neoplastic diseases of hemo-lymphatic system; Examination of cardiac system and special examination of heart (ECG, Echocardiography, Holter and markers for diagnosis of cardiac disorders), Congenital heart diseases, Dilated cardiomyopathy, Endocardiosis, Cardiac arrhythmias, Pericardial disorders. Pet psychology, Pet behaviour,

Adaptation needs and Behavioural medicine

Unit IV

Leptospirosis, Tetanus, Brucellosis, Lyme disease, Rocky mountain spotted fever, Kennel cough, Trypanosomiasis, Ehrlichiosis, Ancylostomiasis, Dirofilariasis,Giardiasis, Coccidiosis/ Isosporosis, Toxoplasmosis, Babesiosis, Neosporosis, Hepatozonoosis and Tape worm infections.

I. **Course Title : Canine and Feline Medicine-II**
II. **Course Code : VMD 605**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

Internal (respiratory, nervous, urogenital, musculoskeletal, eye, ear and skin) and infectious (viral and fungal) diseases of dogs and cats.

V. **Theory**

Unit I

Principles of treatment in respiratory disorders, Diseases of nasal cavity, Tracheo- bronchitis, Chronic bronchitis, Pulmonary congestion and edema, Acute pneumonia, Chronic pneumonia, Feline asthma, Pleural effusions and Neoplasms of respiratory tract.

Diagnostic approach to common manifestations of disease: Seizures, Coma, Monoparesis, Pelvic limb paralysis, Pruritis, alopecia, Obesity, Urinary incontinence, Hematuria; Focal, diffuse and multifocal diseases of brain. Diseases of spinal cord and Peripheral nervous system, Vestibular diseases and toxins affecting nervous system.

Unit II

Diseases of muscles- congenital and inherited diseases of muscles, bone and joints, Myasthenia, Myopathy; Nutritional deficiency diseases- Rickets, Primary and Secondary Hyperparathyroidism, Osteodystrophy and Osteomyelitis.

Diseases of eyelids, Epiphora, Keratitis, Conjunctivitis, Uveitis, Glaucoma, Acute blindness and Neoplasms of eye.

Unit III

Skin diseases, Common pyodermas, Atopy, Dermatophytosis and Dermatomycosis, Demodicosis, Scabies, Myiasis, and Nutritional disorders related to skin and its therapeutic management, Flea allergy and its treatment and control measures, Alopecia. Cutaneous manifestations of hormonal imbalances and systemic disorders, Auto immune diseases of

skin, Diseases of the pinna, Otitis and principles of treatment in otic infections.

Manifestations and principles of treatment of urinary system diseases, Urinary tract infections, Urolithiasis, Nephritis, Nephrosis, Pyelonephritis, Renal failure and neoplasms of urinary tract.

Viral diseases: Canine parvovirus, Canine distemper, Corona viral gastroenteritis, Infectious hepatitis, Infectious tracheobronchitis, Canine herpes virus, Rabies, Feline Panleukopenia, Infectious peritonitis (FIP), Feline leukemia virus infection, Feline immunodeficiency virus, Vaccination schedule for canine and feline diseases, Dermatophytosis, Blastomycosis, Histoplasmosis, Sporotrichosis, and coccidioidomycosis.

I. **Course Title : Metabolic and Endocrine Diseases, Nutritional Deficiencies and Diseases of Mammary Gland**

II. **Course Code : VMD 606**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

Study of diagnosis, management and control of metabolic, endocrine, nutritional and mammary gland diseases.

V. **Theory**

Unit I

Metabolic profile test parturient paresis, Downer cow syndrome, Acute hypokalemia in cattle, Transit recumbency, Lactation tetany of mares, Hypomagnesemia, Tetany of calves, Ketosis, sub-clinical ketosis, Pregnancy toxemia, Fatty liver syndrome, Equine hyperlipidemia, Steatitis, Neonatal hypoglycemia, low milk fat syndrome, Peri-parturient hemoglobinuria and Eclampsia in bitches.

Unit II

Deficiency of energy and protein, Deficiency of fat and water soluble vitamins and deficiency of macro- micro minerals.

Unit III

Mastitis, Diseases of teats and udder in ruminants, “mastitis-metritis-agalactia” in sow and congenital abnormalities of udder and teats.

Unit IV

Diabetes mellitus, Diabetes insipidus, Hypothyroidism, Obesity, Hypo- and hyperadrenocorticism.

I. **Course Title : Paediatrics and Geriatrics**

II. **Course Code : VMD 607**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

Study of non-infectious and infectious diseases of neonates and geriatric animals.

V. **Theory**

Unit I

Perinatal management, Perinatal adaptation, Neonatal health, Asphyxia and Resuscitation; Physical examination of the neonate, perinatal and neonatal mortality, Colostrum and its substitutes, Manifestations of disease. Immunization of neonates, Fluid replacement therapy, Nutritional support, Blood and Serum transfusion, Antimicrobial therapy and neonatal diarrhoea.

Unit III

Non-infectious and infectious diseases of viral, bacterial, mycoplasma and parasitic origin of neonates, Young and aged farm and companion animals; Diseases acquired from dam, Congenital disorders, Metabolic disorders, Nutritional deficiencies, Miscellaneous conditions (hypothermia, hyperthermia, starvation, arthritis), Management of shock and other emergencies, Detection and correction of failure of passive transfer of immunity.

Unit IV

Geriatric diseases: Senility, Dental diseases, Glaucoma, Cataract, Keratitis sicca, Urinary incontinence, Renal insufficiency, Cardiac diseases, Pulmonary diseases, Neoplasia, Bone and joint diseases, Neurologic disorders, Otologic disorders, Endocrine diseases (diabetes mellitus, cushing's disease, hypothyroidism), Liver diseases, Psychological and behaviour disorders.

I. **Course Title : Avian and Swine Medicine**

II. **Course Code : VMD 608**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

Recent concepts in non-infectious and infectious diseases of avian species and pigs.

V. **Theory**

Unit I

Specific needs of avian species; Diseases due to deficiency of vitamins (vitamins A, B complex, C, D, E, K); minerals

(calcium, phosphorus, manganese, zinc, etc.) and sodium chloride.

Unit II

Miscellaneous diseases/ conditions/ vices (cage layer fatigue, beak necrosis, blue comb disease, round heart disease, kerato- conjunctivitis, ascites, urolithiasis, fatty liver, kidney hemorrhagic syndrome, heat stroke, cannabalism, vent picking), egg bound peritonitis, diseases of feather, skin, beak and foot, bumble foot, gout, infectious diseases of poultry (marek's disease, lymphoid leukosis, new castle disease, infectious coryza, fowl typhoid, CRD, pullorum disease, cocciodiosis, chlamydiasis, avian pox, infectious bursal disease, infectious bronchitis, infectious laryngo- tracheitis, etc.)

Unit III

Nutritional deficiency diseases of pigs, swine influenza, hog cholera, african swine fever, swine pox, vesicular exanthema, vesicular stomatitis, rabies. porcineenteroviruses, pseudorabies, listeriosis, leptospirosis, brucellosis, salmonellosis, swine erysipelas, pasteurellosis, tuberculosis, mange, etc.

Unit IV

anthrax,Handling, physical examination, sampling, diagnostic techniques and medication.

I. **Course Title : Zoo, Wild and Laboratory Animal Medicine**
II. **Course Code : VMD 609**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

Study of diagnosis, management and control of Zoo, wild and laboratory animals.

V. **Theory**

Unit I

Study of diseases and health management of zoo, Wild and laboratory animals; Etiology, Clinical signs, Diagnosis and management of various diseases of zoo, wild and laboratory animals. Restraint, Feeding, Diseases and health management of exotic animals kept as pets.

Unit II

Specific diseases of laboratory animals caused by bacteria, viruses, fungi and parasites.

Specific diseases of zoo (captive) animals caused by bacteria, viruses, fungi and parasites.

I. **Course Title : Toxicology and Forensic Medicine**
II. **Course Code : VMD 610**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

Study of diseases caused by physical, chemical, other toxicants in domestic animals and animal welfare issues.

V. **Theory**

Unit I

Diseases caused by physical agents and poisoning of organic and inorganic compounds. Diseases caused by farm chemicals and phytotoxins. Diseases caused by mycotoxins and zootoxins.

Unit II

Collection, Dispatch and Examination of vetro-legal samples. Examination of wounds, blood, offenses and frauds in animal sales. Animal cruelty and welfare related issues. Study of common laws related to vetro-legal aspects.

I. **Course Title : Clinical Diagnostic Techniques**
II. **Course Code : VMD 611**
III. **Credit Hours : 0+2**
IV. **Aim of the course**

To impart training on diagnostic procedures for various diseases of farm and companion animals and their interpretations.

V. **TheoryUnit I**

Peritoneal fluid analysis, Gastrointestinal endoscopy, Colonoscopy, Proctoscopy,
Ultrasonography, Liver biopsy, Interventional imaging, Rhinoscopy, Brochoscopy, Transtracheal lavage, Endotracheal lavage, Broncho-alveolar lavage, Thoracocentesis, Pericardiocentesis, Interpretation of hemogram, Renal and Hepatic function tests. Neurological examination.

Unit II

Electrocardiography, Echocardiography, Pulse oximetry, Blood and blood component therapy, Bone marrow biopsy, Arterial blood gas analysis, Cerebrospinal fluid analysis, Cystocentesis, Urinary catheterization, Renal function tests, Specific gravity of urine by refractometer, Skin-biopsy, Cytology- scrapings, Otoscopy, Direct and indirect ophthalmoscopy, Shirmer tear test, Tonometry. Diagnosis

tests in mastitis. Assay for T_3, T_4, lipase, Amylase, Radio immunoassay and indications of CT, MRI, nuclear medicine.

I. **Course Title : Emergency Medicine**
II. **Course Code : VMD 612**
III. **Credit Hours : 0+2**
IV. **Aim of the course**

Diagnosis and management of common emergencies in animals.

V. **Practical**

- Diagnosis and therapeutic management of various emergencies of cardiovascular, respiratory, gastrointestinal, urinary and nervous systems.
- Diagnosis and therapeutic management of various emergencies of toxicities, sting bites, snake bite and burns in farm and companion animals.
- Monitoring critical ill patient, application of emergency care procedures for resuscitation of critically ill patients.
- Placement of central venous catheters, introsseous fluid administration, endotracheal intubation, gastric lavage, decompression of guttural pouch, stomach, cecum, ventilation, nebulization, fluid therapy, CPR, oxygen therapy, enteral nutrition, nasogastric intubation, Blood transfusion

I. **Course Title : Diagnosis of Veterinary Infectious Diseases**
II. **Course Code : VMD 613**
III. **Credit Hours : 0+1**
IV. **Aim of the course**

Concepts and diagnostic tests in veterinary infectious diseases.

V. **Practical**

- Sampling techniques for collection of samples during research;
- Sensitivity and specificity of diagnostic tests including false positive and false negative tests. Mastitis diagnostic tests;
- Culture and staining techniques;
- Diagnosis of fungal diseases, protozoan and rickettsial diseases, fecal examination for endoparasites, skin scrapping examination for mites, fleas and lice;
- ELISA, PCR, culture sensitivity tests on milk and other body fluids, molecular techniques and types of PCR, Molecular epidemiology tools including RFLP, etc.

I. **Course Title : Oncology and Ethno-veterinary Medicine**

II. **Course Code : VMD 614**

III. **Credit Hours : 1+0**

IV. **Aim of the course**

Study of diagnosis and management of tumors, natural remedies and alternative systems of medicine.

V. **Theory**

Unit I

Tumors related to different systems - biology and pathogenesis of cancer, diagnostic procedures, oncology medicine, chemotherapy, radiation therapy, immuno-therapy and miscellaneous therapeutic measures, including advancements of therapeutic approaches, supportive care for the cancer patient.

Unit II

Natural remedies and products for use towards therapy in animal ailments.

Unit III

Acupuncture, physiotherapy, laser therapy, nutraceuticals and dietary supplements.

I. **Course Title : Animal Disease Investigation and Biosecurity**

II. **Course Code : VMD 615**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

Concepts in investigation of infectious diseases and their prevention.

V. **Theory**

Unit I

Investigation and diagnosis on dead and live diseased animal (s) and poultry. Point source epidemics and propagating epidemics, Collection, Preservation and transport of material in the face of disease outbreak, and processing of material in the laboratory for diagnosis; Recording and analysis of epidemiological data. Establishing working hypothesis and formulating and advising and/ or implementing treatment, control and prevention measures.

Unit II

Biosecurity definition, Related concepts, Principles and basic components of biosecurity, Physical and operational elements of biosecurity. Routes of entry and transmission dynamics of pathogens. Shedding pattern of pathogens by infected animals and their survival in the environment.

Protection of susceptible animals, interruption of pathways of transmission, role of disinfection to break cycle of infection. Sterilization, fumigation and disinfection methods, disinfectants and its classification, Microbial resistance to disinfectants, Risk assessment and its management. Principles of biosecurity in laboratory animal house, Biosecurity measures for collection of specimen from wild animals. Biosecurity in research laboratories. Vaccines-success stories of disease eradication through vaccination.

VI. **Practical**

- Isolation and identification of field isolates and vaccine strains by conventional, immunoassays and molecular techniques.
- To perform an outbreak investigation of infectious diseases and toxicological conditions in livestock and poultry in the field/ organised livestock farms.
- Practical use of disinfectants in destruction of microbes in laboratory and under field conditions. Determination of efficacy/ phenol coefficient of commonly used disinfectants.
- Approaches in animal disease control and eradication. Preliminary steps to control animal disease outbreaks.
- Types of vaccines, vaccination schedule in livestock, pets and poultry

I. **Course Title : Clinical Practice-I**

II. **Course Code : VMD 616**

III. **Credit Hours : 0+3**

IV. **Aim of the course**

Application of the theoretical concepts in practice.

V. **Practical**

- Diagnostic and therapeutic protocol application, specimen collection, examination and management of sick farm and companion animals, use of diagnostic techniques for diagnosis of medicinal cases, acquaintance with different equipment, client management, public relations, code of conduct, hospital management, database management and maintenance of case records, disaster management
- Note: This course shall be conducted in Veterinary Clinical Complex (VCC), where students shall participate in diagnosis and treatment of diseased animals.

I. **Course Title : Clinical Practice-II**
II. **Course Code : VMD 617**
III. **Credit Hours : 0+3**
IV. **Aim of the course**

Application of the theoretical concepts in practice.

V. **Practical**

- Diagnostic and therapeutic protocol application, specimen collection, examination and management of sick farm and companion animals, use of diagnostic techniques for diagnosis of medicinal cases, acquaintance with different equipment, client management, public relations, code of conduct, hospital management, database management and maintenance of case records, disaster management.
- **Note:** This course shall be conducted in Veterinary Clinical Complex (VCC), where students shall participate in diagnosis and treatment of diseased animals.

Course Outline: Lecture wise

VMD 601: Ruminant Medicine-internal 3+0

S. No.	Topics	No. of Lectures
1.	Examination of alimentary tract and abdomen	1
2.	Diseases of the buccal cavity and related organs including pharynx, oesophagus	2
3.	Reticulo-ruminal fermentative disorders (simple indigestion, impaction, ruminal lactic acidosis, alkalosis)	2
4.	Primary and secondary bloat, diaphragmatic hernia	1
5.	Traumatic reticulo-peritonitis, vagal indigestion syndrome, generalised peritonitis vagal indigestion syndrome, generalised peritonitis andomasal impaction	1
6.	Diseases of abomasum (impaction, displacements)	2
7.	(Acute and chronic diarrhoea), hemorrhagic diarrhea	2
8.	Intestinal obstructive disorders (intussusception, volvulus), strangulation	2
9.	Caecal dilatation and volvulus	1
10.	Manifestations of liver and biliary diseases	1
11.	Focal and diffuse diseases of liver, fatty liver syndrome	1
12.	Principle of treatment of respiratory diseases, respiratory insufficiency, anoxias, diseases of nasal cavity, sinuses, diseases of larynx and trachea	2
13.	Epistaxis, hemoptysis, congestion and edema of lungs, hydro and hemothorax	1
14.	Pneumonias and pleuritis	2

15. Manifestations and principles of treatment in uro-genital system; rupture, paralysis 1
16. Infections of urinary bladder 1
17. Urolithiasis, nephritis and renal failure, nephrosis 2
18. Hemolytic uremic like syndrome, uremia and neoplasms of urinary tract 1
19. Examination of cardiac system and special examination of heart (ECG, echocardiography disorders) 1
20. Principal manifestations of cardiovascular diseases 1
21. Congenital cardiac diseases, Myocarditis 1
22. Cardiomyopathy, endocarditis, pericarditis 1
23. Phlebitis, thrombosis, anemia, lymphangitis, lymphadenopathies and thrombocytopenia, lymphosarcoma 2
24. Principles of nervous dysfunctions, clinical manifestation SOL special examination 1
25. Localization of lesion in brain and spinal cord 2
26. Cortical diseases, brain abscess, SOL, meningitis, diseases of brainstem, cerebellar diseases 2
27. Spinal cord compression, peripheral nerve paralysis, Horner Syndrome, facial nerve paralysis 2
28. Principle manifestations and special examination of musculoskeletal system 1
29. Foot lameness, arthritis, osteodystrophies, degenerative joint disease and nutritional deficiency diseases affecting musculoskeletal system 3
30. Diseases of eyes, neoplasms of eyes 1
31. Conjunctivitis, keratitis, uveitis 1
32. Diseases of pinna, otits media, otitis externa 2
33. Skin diseases: folliculitis, furunculosis, and skin neoplasms, skin tumors 1

Suggested Books

- Bradford Smith, David Van Metre, Nicola Pusterla. 2019. *Large Animal Internal Medicine*. 6th Edition, Mosby.
- Neil V Anderson, 1992. *Veterinary Gastroenterology*. 2nd Revised edition, Lea and Febiger, USA.
- Simon F Peek, Thomas J Divers. 2018. *Rebhun's Diseases of Dairy Cattle*. 3rd Edition, Elseviers.
- Research and Review Papers in Current Journals.

VMD 602: Ruminant Medicine-infectious 3+0

S. No. Topics No. of Lectures

1. Principles of prevention and control of infectious diseases 1

2. Anthrax 1
3. Brucellosis 1
4. Mastitis 1
5. Foot rot/ Joint ill 1
6. Black quarter/ Braxy 1
7. Tetanus 1
8. Enterotoxemia 1
9. Bacillary haemoglobinuria 1
10. Botulism 1
11. Colibacillosis 1
12. Pasteurellosis/ Hemorrhagic septicemia 1
13. Tuberculosis 1
14. Paratuberculosis 1
15. Listeriosis 1
16. Leptospirosis 1
17. Acitnomycosis/ Actinobacillosis 1
18. Ringworm 1
19. Systemic mycotic infections (Aspergillosis, candidiasis, histoplasmosis, sporotrichosis, coccidiodomycosis, mycotoxicosis) 1
20. Dermatophilosis 1
21. Campylobacteriosis 1
22. Salmonellosis 1
23. Contagious bovine pleuropneumonia 1
24. Contagious agalactia 1
25. Anaplasmosis 1
26. Chlamydiosis, Q fever, ehrilichiosis 1
27. Blue tongue 1
28. Sheep and goat pox 1
29. Peste des petits ruminants 1
30. Scrapie, louping ill 1
31. Maedi, visna, jagaskiae disease 1
32. Rift valley fever 1
33. Rinderpest 1
34. Bovine viral diarrhea 1
35. Malignant catarrhal fever 1
36. Infectious bovine rhinotracheitis 1
37. Enzootic bovine leucosis 1
38. Ephemeral fever 1
39. Foot and mouth disease 1
40. Rabies 1
41. Principles of control of parasitic diseases 1
42. Amphistomosis 1

43. Fascioliosis 1
44. Gastrointestinal nematodiasis, schistosomosis 1
45. Echinococcosis, tapeworm (cysticercosis) 1
46. Verminous bronchitis, coeneurosis, 1
47. Trypanosomosis, babesiosis 1
48. Theileriosis, hepatozoonosis 1

Suggested Books

- *Dairy Herd Health*. 2012. MJ Green, Andrew J. Bradley. CABI Publishing.
- *Merck's Veterinary Manual* K. 2016. Susan E Aiello, Michael A Moses. (11th Edition). Merck Sharp and Dohme
- *Veterinary Medicine* 2016. Peter Constable, Kenneth W Hinchcliff, Stanley Done, Walter Gruenberg. 11th Edition. Saunders Ltd.
- Research and Review Papers in Current Journals.

VMD 603: Equine Medicine (2+0)

S. No.	Topics	No. of Lectures
1.	Manifestations and principles of treatment of gastrointestinal diseases	1
2.	Diseases of the buccal cavity and oesophagus	2
3.	Gastric dilation and rupture, gastro-duodenal ulceration	1
4.	Diseases of the intestine (colic, duodenitis-proximal jejunitis, acute and chronic diarrhea	3
5.	Diseases of liver	1
6.	Diseases of the pericardium, myocardium and endocardium	2
7.	Cardiac arrhythmias, thrombosis	1
8.	Purpura haemorrhagica, immune-mediated thrombocytopenia of the neonates, neonatal isoerythrolysis	1
9.	Sinusitis, ethmoidal hematoma, guttural pouch tympany/ empyema/ mycosis, pharyngitis, recurrent laryngeal neuropathy	2
10.	Pneumonia and pleuropneumonia,	2
11.	Inflammatory airway disease	1
12.	Recurrent airway obstruction	1
13.	Acute renal failure and chronic renal failure	1
14.	Urinary tract infections	1
15.	Exertional myopathy/ Tying up syndrome, myositis	1
16.	Hyperkalemic periodic paralysis, narcolepsy, myotonia	1
17.	Osteodystrophies	1
18.	Encephalitis, meningo-encephalitis	2
19.	Facial nerve paralysis, radial nerve paralysis, sciatic nerve	

paralysis, femoral nerve paralysis, polyneuritis equi (cauda equine neuritis) 1

20. Bacterial dermatitis (Dermatophilosis, furunculosis, cellulitis, ulcerative lymphangitis, fistulous withers, bacterial psuedomycosis (botryomycosis) 1
21. Viral skin diseases 1
22. Allergic dermatitis: Culicoides hypersensitivity, eosinophilic granuloma, anhidrosis, equine sarcoidosis 2
23. Fungal skin diseases 1
24. Parasitic skin diseases- habronemiasis, onchocerciasis 1

Suggested Books

- *Equine Internal Medicine*. 2017. Stephen Reed, Warwick Bayly, Debra Sellon, 4th Edition, Elsevier, Saunders.
- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre, Nicola Pusterla, 6th Edition, Mosby
- Research and Review Papers in Current Journals.

VMD 604: Canine and Feline Medicine-I (2+0)

S. No.	Topics	No. of Lectures
1.	Diagnostic approach to manifestations of gastrointestinal disorders	2
2.	Disorders of oral cavity, pharynx and oesophagus	1
3.	Common disorders of stomach	1
4.	Disorders of small intestine	1
5.	Disorders of large intestine, rectum and anus	1
6.	Diagnostic approach to manifestations of hepato-biliary diseases	2
7.	Hepato-biliary diseases of dogs and cats	1
8.	Exocrine pancreatic disorders of dogs and cats	1
9.	Diagnostic approach to manifestations of hemo-lymphatic disorders	2
10.	Disorders of hematopoietic system	1
11.	Disorders of lymphatic system	1
12.	Diagnostic approach to manifestations of cardiac diseases	1
13.	Congenital heart diseases	1
14.	Acquired valvular diseases, myocardial and pericardial diseases	1
15.	Behaviour disorders of canine and feline	1
16.	Polysystemic protozoal infection of dogs and cats (Hepatozoonosis, babesiosis, trypanosomiasis, neosporosis, toxoplasmosis)	2
17.	Polysystemic rickettsial diseases of dogs and cats (Ehrlichiosis,	

lyme disease and rocky mountain spotted fever) 2

18. Important bacterial diseases of canine and feline (Leptospirosis, tetanus, brucellosis and kennel cough) 2
19. Endoparasitic infestation of dogs and cats 1
20. Viral diseases of dogs (Canine parvo viral gastroenteritis, canine distemper, corona virus infection, Infectious hepatitis, Infectious trachebronchitis, canine herpes virus and rabies) 3
21. Viral diseases of cats (Feline panleukopenia, feline infectious peritonitis, feline leukemia virus, feline immunodeficiency virus) 2
22. Fungal diseases of dogs and cats 1
23. Vaccination schedule of dogs and cats 1

Suggested Books

- *Small Animal Internal Medicine* 2013. Nelson and Couto, 5th edition, Elesvier Mosby, St. Louis, Missouri
- *Text book of Veterinary Internal Medicine* 2001. Part I and II, Ettinger and Feldman, 7th Edition, *Publisher*: Saunders
- *Small Animal Medical Diagnosis* 2009. MD Lorenz, TM Neer and PL Demars, 3rd Edition, Willey Blackwell, Iowa, USA.
- Research and Review Papers in Current Journals.

VMD 605: Canine and Feline Medicine-II (2+0)

S. No.	Topics	No. of Lectures
1.	Clinical manifestations of upper and lower respiratory tract disorders	1
2.	Canine infectious tracheobronchitis, chronic bronchitis in dogs, feline bronchitis	1
3.	Pneumonia (viral, bacterial, fungal), pulmonary neoplasia, pulmonary edema	1
4.	Diagnostic approach to pleural effusions	1
5.	Diagnostic approach to diseases of nasal cavity	1
6.	Principles of therapeutic management of respiratory tract disorders	1
7.	Clinical manifestations of urinary tract disorders	1
8.	Acute and chronic renal failure	1
9.	Canine and feline urinary tract infections	1
10.	Disorders of micturition	1
11.	Neoplasms of urinary tract	1
12.	Neurological manifestations of systemic diseases	1
13.	Diagnostic approach to seizures, ataxia, paresis and paralysis	

1

14. Inflammatory brain disorders (bacterial, viral, protozoal, mycotic, parasitic) 2
15. Diseases of spinal cord (osteomyelitis, intervertibral disc disease) 1
16. Disorder of peripheral nerves (developmental and congenital disorders, metabolic and toxic disorders, inflammatory and immune mediated neuropathies) 2
17. Joint diseases of dogs and cats (Non inflammatory and inflammatory) 1
18. Disorders of muscles (inflammatory myopathies, bacterial, parasitic, immunemediated, degenerative and inherited myopathies 1
19. Nutritional secondary hyperparathyroidism, rickets 1
20. Diseases of ears (otitis externa, interna, media), neoplasms, Principles of treatment of otitic infections 1
21. Skin (endocrinopathies, bacterial, parasitic, fungal skin disorders, nutritional disorders related to skin) 2
22. Alopecia, atopy, flea allergy dermatitis 1
23. Diagnostic cytology of skin lesions, treatment and control measures. 1
24. Eyes (diseases of eye lids, keratitis, conjuctivitis, uveitis, glaucoma, acute blindness, neoplasms of eye. 1
25. Viral diseases of dogs and cats 2
26. Vaccination for canine and feline diseases 1
27. Fungal diseases of dogs and cats 2

Suggested books

- *Small Animal Internal Medicine* 2013. by Nelson RW and Couto, CG 5th edition, Elesvier Mosby, St. Louis Missouri
- *Text book of Veterinary Internal Medicine 2010. by Ettinger and Feldman, 7th Edition, Publisher*: Saunders
- Research and Review Papers in Current Journals.

VMD 606: Metabolic and Endocrine Diseases, Nutritional Deficiencies and Diseases of Mammary Gland (2+0)

S. No. Topics No. of lectures

1. General aspects of production diseases and metabolic profile test 1
2. Parturient paresis in dairy animals - etiology, pathogenesis, diagnosis, prevention and therapeutic management 1
3. Downers cow syndrome and lactation tetany of mares 1
4. Ketosis, sub clinical ketosis and fatty liver syndrome 1
5. Nutritional haemoglobinuria in dairy animals 1

6. Hypomagnesemic tetany in cattle 1
7. Pregnancy toxaemia in sheep 1
8. Eclampsia in bitches-etiology, pathogenesis, diagnosis, prevention and therapeutic management 1
9. Acute hypokalemia and transit recumbency of ruminants 1
10. Equine hyperlipemia, steatitis and neonatal hypoglycaemia 1
11. Deficiencies of energy and protein 1
12. Iodine deficiency disorders of ruminants 1
13. Copper deficiency diseases of ruminants 1
14. Diseases associated with deficiency of zinc and manganese 1
15. Diseases associated with deficiency of iron and cobalt 1
16. Vitamin E and selenium deficiency 1
17. Diseases associated with deficiency of vitamin B-complex1
18. Diseases associated with deficiencies of vitamin A and K 1
19. Rickets, osteoporosis and osteodystrophic fibrosa 1
20. Diabetes mellitus in dogs 1
21. Diabetes insipidus in dogs 1
22. Hypo- and hyperthyroidism in dogs 1
23. Hypo- and hyperadrenocorticism in dogs 1
24. Anatomy of the mammary glands, physiology of lactation and congenital abnormalities of udder and teats 1
25. Physical and chemical tests for detection of mastitis 1
26. Detection and identification of pathogenic bacteria in milk1
27. Epidemiology, treatment and control of mastitis caused by contagious, environment and opportunistic pathogens 2
28. Specific and non-specific viral lesions of teats and udder 1
29. Teat stenosis; udder oedema; galactorrhagia, galactogogue; agalactia 1
30. Heifer and goat mastitis, mastitis-metritis-agalactia in sows1
31. Public health importance of mastitis 1

Suggested books

- *Veterinary Medicine* 2007. *A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs and Goats by Otto M Radostits*, Clive C Gay, Kenneth W Hinchcliff and Peter D Constable. 10th Edition. Saunders.
- *Clinical Endocrinology of Companion Animals* (2013). Ed. J Rand 1st Edition edt.by Jacquie Rand (Editor), Ellen Behrend (Editor), Danielle Gunn-Moore (Editor), Michelle Campbell- Ward (Editor). Wiley-Blackwell.
- Research and Review Papers in Current Journals.

VMD 607: Paediatrics and Geriatrics (2+0)

S. No. Topics No. of Lectures

Unit I

1. Perinatal adaptation, neonatal health, asphyxia and resuscitation 1
2. Physical examination of the neonate, disease manifestation, Supportive care of the abnormal newborn 1
3. Failure of passive transfer of immunity and its management. 1

Unit II

4. Pediatric pharmacology 1
5. Fluid replacement therapy 1
6. Immunization of neonates, nutritional support, blood and serum transfusion 1

Unit III

7. Distended and painful abdomen, bloat 1
8. Respiratory distress in the neonates 1
9. Viral diseases of pups, foals and calves 2
10. Bacterial diseases of pups, foals and calves 2
11. Neonatal isoerythrolysis in foals, pups and kittens 1
12. Congenital abnormalities of pups, foals and calves 1
13. Peri-natal care and diseases of the newborn 1
14. Non infectious diseases of pups 1
15. Metabolic disorders, nutritional deficiencies, miscellaneous conditions (hypothermia, hyperthermia, starvation 2
16. Care, management and treatment of sick puppies 1

Unit IV

17. Guidelines for care of geriatric dogs 1
18. Neuromuscular dysfunctions in geriatric dogs 1
19. Common eye and ear affections in older canine and feline patients 1
20. Hepatic and pancreatic disorders in older dogs and cats 1
21. Paresis and/ or depressed mentation 1
22. Urinary system diseases in geriatric dogs and cats 1
23. Endocrine and metabolic disorders in geriatric patients 1
24. Respiratory diseases in older dogs and cats 2
25. Cardiac disorders in geriatric dogs and cats 1
26. Cancer therapy in geriatric patients 1
27. Skeletal disorders in geriatric patients 1
28. Behaviour disorders in geriatric dogs 1

Suggested Readings

- *Equine Pediatric Medicine*. 2018. WV Bernard, BS Barr, 2nd edition, CRC Press.
- *Treatment and Care of the Geriatric Veterinary Patients* 2017. Mary Gardne and Dani McVety, Wiley-Blackwell.
- *Small Animal Pediatrics* 2011. Michael E. Peterson and

Michelle Anne Kutzler, Elsevier.

- Research and Review Papers in Current Journals.

VMD 608: Avian and Swine Medicine (2+0)

S. No.	Topics	No. of Lectures
1.	General handling, sample collection and medication in various Avian Spps.	1
2.	Etio-pathogenesis, symptomatology, diagnosis and treatment of diseases due to riboflavin deficiency in poultry	1
3.	Encephalomalacia (Crazy chick disease)	1
4.	Rickets and calcium deficiency in poultry	1
5.	Fatty liver and kidney syndrome	1
6.	Manganese and zinc deficiency in poultry	1
7.	Colibacillosis (including peritonitis in layers and salpingitis)	1
8.	Fowl cholera	1
9.	Yolk sac infection and omphalitis	1
10.	Salmonellosis and mycoplasmosis in poultry	1
11.	Infectious bursal disease (Gumboro disease) and Inclusion body hepatitis	1
12.	Infectious laryngotracheitis and infectious bronchitis	1
13.	New castle disease and marek's disease (including transient paralysis)	1
14.	Egg drop syndrome 76 (127 adenovirus/ BC14 infection)	1
15.	Lymphoid leukosis and other leukoses	1
16.	Parasitic diseases (Ascaridiasis and coccidiosis)	1
17.	Miscellaneous poultry diseases (cage layer fatigue, cannibalism, moult and prolapse of oviduct)	1
18.	General handling, physical examination and sample collection in pigs	1
19.	Mineral deficiency diseases in pigs (Calcium, phosphorus, iron, copper and zinc)	1
20.	Vitamin deficiency diseases in pigs (vitamin A, D, E, K, riboflavin and niacin)	1
21.	Swine influenza	1
22.	Swine fever (African and classical)	1
23.	Swine Pox	1
24.	Vesicular exanthema and vesicular stomatitis	1
25.	Swine dysentery (scours) and transmissible gastro-enteritis (TGE)	1
26.	Streptococcal meningitis	1
27.	Porcine reproductive and respiratory syndrome (PRRS)	1
28.	Pneumonia in pigs	1
29.	Glassers disease and greasy pig disease	1

30. Swine erysipelas and mange 1
31. FMD and brucellosis 1
32. New and emerging diseases (Nipah virus) 1

Suggested Poultry Books

- *Diseases of Poultry*. 2013. DE Swayne, JR Glisson, LR McDougald, LK Nolan, DL Suarwz, and VL Nair. *13th Edition,* Wiley-Blackwell.
- *Diseases of poultry and their control*. 2001. R. Chandra, VDP Rao, JC Gomez-Villamandos, SK Shukla and PS Banerjee. 1st edition, International book distributing Co., Lucknow, India. 2001.
- Research and Review Papers in Current Journals.

Suggested Swine Books

- *Diseases of Swine*. 2012. JJ Zimmerman, LA Karriker, A Ramirez, KJ Schwartz and GW. Stevenson. 12th edition, Wiley-Blackwell.
- *Diseases of Swine* 2006. BE Straw, JJ Zimmerman, SD'Allaire and DJ Taylor. 9th edition, Blackwell Publishing.
- Research and Review Papers in Current Journals.

VMD 609: Zoo, Wild and Laboratory Animal Medicine (1+0)

S. No. Topics No. of Lectures

1. Taxonomy of various genera of wild/ zoo animals of India along with their descriptions. 1
2. Basic principles of habitat and housing of various classes of wild and zoo animals. 1
3. Nutrient requirements, feeding habits and feeds of zoo, wild and laboratory animals. 2
4. Diet formulation and feeding of various age groups, sick and geriatric animals. 1
5. Post mortem examination, handling, processing and interpretation of pathological materials from zoo and wild animals. 1
6. Breeding for conservation of wild animals. 1
7. Population dynamics of wild animals, effective population size of wild animals in captivity/ zoo/ natural habitats. 1
8. Restrain, capture, handling, physical examination and transport of wild and zoo animals. 1
9. Principles of anesthesia, anesthetics, chemicals of restraining, common surgical Interventions; Capture myopathy. 2
10. Acts and Rules related to zoo and wild animals. 1

11. Principles of zoo hygiene, public health problems arising from zoos. 1
12. Prevention, control and treatment of infectious, parasitic, nutritional and metabolic diseases in zoo and wild animals. 2
13. Prevention, control and treatment of infectious, parasitic, nutritional and metabolic diseases of laboratory animals. 1

Suggested Books

- *Wild Mammals in Captivity: Principles and Techniques for Zoo Management* (2010). 2nd ed. - Kleiman, DG, University of Chicago Press
- *Zoo and Wild Animal Medicine Current Therapy* (2007). 6th ed. - C Fowler, ME
- *Zoo Animal and Wildlife Immobilization and Anesthesia* (2014). 2nd Ed.-C West, D Heard. N Caulkett, Wiley Blackwell
- Research and Review Papers in Current Journals.

VMD 610: Toxicology and Forensic Medicine (1+0)

S. No.	Topics	No. of Lectures
1.	Lead poisoning	1
2.	Arsenic and selenium poisoning	1
3.	Fluoride and copper toxicity	1
4.	Diseases associated with physical agents	1
5.	Chlorinated hydrocarbons, organophosphorous compounds and carbamates poisoning	1
6.	Nitrate nitrite poisoning, cyanide and urea poisoning	1
7.	Poisoning by mycotoxins and important phytotoxicoses	1
8.	Snakebite poisoning; Bee stings	1
9.	Examination of blood stains	1
10.	The vetero-legal wounds, causes of death from wounds	1
11.	Post-mortem examination of veterolegal case, submission of specimens in suspected cases of poisoning,	1
12.	Collection and submission of specimens for histo-pathological examination, and various modern techniques for diagnosis of veterolegal cases	1
13.	Common frauds in the sale of livestock and livestock products	1
14.	Common offenses against animals in India	1
15.	Laws related to animal welfare in India	1
16.	Functioning of Animal welfare board	1

Suggested Books

- *Veterinary Toxicology*. 2014. SK Garg, CBS Publishers.

- *Veterinary Medicine- A textbook of the diseases of cattle, horses, sheep, pigs and goats* by Constable *et al*. 11th Ed., Saunders Ltd.
- *Animal Welfare Ethics and Jurisprudence* 2014. Kirti Dua, 1st Ed., Kalyani Publishers.
- *Veterinary Jurisprudence*. 2015. SN Sharma AK Gahlot and RK Tanwar. 7th Ed., NBS Publisher and Distributor.
- Research and Review Papers in Current Journals.

VMD 611: Clinical Diagnostic Techniques (0+2)

S. No.	Topics	No. of Practicals
1.	Endoscopy in small animals	1
2.	Endoscopic examination of URT in ruminants and equine	1
3.	Tracheo-broncheal lavage in ruminants, horses and dogs	2
4.	Thoracocentesis in dogs, cattle/ buffalo and horses	2
5.	Peritonial fluid collection and examination in dogs, cattle, buffalo and horse	1
6.	Cystocentesis in dogs and urine examination	1
7.	Electrocardiography in dogs and its interpretation	1
8.	Electrocardiography in large animals and its interpretation	1
9.	Techniques in ocular examination	1
10.	Cerebrospinal fluid collection and examination	1
11.	Dermatological examination	1
12.	Collection of biopsy samples (Skin and liver)	2
13.	Diagnosis tests in mastitis	1
14.	Nasogastric/ orogastric intubation in large animals	1
15.	Echocardiography in large and small animals	2
16.	Liver function tests and their interpretation	1
17.	Pericardiocentesis in large and small animals	1
18.	Urinary Catheterization in male and female dogs	1
19.	Urinary Catheterization in a cattle/ buffalo and a mare	1
20.	Renal function tests and their interpretation	1
21.	Arterial blood collection and interpretation of acid base and blood gas analysis	1
22.	Diagnostic tests in ear affections	1
23.	Physical and special examination of musculoskeletal system	1
24.	Neurological examination in small and large animals	2
25.	Bone marrow collection in small and large animals	2
26.	Ultrasonography of chest and abdomen in large animal disease diagnosis	1
27.	CT, MRI, Pulse Oximetry, Radioimmuno assay, Nuclear Medicine	2

Suggested Books

- *Large Animal Internal Medicine*. 2015. Bradford P. Smith, 5th Edition, Mosby Elsevier.
- *Small Animal Clinical Techniques*. 2010. Susan M. Taylor, Saunders Elsevier.
- *Handbook of Veterinary Neurology*. 2010. Michael D. Lorenz, Joan R. Coates and Marc Kent, 5th Edition, Saunders Elsevier.
- *Handbook of Equine Respiratory Endoscopy*. 2007. Safia Barakzai, First Edition, Saunders Elsevier.
- *Manual of Canine and Feline Cardiology*. 2008. Larry P. Tilley, Francis W.K. Smith Jr., M.A. Oyama and M.M. Sleeper, 4th Edition, Saunders Elsevier.
- *Diagnostic Techniques in Equine Medicine: A Textbook for Students and Practitioners Describing Diagnostic Techniques Applicable to the Adult Horse* (2009), Frank GR Taylor, Tim J Brazil and Mark H Hillyer, 2nd Edition, Saunders Elsevier.
- Research and Review Papers in Current Journals.

VMD 612: Emergency Medicine (0+2)

S. No.	Topics	No. of Practicals

Practical

1. Triage and stabilization of critical ill patient 1
2. Cardiopulmonary resuscitation (CPR) in dogs 1
3. Oxygen therapy in dogs 1
4. Gastrointestinal decompression in large and small animal 2
5. Management of Acute respiratory distress syndrome in small animals 1
6. Trans-thoracic drainage of pleural effusions in large and small animals 2
7. Trans-thoracic drainage of pericardial effusions in large and small animals 2
8. Intra-osseous fluid administration in pups 1
9. Management of gastrointestinal emergencies; gastric lavage, pain management 1
10. Endotracheal intubation in dogs 1
11. Clinical examination and therapeutic management of status epilepticus in small animals 1
12. Management of the shock patient 1
13. Blood transfusion in small and large animals 2

14. Entral nutrition in horse and dog 2
15. Management of metabolic emergencies (Addison's disease, Diabetic ketoacidosis, Eclampsia, etc.) 2
16. Management of acute renal failure 1
17. Diagnosis and management of cardiac arrhythmias 1
18. Acute obstrcutive colic and its management 1
19. Poisons and toxins 2
20. Urinary tract emergencies 2
21. Ocular emergencies 2
22. Neurological emergencies 2

Suggested Books

- *Kirk and Bistner's Handbook of Veterinary Procedures and Emergency Treatment*. 2012. Richard B. Ford and Elisa Mazaferro, 9th Edition, Saunders Elsevier.
- *Blackwell's Five Minute Veterinary Consult Clinical Companion, Small Animal Emergency and Critical Care*. 2010. Mazzaferro, M. E. 1st Edition, (Wiley Blackwell)
- *Equine Emergencies Treatment and Procedures*. 2008. Orsini J.A. and Divers T.J., 3rd Edition, Saunders Elsevier.
- Research and Review Papers in Current Journals.

VMD 613: Diagnosis of Veterinary Infectious Diseases (0+1)

S. No. Topics No. of Practicals

Practical

1. Techniques of random/ probability sampling and using survey tool box software for random selection of villages/ animals from a state population 1
2. Sources of data and collection of animal health information using passive data and active surveillance 1
3. Significance of sensitivity and specificity of a diagnostic test and false positive/ negative reactions of a particular test 1
4. Diagnosis of mastitis by BTB card, SLS paddle test, electrical conductivity meter and somatic cell count. 1
5. Inoculation of sample on culture media, and isolation/ identification of the organism 1
6. Culture sensitivity tests on milk and other body fluids 1
7. Collection and examination of samples for fungal infections 1
8. Preparation of blood smear for protozoan and ricketssial disease examination 1
9. Examination of parasitic eggs and along with their identification points including McMaster egg counting technique

1

10. Collection and/ or examination of skin scrapings for mites, ticks, lice or fleas 1
11. Screening tests for animal infectious diseases, including TB, JD, glanders and brucellosis 2
12. Enzyme linked immunosorbant assay (ELISA): direct, indirect and competitive 1
13. Use of Polymerase chain reaction (PCR) in animal disease diagnosis and its types 2
14. Molecular epidemiology tools to study strain variation including RFLP, PCR-RFLP, etc. 1

Suggested Books

- *Veterinary Epidemiology* (2018). Michael Thrusfield, Robert Christley. Wiley-Blackwell
- *Veterinary Epidemiologic Research.* (2003). Ian Dohoo, Wayne Martin and Henryk Stryhn, AVC Inc., Charlottetown.
- *Diseases of Animals: Diagnosis and Management* (2013). Singh, Bhoj and Somvanshi, R. Indian Veterinary Research Institute
- *Veterinarian's Guide to the Laboratory Diagnosis of Infectious Diseases* (1986). Gordon R. Carter. Veterinary Medicine Publishing Company
- Research and Review Papers in Current Journals.

VMD 614: Oncology and Ethno-veterinary Medicine (1+0)

S. No. Topics No. of Lectures

1. Introduction to tumors 1
2. Conventional and advanced diagnostic techniques for diagnosis of tumors 1
3. Basic and advancements in chemotherapy and radiation therapy for tumors 1
4. Immune-therapy and other miscellaneous therapy for cancer patients 1
5. Principles of nutrition and management of chronic pain in cancer
6. patients 1
7. Tumors associated with gastrointestinal tracts 1
8. Tumors associated with liver and spleen 1
9. Tumors associated with endocrine system and urinary system 1
10. Tumors associated with skin, subcutaneous tissues, eye and

ear 1
11. Tumors associated with hemopoietic and respiratory systems 1
12. Principles of herbal medicines and their use in treating animal diseases 1
13. Principles of homeopathic medicines and their use in treating animal diseases 1
14. Application of acupuncture in the management of animal diseases 1
15. Physiotherapy and laser therapy in animal diseases 1
16. Common nutraceutical ingredients (prebiotics, probiotics, synbiotics, enzymes and antibacterial alternatives) 1
17. Use of nutraceuticals in prevention and treatment of various animal diseases 1

Suggested Books

- *BSAVA Manual of Canine and Feline Oncology* by Dobson, Jane M. and Lascelles, B Duncan X. 3rd Ed., BSAVA.
- *Veterinary Herbal Medicine* by SG Wynn and BJ Fougere. 1st Ed., Mosby Elsevier.
- *Textbook of Veterinary Homeopathy*, by J Saxton and P Gregory. Beaconsfield Publishers, Beaconsfield
- *Complementary and Alternative Veterinary Medicine* by Narda G Robinson In: Merck Veterinary Manual. 11th Ed., Wiley.
- *Nutraceuticals in Veterinary Medicine* by, Ramesh C Gupta, Ajay Srivastava and Rajiv Lall. 1st Ed., 2019 Springer.
- Research and Review Papers in Current Journals.

VMD 615: Animal Disease Investigation and Biosecurity (1+1)

S. No. Topics No. of lectures/Practicals

Theory

1. Investigation and diagnosis on dead animals and poultry 1
2. Investigation and diagnosis on live animals and poultry 1
3. Point source epidemics and propagating epidemics 1
4. Collection, preservation and transport of material in the face of disease outbreak 1
5. Processing of material in the laboratory for diagnosis 1
6. Recording and analysis of epidemiological data 1
7. Establishing working hypothesis 1
8. Formulating and advising and/ or implementing treatment, Control and prevention strategies 1
9. Definition and related concepts of biosecurity, principles and

basic components of biosecurity, physical operational elements of biosecurity 1

10. Routes of entry and transmission dynamics of pathogens1
11. Shedding pattern of pathogens by infected animals and their survival in the environment 1
12. Protection of susceptible animals, interruption of pathways of transmission 1
13. Role of disinfection to break cycle of infection, sterilization,
14. fumigation and disinfection methods 1
15. Disinfectants and its classification; microbial resistance to
16. disinfectants, risk assessment and its management 1
17. Principles of biosecurity for laboratory animal house, biosecurity in research laboratories, biosecurity measures for collection of specimen from wild animals 1
18. Vaccines- success stories of disease eradication through vaccination 1

Practical

1. Isolation and identification of field isolates and vaccine strains by conventional, immunoassays and molecular techniques 3
2. Outbreak investigation of infectious diseases in livestock and poultry in the field/ organized livestock farms 2
3. Outbreak investigation of toxicological conditions in livestock and poultry in the field/ organized livestock farms 1
4. Practical use of disinfectants in destruction of microbes in the laboratory and under field conditions 1
5. Determination of efficacy/ phenol coefficient of commonly used disinfectants 1
6. Approaches in animal disease control and eradication 1
7. Preliminary steps to control animal disease outbreaks 1
8. Types of vaccines- conventional and recombinants 1
9. Vaccination schedule in cattle, sheep and, goats 2
10. Vaccination schedule in horses and pigs 1
11. Vaccination schedule of pets including dogs and cats 1
12. Vaccination schedule of poultry including layers and broiler 1

Suggested Books

- *History of the Surveillance and Control of Transmissible Animal Diseases*. (2003). Jean Blancou. Office International des Epizooties
- *Veterinary Epidemiology* (2018). Michael Thrusfield, Robert Christley. Wiley-Blackwell
- *Biosecurity in Animal Production and Veterinary Medicine* (2018). Jeroen Dewulf, Filip Van Immerseel. *From*

Principles to Practice. AMSTERDAM University Press
- Research and Review Papers in Current Journals.

Course Contents
Ph.D. in Veterinary Medicine

I. **Course Title : Farm Animal Gastroenterology**
II. **Course Code : VMD 701**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

Study of contemporary advancements in farm animal gastroenterology.

V. **Theory**

Unit I

Advances in diagnosis, Therapy and control of diseases of gastrointestinal system and associated organs of farm animals.

Unit II

Advances in diagnosis, Therapy, Control and prevention of infectious diseases of gastrointestinal system and associated organs of farm animals.

I. **Course Title : Farm Animal Cardiopulmonary and Urinary System Diseases**
II. **Course Code : VMD 602**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

Advances in diseases of cardio-pulmonary and urinary systems.

V. **Theory**

Unit I

Advances in diagnosis and therapeutic management of internal diseases of circulatory system and urinary systems.

Unit II

Advances in diagnosis and therapeutic management of internal diseases of respiratory system.

Unit III

Advances in diagnosis, control, prevention and therapeutic management of infectious diseases of cardiopulmonary and urinary systems.

I. **Course Title : Farm Animal Neurological and Musculo-skeletal System Diseases**
II. **Course Code : VMD 703**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

Study of recent advances in diseases of neurological and musculoskeletal systems.

V. **Theory**

Unit I

Advances in diagnosis, Therapy and control of internal diseases of nervous and musculoskeletal system.

Unit II

Advances in diagnosis, Therapy, Control and prevention of infectious diseases of nervous and musculo-skeletal systems.

I. **Course Title : Farm Animal Neonatology**

II. **Course Code : VMD 704**

III. **Credit Hours : 1+0**

IV. **Aim of the course**

Study of recent advances in care and disease management of equine and ruminant neonates.

V. **Theory**

Unit I

Advances in diagnosis, Therapy, Prevention and control of internal and infectious diseases of equine neonate.

Unit II

Advances in diagnosis, Therapy, Prevention and control of internal and infectious diseases of ruminant neonate.

I. **Course Title : Herd Health Management**

II. **Course Code : VMD 705**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

Recent concepts in herd health medicine.

V. **Theory**

Unit I

General principles, Interactions between health and production, Herd medicine and population health.

Unit II

Herd health management programme for enzootic herds/ flocks.

Unit III

Recent concepts on herd management of chronic Bacterial, parasitic and fungal and rickettsial diseases.

Unit IV

Biosecurity and infection control, Herd and flock immunity, Quality management of herd health, Control of infectious diseases in the herd, Herd health economics.

VI. **Practical**

Visit to farms, Assessment of their problems, Estimating the presence and prevalence of a disease and new proposals for

prevention and control strategies of a specific disease and its impact.

I. **Course Title : Canine and Feline Gastroenterology**

II. **Course Code : VMD 706**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

Study of advancements in canine and feline gastroenterology.

V. **Theory**

Unit I

Advances in diagnosis, Therapy and control of internal diseases of gastrointestinal system and associated organs of canine and feline.

Unit II

Advances in diagnosis, Therapy, Control and prevention of infectious diseases of gastrointestinal system and associated organs in canine and feline.

I. **Course Title : Advances in Neurological and Musculoskeletal System Diseases of Canine and Feline**

II. **Course Code : VMD 707**

III. **Credit Hours : 1+0**

IV. **Aim of the course**

Study of recent advances in the field of neurological and musculoskeletal diseases.

V. **Theory**

Unit I

Advances in diagnosis, Therapy and control of internal diseases of nervous and musculoskeletal systems.

Unit II

Advances in diagnosis, Therapy and control of infectious diseases of nervous and musculoskeletal systems.

I. **Course Title : Canine and Feline Cardiopulmonary and Urinary System Diseases**

II. **Course Code : VMD 708**

III. **Credit Hours : 1+0**

IV. **Aim of the course**

Advances in cardiopulmonary and urinary systems.

V. **Theory**

Unit I

Advances in diagnosis and therapeutic management of internal diseases of circulatory and urinary systems.

Unit II

Advances in diagnosis, therapeutic management of internal diseases of respiratory system.

Advances in diagnosis, therapeutic management, prevention and control of infectious diseases of cardiopulmonary and urinary systems.

I. **Course Title : Dermatology and Endocrinology**
II. **Course Code : VMD 709**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

Recent concepts in diagnosis, management and control of diseases of skin and endocrine organs.

V. **Theory**

Unit I

Advances in diagnosis, therapy, prevention and control of infectious and non-infectious diseases of skin and integumentary systems.

Unit II

Advances in diagnosis, therapy and control of diseases of endocrine system.

I. **Course Title : Canine and Feline Eye and Ear Diseases**
II. **Course Code : VMD 710**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

Study of recent advances in eye and ear diseases of canine and feline.

V. **Theory**

Unit I

Advances in examination, diagnosis and therapy of diseases of eye.

Unit II

Advances in diagnosis and therapy of diseases of ear.

I. **Course Title : Veterinary Diagnostics**
II. **Course Code : VMD 711**
III. **Credit Hours : 0+2**
IV. **Aim of the course**

Study of recent advances in diagnostics.

V. **Practical**

Unit I

Analysis and interpretation of hemogram, serum and blood

biochemicals.

Unit II

Imaging techniques for the diagnosis of animal diseases (electrocardiography, echocardiography, etc.) Ophthalmoscopy, Ultrasonography, Pulse-oximetry. Assignments on advanced diagnostic techniques for various diseases of domestic animals. Use of above mentioned advanced diagnostic techniques where ever possible. Collection and examination of CSF, gastric/ rumen/ abomasal, peritoneal fluid, absorption and digestion tests, low and high dose dexamethasone test, ACTH stimulation test, hormone profile and enzyme profile.

I. **Course Title : Metabolic and Nutritional Deficiency Diseases**
II. **Course Code : VMD 712**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

Recent trends in diagnosis, management and control of metabolic and nutritional diseases.

V. **Theory**

Unit I

Metabolic profile tests, Parturient paresis, Downer's cow syndrome, Acute hypokalemia in cattle, Transit recumbency and lactation tetany of mares, Hypomagnesemic tetany of calves, Ketosis, Subclinical ketosis, Pregnancy toxemia, Fatty liver syndrome, Equine hyperlipidemia, Steatitis, Neonatal hypoglycemia, Low milk fat syndrome, Postparturient hemoglobinuria and eclampsia in bitches.

Unit II

Deficiency of energy and protein, Deficiency of fat. Deficiency of fat and water soluble vitamins, Deficiency of macro and micro minerals.

Unit III

Diabetes mellitus, diabetes insipidus, hypothyroidism, obesity, hypo- and hyperadrenocorticism, hormone deficiency syndromes.

I. **Course Title : Emergency and Critical Care Medicine**
II. **Course Code : VMD 713**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

Recent advancement in emergency medicine and critical care.

V. **Theory**

Unit I

Diagnosis and therapeutic management of various emergencies of cardiovascular, respiratory, gastrointestinal, urinary and nervous

systems.

Unit II

Diagnosis and therapeutic management of various emergencies of toxicities, sting bites and burns in farm and companion animals.

Unit III

Monitoring critical ill patient, application of emergency care procedures for resuscitation of critically ill patients.

- Placement of central venous catheters, Intra-osseous fluid administration, Endotracheal intubation, Gastric lavage, Decompression of guttural pouch, Stomach, Cecum, Ventilation, Nebulisation, Fluid therapy, CPR, oxygen therapy, Enteral nutrition, Nasogastric intubation.
- Continuous rate infusion, Defibrillation– Demonstration, Peritoneal dialysis, Peritoneal diagnostic lavage, Management of hypo/ hyper thermia, Trocarization.

I. **Course Title : Emerging and Re-emerging Animal Diseases**
II. **Course Code : VMD 714**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

Study on emerging and re-emerging diseases of animals.

Unit I

General concepts for emergence of new diseases and re-emergence of old diseases. Factors and determinants of emerging diseases. The role of wildlife in emerging and re-emerging diseases.

Unit II

Microbial adaptation and change; Epidemiological processes involved in the emergence of vector-borne diseases. Epidemiology of globally and nationally important emerging/ re-emerging diseases and designing of strategies for their prevention and control.

I. **Course Title : Prevention and Control of Infectious Diseases of Ruminants**
II. **Course Code : VMD 715**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

Recent concepts in prevention and control of infectious diseases of ruminants.

V. **Theory**

Unit I

Bacterial and viral diseases of economic importance in bovines, sheep and goats.

Unit II

Fungal and parasitic diseases of economic importance in bovines, sheep and goats.

Unit III

Blood protozoan and rickettsial diseases of economic importance in bovines, sheep and goats.

I. **Course Title : Clinical Practice-I**
II. **Course Code : VMD 716**
III. **Credit Hours : 0+2**
IV. **Aim of the course**

Application of the theoretical concepts in practice.

Diagnostic and therapeutic protocol application, Specimen collection, Examination and management of sick farm and companion animals, Use of diagnostic techniques for diagnosis of medicinal cases, Acquaintance with different equipment, Client management, public relations, Code of conduct, hospital management, Database management and maintenance of case records, Disaster management.

Note: This course shall be conducted in Veterinary Clinical Complex (VCC) where students shall participate in diagnosis and treatment of diseased animals.

I. **Course Title : Clinical Practice-II**
II. **Course Code : VMD 717**
III. **Credit Hours : 0+2**
IV. **Aim of the course**

Application of the theoretical concepts in practice.

V. **Practical**

Diagnostic and therapeutic protocol application, Specimen collection, Examination and management of sick farm and companion animals**,** Use of diagnostic techniques for diagnosis of medicinal cases, Acquaintance with different equipment, Client management, Public relations, Code of conduct, Hospital management, Database management and maintenance of case records, Disaster management.

Note: This course shall be conducted in Veterinary Clinical Complex (VCC) where students shall participate in diagnosis and treatment of diseased animals.

I. **Course Title : Clinical Practice-III**
II. **Course Code : VMD 718**
III. **Credit Hours : 0+2**
IV. **Aim of the course**

Application of the theoretical concepts in practice.

v. **Practical**

Diagnostic and therapeutic protocol application, Specimen collection, Examination and management of sick farm and companion animals, Use of diagnostic techniques for diagnosis of medicinal cases, Acquaintance with different equipment, Client management, Public relations, Code of conduct, Hospital management, Database management and maintenance of case records, Disaster management.

Course Outline: Lecture wise

VMD 701: Farm Animal Gastroenterology (2+0)

S. No.	Topics	No. of Lectures
1.	Physical examination in gastrointestinal disease diagnostic strategies and initial plan in assessment of gastrointestinal function	1
2.	Imaging techniques for the gastrointestinal system radiography of the gastrointestinal system veterinary nuclear medicine	1
3.	Clinical pharmacology of the gastrointestinal tract	1
4.	Principles of fluid therapy in cattle, horse, pig, sheep and goat	1
5.	Diseases of the buccal cavity and related organs including pharynx, oesophagus	1
6.	Reticulo-ruminal disorders – recent concepts in fermentative disorders-simple indigestion, impaction, ruminal lactic acidosis, alkalosis	2
7.	Primary and secondary bloat- diagnosis	1
8.	Traumatic reticulo-peritonitis, vagal indigestion syndrome, generalised peritonitis, omasal impaction and abdominal distension	2
9.	Diseases of abomasum (impaction, displacements, ulcers)	1
10.	Intestinal disorders (intussusception, volvulus), strangulation, caecal dilatation and volvulus in ruminants.	1
11.	Diseases of bovine liver	1
12.	Diarrhea in cattle and small ruminants	1
13.	Bacterial and viral diseases: Campylobacteriosis, intestinal chlamydial infectionssalmonellosis, tyzzer's diseaseinfectious disease involving gut such as RP, BVD. FMD, actinomycosis, actinobacillosis	3
14.	Protozoal diseases: Coccidiosis, cryptosporidiosis	1
15.	Gastrointestinal parasites of pigsAscaris sp, oesophagostomum, stomach worms, strongyloides sp, trichuris sp	1
16.	Gastrointestinal parasites of horsesGastrophilus, habronema, oxyuris, parascaris, large strongyles, small strongyles, strongyloides, tapeworms, trichostrongylus	2
17.	Gastrointestinal Parasites of cattleCooperia, bunostomum, strongyloidees, nematodirus, toxocara, oesophgostomum, chabertia, trichuris, tapeworms	2
18.	Gastrointestinal parasites of sheep and goatsHaemonchus, ostertagia, and trichostrongylus, intestinal trichostrongylosis, nematodirus, oesophagostomum, chabertia, storngyloides,	

trichuris, tapeworms 2
19. Gastrointestinal diseases – Horse and Pigs 1
20. Dysphagia in horses 1
21. Diseases of stomach: GIT ulceration, gastric dilation, impaction, gastric parasitism in horses and pigs 1
22. Diseases causing equine colic such as anterior enteritis, small intestine strangulation, intestine impaction. Protocol and management of equine colic 1
23. Obstructive intestinal diseases in horse 1
26. Chronic weight loss without diarrhea, pain or icterus in horse 1
27. Swine dysentery, hog cholera 1

Suggested Books

- *Equine Internal Medicine*. 2017. Stephen Reed, Warwick Bayly and Debra Sellon, 4th Edition, Elsiever, Saunders.
- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre and Nicola Pusterla, 6th Edition, Mosby
- *Rebhun's Diseases of Dairy Cattle*. 2018. Simon F Peek and Thomas J Divers, 3rd Edition, Elseviers
- *Veterinary Gastroenterology.* 1992. Neil V. Anderson, 2nd Revised edition, Lea and Febiger, USA.
- Research and Review Papers in Current Journals.

VMD 702: Farm Animal Cardiopulmonary and Urinary System Diseases (2+0)

S. No	Topics	No. of Lectures
1.	Evaluation of patient with respiratory signs	1
2.	Diagnostic aids in evaluation of respiratory line	1
3.	Retropharyngeal lymph node abscessation in horses	1
4.	Pharyngeal affections in horses and Pharyngeal trauma in ruminants	1
5.	Diseases of guttural pouch in horses	1
6.	Laryngeal granuloma, abscess, edema	1
7.	Tracheal collapse and stenosis in farm animals	1
8.	Ethmoid hematoma in horses, diseases of paranasal sinuses in farm animals	1
9.	Disorders of equine soft palate	1
10.	Bacterial pneumonia and pleuropneumonia in adult horse	1
11.	Pneumonia in foals	1
12.	Pulmonary edema and smoke inhalation	1
13.	Recurrent airway obstruction in horses	1

14. Inflammatory airway disease in horses 1
15. Epistaxis and Exercise induced pulmonary hemorrhage in horses 1
16. Bronchopneumonia and interstitial pneumonia in ruminants 1
17. Hypersensitivity and metastatic pneumonia 1
18. Progressive viral pneumonia of sheep and goats 1
19. Pleuritis and pleural effusions, pneumothorax and lung tumors 1
20. Viral pneumonia of sheep 1
21. Congenital cardiac diseases 1
22. Pericardial diseases 1
23. Myocardial diseases 1
24. Endocardial diseases 1
25. Cardiac arrythmias 1
26. Anaemia 1
27. Bleeding disorders 1
28. Renal failure in horses 1
29. Urinary incontinence and urethral obstruction in equine and bovine 1
30. Polyuria and polydypsia in horses, urinary system disorders in the foal 1
31. Ulcerative posthitis and vulvitis in small ruminants 1
32. Bacterial pyelonephritis and urinary tract infection, leptospirosis 1

Suggested Books

- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre and Nicola Pusterla, 6th Edition, Mosby
- *Veterinary Medicine: A textbook of the diseases of cattle, horses, sheep, pigs and goats* by Otto M Radostits, Clive C Gay, Kenneth W Hinchcliff and Peter D Constable.10th Edition. Saunders
- *Rebhun's Diseases of Dairy Cattle*. 2018. Simon F Peek, Thomas and J Divers, 3rd Edition, Elseviers
- Research and Review Papers in Current Journals.

VMD 703: Farm Animal Neurological and Musculo-skeletal System Diseases (1+0)

S. No. Topic No. of Lectures

1. Neurological examination in bovine and equine patients; Localization of lesions in nervous system 1
2. Disease of brain stem in equines and bovines 1
3. Diseases producing cortical signs in equines and bovines 1
4. Diseases of spinal cord and Peripheral neuropathies 1
5. Viral/ Prions encephalopathies: Equine herpes virus, Eastern/ Western equine encephalopathies, Bovine Spongifrom

Encepahlopathy, etc. 2

6. Parasitic thromboembolism and Equine Protozoal encephalomyelitis 1
7. Encephalomalacia, Narcolepsy and Hyperkalemic periodic paralysis 1
8. Diagnostic approach to musculoskeletal abnormalities 1
9. Diseases of Muscle tone; Muscle Cramping 1
10. Nonexertional Rhabdomyolysis in Horses: Inflammatory myopathies, nutritional, toxic and traumatic rhabdomyolysis 1
11. Exertional Myopathies in Horses: Congenital, acquired and metabolic disorders 1
12. Osteochondrosis, Septic (Infectious) arthritis osteomyelitis, osteoarthritis, laminitis in horse 1
13. Bovine foot lameness: Characteristics of lameness, metabolic and infectious causes and conformation defects 2
14. Nutrition and Lameness, Claw trimming and foot baths 1

Suggested Books

- *Bovine Laminitis and Lameness*. 2007. Paul R Greenough, First Edition, Saunders Elsevier.
- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre, Nicola Pusterla, 6th Edition, Mosby
- *Handbook of Veterinary Neurology*. 2010. Michael D Lorenz, Joan R Coates and Marc Kent, 5th Edition, Saunders Elsevier.
- *Equine Internal Medicine*. 2004. Stephen M Reed, Warwick M Bayly and Debra C Sellon, 2nd Edition, Saunders Elsevier.
- Research and Review Papers in Current Journals.

VMD 704: Farm Animal Neonatology (1+0)

S. No.	Topics	No. of Lectures
1.	Advances in management during perinatal adaption period	1
2.	Manifestations of neonatal diseases in calves	2
3.	Manifestations of neonatal diseases in foals	2
4.	Manifestations of neonatal diseases in lambs and kids	2
5.	Neonatal infection and sepsis	1
6.	Advances in diagnostic procedures in neonates	2
7.	Advances in intensive care of management of critically ill neonates	2
8.	Advances in chemotherapeutic management of neonatal diseases	2
9.	Vaccination and maternal antibody interference	1
10.	Advances in management of orphan neonates	1

Suggested Books

- *Equine Pediatric Medicine*. 2018.W V Bernard, BS Barr, 2nd edition, CRC Press
- *Practical Lambing and Lamb Care*. 2018. N Sargison, JP Crilly and A Hopker, 4th edition, Wiley Blackwell
- *Equine Neonatal Medicine*. 2006. MR Paradis, 1st edition, Saunders
- *Bovine Neonatology*. 2009. *Veterinary Clinics of North America: Food Animal Practice*. 1st Edition, Saunders
- Research and Review Papers in Current Journals.

VMD 705: Herd Health Management (2+1)

S. No.	Topics	No. of Lectures/Practicals
Theory		
1.	General principles of herd health management	2
2.	Factors to be considered for successful implementation of herd health program	1
3.	Interaction between health and production	2
4.	Monitoring young stock health	1
5.	Targets for young stock rearing and dairy cow culling	1
6.	Disease control in rearing period	1
7.	Herd Medicine and population health	2
8.	Herd nutrition for optimum health	2
9.	Recent concepts on herd management of bacterial diseases	2
10.	Recent concepts on herd management of viral diseases	2
11.	Recent concepts on herd management of parasitic diseases	1
12.	Recent concepts on herd management of fungal diseases	1
13.	Recent concepts on herd management of rickettsial diseases	1
14.	Herd management of metabolic diseases	1
15.	Herd management of deficiency diseases	1
16.	Biosecurity and infection control	1
17.	Herd and flock immunity	1
18.	Quality management of herd health	1
19.	Control of infectious diseases in the herd	1
20.	Herd health economics	1
21.	Importance and steps of record keeping	2
22.	Control of lameness	1
23.	Diagnosis and control of mastitis and enhancement of milk quality	2
Practicals		
1.	Recent advances in calf management and diseases	1
2.	Appropriate animal housing	1
3.	Epidemiological investigations for problem identification at	

farm 1
4. Farm biosecurity 1
5. Recent advances in disinfection of farm sheds and other equipments 1
6. Stress control of farm animals with respect to environmental and production stress 1
7. Record keeping 1
8. Recent advances in disease testing (TB, JD, Brucellosis, Mastitis) 1
9. Routine farm procedures 2
10. Herd vaccination 1
11. Ecto and endo parasitism: principles and latest control trends 1
12. Recent advances in mastitis control 1
13. Recent advances in lameness control 1
14. Establishment of farm laboratoty 1
15. Use of medicines and food safety 1

Suggested Books

- *Dairy Herd Health*. 2012. MJ Green and Andrew J Bradley. CABI *Publishing*
- *Herd Health: Food, Animal, Production, Medicine*. 1994. OM Radostits, KE Leslie, J Fetrow and WB. Saunders,
- *Veterinary Epidemiology*. 2018. Michael Thrusfield, Robert Christley. Wiley-Blackwell
- *The Keys to Herd Health*. 2006. Jerry Brunetti. Acres U.S.A.
- *Herd Health and Production Management in Dairy Practice*. 2003. Arie Brand. International Book Distributing Company
- Research and Review Papers in Current Journals.

VMD 706: Canine and Feline Gastroenterology (2+0)

S. No. Topics No. of Lectures

1. Introduction to gastrointestinal function and microbiota 2
2. Diagnostic approach to anorexia, abdominal pain and vomiting 2
3. Approach to clinical signs of diarrhea, constipation and tenesmus 2
4. Diagnostic and therapeutic approach to hematochezia and melena 2
5. Diagnostic approach to hepato-biliary diseases and pancreatic diseases, coagulopathy, icterus, ascites and hepatoencephalopathy 2
6. Approach to clinical signs of weight loss and cachexia 1
7. Nutritional approach to gastrointestinal disease management 2
8. Pharmacological approach to gastrointestinal disease: antiemetic,antidiarrhoeal and cytoprotective agents 1

9. Pharmacological approach to gastrointestinal disease: antimicrobial and anthelmintic agents 1
10. Pharmacological approach to gastrointestinal disease: prokinetics, probiotics and laxatives 1
11. Chemotherapy and immunosuppressive drugs in gastrointesinal disease 1
12. Dentistry and diseases of oropharynx 1
13. Diagnostic evaluation and diseases of esophagus 1
14. Gastric diseases: Gastritis, ulceration, neoplasia and dysmotility 2
15. Advances in treatment and management of Small intestinal diseases 1
16. Diagnostic approach and management of inflammatory bowel disease (IBD), Ulcerative colitis, bacterial, parasitic and fungal infections of large intestine 2
17. Diagnostic evaluation and treatment of diseases of anorectum 1
18. Diagnostic evaluation and common affections of pancreas 1
19. Liver: Parenchymal, neoplastic, metabolic and biliary disorders 3
20. Breed related gastrointestinal disorders 1
21. Behaviour and gastrointestinal disease 1

Suggested books

- *Canine and Feline Gastroenterology*. 2013. RJ Washabau and MJ Day, Elesvier Mosby, St. Louis Missouri
- *Text Book of Veterinary Internal Medicine*. 2001. Part I and II, Ettinger and Feldman, 7th Edition, Saunders
- *Small Animal Medical Diagnosis*. 2009. MD Lorenz, TM. Neer and PL Demars, 3rd Edition, Willey Blackwell, Iowa, USA.
- Research and Review Papers in Current Journals.

VMD-707 Advances in Neurological and Musculoskeletal System Diseases of Canine and Feline (1+0)

S. No Topics No. of Lectures

1. Classification and general diagnostic features of acquired myopathies in dogs and cats 1
2. Developmental and genetic bone disorders 1
3. Idiopathic bone disorders 1
4. Metabolic, nutritional and endocrine bone disorders 1
5. Neoplasms of bones 1
6. Focal brain diseases of rapid onset- idiopathic epilepsy, idiopathic vestibular disease, trigeminal neuropathy, idiopathic facial nerve paralysis 1

7. Brain diseases of intermediate onset- brain abscesses 1
8. Focal brain diseases of slow onset- Thiamine deficiency, hypoglycemia, poisons 1
9. Inflammatory brain disorders- viral, bacterial, protozoal and mycotic encephalitis 1
10. Inflammatory meningitis-granulomatous meningo-encephalitis, Pug encephalitis, rickettsial diseases 1
11. Metabolic diseases with neurological signs 1
12. Diseases affecting cervical spinal cord and brachial plexus 1
13. Diseases affecting thoraco-lumbar and lumbo-sacral segments of spinal cord 2
14. Inflammatory and immune mediated neuropathies 1
15. Metabolic and toxic causes affecting peripheral nerves dysfunctions 1

Suggested Books

- *Handbook of Veterinary Neurology*. 2011. MD Lorenz, JR Coates and Marc Kent 5th Edition. Elsevier Saunders
- *Textbook of Veterinary Internal Medicine: Diseases of the Dog and Cat*. 2010. Stephen J. Ettinger and Edward C. Feldman, Elsevier Saunders 7th Edition.
- *Veterinary Clinics of North America: Small Animal Practice*, Elsevier, Monthly
- Research and Review Papers in Current Journals.

VMD 708: Canine and Feline Cardiopulmonary and Urinary System Diseases (1+0)

S. No Topic No. of Lectures

1. Pathophysiology of heart failure, Clinical manifestations of cardiac diseases 1
2. Diagnostic tests for cardiovascular system (radiography, electrocardiography and echocardiography) 1
3. Therapeutic management of heart failure 1
4. Cardiac arrhythmias and anti-arrhythmic therapy 1
5. Acquired valvular heart diseases (Degenerative atrioventricular
6. valve diseases and infectious endocarditis) 1
7. Myocardial diseases od dogs and cats(Canine dilated cardiomyopathy, canine hypertrophic cardiomyopathy and feline cardiomyopathies) 1
8. Pericardial diseases and cardiac tumors, systemic arterial hypertension 1
9. Clinical evaluation of patient with respiratory diseases 1
10. Feline upper respiratory tract infections 1

11. Bacterial rhinitis, allergic rhinitis, nasal mycosis, nasal tumors, polypsin dogs and cats 1
12. Diseases of trachea (infectious tracheobronchitis, lungworms, tracheal hypoplasia and tracheal collapse), Canine and feline bronchitis 1
13. Pulmonary parenchymal diseases (infectious- viral, bacterial, protozoal, fungal and parasitic) 1
14. Pulmonary neoplasia, pulmonary edema, pleural effusions, pneumothorax 1
15. Clinical approach and laboratory evaluation of renal diseases, Glomerulonephritis, Urolithiasis 1
16. Acute and chronic renal failure 1
17. Canine and feline lower urinary tract disorders, Disorders of micturition, Neoplasms of urinary tract 1

Suggested Books

- *Small Animal Internal Medicine*. 2013. Nelson RW and Couto, CG 5th edition, Elesvier Mosby, St. Louis Missouri
- *Text book of Veterinary Internal Medicine*. 2010. Ettinger and Feldman, 7th Edition, Saunders
- Research and Review Papers in Current Journals.

VMD 709: Dermatology and Endocrinology (1+0)

S. No. Topics No. of Lectures

1. New trends in management of adrenal gland diseases in dogs and cats 1
2. Hyperadrenocorticism (Pituitary pars intermedia dysfunction) in horses 1
3. Primary hyperaldosteronism and pheochromocytoma in dogs and cats 1
4. Advances in management of diabetes mellitus and diabetic ketoacidosis 1
5. Equine metabolic syndrome/ Insulin resistance syndrome in horses 1
6. Hypo and hyperthyroidism in dogs and cats 1
7. Hypo and hypercalcemia in dogs and cats 1
8. Hyposomatotropism and acromegaly in dogs 1
9. Advances in management of diabetes Insipidus and polyuria/ polydipsia in Dogs and cats 1
10. Advances in management of autoimmune disorders (different forms of pemphigus) 1
11. Diagnosis, therapy and prevention of hypersensitivity disorders –Atopy, urticaria, milk allergy, vasculitis, contact dermatitis,

culicoides hypersensitivity 1

12. Diagnosis, therapy and prevention of bacterial skin dermatitis-dermatophillus, folliculitis, staphylococcal cellulitis, equine corynebacterial dermatitis 1
13. Diagnosis, therapy and prevention of fungal skin dermatitis-dermatophytosis, malasezzial dermatitis 1
14. Diagnosis, therapy and prevention of parasitic skin dermatitis-mange, culicoides hypersensitivity, onchocerciasis, stephanofilaria, cutaneous hebronemiasis 1
15. Diagnosis, therapy and prevention of viral diseases-warts, pox diseases 1
16. Advanced diagnosis of skin tumors 1

Suggested Books

- *Clinical Endocrinology of companion animals*. 2013. Ed. J Rand 1st Edition edt. by Jacquie Rand (Editor), Ellen Behrend (Editor), Danielle Gunn-Moore (Editor) and Michelle Campbell-Ward (Editor). Wiley-Blackwell.
- *Muller and Kirk's Small Animal Dermatology*. 2013. 8th Edition. Edited by WH Miller, CE Griffin and KL Campbell. Elsevier, St Louis, MO, USA,
- *Equine dermatology*. 2011. 2nd Edition edited by Danny W Scott and William H. Miller, Jr 2nd edition. Elsevier, St Louis, MO, USA.
- Research and Review Papers in Current Journals.

VMD 710: Canine and Feline Eye and Ear Diseases (1+0)

S. No. Topics No. of Lectures

Advances in Examination, Diagnosis and Therapy of diseases of eye

1. Diseases of the eyelid and Conjunctiva 2
2. Diseases of the cornea and sclera 1
3. Disease of the lens, uvea: Glaucoma 2
4. Disease of the retina, choroid, and optic nerve 2
5. Disease of the Lacrimal apparatus 1
6. Diseases of the the Orbit 1
7. Neuro-ophthalmology 1
8. Tumors of eye 1

Advances in Diagnosis and Therapy of diseases of ear

1. Otitis Externa 1
2. Diseases of the external ear canal and pinna 1
3. Otitis media and Otitis interna 2
4. Tumors of ear 1

Suggested Books

- *Veterinary Opthalmology*. 2013. Kirk N Gellat, Brian C Gilger and Thomas J Kern, 5th edition.Wiley Blackwell,
- *Saunders Manual of Small Animal Practice*. 2016. SJ Birchard and RG Sherding, WB Saunders Company
- Research and Review Papers in Current Journals.

VMD 711: Veterinary Diagnostics (0+2)

S. No. Topics No. of Practicals

Practical

1. (i) Endoscopic procedures in small animals
   (ii) Diagnostic aids and ancillary diagnostic tests in diseases of gastrointestinal system 2
2. Endoscopic examination of URT in ruminants 1
3. Endoscopic examination of URT in equines 1
4. Tracheo-bronchial lavage in ruminants, horses and dogs 2
5. Thoracocentesis in dogs, cattle/ buffalo and horses 2
6. Electrocardiography in dogs and its interpretation/ Electrocardiographic diagnosis of arrhythmia in dogs 2
7. Electrocardiography in diagnosis of arrhythmias in horses and dairy animals 1
8. Cerebrospinal fluid collection, examination and diagnosis and clinical case study (5 animals) 1
9. Dermatological examination and case workup 1
10. Biopsy collection techniques and its application on clinical cases 1
11. Pericardiocentesis and drainage of effusions in large and small animals 1
12. Neurological examination in small and large animals 2
13. Techniques in ocular examination-cytology, opthalmoscopy, measurement of intraocular pressure 2
14. Bone marrow collection and its application in diagnosis in small and large animals 1
15. Ultrasonography in various thoracic and abdominal affections in large animals 1
16. Echocardiography in valvular and myocardial diseases in small animals 1
17. Echocardiography in valvular and myocardial diseases in large animals 1
18. Liver function tests and their interpretation with case studies 1
19. Arterial blood collection and interpretation of acid base and blood gas analysis 1

20. Concepts and diagnostic tests in veterinary infectious diseases Sampling techniques for collection of samples during research 2
21. ELISA and its types, molecular techniques and types of PCR 1
22. Molecular epidemiology tools including RFLP, etc. 2
23. Molecular diagnostic techniques of fungal diseases, protozoan and rickettsial diseases 2

Suggested Books

- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre and Nicola Pusterla, 6th Edition, Mosby
- *Small Animal Clinical Techniques*. 2010. Susan M Taylor, Saunders Elsevier
- Handbook of Veterinary Neurology. 2010. Michael D. Lorenz, Joan R. Coates and Marc Kent, 5th Edition, Saunders Elsevier.
- *Handbook of Equine Respiratory Endoscopy*. 2007. Safia Barakzai, 5th Edition, Saunders Elsevier.
- *Manual of Canine and Feline Cardiology*. 2008. Larry P Tilley, Francis WK Smith Jr., MA Oyama and MM Sleeper, 4th Edition, Saunders Elsevier.
- *Diagnostic Techniques in Equine Medicine: A Textbook for Students and Practitioners Describing Diagnostic Techniques Applicable to the Adult Horse.* 2009. Frank GR Taylor, Tim J Brazil and Mark H Hillyer, 2nd Edition, Saunders Elsevier.
- Research and Review Papers in Current Journals.

VMD 712: Metabolic and Nutritional Deficiency Diseases (2+0)

S. No. Topics No. of Lectures

1. Strategies for transition cow health management 1
2. Latest trends in prevention and management of parturient paresis with special reference to calcium cyclers and DCAD 1
3. Current approach to diagnosis and management of downer's cow syndrome and acute hypokalemia in cow 1
4. Lactation tetany and transit recumbency in mares 1
5. Update on diagnosis and management of hypomagnesemic tetany in calves 1
6. Recent trends in diagnosis and management of ketosis in dairy animals with special reference towards blood metabolites and genomic tools 1
7. Pregnancy toxemia in sheep and goats: current diagnosis and treatment strategies 1
8. Biomarkers of fatty liver syndrome in dairy cattle: Latest

diagnosis and treatment protocols 1

9. Update on equine hyperlipidemia and steatitis 1
10. Neonatal hypoglycemia: Recent trends in diagnosis and management 1
11. Sub-acute ruminal acidosis (SARA) and low milk fat syndrome 1
12. Nutritional/ parturient/ puerperal hemoglobinuria 1
13. Recent trends in diagnosis and management of eclampsia in bitches 1
14. Exertional myopathies in horse 1
15. Nutritional secondary hyperparathyroidism (bighead; bran disease) 1
16. Recent trends in mineral supplementation in livestock with Special reference to chelated and non-chelated supplements 1
17. Diseases due to trace elements deficiency in dairy cattle 1
18. Oxidative stress during transition period: Role of various vitamins and minerals 1
19. Recent trends in feeding strategies during transition period for prevention of vitamin and mineral deficiencies 1
20. Update on importance of vitamin E and selenium in transition cows 1
21. Disorders due to sodium and potassium deficiency 1
22. Canine diabetes mellitus: Update on diagnosis and management 1
23. Canine diabetes insipidus: Update on diagnosis and management 1
24. Hypothyroidism in canine: Recent trends in diagnosis and management 1
25. Obesity in pet animals: etio-pathogenisis, diagnosis and lifestyle management 1
26. Diagnostic tools and treatment protocols for hypo and hyper adrenocorticism in dogs 1
27. Recent trends in diagnosis, treatment and prevention of vitamin A deficiency diseases 1
28. Diseases due to thiamine deficiency (PEM) 1
29. Disorders due to vit K deficiency 1
30. Approaches towards diagnosis, treatment and prevention of riboflavin (vit B2) deficiency in swine and poultry 1
31. Update on diagnosis, treatment and prevention strategies for niacin deficiency in swine and poultry 1
32. Diagnosis, management and prevention of Pantothenic acid deficiency in swine and poultry 1

Suggested Books

- *Veterinary Medicine*. 2006. OM Radostits, CC Gay, KW Hinchcliff and PC Constable, 10th Edition, Saunders.
- *Large Animal Internal Medicine*. 2019. Bradford Smith, David Van Metre and Nicola Pusterla, 6th Edition, Mosby
- *Textbook of Preventive Veterinary Medicine and Epidemiology*. 2010. RD Sharma, M Kumar and MC Sharma, ICAR- New Delhi.
- *Textbook of Veterinary Internal Medicine Expert Consult*. 2016. SJ Ettinger, EC Feldman and E Cote, 8th Edition, Saunders-Elsevier
- Research and Review Papers in Current Journals.

VMD 713: Emergency and Critical Care Medicine (1+1)

S. No.	Topics	No. of Lectures/Practicals
Theory		
1.	Triage and stabilization of critical ill patient	1
2.	Newer therapeutic approach in management of a shock patient	2
3.	Advances in management of respiratory emergencies	2
4.	Gastrointestinal emergencies in small and large animals	2
5.	Management of metabolic emergencies (Addison's disease, Diabetic ketoacidosis, Eclampsia, etc.) in small animals	1
6.	Diagnosis and management of Cardiac arrhythmias	1
7.	Acute obstructive colic and its management	1
8.	Poisoning and toxocosis in animals and its management	2
9.	Urinary system emergencies	1
10.	Ocular emergencies	1
11.	Neurological emergencies	1
12.	Pain, assessment and its management	1
Practicals		
1.	Cardiopulmonary resuscitation (CPR) in dogs and monitoring of critical ill patient and oxygen therapy in dogs	1
2.	Gastrointestinal decompression in large and small animals	1
3.	Clinical approach to acute respiratory distress syndrome in small animals	1
4.	Trans-thoracic drainage of pleural effusions in large animals	1
5.	Trans-thoracic drainage of pericardial effusions in large and small animals	1
6.	Intra-osseous fluid administration in pups	1
7.	Procedures for gastrointestinal emergencies in small animals	1
8.	Procedures for gastrointestinal emergencies in large animals	1

9. Blood component therapy in critical patients 1
10. Endotracheal intubation in dogs 1
11. Clinical examination and therapeutic management of status epilepticus in small animals 1
12. Case Studies on GIT emergencies 1
13. Case Studies on Respiratory emergencies 1
14. Case Studies on Cardiac emergencies 1
15. Case Studies on hematological emergencies 1
16. Case Studies on metabolic emergencies 1

Suggested Books

- *Kirk and Bistner's Handbook of Veterinary Procedures and Emergency Treatment*. 2012. Richard B Ford and Elisa Mazaferro, 9th Edition, Saunders Elsevier.
- *Blackwell's Five Minute Veterinary Consult Clinical Companion, Small Animal Emergency and Critical Care*. 2010. Mazzaferro ME. 1st Edition, (Wiley Blackwell)
- *Equine Emergencies Treatment and Procedures*. 2008. Orsini JA and Divers TJ, 3rd Edition, Saunders Elsevier.
- Research and Review Papers in Current Journals.

VMD 714: Emerging and Re-emerging Animal Diseases (2+0)

S. No. Topics No. of lectures

1. Definitions and concepts of emerging, re-emerging, exotic, exzootic and endemic diseases 2
2. General concepts of new animal diseases 1
3. Conditions for emergence of new animal diseases 2
4. General concepts for re-emergence of old animal diseases 1
5. Conditions for re-emergence of old animal diseases 2
6. Factors and determinants of emerging diseases 3
7. Effect of climate change on emergence of diseases 2
8. The role of wildlife in the emergence and re-emergence of animal diseases 2
9. Microbial adaptation and change 2
10. Epidemiological processes involved in the emergence of vector-borne diseases 2

Epidemiology of globally and nationally important emerging/ re-emerging diseases and designing of strategies for prevention and control of nationally important emerging/ re-emerging diseases

11. Tuberculosis 1
12. Foot and mouth disease 1
13. Hemorrhagic septicemia 1
14. Bovine viral diarrhea 1

15. Anthrax 1
16. PPR 1
17. Blue tongue 1
18. Swine flu 1
19. Swine fever 1
20. Paratuberculosis 1
21. Glanders 1
22. Equine disesases manifested by nervous signs 1
23. Equine infectious anemia and African horse sickness 1

Suggested Books

- *Veterinary Epidemiology.* 2018. Michael Thrusfield, Robert Christley. Wiley-Blackwell
- *Emerging Diseases of Animals.* 2000. Corrie Brown and Carole Bolin. ASM Press
- *Emerging and Re-emerging Infectious Diseases of Livestock*. 2017. Jagadeesh Bayry. Springer
- *Transboundary and Emerging Diseases of Animals.* 2016. Anna Rovid Spickler, James A Roth, Gayle Brown and Jane Galyon. Center for Food Security and Public Health
- Research and Review Papers in Current Journals.

VMD 715: Prevention and Control of Infectious Diseases of Ruminants (2+0)

S. No. Topics No. of Lectures

1. Advances in principles of prevention and control of infectious diseases 1
2. Anthrax as a biological weapon: strategies for its control in animals 1
3. Screening and control of Brucellosis in organized dairy herds 1
4. Diagnosis and management of Mastitis 1
5. Pathogenesis and sympotomatology of Clostridial diseases 2
6. Pathogenesis and control of Colibacillosis 1
7. Recent advances in diagnosis and control of Hemorrhagic septicemia 1
8. Approaches in diagnosis of Tuberculosis 1
9. Paratuberculosis: differential diagnosis and control 1
10. Epidemiology, pathogenesis and diagnosis of Listeriosis 1
11. Pathogenesis and control of Leptospirosis in animals 1
12. Clinical presentation, differential diagnosis and treatment of Acitnomycosis and Actinobacillosis 1
13. Advancement in diagnosis and treatment of dermatophytosis and other fungal infections 1
14. Differential diagnosis and control of campylobacteriosis 1

15. Latest advancements in Salmonellosis 1
16. Advancement in diagnosis and control of Mycoplasma infections 1
17. Latest trends in diagnosis and treatment of anaplasmosis 1
18. Latest trends in diagnosis and control of Blue tongue 1
19. Recent advancement in management of sheep and goat pox 1
20. Recent literature on diagnosis and control of Peste des petits ruminants 1
21. Lessons to be learnt from eradication of Rinderpest 1
22. Recent advances in Bovine viral diarrhea and malignant catarrhal fever 1
23. Recent literature on Infectious bovine rhinotracheitis 1
24. Recent studies on clinical symptomatology and diagnosis of ephemeral fever 1
25. Advancements in diagnosis and control of Foot and mouth disease 1
26. Recent approaches in diagnosis and control of Rabies 1
27. Principles of control of parasitic diseases 1
28. Recent trends in Clinical symptomatology, diagnosis and control of Amphistomosis and fascioliosis 1
29. Recent approaches in control of major endoparasitic infestations 1
30. Recent advancements in diagnosis and control of trypanosomosis 1
31. Recent advancements in diagnosis and control of babesiosis and theileriosis 1

Suggested Books

- *Merck's Veterinary Manual K*. 2016. Susan E Aiello and Michael A Moses, 11th Edition, Merck Sharp and Dohme
- *Veterinary Medicine.* 2016. Peter Constable, Kenneth W Hinchcliff, Stanley Done and Walter Gruenberg, 11th Edition. Saunders Ltd.
- *Dairy Herd Health.* 2012. MJ Green and Andrew J Bradley. CABI Publishing
- Research and Review Papers in Current Journals.

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Medicine

I. Internal diseases of digestive, respiratory, urinary, cardiovascular, blood and blood forming organs, nervous, musculoskeletal system, skin, eye and ear of bovine, sheep and goat.

- Examination of alimentary tract and abdomen of ruminants; diseases of the buccal cavity, pharynx, oesophagus; reticulo-ruminal fermentative disorders (simple indigestion, impaction, ruminal lactic acidosis), primary and secondary bloat, diaphragmatic hernia, traumatic reticulo-peritonitis and omasal impaction.
- Diseases of abomasum (impaction, displacements, ulcers, bloat), acute and chronic diarrhoea, peritonitis, caecal dilatation and hemorrhagic bowel syndrome.
- Manifestations of liver and biliary diseases, focal and diffuse diseases of liver.
- Disease of nasal cavity, sinuses, disease of larynx and trachea, pneumonia, pleuritis.
- Manifestations and principles of treatment in uro-genital system; rupture, paralysis and infections of urinary bladder; urolithiasis, nephritis and renal failure, nephrosis, renal ischemia, hemolytic uremic like syndrome, uremia and neoplasms of urinary tract.
- Examination of cardiac system and Special examination of heart (ECG, echocardiography, markers for diagnosis of cardiac disorders. Principal manifestations of cardiovascular diseases, congenital cardiac diseases, myocarditis, cardiomyopathy, endocarditis, pericarditis, phlebitis, thrombosis, anemia, lymphangitis, lymphadenopathies and thrombocytopenia.
- Principles of nervous dysfunction, clinical manifestation and special examination, localization of lesion in brain and spinal cord, cortical diseases, brain abscess, meningitis, diseases of brainstem, cerebellar diseases, spinal cord compression and cranial and peripheral nerve paralysis.
- Principal manifestations and special examination of musculoskeletal system, myositis, myopathies, foot lameness, arthritis, osteodystrophies, degenerative joint disease and nutritional deficiency diseases affecting musculoskeletal system.
- Conjunctivitis, keratitis, uveitis, horner syndrome, neoplasms of eye, otits media, otitis externa.
- Skin diseases: folliculitis, furunculosis and skin neoplasms.

II. Bacterial, fungal, chlamydial, viral, parasitic, mycoplasmal, prions and rickettsial diseases of bovine, sheep, and goat.

- Clostridial diseases – black quarter, botulism, bacillary hemoglobinuria, braxy, enterotoxemia, malignant edema, pulpy kidney disease, tetanus, collibacilosis, salmonellosis, compylobacteriosis, listeriosis, actinobacillosis, actinomycosis, anthrax,
  tuberculosis, johne's disease, leptospirosis, pasteurellosis, ulcerative lymphangitis,
  infectious bovine keratoconjuctivitis, dermatophytosis.
- Foot and mouth disease, vesicular stomatitis, vesicular exanthema, rinderpest, PPR, bovine viral diarrhea, mucosal disease, ephemeral fever, bovine herpes viral diseases, leucosis, viral pneumonia, pox diseases, infectious gastroenteritis of viral etiology, Malignant catarrh fever, rabies, bluetongue, louping ill, papillomatosis, contagious ecthyma (orf), caprine arthritis and encephalopathy (CAE), contagious bovine pleuropneumonia and contagious caprine pleuropneumonia.
- Bovine anaplasmosis, theileriasis, babesiosis, fascioliosis, amphistomiosis, gastrointestinal nematodiosis, schistosomiosis, Lung worm infection, echinococcosis, coenurosis and tapeworm infections, coccidiosis, parasitic dermatitis (scabies, psoroptes).

III. Internal and infectious diseases of Equines

- Diseases of buccal cavity (dental diseases, stomatitis), oesophagus, gastric dilatation,
  gastro-duodenal ulceration, acute and chronic diarrhea, colic, acute and chronic hepatitis.
- Diseases of cardio-vascular system and blood forming organs.
- Manifestations and principles of treatment in respiratory disorders, epistaxis, pharyngitis, sinusitis, guttural pouch diseases, tracheal collapse, adult pneumonia, foal pneumonia, recurrent air way obstruction, inflammatory airway disease, pleurapneumonia, pulmonary congestion and edema.
- Manifestations and principles of treatment of urinary system diseases; rupture of urinary bladder, paralysis, urolithiasis, urinary tract infections, acute and chronic renal failure and neoplasms of urinary tract.
- Principal manifestations of musculoskeletal diseases, laminitis, inflammatory myopathy, exertional myopathies, myotonia, hyperkalemic periodic paralysis and nutritional deficiency diseases affecting musculoskeletal system.
- Nervous diseases, viral encephalitis, trauma to brain and cranial nerves, brain abscess, peripheral vestibular disease, temporo-hyoid osteoarthropathy, ataxia (sorghum toxicity, spinal abscesses), peripheral facial nerve paralysis, peripheral nerve disorders.
- Skin diseases - bacterial, fungal, parasitic and allergic dermatitis (culicoides hypersensitivity), cutaneous eczema, cutaneous acne,

cutaneous pustular dermatitis, candidiasis, histoplasmosis and dermatophytosis.

- Bacterial, fungal and viral keratitis, equine recurrent uveitis, ocular neoplasia.
- Trypanosomiasis/dourine, babesiosis, parasitic pneumonia, strangles, equine influenza, equine herpes virus infection, equine infectious anaemia and setariasis.

IV. Internal (digestive, liver, pancreas, cardiovascular, blood and blood forming organs) and infectious (bacterial, parasitic and protozoal) diseases of dogs and cats.

- Diagnostic approach to common manifestations of disease: vomiting, acute diarrhea, chronic diarrhea, syncope, anemia, jaundice, fever, weight loss, edema, dyspnoea, coughing and nasal discharge.
- Etiology, pathogenesis, clinical signs, clinical pathology, diagnosis, differential diagnosis and treatment of diseases of the oral cavity, oesophagus, acute gastritis, chronic gastritis, gastric dilatation, volvulus, tumors of the stomach, intussusception, acute enteritis, chronic enteritis, inflammatory bowel disease, colitis, gastric and intestinal foreign bodies, diseases of rectum and anal sac, peritonitis, acute hepatitis, chronic hepatitis, diseases of gall bladder, cholangitis, acute pancreatitis and exocrine pancreatic insufficiency.
- Anemia, lymphangitis, lymphadinopathies, coagulopathies, immune mediated diseases, neoplastic diseases of hemo-lymphatic system.
- Examination of cardiac system and special examination of heart (ECG, echocardiography, markers for diagnosis of cardiac disorders), congenital heart diseases, dilated cardiomyopathy, endocardiosis, cardiac arrhythmias, pericardial disorders.
- Pet psychology, pet behaviour, adaptation needs and behavioural medicine.
- Leptospirosis, tetanus, brucellosis, lyme disease, kennel cough, trypanosomiasis, ehrlichiosis, babesiosis, hepatozonoosis, ancylostomiasis, dirofilariasis, giardiasis, coccidiosis/isosporosis, toxoplasmosis, neosporosis, and tape worm infections.

V. Internal (respiratory, nervous, urogenital, musculoskeletal, eye, ear and skin) and infectious (viral and fungal) diseases of dogs and cats.

- Principles of treatment in respiratory disorders, diseases of nasal cavity, tracheobronchitis, chronic bronchitis, pulmonary congestion and edema, acute pneumonia, chronic pneumonia, feline asthma, pleural effusions and neoplasms of respiratory tract.
- Diagnostic approach to common manifestations of disease: seizures, coma, monoparesis, pelvic limb paralysis, pruritis, alopecia, obesity, urinary incontinence, hematuria.

- Focal, diffuse and multifocal diseases of brain. Diseases of spinal cord and peripheral nervous system, vestibular diseases and toxins affecting nervous system.
- Diseases of muscles- congenital and inherited diseases of muscles, bone and joints, myasthenia, myopathy; Nutritional deficiency diseases- rickets, primary and secondary hyperparathyroidism, osteodystrophy and osteomyelitis.
- Diseases of eyelids, epiphora, keratitis, conjunctivitis, uveitis, glaucoma, acute blindness and neoplasms of eye.
- Skin diseases, pyodermas, atopy, dermatomycosis, demodicosis, scabies, myiasis, and nutritional disorders related to skin and its therapeutic management, flea allergy and its treatment and control measures, alopecia.
- Cutaneous manifestations of hormonal imbalances and systemic disorders, auto immune diseases of skin, diseases of the pinna, otitis and principles of treatment in otic infections.
- Manifestations and principles of treatment of urinary system diseases, urinary tract infections, urolithiasis, nephritis, nephrosis, pyelonephritis, renal failure and neoplasms of urinary tract.
- Viral diseases: Canine parvovirus, canine distemper, corona viral gastroenteritis, infectious hepatitis, infectious tracheobronchitis, canine herpes virus, rabies, feline panleukopenia, infectious peritonitis (FIP), feline leukemia virus infection, Feline immunodeficiency virus, vaccination schedule for canine and feline diseases, dermatophytosis.

VI. Study of diagnosis, management and control of metabolic, endocrine, nutritional and mammary gland diseases.

- Metabolic profile test, parturient paresis, downer cow syndrome, acute hypokalemia in cattle, transit recumbency, lactation tetany of mares, hypomagnesemia, tetany of calves, ketosis, sub-clinical ketosis, pregnancy toxemia, fatty liver syndrome, equine hyperlipidemia, steatitis, neonatal hypoglycemia, low milk fat syndrome, periparturient hemoglobinuria and eclampsia in bitches.
- Deficiency of energy and protein, deficiency of fat and water soluble vitamins and deficiency of macro- micro minerals.
- Mastitis, diseases of teats and udder in ruminants, “mastitis-metritis-agalactia” in sow and congenital abnormalities of udder and teats.
- Diabetes mellitus, diabetes insipidus, hypothyroidism, obesity, hypo- and hyperadrenocorticism.

VII. Recent concepts in non-infectious and infectious diseases of avian species and pigs.

- Specific needs of avian species; Diseases due to deficiency of vitamins (vitamins A, B complex, C, D, E, K); minerals (calcium, phosphorus, manganese, zinc etc.) and sodium chloride.
- Miscellaneous diseases/conditions/ vices (cage layer fatigue, beak necrosis, blue comb disease, round heart disease, kerato- conjunctivitis, ascites, urolithiasis, fatty liver, kidney hemorrhagic syndrome, heat stroke, cannabalism, vent picking), egg bound peritonitis, diseases of feather, skin, beak and foot, bumble foot, gout, infectious diseases of poultry (marek's disease, lymphoid leukosis, new castle disease, infectious coryza, fowl typhoid, fowl cholera, CRD, pullorum disease, cocciodiosis, chlamydiasis, avian pox, infectious bursal disease, infectious bronchitis, infectious laryngo- tracheitis etc.)
- Nutritional deficiency diseases of pigs, swine influenza, hog cholera, african swine fever, swine pox, rabies, Porcine enteroviruses, pseudorabies, listeriosis, leptospirosis, brucellosis, salmonellosis, swine erysipelas, pasteurellosis, mange etc.

VIII. Study of diseases caused by physical, chemical, other toxicants in domestic animals and animal welfare issues.

- Diseases caused by physical agents and poisoning of organic and inorganic compounds. Diseases caused by farm chemicals and phytotoxins. Diseases caused by mycotoxins and zootoxins.
- Collection, dispatch and examination of veterolegal samples.
- Examination of wounds, blood, offenses and frauds in animal sales. Animal cruelty

and welfare related issues. Study of common laws related to vetero-legal aspects.

IX. Study of diagnosis and management of tumors, natural remedies and alternative systems of medicine.

- Tumors related to different systems - biology & pathogenesis of cancer, diagnostic procedures, oncology medicine, chemotherapy, radiation therapy, immuno-therapy and miscellaneous therapeutic measures, including advancements of therapeutic approaches, supportive care for the cancer patient.
- Natural remedies and products for use towards therapy in animal ailments.
- Acupuncture, physiotherapy, laser therapy, nutraceuticals and dietary supplements.

X. Concepts in investigation of infectious diseases and their prevention.

- Investigation and diagnosis on dead and live diseased animal (s) and poultry. Point source epidemics and propagating epidemics, Collection, preservation and transport of material in the face of disease outbreak, and processing of material in the laboratory for diagnosis; Recording and analysis of epidemiological data; Establishing working hypothesis and

formulating and advising and/or implementing treatment, control and prevention measures.

- Biosecurity definition, related concepts, principles and basic components of biosecurity, physical and operational elements of biosecurity. Routes of entry and transmission dynamics of pathogens. Shedding pattern of pathogens by infected animals and their survival in the environment. Protection of susceptible animals, interruption of pathways of transmission, role of disinfection to break cycle of infection.
- Sterilization, fumigation and disinfection methods, disinfectants and its classification, microbial resistance to disinfectants, risk assessment and its management. Principles of biosecurity in laboratory animal house, biosecurity measures for collection of specimen from wild animals. Biosecurity in research laboratories. Vaccines-success stories of disease eradication through vaccination

Veterinary Microbiology

DEPARTMENT OF VETERINARY MICROBIOLOGY
Course Structure for M.V.Sc degree programme (Semester Wise)

Course Code	Course Title	Credit Hours	Semester
VMC 601*	GENERAL BACTERIOLOGY	2+1	I
VMC 603*	GENERAL VIROLOGY	2+1	I
VMC 605*	PRINCIPLES OF VETERINARY IMMUNOLOGY	2+1	I
VMC 606*	VETERINARY MYCOLOGY	1+1	I
VMC 607	VACCINOLOGY	2+0	I
VMC 611	MUCOSAL IMMUNOLOGY	1+0	I
VMC 602	SYSTEMATIC VETERINARY BACTERIOLOGY	2+1	II
VMC 604	SYSTEMATIC VETERINARY VIROLOGY	2+1	II
VMC 608	TECHNIQUES IN MICROBIOLOGY	0+2	II
VMC 609	TECHNIQUES IN MOLECULAR MICROBIOLOGY	1+2	II
VMC 610	MOLECULAR IMMUNOLOGY	1+1	II
VMC 612	INTRODUCTION TO MICROBIAL BIO-INFORMATICS	1+0	II
VMC 691	MASTER'S SEMINAR	1+0	I & II
VMC 699	MASTER'S RESEARCH	0+30	I & II
* Compulsory Courses			

DEPARTMENT OF VETERINARY MICROBIOLOGY
Course Structure for Ph.D degree programme (Semester Wise)

Course Code	Course Title	Credit Hours	Semester
VMC 701*	ADVANCES IN VETERINARY BACTERIOLOGY	2+1	I
VMC 702	ADVANCES IN VETERINARY MYCOLOGY	2+1	I
VMC 706*	ADVANCES IN VETERINARY VIROLOGY	2+1	I
VMC 708	STRUCTURE FUNCTION RELATIONSHIP OF DNA AND RNA VIRUSES	2+0	I
VMC 711*	ADVANCES IN VETERINARY IMMUNOLOGY	2+1	I
VMC 712	CYTOKINES AND CHEMOKINES	2+ 0	I
VMC 714	ADVANCES IN VACCINOLOGY	2+0	I
VMC 715	CURRENT TOPICS IN INFECTION AND IMMUNITY	2+0	I
VMC 703	BACTERIAL GENETICS	2+0	II
VMC 704	MICROBIAL TOXINS	2+1	II
VMC 705	BACTERIAL PATHOGENESIS	2+0	II
VMC 707	MOLECULAR VIRAL PATHOGENESIS	2+1	II
VMC 709	ONCOGENIC VIRUSES	2+0	II
VMC 710	SLOW VIRAL INFECTIONS AND PRIONS	1+0	II
VMC 713	IMMUNOREGULATION	1+0	II
VMC 716	VETERINARY MICROBIAL BIOTECHNOLOGY	2+1	II
VMC 790	SPECIAL PROBLEM	0+1	II
VMC 791	DOCTORAL SEMINAR-I	1+0	I & II
VMC 792	DOCTORAL SEMINAR-II	1+0	I & II
VMC 799	DOCTORAL RESEARCH	0+75	I & II
* Compulsory Courses			

Course Contents
M.V.Sc. in Veterinary Microbiology

I. **Course Title : General Bacteriology**
II. **Course Code : VMC 601**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To impart knowledge of general bacteriology.

V. **Theory**

Unit I

Historical events of microbiology, Taxonomy and nomenclature of bacteria. Basic principles of microscopy and micrometry, Classical, Confocal, Nomaraski and electron microscopy. Staining of bacteria, Structure and function of bacterial cell. Growth, Nutrition, Metabolism, principles of bacterial disease diagnosis.

Unit II

Secretion and excretion systems of bacteria. General Bacterial genetics, Bacterial variation, Horizontal genetic transfer mechanisms (transformation, transduction and conjugation), Plasmids, Transposons and drug resistance.

Unit III

Determinants of pathogenicity and its molecular basis, Markers and PAMPs, exotoxin and endotoxin.

Bacteriophages: temperate and virulent phages; lysogeny and lysogenic conversion. Antimicrobial agents and disinfectants: Mechanism of action, Resistance and susceptibility testing. Bacterial immunity.

VI. **Practical**

Orientation to a bacteriology laboratory, Sterilization and disinfection techniques, Laboratory biosafety and biosecurity. Cultivation of aerobic, Microaerophilic and anaerobic bacteria, Isolation of bacteria in pure culture, Microscopy, Morphological characterization of bacteria, Different staining methods and biochemical tests for identification of bacteria, Determination of bacterial number and biomass and standard protocols for antibiotic sensitivity test and detection of MIC.

I. **Course Title : Systematic Veterinary Bacteriology**
II. **Course Code : VMC 602**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To learn different aspects with regards to the virulence factors, Antigenic and structural components, Epidemiology, Pathogenesis,

Diagnosis and control of important aerobic, Microaerophilic and anaerobic pathogenic bacteria.

V. **Theory**

Unit I

Systematic study of following groups of bacteria:

Spirochetes: *Leptospira, Brachyspira* and *Borrelia.*

Gram-negative

- Aerobic/ Microaerophillic, motile helical/ vibrioid: *Campylobacter;*
- Aerobic/ Microaerophillic rods/ cocci: *Bordetella, Brucella, Morexella, Pseudomonas* and *Burkholderia;*
- Facultative anaerobic Gram-negative rods: members of *Enterobacteriaceae, Pasteurella, Mannheimia Yersinia* and *Haemophilus;*
- Anaerobic, straight, curved and helical rods: *Dichelobacter* and*Fusobacterium*

Unit II

Rickettsia and Chlamydia: *Rickettsia, Chlamydia* (*Chlamydophila*) and *Coxiella.*

Gram-positive

- Gram-positive cocci: *Staphylococcus* and *Streptococcus* including *Enterococcus*.
- Endospore-forming rods: *Bacillus*and *Clostridium*.
- Regular non-spore forming rods: *Erysipelothrix* and *Listeria*
- Irregular non-spore forming rods: *Actinomyces*, *Corynaebacterium* and *Trueperella.*

Unit III

- Mycobacteria: *Mycobacterium*; *Actinomycetes*: *Nocardia* and *Rhodococcus, Dermatophilus.*
- Mollicutes: *Mycoplasma.*

Unit IV

- Emerging and transboundary bacterial pathogens.

VI. **Practical**

Collection, transport and dispatch of clinical samples from various disease conditions. Isolation of bacteria in pure cultures from different clinical samples. Identification of the bacteria using staining, biochemical tests and other molecular techniques. Preservation and storage of bacterial cultures.

I. **Course Title : General Virology**

II. **Course Code : VMC 603**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To study general aspects of viral structure, classification, replication, interactions and immunity against viruses.

V. **Theory**

Unit I

History of virology, Origin and nature of viruses, Morphological structure and chemical composition of viruses, Nomenclature and classification of viruses, Cultivation and purification of viruses, Laboratory diagnosis of viral infections, Viroid and Prions.

Replication of DNA and RNA viruses, genetic and non-genetic interactions between viruses.

Unit III

Virus-cell interactions, viral pathogenesis, viral persistence, oncogenic, oncolytic viruses and epidemiology of viral infections.

Unit IV

Immune response to viruses, viral vaccines, viral chemotherapy.

VI. **Practical**

Orientation to a virology laboratory, Preparation of glassware, Plasticware, Media and reagents for cell culture and other items required for virus cultivation. Protocols for primary and secondary cell cultures, Maintenance of cell lines, Cryopreservation of cells and their revival. Staining of virus infected cultured cells and demonstration of inclusion bodies. Viable cell counting. Cultivation of viruses in embryonated chicken eggs and cell cultures.

I. **Course Title : Systematic Veterinary Virology**

II. **Course Code : VMC 604**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To study viral properties, epidemiology, pathogenesis and disease status in India, diagnosis, immunity and control of diseases caused by viruses belonging to different families of animal viruses.

V. **Theory**

Unit I: Double and Single stranded DNA virus families

Poxviridae, *Asfarviridae*, *Herpesviridae*, *Adenoviridae*, *Papillomaviridae*, *Polyomaviridae*, *Parvoviridae*, *Circoviridae* and *Hepdnaviridae.*

Unit II: Single stranded Negative sense and Double stranded RNA viruses *Orthomyxoviridae*, *Paramyxoviridae, Rhabdoviridae, Bornaviridae, Reoviridae* and *Birnaviridae.*

Unit III: Single stranded Positive sense RNA viruses

Picornaviridae, *Caliciviridae*, *Togaviridae*, *Flaviviridae*, *Coronaviridae*, *Arteriviridae*,*Astroviridae* and *Retroviridae.*

Unit IV: Prions

BSE, Scrapie and introduction to viriods.

Unit V

Emerging, re-emerging and transboundary viral pathogens

VI. **Practical**

Collection, Preservation, Transportation of clinical samples and their processing for virus isolation and identification. Isolation and cultivation of viruses from clinical samples, using different methods and its plaque purification. Titration of viruses for 50% end points using different methods, Serum neutralization test.

Electropherotyping, Concentration and purification of viruses by chemical agents, differential centrifugation, density gradient centrifugation and ultra-filtration. Methods for preservation of animal viruses.

I. **Course Title : Principles of Veterinary Immunology**

II. **Course Code : VMC 605**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To understand the fundamental principles of veterinary immunology and its applications**.**

V. **Theory**

Unit I

Introduction to livestock and poultry immune system: ontogeny and phylogeny of vertebrate immune system, cells and organs of immune system. Types of immunity: Innate and adaptive immune system.

Unit II: Antigen and its characteristics

Characteristic of ideal antigen; Classification of antigens, Factors affecting immunogenicity, Concept of hapten and carrier. Antigenic determinant/ epitope and cross reactivity. B-cell epitope and T cell epitope. Immunoglobulins: Basic structure and function of immunoglobulins, Immunoglobulin diversity and immunoglobulin classes.

Antigen recognition by B cell and T cell: B cell receptor, T cell receptor, receptor diversity, B cell and T cell activation.

Unit III: Major Histocompatibility Complex

General feature, structure, function, gene organization, MHC and immune response. Immune-response development: Phases of humoral and cell mediated immune response. Immunoregulation with B and T cells: Antigen recognition, antigen presentation and processing, antigen recognition by TCR, MHC restriction, Cytokines and chemokines. Cell mediated immune response: General properties of effector T cells, cytotoxic T cells, NK-cells and

ADCC. Role of integrin and selectin.

Unit IV: Complement System

Basic concept of complement, mechanism of complement activation, complement pathways and Complement deficiencies. Autoimmunity and autoimmune diseases, immunological tolerance and hypersensitivity: classification, mechanism of induction with examples. Immunodeficiency: Types with examples. Immune response in foetus and new born.

Unit V: Antigen antibody interaction

Antibody affinity, avidity, cross reactivity, precipitation and agglutination test, radio-immunoprecipitation assay (RIPA), ELISA, Western blotting, Immunodiagnostics and Immunotherapy. Monoclonal antibodies and methods for production and characterization of monoclonal antibodies.

VI. **Practical**

Preparation of antigens, raising of antisera against soluble and insoluble antigens.Detection of antibody by gel diffusion, radial immunodiffusion, immune- electrophoresis techniques. Haemagglutination and haemagglutination inhibition test, ELISA and its modifications. Immunoblotting. Agglutination tests. Separation and purification of Immunoglobulin from serum. Separation of mononuclear cells from blood by density gradient centrifugation, viable count of lymphocyte by dye exclusion method. Measurement of T cell response (DTH, lymphoproliferative assay).

I. **Course Title : Veterinary Mycology**

II. **Course Code : VMC 606**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To learn detailed morphological, cultural features, virulence factors, antigenic and structural components, epidemiology, pathogenesis, diagnosis and control of fungal infections.

V. **Theory**

Unit I

History of mycology, Glossary of mycological terms; Morphology of fungi: structure and ultra-structure, differentiation, nutrition, physiology, reproduction, spores, cultural characters and classification of fungi of veterinary importance. Fungal immunity. Antifungal agents and important techniques in diagnosis of fungal infections.

Unit II: Systematic study of animal mycoses:

Aspergillosis, Candidiasis, Cryptococcosis, Epizootic lymphangitis, Rhinosporodiosis, Zygomycosis, Blastomycosis, Sporotrichosis,

Histoplasmosis, Coccidioidomycosis, Mycetomas, Dermatophytoses, Dermatomycosis, Mycotoxicosis, Malassezia infections, Mycotic abortion, Mycotic mastitis, and Emerging mycoses.

VI. **Practical**

Collection and processing of clinical material for isolation of fungi. Microscopy of fungi: Lactophenol cotton blue and India ink preparations. Preparation of basal and special fungal media of veterinary importance. Slide culture and cellophane tape technique for fungi. Diagnosis of dermatophytes. Biosafety precautions in handling yeast and dimorphic fungi. Study of gross and microscopic characters of pathogenic fungi, antifungal sensitivity testing, detection of mycotoxin. Serological and molecular diagnosis in fungi.

I. **Course Title : Vaccinology**
II. **Course Code : VMC 607**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To understand different aspects of vaccines, their production, standardization and quality control of various vaccine used in animals.

Unit I

Types of vaccines andvaccine components, factors influencing choice of vaccines.

New generation vaccines: subunit vaccines, peptide vaccines, recombinant vaccines, reverse genetics vaccines, Marker and DIVA enabled vaccines and transmission blocking vaccines.

Unit II: Preparation of vaccines

Identification of candidate strain, identification of epitopes, seed and challenge strain maintenance. Classical methods of inactivation, exaltation and attenuation of pathogens and their molecular basis. Technology of production of different types of vaccines.Multicomponent vaccines. Recent advances in vaccine delivery systems. Advances in vaccinesadjuvants with their classification and mode of action.

Unit III

Standardization of veterinary vaccines as per National and Global standards. Laws and regulatory requirements about veterinary biological and Indian pharmacopoeia.

Unit IV

Vaccine failure and post vaccinal reactions. Factors affecting

response to vaccines: maintenance of vaccines and cold chain. Quality control. Principles of development of vaccination schedule, methods of conducting vaccine trials (lab to field use) and pharmaco-vigilance. Scaling up methods of vaccine production.

I. **Course Title : Techniques in Microbiology**
II. **Course Code : VMC 608**
III. **Credit Hours : 0+2**

(Course to be offered to the students not majoring in Veterinary Microbiology)

IV. **Aim of the course**

To give overview of the techniques used in microbiology.

V. **Theory**

Unit-I

Orientation to a microbiology laboratory. Different sterilization and disinfection techniques. Laboratory biosafety and biosecurity. Microscopy, media preparation, isolation, cultivation and purification of bacteria and fungi and their morphological and biochemical characterization. Antibacterial sensitivity test by Disc diffusion, broth dilution and MIC determination technique.

Unit II

Cultivation of viruses in embryonated eggs and cell culture. Virus Neutralization test.

Unit III

Different immunological techniques: Agglutination, precipitation, ELISA, Haemagglutination and HaemagglutinationInhibition and other immunological assays.

I. **Course Title : Techniques in Molecular Microbiology**
II. **Course Code : VMC 609**
III. **Credit Hours : 1+2**
IV. **Aim of the course**

To provide training in molecular biology and other diagnostic techniques used inmicrobiology

V. **Theory**

Unit I

Basic requirements for establishing molecular diagnostics Laboratory. Principles of molecular diagnostic tests. Methods of nucleic acid extraction from pathogenic microorganisms.

Unit II

PCR, and variants of PCR. Principles of primer designing. Gel electrophoresis methods andblotting techniques: Southern blotting, northern blotting, western blotting, dot-blot. Microarrays,

nucleic acid sequencing methods. Sequence analysis- sequence editing, sequence alignment, sequence comparison and phylogentic analysis. Gene cloning and expression. Molecular diagnosis as epidemiological tool.Development and validation of diagnostic tests.

VI. **Practical**

Unit I

Orientation of molecular diagnosis laboratory: diagnostic PCR laboratory (handling RNA and DNA). Extraction of nucleic acid from different microbes: Gram positive bacteria, Gram negative bacteria, DNA viruses, RNA Viruses and fungi, DNA and RNA isolation from cell culture and blood and isolation of plasmids. Quality and quantity check of nucleic acids.

Unit II

Principles for Primer designing. Procedure for molecular diagnostic tests like PCR, RT-PCR and LAMP. Absolute and relative quantitation of DNA/ RNA using Q- PCR. SDS PAGE of proteins and RNA, study of nucleic acid and proteins by blotting techniques. Restriction Enzyme digestion Techniques and RFLP; PCR product concentration and purification for sequencing. Nucleic acid sequence analysis. Gene Cloning, expression and purification of expression products. An
introduction to high throughput sequencing and MALDI-TOF.

I. **Course Title : Molecular Immunology**

II. **Course Code : VMC 610**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To learn about molecular aspects of immunology**.**

V. **Theory**

Unit I

Molecular Structure and function of PRRs. Ligands of PRRs, signal transduction through PRRs andinflammosome. Cytokines, Lymphocyte markers and CD nomenclature.

Unit II

Molecular structure of Immunoglobulin and class, Isotypes, Synthesis and expression of immunoglobulin, Rearrangement and its organization, Immunoglobulin gene diversity and mechanism of recombination of B cell gene. Theory of antibody generation. Signature molecules of T cell and T regulatory cell. T cell receptor andT cell gene diversity.

Unit III

MHC structure, Genomic organization of the MHC gene

haplotype. Concept of congenic and syngeneic, concept of polymorphism of MHC gene, pathway of signal transduction, role of co-stimulators in B cell and T cell activation and recruitment of adaptor proteins. Molecular mechanisms (events) of cell cytotoxicity.

VI. **Practical**

Isolation and purification of mammalian and avian immunoglobulin by precipitation technique: Caprylic acid, PEG, Ammonium Sulphate, Sodium Sulphate. Separation of immunoglobulins by size, charge and ligand affinity: size exclusion chromatography (gel filteration on Sephadex G200), ion exchange chromatography, affinity chromatography (Protein-A-Sepharose). Immuno-electrophoresis Technique: polyacrylamide gel electrophoresis innative and reducing conditions, fixed andgradient gel, Western blot, Crossed immune-electrophoresis. Chemiluminscence assay and Cell cytotoxicity assays; Non-radioactive methods like LDH release assay. Antigen detection by Immuno PCR. Haplotype matching between individuals, Flow cytometry for CD4 and CD8 ratio determination and other applications. ELISpot test for cytokine assay.

I. **Course Title : Mucosal Immunology**

II. **Course Code : VMC 611**

III. **Credit Hours : 1+0**

IV. **Aim of the course**

To learn about mucosal immunity.

V. **Theory**

Unit I: Innate Mechanisms

Mucosal barrier: Development and physiology of mucosal defense. Cells and lymphoid tissues of mucosal immune system: MALT, GALT, NALT and BALT. Innate immune response at mucosal surfaces: mucus, antimicrobial peptides, role of PRRs, intestinal Dendritic cell, intestinal macrophage, mucosal inductive and effector sites. Antigen uptake and presentation at mucosal sites, transepithelial transport of antigen.

Unit II: Acquired response

Mucosal Immunoglobulin, IgA synthesis and transport to intestinal lumen.Description and role of Paneth cell and crypto patches.M-cells and their functions.Mucosal immune effector mechanisms including secretory IgA response. Extrathymic functions. T cell development in mucosal tissues and their phenotypes.

Unit III: Applications

Importance and limitations of mucosal immunization. Mucosal adjuvants and delivery systems. Oral tolerance mechanistic approach. Immunopathology at mucosal surfaces: Celiac disease, Inflammatory bowel disease, Johne's disease; Assessment of mucosal immune response and potency testing.

I. **Course Title : Introduction to Microbial Bioinformatics**
II. **Course Code : VMC 612**
III. **Credit Hours : 1+0**

(Relevant practical demonstrations be given along with theory topic)

IV. **Aim of the courses**

To learn about key bioinformatics techniques, tools and databases.

V. **Theory**

Unit I

Introduction to Bioinformatics; History, Scope and Application, Internet and world wide web. Bioinformatics resources and information retrieval system. Nucleic acid sequence databases, Genome databases, Protein sequence databases, Metabolic pathways databases, NCBI, ExPASy and Ensemble Genome browser.

Unit II

Sequence comparison and alignment methods; Introduction to sequence alignment, principal methods of pairwise sequence alignment and Dot plot analysis. Significance of BLAST and FASTA programs in DNA and protein sequence analysis, variants of BLAST and FASTA programs. Introduction to multiple sequence alignment and Phylogenetic analysis to retrieve evolutionary information, Global multiple sequence alignment tool- CLUSTAL-W.

Unit III

Overview of protein structure and databases, Structure based protein classification, Protein structure database (CASP), Protein structure alignment tools (VAST, DALI), Protein 3-D structure visualization and modeling using SWISS PROT.

Course Outline-cum-Lecture Schedule for Master degree Programme

VMC 601: General Bacteriology (2+1)

S.No.	Topic of Syllabus	Lecture/ Practical
Theory		
1.	Historical events of Microbiology	2
2.	Taxonomy and nomenclature of bacteria	1
3.	Basic principle of microscopy and micrometry	1
4.	Classical, Confocal, Nomaraski and Electron Microscopy	2
5.	Staining of bacteria	1
6.	Structure and function of bacterial cell	3
7.	Bacterial growth, nutrition and metabolism	3
8.	Secretion and excretion systems of bacteria	2
9.	General Principles of bacterial disease diagnosis	2
10.	Bacterial genetics and Bacterial variation	1
11.	Horizontal genetic transfer mechanisms- transformation, Transduction and conjugation	1
12.	Plasmids, transposons and drug resistance	1
13.	Determinants of pathogenicity and its molecular basis	2
14.	Markers and PAMPs, exotoxin and endotoxin	1
15.	Bacteriophages- temperate and virulent phages, lysogeny and lysogenic conversion	2
16.	Antimicrobial agents	2
17.	Disinfectants -Mechanism of action	2
18.	Disinfectants -resistance and susceptibility testing	1
19.	Bacterial immunity	2
	Total	32
Practical		
1.	Orientation to a bacteriology laboratory	1
2.	Different sterilization and disinfection techniques	2
3.	Laboratory biosafety and biosecurity	1
4.	Cultivation of aerobic, microaerophilic and anaerobic Bacteria using bacteriological media	2
5.	Isolation of bacteria in pure culture	2
6.	Microscopy	1
7.	Morphological characterization of bacteria by different staining methods	2
8.	Important biochemical tests for identification of bacteria	2
9.	Determination of bacterial number and biomass by different methods	1
10.	Standard protocols for antibiotic sensitivity test	2
11.	Detection of MIC	1
	Total	16

VMC 602: Systematic Veterinary Bacteriology (2+1)

S.No.	Topic of Syllabus	Lecture/Practical
Theory		
1.	Spirochetes: *Leptospira, Brachyspira* and *Borrelia*	2
2.	*Campylobacter*	1
3.	*Bordetella* and *Morexella*	1
4.	*Brucella*	2
5.	*Pseudomonas* and *Burkholderia*	1
6.	*Enterobacteriaceae*	3
7.	*Pasteurella, Mannheimia* and *Yersinia*	2
8.	*Haemophilus*	1
9.	*Dichelobacter* and *Fusobacterium*	1
10.	Rickettsia and Chlamydia-*Rickettsia*	1
11.	Rickettsia and Chlamydia- *Chlamydia* (*Chlamydophila*) and *Coxiella*	1
12.	*Staphylococcus*	1
13.	*Streptococcus* and *Enterococcus*	2
14.	*Bacillus*	1
15.	*Clostridium*	3
16.	*Erysipelothrix* and *Listeria*	2
17.	*Actinomyces*, *Corynebacterium* and *Truepurella.*	1
18.	*Mycobacterium*	2
19.	Actinomycetes: *Nocardia* and *Rhodococcus* and *Dermatophilus*	2
20.	Mollicutes (*Mycoplasma)*	1
21.	Emerging and transboundary bacterial pathogens	2
	Total	32

Practical

1.	Collection, transport and dispatch of clinical samples from various disease conditions	2
2.	Isolation of bacteria in pure cultures from different clinical samples	8
3.	Identification of the bacteria using staining, biochemical tests and other molecular techniques	4
4.	Preservation and storage of bacterial cultures	2
	Total	16

VMC 603: General Virology (2+1)

S.No.	Topic of Syllabus	Lecture/ Practical
Theory		
1.	History of virology	1
2.	Origin and nature of viruses	1
3.	Morphological structure and chemical composition of viruses	2
4.	Nomenclature and classification of viruses	2

5.	Cultivation and purifications of viruses	2
6.	Laboratory diagnosis of viral infections	2
7.	Viroid and Prions	1
8.	Replication of DNA viruses	2
9.	Replication of RNA viruses	3
10.	Genetic and non-genetic interactions between viruses	2
11.	Virus-cell interactions	1
12.	Viral pathogenesis	2
13.	Viral persistence	1
14.	Oncogenic and oncolytic viruses	2
15.	Epidemiology of viral infections	2
16.	Immune response to viruses	2
17.	Viral vaccines	2
18.	Viral chemotherapy	2
	Total	32

Practical

1.	Orientation to a virology laboratory	1
2.	Preparation of glassware, plasticware, media and reagents for cell culture	2
3.	Other items required for virus cultivation	1
4.	Protocols for primary and secondary cell cultures	2
5.	Maintenance of cell lines	1
6.	Cryopreservation of cells and their revival	2
7.	Staining of virus infected cultured cells	1
8.	Demonstration of inclusion bodies	1
9.	Viable cell counting	1
10.	Cultivation of viruses in embryonated chicken eggs	2
11.	Virus cultivation in primary cell cultures and cell lines	2
	Total	16

VMC 604: Systematic Veterinary Virology (2+1)

S.No.	Topic of Syllabus	Lectures/ Practicals

Theory

1.	*Poxviridae*	2
2.	*Asfarviridae*	1
3.	*Herpesviridae*	3
4.	*Adenoviridae*	2
5.	*Papilomaviridae* and *Polyomaviridae*	1
6.	*Parvoviride*	1
7.	*Circoviridae* and *Hepdnaviridae*	1
8.	*Orthomyxoviridae*	2
9.	*Paramyxoviridae*	2
10.	*Rhabdoviridae*	2

11. *Bornaviridae* 1
12. *Reoviridae* 2
13. *Birnaviridae* 1
14. *Picorna* and *Caliciviridae* 2
15. *Togaviridae* and *Flaviviridae* 2
16. *Coronaviridae* 1
17. *Arteriviridae* and *Astrovirida* 1
18. *Retroviridae* 2
19. Prions: BSE, Scrapie and introduction to viriods 2
20. Emerging, re-emerging and transboundary viral pathogens 1

Total 32

Practical

1. Collection, preservation, transportation of clinical samples 1
2. Processing clinical samples for virus isolation and identification 6
3. Isolation and cultivation of viruses from clinical samples, using different methods and its plaque purification
4. Titration of viruses for 50% end points using different methods 2
5. Detection of viral antibodies by serum neutralization test 2
6. Electropherotyping 2
7. Concentration and purification of animal viruses by chemical agents, differential centrifugation, density gradient centrifugation and ultra-filtration 2
8. Methods for preservation of animal viruses 1

Total 16

VMC 605: Principles of Veterinary Immunology (2+1)

S.No. Topic of Syllabus Lectures/ Practicals

Theory

1. Introduction to livestock and poultry immune system 1
2. Ontogeny and phylogeny of vertebrate immune system 1
3. Cells and organs of immune system 1
4. Types of immunity- Innate and adaptive immune system 1
5. Antigen and its characteristics- Characteristic of ideal antigen, classification of antigens, Factors affecting immunogenicity, Concept of hapten and carrier, Antigenic determinant/ epitope and cross reactivity, B-cell epitope and T cell epitope 2
6. Immunoglobulins- Basic structure and function of immunoglobulins 1
7. Immunoglobulin diversity and Immunoglobulin classes 1
8. Antigen recognition by B cell and T cell 1
9. B cell receptor/ immunoglobulins and T cell receptor 1

10. Receptor diversity- B cell and T cell activation 1
11. Major Histocompatibility Complex(General feature, structure, function, gene organization, MHC and immune response and Cytokines and chemokines) 2
12. Immune response development- Phases of humoral and cell Mediated immune response 2
13. Immunoregulation with B and T cells(Antigen recognition, Antigen presentation and processing, Antigen recognition by TCR and MHC restriction) 1
14. Cell mediated immune response- General properties of effector T cells, cytotoxic T cells, NK-cells and ADCC, Role of integrin and selectin 2
15. Complement System- Basic concept of complement, Mechanism of complement activation, complement pathways and Complement deficiencies 2
16. Autoimmunity, autoimmune diseases and Immunological tolerance 1
17. Hypersensitivity- Classification and mechanism of induction with examples 2
18. Immunodeficiency- Types with examples 1
19. Immune response in foetus and new born 1
20. Antigen antibody interaction- Antibody affinity, avidity, cross reactivity, precipitation and agglutination test 2
21. ELISA and Western blotting 1
22. Immunodiagnostics and Immunotherapy 1
23. Monoclonal antibodies and methods for production of Monoclonal antibodies 1

Total 32

Practical

1. Preparation of antigens 1
2. Raising of antisera against soluble and insoluble antigens 1
3. Detection of antibody by gel diffusion, radial immune-diffusion and immune-electrophoresis techniques 2
4. Haemagglutination and haemagglutination inhibition test 2
5. ELISA and its modifications 2
6. Immunoblotting 1
7. Different agglutination tests 2
8. Separation and purification of Immunoglobulin from serum 1
9. Separation of mononuclear cells from blood by density gradient centrifugation 1
10. Viable count of lymphocyte by dye exclusion method 1
11. Measurement of T cell response- DTH and lymphoproliferative assay 2

Total 16

VMC 606: Veterinary Mycology (1+1)

S.No.	Topic of Syllabus	Lectures/Practicals

Theory

1. Historyof mycology and Morphology of fungi 1
2. Structure and Ultra structure 1
3. Differentiation, nutrition, physiology, reproduction, spores and cultural characters 2
4. Classification of fungi of veterinary importance 1
5. Glossary of mycological terms and antifungal agents 1
6. Important techniques in diagnosis of fungal infections 1
7. Aspergillosis 1
8. Candidiasis, Cryptococcosis and Pachydermatitis 1
9. Epizootic lymphangitis and Rhinosporodiosis 1
10. Zygomycosis and Blastomycosis 1
11. Sporotrichosis and Histoplasmosis 1
12. Coccidioidomycosis and Mycetomas 1
13. Mycotic abortion and mycotic mastitis 1
14. Dermatophytoses and dermatomycosis 2
15. Mycotoxicosis and Emerging mycoses 1 Total 16

Practical

1. Collection and processing of clinical material for isolation of fungi 1
2. Microscopy of fungi-Lactophenol cotton blue and india ink preparations 2
3. Preparation of basal and special fungal media of veterinary importance 1
4. Slide culture and cellophane tape technique for fungi 2
5. Biosafety precautions in handling yeast and dimorphic fungi 1
6. Study of gross and microscopic characters of pathogenic fungi 5
7. Diagnosis of dermatophytes 1
8. Antifungal sensitivity testing 1
9. Detection of mycotoxin 1
10. Serological and molecular diagnosis in fungi 1

Total 16

VMC 607: Vaccinology (2+0)

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Types of vaccines	1
2.	Vaccine components, Immunogens and factors influencing choice of vaccines	1
3.	New generation vaccines- subunit vaccines, peptide vaccines and recombinant vaccines	2
4.	Reverse genetics vaccines, Marker and DIVA vaccines and transmission blocking vaccines	2
5.	Preparation of vaccines- Identification of candidate strain, identification of epitopes	2
6.	Seed and challenge strain maintenance	1
7.	Classical methods of exaltation and attenuation of pathogens and their molecular basis	2
8.	Technology of production of different types of vaccines	1
9.	Recent advances in vaccine delivery systems and multicomponent vaccines	2
10.	Advances in vaccines, adjuvants with their classification and mode of action	2
11.	Standardization of veterinary vaccines as per National and Global standards	2
12.	Laws and regulatory requirements concerning veterinary biologicals	2
13.	Indian pharmacopoeia	2
14.	Vaccine failure and Post vaccinal reactions	1
15.	Factors affecting response to vaccines and Quality control	2
16.	Principles of development of vaccination schedule	1
17.	Principles of development of vaccination schedule	1
18.	Methods of conducting vaccine trials (lab to field use)	1
19.	Pharmaco-vigilance	1
20.	Scaling up methods of vaccine production	1
	Total	32

VMC 608: Techniques in Microbiology (0+2)

S.No.	Topic of Syllabus	Practicals
Practical		
1.	Orientation to a microbiology laboratory	1
2.	Different sterilization and disinfection techniques	2
3.	Laboratory biosafety and biosecurity	1
4.	Microscopy	2
5.	Media preparation	2
6.	Isolation, cultivation and purification of bacteria and fungi	2
7.	Morphological and biochemical characterization	3
8.	Antibacterial sensitivity test by Disc diffusion, broth dilution and MIC determination technique	3
9.	Cultivation of viruses in embryonated eggs	2
10.	Cultivation of viruses in cell culture	3
11.	VNT	1
12.	Different immunological techniques- Agglutination	2
13.	Precipitation	2
14.	HA and HI	2
15.	ELISA	2
16.	Other immunological assays	2
	Total	32

VMC 609: Techniques in Molecular Microbiology (1+2)

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	Basic requirements for establishing molecular diagnostics Laboratory	1
2.	Principles of molecular diagnostic tests	2
3.	Methods of nucleic acid extraction from pathogenic microorganisms	2
4.	PCR and variants of PCR	3
5.	Principles of primer designing	1
6.	Gel electrophoresis methods	1
7.	Blotting Techniques- Southern blotting, northern blotting, Western blotting and dot-blot	1
8.	Nucleic acid sequencing methods	1
9.	Sequence analysis-sequence editing, sequence alignment, Sequence comparison and phylogentic analysis	1
10.	Gene cloning and expression	1
11.	Molecular diagnosis as epidemiological tool	1
12.	Development and validation of diagnostic tests	1
	Total	16

Practical

1. Orientation of molecular diagnosis laboratory 1
2. RNA and Diagnostic PCR lab (Handling RNA and DNA) 2
3. Extraction of nucleic acid from different microbes(Gram Positive bacteria, Gram Negative bacteria, DNA viruses and RNA Viruses and fungi) 4
4. DNA and RNA isolation from cell culture and blood 2
5. Quality and quantity check of nucleic acid-Microlitre spectrophotometery and gel electrophoresis 2
6. Principles for Primer designing 1
7. Procedure for molecular diagnostic tests like PCR, RT-PCR and LAMP 3
8. Absolute and relative quantitation of DNA/ RNA using Real time PCR. 2
9. SDS PAGE of proteins and RNA 2
10. Study of nucleic acid and proteins by blotting techniques 2
11. Restriction Enzyme Techniques (REA and RFLP) 2
12. PCR product concentration and purification for sequencing 2
13. Nucleic acid sequence analysis 2
14. Gene Cloning, expression and purification of expression products 3
15. Idea of high throughput sequencing and MALDI-TOF 2

Total 32

VMC 610: Molecular Immunology (1+1)

S.No. Topic of Syllabus Lectures/ Practicals

Theory

1. Molecular Structure and function of PRRs 1
2. Ligands of PRRs and signal transduction through TLR, 1
3. Inflammosome 1
4. Cytokines 1
5. Lymphocyte markers and CD nomenclature 1
6. Molecular structure of Immunoglobulin and class, isotypes, synthesis and expression of immunoglobulin, 1
7. Rearrangement and its organization, immunoglobulin gene diversity and mechanism of recombination of B cell gene 2
8. Theory of antibody generation 1
9. Signature molecules of T cell and T reg cell, T cell receptor and T cell gene diversity 2
10. MHC structure, Genomic organization of the MHC gene haplotype and pathway of signal transduction 1
11. Concept of congenic and syngeneic and Concept of polymorphism of MHC gene 1

12. Role co-stimulators in B cell and T cell activation and recruitment of adaptor proteins 1
13. Molecular mechanisms (events) of cell cytotoxicity 2

Total 16

Practical

1. Isolation and purification of mammalian and avian immunoglobulin by precipitation technique: - Caprylic acid, PEG, Ammonium Sulphate and Sodium Sulphate 2
2. Separation of immunoglobulins by size, charge and ligand affinity size exclusion chromatography (Sephadex 200), Ion exchange chromatography (DEAE), affinity chromatography (Protein-A, Sepharose) Immuno-electrophoresis Technique 2
3. Polyacrylamide gel electrophoresis innative and reducing conditions; fixed and gradient gel 2
4. Western blot and Crossed immune-electrophoresis 2
5. Solid Phase ELISA and Chemiluminscence assay 1
6. Cell cytotoxicity assaya - Non radioactive methods like LDH Realease assay 2
7. Antigen detection by Immuno PCR 1
8. Haplotype matching between individuals 2
9. Flow cytometry for CD4 and CD8 ratio determination and other applications 1
10. ELISPOT test for cytokine assay 1

Total 16

VMC 611: Mucosal Immunology (1+0)

S.No. Topic of Syllabus Lectures

Theory

1. Mucosal barrier- Development and physiology of mucosal defence. Mucosal inductive and effector sites 1
2. Cells and lymphoid tissues of mucosal immune system 1
3. MALT, GALT, NALT and BALT 1
4. Innate immune response at mucosal surfaces: Mucus, Antimicrobial peptides and Role of PPRs 1
5. Intestinal Dendritic cell and intestinal macrophage 1
6. Antigen uptake and presentation at mucosal sites and Transepithelial transport of antigen 1
7. Mucosal Immunoglobulin, IgA synthesis and transport to intestinal lumen 1
8. Extrathymic Description and role ofPaneth cell and crypto patches 1
9. M-cells and their functions 1
10. Mucosal immune effector mechanisms including secretory

IgA response 1

11. T cell development in mucosal tissues and their phenotypes and functions 1
12. Importance and limitations of mucosal immunization. 1
13. Mucosal adjuvants and delivery systems 1
14. Oral tolerance mechanistic approach. 1
15. Immunopathology at mucosal surfaces: Celiac disease, Inflammatory bowel disease, Jhone's disease 1
16. Assessment of mucosal immune response and potency testing 1

Total 16

VMC 612: Introduction to Microbial Bio-informatics (1+0)

S.No.	Topic of Syllabus	Lectures

Theory

1. Introduction to Bioinformatics; History, Scope and Application 1
2. Bioinformatics Resources and databases 1
3. Introduction to NCBI, ExPASy and Ensembl Genome browser 1
4. Sequence comparison and alignment methods 1
5. Principal and methods of Pairwise sequence alignment 1
6. Dotplot analysis 1
7. BLAST and FASTA programs and their variants 1
8. DNA and protein sequence analysis 1
9. Introduction to Multiple sequence alignment 1
10. Introduction to Phylogenetic analysis 1
11. Global multiple sequence alignment (CLUSTAL-W) 1
12. Introduction to protein structure and databases 1
13. Structure based protein classification 1
14. Protein structure database -CASP 1
15. Protein structure alignment tools (VAST, DALI) 1
16. Protein 3-D structure visualization and modeling 1

Total 16

Course Contents
Ph.D. in Veterinary Microbiology

I. **Course Title : Advances in Veterinary Bacteriology**
II. **Course Code : VMC 701**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To learn about the latest development in field of bacteriology.

V. **Theory**

Unit I

Recent advances in bacterial taxonomy and phylogeny, advanced studies on cytology, molecular structure and function of bacterial cell surface, peptidoglycans, walls of Gram-positive and Gram-negative bacteria, Cell surface appendages: Flagella and Fimbriae. Role of bacteria cell envelope in pathogenicity and immunogenicity, Biochemical activities, Antigenic structure. Bacterial secretory and excretory system.

Unit II

Bacterial whole genome sequence analysis and its application.

VI. **Practical**

Isolation of bacterial LPS, OMP, Peptidoglycans, Capsule, Flagellar antigen, genotyping, phage typing, serotyping of bacteria, studies on host pathogen interactions.

I. **Course Title : Advances in Veterinary Mycology**
II. **Course Code : VMC 702**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To learn about the latest development in the field of mycology.

V. **Theory**

Unit I

Advanced studies on taxonomy, Genetics, Physiology and Antigenic characterization of pathogenic fungi.

Unit II

Advanced studies on molecular approaches for identification of fungi; immunology and serology of mycoses, antifungal therapy, fungal vaccines, fungal viruses.

VI. **Practical**

Morphological, Biochemical and Physiological studies of various fungi. *In vivo*
pathogenicity study. Molecular detection and characterization of fungi.

I. **Course Title : Bacterial Genetic**
II. **Course Code : VMC 703**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To learn the various aspects of bacterial genetics.

V. **Theory**

Unit I

Comparative studies of prokaryotic and eukaryotic genome and their replication; structure, classification and replication of plasmids.

Unit II

Bacterial variations: Phenotypic and genotypic variations, Mutations and mutagenesis, Types of bacterial mutants, Detection of mutants and genemapping. Mechanism of gene transfer: Transduction, Transformation and conjugation. Types and mechanism of recombination: Reciprocal, Non-reciprocal and illegitimate recombination's.

Unit III

Mobile genetic elements, molecular mechanism of antibiotic resistance, regulation of gene expression.

I. **Course Title : Microbial Toxins**
II. **Course Code : VMC 704**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To learn about the structure, Mechanism of action, Methods of detection of various bacterial and fungal toxins.

V. **Theory**

Unit I

Classification of bacterial and fungal toxin on the basis of their structure and functions. The role of microbial toxins in the pathogenesis of diseases; biochemical and biological characteristics of toxins. Toxin producing Grams-positive and Grams- negative bacteria. Properties and clinical conditions produced by different bacterial and fungal toxins. Analytical methods for detection of bacterial and fungal toxins: Biological assays, Immunological assays, Nucleic acid-based methods.

Unit II

Application of microbial toxins andimmunobiological studies of toxins.

VI. **Practical**

Detection and identification of Mycotoxigenic fungi and mycotoxins. Method of detection of bacterial endotoxin, Production of toxins in suitable media, Purification and

characterization of toxins, Biological characterization in animal and in tissue culture. Toxin neutralization test.

I. **Course Title : Bacterial Pathogenesis**
II. **Course Code : VMC 705**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To learn the molecular mechanisms of bacterial pathogenesis.

V. **Theory**

Unit I

Molecular structure, Production and mode of action of bacterial virulence factors, Bacterial biofilms and advance studies on pathogenesis of bacterial diseases of various systems.

Unit II

Host-pathogen interaction, Animal models for bacterial pathogens.

I. **Course Title : Advances in Veterinary Virology**
II. **Course Code : VMC 706**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

Advanced study of virus structure, Their nucleic acids and proteins; Latest trendsin animal virus research.

V. **Theory**

Unit I

Biology of RNA and DNA virus replication. An introduction to bacteriophages and phage replication.

Unit II

Current concepts in animal virus research with respect to viral structure and architecture, viral virulence, viral pathogenesis, persistence and oncogenesis. Viruses as bio-terror agents and viruses for pest management (Bio-control).

Unit III

Antiviral drugs: Scope, Use and limitations, Existing antiviral drugs and their mechanism of action, Latest trends in antiviral drug development.

Unit IV

Preparation of plasmid backbone, Preparation of viral genes for cloning and cloning in viral genome backbone, Confirmation of cloned genes, Development of positive marker and negative markers, DIVA vaccine, Different types of viral vectors (vaccinia, adenoviral, retroviral vectors).

VI. **Practical**

Characterization of viral proteins and genome. Problem oriented

practical assignments aimed at development of bioreagents and relevant diagnostic tests.

I. **Course Title : Molecular Viral Pathogenesis**
II. **Course Code : VMC 707**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study molecular and genetic determinants of viral virulence and pathogenesis;

V. **Theory**

Unit I

Study of virus host interactions: Host specificity, Tissue tropism, Mechanism of virus spread in the body.

Unit II

Host immune responses to viral infections; Viral strategies to evade host immune responses. Viral interference and interferons.

Unit III

Pathogenesis of viral diseases of various systems, animal models for studying viral pathogenesis, molecular and genetic determinants of viral virulence, mechanisms of viral virulence.

Unit IV

Molecular and genetic determinants of viral persistence, viral oncogenesis, viral immunosuppression, and immunopathology.

VI. **Practical**

Pathotyping of animal viruses using Newcastle disease virus as model, Determination of immunosuppressive potential of animal viruses using infectious bursal disease virus/ Marek's disease virus/ chicken anaemia virus, Characterization of molecular determinants of viral virulence using variants, Recombinants and reassortants.

I. **Course Title : Structure Function Relationship of DNA and RNA Viruses**
II. **Course Code : VMC 708**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To understand the relationship between structure and function of DNA and RNA viruses of animals for the development of antivirals.

V. **Theory**

Unit I

Next generation viral vaccine and Methods of studying virus structure and architecture, Methods of amplification of viral nucleicacids, Molecular characterization of viral protein and

nucleic acids, Nucleotide sequencing and its analysis by software programmes.

Unit II

Detailed study of virus replication in various groups of animal viruses.

Unit III

Understanding the relationship between structure and function of animal DNA and RNA viruses, Development of modern vaccines and antivirals using the relationship between structure and function of animal DNA and RNA viruses.

I. **Course Title : Oncogenic Viruses**
II. **Course Code : VMC 709**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To study mechanisms of viral oncogenesis.

V. **Theory**

Unit I

General features of cell transformation and characterization of transformed cells. Oncogenic RNA and DNA viruses. Oncolytic viruses, viral and cellular oncogenes.

Unit II

Mechanisms of viral oncogenesis and diagnosis of viral oncogenesis**.**

I. **Course Title : Slow Viral Infections and Prions**
II. **Course Code : VMC 710**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

To study slow viral infections, properties and replication of prions and diseases caused by them.

V. **Theory**

Unit I

Epidemiology, Pathogenesis, Diagnosis and control of slow viral infections.

Unit II

Properties, Replication and epidemiology of prions. Pathogenesis, immunity, Diagnosis and control of Scrapies, Bovine spongiform encephalopathy, Chronic wasting disease of dear, Transmissible mink encephalopathy. Recent trends in prion research.

I. **Course Title : Advances in Veterinary Immunology**
II. **Course Code : VMC 711**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To study recent advances in immunology.

V. **Theory**

Unit I

Cells and tissues of immune system: Significance of HSC l, Origin of myeloid cells; Lymphoid cells (T and B cells), NK cells, NKT cell, Apoptosis and its role in homeostatic mechanism. Ontogeny of the lymphoid tissue in mammals and birds. Cell adhesion molecules, Recirculation and trafficking, Cell homing receptor. Antigen presenting cells and their functions at cellular level.

Unit II

Cytokines, chemokines and cytokine receptors.

Developmental biology of Immune cells**:** Early development of T and B cells and its differentiation, Maturation in primary lymphoid organ. B cell development and T cell development. Lineage commitment, Memory generation. Organization of expression of lymphocyte receptors gene, Multigenic organization of immunoglobulin gene andthymic selection of T cell repertoire. Concept of extrathymic origin of T cells. Effector and memory T and B cells.

Unit IV

Recombination events in T and B cell: Mechanism of recombination of immunoglobulin genes and T cell receptor genes.

Unit V

Activation of T and B cells: Clonal expansion. Role of T cell help in B cell response, affinity maturation of B cells and class switching and T cell activation.

Unit VI

MHC**:** MHC class-I and II structure and gene arrangement, polymorphism, antigen processing and presentation mechanism.

Unit VII

Antibody mediated and cell mediated effector functions. Cellular immune response: Effector mechanisms of CTL, NK cells and NK T cell activation. Regulation of immune response. Role of T reg-cells, immunological tolerance and graft rejection.

VI. **Practical**

Purification of immunoglobulin classes, Subclasses, Fragmentation of antibody by enzyme digestion to F (ab)2 and Fc fragments, Affinity chromatography techniques. Separation of protein by SDS PAGE under reducing condition.Western blot experiment to detect the immunogenic protein, ELISPOT, cytotoxic T cell assay,

morphological and functional assays of blood monocytes. FACS and MACS.

I. **Course Title : Cytokines and Chemokines**
II. **Course Code : VMC 712**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To study recent advances in cytokines and chemokines**.**

V. **Theory**

Unit I

Properties of cytokines. General structure and function of classification of cytokines family's, Cytokine secretion by Th1 and Th2 subsets. Cytokines cross regulation. Cytokine receptors:general structure of cytokine receptors, Immunoglobulin superfamily receptors, class 1 and class 2 cytokine receptor families. TNF receptor families and cytokine antagonists.

Unit II

Cytokine related diseases. Therapeutic uses of cytokines and their receptors. Chemokines: subgroups of chemokines and their structures and functions, chemokine receptor families.

Immunomodulators: Types of immunomodulators and their mechanism of action. Adjuvants: classification, Mode of action, Adjuvants combination and safety. Cytokine as adjuvant, PLG and microparticle as adjuvant, TLR agonist as adjuvant. Antigen delivery system and mode of action. Immunostimulants: Bacterial product and synthetic Compound, Complex carbohydrates, Immune enhancing drugs, Vitamins and cytokines.

Unit IV

Immunosuppression, Neuroendocrine control of immunoregulation, Immuno- suppressive agents and drugs, Corticosteroids, Cyclosporin's, Cyclophosphamide and other agents, Like irradiation and the mode of action**.**

I. **Course Title : Immunoregulation**
II. **Course Code : VMC 713**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

To study recent advances in immunoregulation mechanisms**.**

V. **Theory**

Unit I

Molecular mediators of immune response: Lymphokines and monokines. Idiotypic networks. Epitope specific regulation. Th, Tc and Treg cells. MHC in immuno- regulation, Immune response

genes. Antigen specific suppressor molecules produced by T cells. Immunosuppressive agents and immune-stimulation. Immunoregulatory pathways.

I. **Course Title : Advances in Vaccinology**
II. **Course Code : VMC 714**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To learn about advances in vaccine research and modern approaches for the vaccine development.

V. **Theory**

Unit I

Different phases in vaccine development. Direct and indirect correlates of protection. Antigen identification and characterization employing emerging technologies such as microarrays, *in vivo* expression technology, Signature-tagged mutagenesis and phage display technology.

Unit II

Immuno-informatics applied to epitope mapping, T cell epitopes and identification of pathogenic epitopes. Novel vaccines: nucleic acids, Marker vaccines, Mucosal vaccines, Bacterial ghosts as vaccines and virus-like particles. Futuristic vaccines: anti-allergic, Anti-autoimmune diseases, De-addiction vaccines and transplant survival/ prolonging vaccines.

I. **Course Title : Current Topics in Infection and Immunity**
II. **Course Code : VMC 715**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

Discussions on recent developments in the immunobiology of major viral, bacterial and fungal diseases of animals.

V. **Theory**

Unit I

Introduction and historical developments. Host-pathogen relationship.

Unit II

Effector mechanisms of specific and non-specific immunity to different groups of microbes.

Unit III

Immunobiology of major viral, Bacterial and fungal diseases of animals. Types of vaccines for infectious diseases; Current trends in vaccine development.

I. **Course Title : Veterinary Microbial Biotechnology**

II. **Course Code : VMC 716**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To understand as to how microbial processes and activities can be used for development of medically and industrially important products and processes.

V. **Theory**

Unit I

History of microbial biotechnology. Microbes in nature.Microbes as infectious agents of human and animals. Host-microbe relationships. Microbial metabolism and growth characteristics. Microbial genetics.

Unit II

Introduction to molecular biology of microorganisms: DNA, RNA and proteins structure and functions. DNA replication, RNA transcription, reverse transcription, protein translation and regulatory mechanisms. Bacterial extrachromosomal DNA elements.

Unit III

Genetic engineering: Restriction enzymes, DNA ligases, DNA polymerases, RNases and DNases and other enzymes. DNA sequencing. Plasmids and phage-derived vectors, Bacterial hosts for cloning and expression of transgenes. Genomic libraries and sequencing. Blotting of DNA, RNA and proteins. Polymerase chain reaction. An introduction to Microarrays and Metagenomics.

Unit IV

Expression of antigens and antibody fragments useful as diagnostic reagents and vaccines. PCR and blotting techniques in infectious disease diagnosis. Nucleic acid vaccines. Vectored viral and bacterial vaccines. Construction of defined mutants and marker vaccines using genetic manipulation techniques.Manipulation of microbial processes for production of industrially useful substances.

VI. **Practical**

Extraction of nucleic acids from viruses and bacteria. Restriction endonuclease digestion of DNA and resolution in agarose gel electrophoresis. PCR amplification of DNA. RT-PCR of RNA. Insertion of DNA fragments into plasmid/ phagemid/ phage vectors. Construction of competent *E. coli* host cells. Transformation and transfection of competent *E. coli* cells. Screening of transformants and isolation of clones. Sequence analysis of clones/ PCR amplicons. Expression of genes of bacterial/ viral antigens. Use of PCR for infectious disease

diagnosis.

I. **Course Title : Special Problem**
II. **Course Code : VMC 790**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

To provide expertise in handling practical research problem(s).

V. **Practical**

Short research problem(s) involving contemporary issues and research techniques.

Course Outline-cum-Lecture Schedule forDoctoral Degree Programme

VMC 701: Advances in Veterinary Bacteriology 2+1

S.No.	Topic of Syllabus	Lecture/ Practical
Theory		
1.	Recent advances in bacterial taxonomy and phylogeny	3
2.	Advanced studies on bacterial cytology	2
3.	Molecular structure and function of bacterial cell surface Peptidoglycans	2
4.	Walls of Gram-positive and Gram-negative bacteria	2
5.	Cell surface appendages: Flagella and Fimbriae	3
6.	Role of bacteria cell envelope in pathogenicity and immunogenicity	4
7.	Biochemical activities	4
8.	Antigenic structure	4
9.	Bacterial secretory and excretory system	4
10.	Bacterial whole genome sequence analysis and its application	4
	Total	32
Practical		
1.	Isolation of bacterial LPS	1
2.	Isolation of bacterial OMP	1
3.	Isolation of bacterial Peptidoglycans	1
4.	Isolation of bacterial Capsule	1
5.	Isolation of bacterial Flagellar antigen	1
6.	Genotyping of bacteria	2
7.	Phage typing of bacteria	2
8.	Serotyping of bacteria	3
9.	Studies on host pathogen interactions	4
	Total	16

VMC 702: Advances in Veterinary Mycology 2+1

S.No.	Topic of Syllabus	Lecture/ Practical
Theory		
1.	Advanced studies on taxonomy of pathogenic fungi	2
2.	Advanced studies on genetics of pathogenic fungi	4
3.	Advanced studies on physiology of pathogenic fungi	4
4.	Advanced studies on antigenic characterization of pathogenic fungi	6
5.	Advanced studies on molecular approaches for identification of fungi	4
6.	Immunology and serology of mycoses	4

7. Antifungal therapy 4
8. Fungal vaccines 2
9. Fungal viruses 2

Total 32

Practical

1. Morphological, biochemical and physiological studies of various fungi 6
2. *In vivo* pathogenicity study 5
3. Molecular detection and characterization of fungi 5

Total 16

VMC 703: Bacterial Genetics 2+0

S.No. Topic of Syllabus Lecture

Theory

1. Comparative studies of prokaryotic and eukaryotic genome and their replication 3
2. Structure, classification and replication of plasmids 3
3. Bacterial variations: Phenotypic and genotypic variations 3
4. Mutations and mutagenesis, types of bacterial mutants and detection of mutants 4
5. Gene mapping 3
6. Mechanism of gene transfer: transduction, transformation and conjugation 4
7. Types and mechanism of recombination: Reciprocal, non-reciprocal and illegitimate recombination's 4
8. Mobile genetic elements 3
9. Molecular mechanism of antibiotic resistance 3
10. Regulation of gene expression 2

Total 32

VMC 704: Microbial Toxins 2+1

S.No. Topic of Syllabus Lectures/ Practicals

Theory

1. Classification of bacterial and fungal toxin on the basis of their structure and functions 4
2. The role of microbial toxins in the pathogenesis of diseases 3
3. Biochemical and biological characteristics of toxins 5
4. Toxin producing Grams-positive and Grams-negative bacteria 2
5. Properties and clinical conditions produced by different bacterial and fungal toxins 4
6. Analytical methods for detection of bacterial and fungal toxins: Biological assays, immunological assays, Nucleic acid-based

methods 8
7. Application of microbial toxins 3
8. Immuno-biological studies of toxins 3
Total 32

Practical

1. Detection and identification of Mycotoxigenic fungi and mycotoxins 2
2. Method of detection of bacterial endotoxin 3
3. Production of toxins in suitable media 3
4. Purification and characterization of toxins 3
5. Biological characterization in animal and in tissue culture 3
6. Toxin neutralization test 2

Total 16

VMC 705: Bacterial Pathogenesis 2+0

S.No. Topic of Syllabus Lectures

Theory

1. Molecular structure, production and mode of action of bacterial virulence factors 8
2. Bacterial biofilms 4
3. Advancee studies on pathogenesis of bacterial diseases of various systems 8
4. Host-pathogen interaction 8
5. Animal models for bacterial pathogens 4

Total 32

VMC 706: Advances in Veterinary Virology 2+1

S.No. Topic of Syllabus Lectures/ Practicals

Theory

1. Biology of RNA and DNA virus replication 2
2. An introduction to bacteriophages and phage replication 2
3. Current concepts in animal virus research with respect to viral structure and architecture 3
4. viral virulence, viral pathogenesis, persistence and oncogenesis 4
5. Viruses as bio-terror agents and viruses for pest management (Bio-control) 2
6. Antiviral drugs: Scope, use and limitations 3
7. Existing antiviral drugs and their mechanism of action 2
8. Latest trends in antiviral drug development 2
9. Preparation of plasmid backbone, preparation of viral genes for cloning and cloning in viral genome backbone 3
10. Confirmation of cloned genes 2

11. Development of positive marker and negative markers 2
12. DIVA vaccine 2
13. Different types of viral vectors (vaccinia, adenoviral, retroviral vectors) 3

Total 32

Practical

1. Characterization of viral proteins and genome 8
2. Problem oriented practical assignments aimed at development of bioreagents and relevant diagnostic tests 8

Total 16

VMC 707: Molecular Viral Pathogenesis 2+1

S.No. Topic of Syllabus Lectures/ Practicals

Theory

1. Study of virus host interactions: host specificity, tissue tropism And mechanism of virus spread in the body 3
2. Host immune responses to viral infections 2
3. Viral strategies to evade host immune responses 2
4. Viral interference and interferons 2
5. Pathogenesis of viral diseases of various systems 3
6. Animal models for studying viral pathogenesis 3
7. Molecular and genetic determinants of viral virulence 3
8. Mechanisms of viral virulence 3
9. Molecular and genetic determinants of viral persistence 3
10. Viral oncogenesis 4
11. Viral immunosuppression and immunopathology 4

Total 32

Practical

1. Pathotyping of animal viruses using Newcastle disease virus as model 4
2. Determination of immunosuppressive potential of animal viruses using infectious bursal disease virus/ Marek's disease virus/ chicken anaemia virus 8
3. Characterization of molecular determinants of viral virulence Using variants, recombinants and reassortants 4

Total 16

VMC 708: Structure Function Relationship of DNA and RNA Viruses 2+0

S.No. Topic of Syllabus Lectures

Theory

1. Methods of studying virus structure and architecture 3
2. Methods of amplification of viral nucleicacids 2

3. Molecular characterization of viral protein and nucleic acids 3
4. Nucleotide sequencing and its analysis by software programmes 6
5. Detailed study of virus replication in various groups of animal viruses 6
6. Understanding the relationship between structure and function of animal DNA and RNA viruses 6
7. Development of modern vaccines and antivirals using the relationship between structure and function of animal DNA and RNA viruses 6

Total 32

VMC 709: Oncogenic Viruses 2+0

S.No.	Topic of Syllabus	Lectures

Theory

1. General features of cell transformation and characterization of transformed cells 4
2. Oncogenic RNA and DNA viruses 4
3. Oncolytic viruses 5
4. Viral and cellular oncogenes 5
5. Mechanisms of viral oncogenesis 8
6. Diagnosis of viral oncogenesis 6

Total 32

VMC 710: Slow Viral Infections and Prions 1+0

S.No.	Topic of Syllabus	Lectures

Theory

1. Epidemiology of slow viral infections 1
2. Pathogenesis of slow viral infections 1
3. Diagnosis and control of slow viral infections 2
4. Properties, replication and epidemiology of prions 2
5. Scrapies 2
6. Bovine spongiform encephalopathy 2
7. Chronic wasting disease of dear 2
8. Transmissible mink encephalopathy 2
9. Recent trends in prion research 2

Total 16

VMC 711: Advances in Veterinary Immunology 2+1

S.No.	Topic of Syllabus	Lectures/ Practicals

Theory

1. Significance of HSC l and Origin of myeloid cells 1
2. Lymphoid cells (T and B cells), NK cells and NKT cell 1

3. Apoptosis and its role in homeostatic mechanism 1
4. Ontogeny of the lymphoid tissue in mammals and birds 1
5. Cell adhesion molecules, recirculation and trafficking, cell homing receptor 2
6. Antigen presenting cells and their functions at cellular level 1
7. Cytokines, chemokines and cytokine receptors 2
8. Early development of T and B cells and its differentiation and maturation in primary lymphoid organ 1
9. B cell development and T cell development 2
10. Lineage commitment and memory generation 2
11. Organization of expression of lymphocyte receptors gene 2
12. Multiagenic organization of immunoglobulin gene 1
13. Thymic selection of T cell repertoire. 1
14. Concept of extrathymic origin of T cells 1
15. Effector and memory T and B cells 1
16. Mechanism of recombination of immunoglobulin genes and T cell receptor genes 2
17. Clonal expansion 1
18. Role of T cell help in B cell response 1
19. Affinity maturation of B cells and class switching and T cell activation 1
20. MHC class-I and II structure and gene arrangement, polymorphism, antigen processing and presentation mechanism 2
21. Effector mechanisms of CTL, NK cells and NK T cell activation 2
22. Regulation of immune response 2
23. Role of T reg-cells, immunological tolerance and graft rejection 1

Total 32

Practical

1. Purification of immunoglobulin classes, subclasses, fragmentation of antibody by enzyme digestion to F (ab) 2 and Fc fragments, affinity chromatography techniques 2
2. Separation of protein by SDS PAGE under reducing condition 2
3. Western blot experiment to detect the immunogenic protein 2
4. ELISPOT 2
5. Cytotoxic T cell assay 2
6. Morphological and functional assays of blood monocytes 2
7. FACS 2
8. MACS 2

Total 16

VMC 712: Cytokines and Chemokines 2+ 0

S.No.	Topic of Syllabus	Lectures
Theory		
1	Properties of cytokines	2
2	General structure and function of classification of cytokines family's, cytokine secretion by Th1 and Th2 subsets	2
3	Cytokines cross regulation	2
4	Cytokine receptors:general structure of cytokine receptors, immunoglobulin superfamily receptors, class-1 and class-2 cytokine receptor families	3
5	TNF receptor families and cytokine antagonists	2
6	Cytokine related diseases	2
7	Therapeutic uses of cytokines and their receptors	2
8	Chemokines: subgroups of chemokines and their structures and functions, chemokine receptor families	3
9	Types of immunomodulators and their mechanism of action	2
10	Adjuvants: classification, mode of action, adjuvants combination and safety	2
11	Cytokine as adjuvant, PLG and microparticle as adjuvant, TLR agonist as adjuvant	2
12	Antigen delivery system and mode of action.	
13	Immunostimulants: bacterial product and synthetic compound, complex carbohydrates, immune enhancing drugs, vitamins and cytokines	3
14	Immunosuppression, Neuroendocrine control of immunoregulation, Immunosuppressive agents and drugs, corticosteroids, cyclosporin's, cyclophosphamide and other agents, like irradiation and the mode of action	3
	Total	32

VMC 713: Immunoregulatio n 1+0

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Molecular mediators of immune response:lymphokines and monokines	2
2.	Idiotypic networks	2
3.	Epitope specific regulation	2
4.	Th, Tc and Treg cells	2
5.	MHC in immunoregulation, immune response genes	2
6.	Antigen specific suppressor molecules produced by T cells	2
7.	Immunosuppressive agents and immune-stimulation	2
8.	Immunoregulatory pathways	2
	Total	16

VMC 714: Advances in Vaccinology 2+0

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Different phases in vaccine development	4
2.	Direct and indirect correlates of protection	2
3.	Antigen identification and characterization employing emerging technologies such as microarrays, in vivo expression technology, signature-tagged mutagenesis and phage display technology	6
4.	Immuno-informatics applied to epitope mapping, T cell epitopes and identification of pathogenic epitopes	8
5.	Nucleic acids, marker vaccines, mucosal vaccines, bacterial ghosts as vaccines and virus-like particles	6
6.	Futuristic vaccines: anti-allergic, anti-autoimmune diseases, de-addiction vaccines and transplant survival/ prolonging vaccines	6
	Total	32

VMC 715: Current topics in Infection and Immunity 2+0

S.No.	Topic of Syllabus	Lectures
Theory		
1.	Introduction and historical developments	5
2.	Host-pathogen relationship	6
3.	Effector mechanisms of specific and non-specific immunity to Different groups of microbes	6
4.	Immunobiology of major viral, bacterial and fungal diseases of animals	6
5.	Types of vaccines for infectious diseases	5
6.	Current trends in vaccine development	6
	Total	32

VMC 716: Veterinary Microbial Biotechnology 2+1

S.No.	Topic of Syllabus	Lectures/ Practicals
Theory		
1.	History of microbial biotechnology	1
2.	Microbes in nature	1
3.	Microbes as infectious agents of human and animals	1
4.	Host-microbe relationships	1
5.	Microbial metabolism and growth characteristics	1
6.	Microbial genetics	1
7.	Introduction to molecular biology of microorganisms: DNA, RNA and proteins structure and functions	2
8.	DNA replication, RNA transcription, reverse transcription,	

protein translation and regulatory mechanisms 2

9. Bacterial extrachromosomal DNA elements 1
10. Genetic engineering: restriction enzymes, DNA ligases, DNA polymerases, RNases and DNases and other enzymes 2
11. DNA sequencing 2
12. Plasmids and phage-derived vectors, bacterial hosts for cloning and expression of transgenes 2
13. Genomic libraries and sequencing 1
14. Blotting of DNA, RNA and proteins 2
15. Polymerase chain reaction 1
16. An introduction to Microarrays and Metagenomics 1
17. Expression of antigens and antibody fragments useful as diagnostic reagents and vaccines 2
18. PCR and blotting techniques in infectious disease diagnosis 2
19. Nucleic acid vaccines 1
20. Vectored viral and bacterial vaccines 1
21. Construction of defined mutants and marker vaccines using genetic manipulation techniques 2
22. Manipulation of microbial processes for production of industrially useful substances 2

Total 32

Practical

1. Extraction of nucleic acids from viruses and bacteria 2
2. Restriction endonuclease digestion of DNA and resolution in Agarose gel electrophoresis 1
3. PCR amplification of DNA 1
4. RT-PCR of RNA 1
5. Insertion of DNA fragments into plasmid/ phagemid/ phage vectors 2
6. Construction of competent *E. coli* host cells 2
7. Transformation and transfection of competent *E. coli* cells 1
8. Screening of transformants and isolation of clones 1
9. Sequence analysis of clones/ PCR amplicons 2
10. Expression of genes of bacterial/ viral antigens 2
11. Use of PCR for infectious disease diagnosis 1

Total 16

VMC 790: Special Problem 0+1

Practical

Short research problem(s) involving contemporary issues and research techniques. Planning a short research problem or working on a published research paper or new developments.

Suggested Reading

- AM Lesk. 2002. *Introduction to Bioinformatics*. Oxford University press.
- Abbas AH. Lichtman and S. Pillai. 2017. *Cellular and Molecular Immunology: Functions and Disorders of the Immune System*, 7th Ed., Elsevier.
- B Detrick and RG Hamilton and JH Schimitz. 2016. *Manual of Molecular and Clinical Laboratory Immunology*. 8th Ed. American Society for Microbiology.
- B Markey, F Leonard, M Archambault, A Cullinane and D Maguire. 2013. *Clinical Veterinary Microbiology* 2nd Ed. MOSBY- Elsevier.
- BD Singh. 2012. *Biotechnology: Expanding Horizons*, 4th Ed.Kalyani Pub.
- C Hirsh, NJ MacLachlan and RL Walker. 2004. *Veterinary Microbiology*, 2nd Edn., Wiley-Blackwell Pub.
- CC Kibbler, R Barton, Neil AR Gow, S Howell, DM MacCallum and RJ Manuel. 2018. *Oxford Textbook of Medical Mycology*, 1st Ed., Oxford University Press.
- CM Fraser, T Read and KE Nelson. 2010. *Microbial Genomes (Infectious Disease)*. 1st Edition, Humana Press.
- D Balasubramanian, CFA Bryce, K Jayaraman, J Green and K Dharmalingam. 2004. *Concepts in Biotechnology*, Revised edition, Universities Press Pub.
- DW Mount. 2001. *Bioinformatics: Sequence and genome analysis*. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
- FA Murphy, EPJ Gibbs, MK Holzmek and MJ Studdert. 1999. *Veterinary Virology*. 3rd Ed. Academic Press.
- GJ Tortora, BR Funke, CL Case, D Weber and W Bair. 2018. *Microbiology: An Introduction*, 13th Ed., Pearson Pub.
- GM Callahan and RM Yates. 2014. *Basic Veterinary Immunology*. 1st Edn., University Press of Colorado.
- JB Carter and VA Saunders. 2013. *Virology: Principles and Applications*, 2nd Ed., John Wiley and Sons Pub.
- J Glenn Songer and KW Post. 2004. *Veterinary Microbiology: Bacterial and Fungal Agents of Animal Diseases*. 1st Ed., Saunders Pub.
- J Punt, S Stranford, P Jones and J Owen. 2019. *Kuby Immunology*, 8th Ed., W.H. Freeman Pub.
- J Willey, K Sandman and D Wood. 2019. *Prescott's Microbiology*, 11th Edn., McGraw-Hill Education Pub.
- J Mestecky, W Strober, MW Russell, H Cheroutre, BN Lambrecht and BL Kelsall. 2015.

Mucosal Immunology 4th Edn., Academic Press.
- JE Coligan, AM Kruisbeek, DH Margulies, EM Shevach and W Strober. 2003. *Current Protocols in Immunology*. 3rd Edn. John Wiley and Sons.
- L Gyles, JF Prescott, J Glenn Songer and CO Thoen. 2010. *Pathogenesis of Bacterial Infections in Animals*, 4thEdn., Wiley-Blackwell Pub.
- MJ Dey and RM Schultz. 2014. *Veterinary Immunology: Principles and Practice*, 2nd Edn., CRC Press/ Taylor and Francis.
- MM Levine, JB Kaper, R Rappuoli, MA Liu and MF Good. 2004. *New Generation Vaccines*. 3rd Ed. Marcel-Dekker.
- NJ Maclachlan and EJ Dubovi. 2016. *Fenner's Veterinary Virology*. 5thEdn., Academic Press.
- PJ Quinn, BK Markey, FC Leonard, P Hartigan, S Fanning and ES Fitzpatrick. 2011. *Veterinary Microbiology and Microbial Disease*, 2nd Ed., Wiley-Blackwell Pub.
- PJ Delves, SJ Martin, DR Burton and IM Roitt. 2017. *Roitt's Essential Immunology* 13th Edition, Wiley Blackwell.
- R Tizard. 2017. Veterinary Immunology, 10thEdn., Saunders Publ
- S Giguère, JF Prescott and PM Dowling. 2013. *Antimicrobial Therapy in Veterinary Medicine*, 5th Ed., John Wiley and Sons, Inc.
- SJ Flint, V Racaniello, G Rall and A Skalka. 2015. *Principles of Virology*, 4th Edition (2 volume set). ASM press
- S Jameel and L Villarreal. 2000. *Advances in Animal Virology*. Science Pub.
- Samanta. 2015. *Veterinary Mycology*. Springer, India, Private Ltd Pub.
- WJW Morrow, NA Sheikh, CS Schmidt and D Huw Davies. 2012. *Vaccinology: Principles and Practice*1 edition Wiley-Blackwell.
- TA Brown. 2016. *Gene Cloning and DNA Analysis*. 7th Edition., Wiley Blackwell
- WJ Dodds and R Schulz. 1999. *Veterinary Vaccines and Diagnostics*. Vol. 41 (Advances in Veterinary Medicine) 1st Ed. Academic Press.
- For Ph.D. Courses: Selected articles and reviews from journals

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Microbiology

I. Course Title: General Bacteriology
II. Course Code: VMC 601
III. Credit Hours: 2+1
Unit I
Historical events of microbiology, Taxonomy and nomenclature of bacteria. Basic principles of microscopy and micrometry, Structure and function of bacterial cell. Growth, Nutrition, Metabolism, Secretion and excretion systems of bacteria.
Unit II
Bacterial genetics, Bacterial variation, Horizontal genetic transfer mechanisms (transformation, transduction and conjugation), Plasmids, Transposons and drug resistance.
Unit III
Determinants of pathogenicity and its molecular basis, Markers and PAMPs, exotoxin and endotoxin. Bacteriophages: temperate and virulent phages; lysogeny and lysogenic conversion. Antimicrobial agents and disinfectants: Mechanism of action, Resistance and susceptibility testing. Bacterial immunity.
I. Course Title: Systematic Veterinary Bacteriology
II. Course Code: VMC 602
III. Credit Hours: 2+1
Unit I
Systematic study of following groups of bacteria:

- Spirochetes: *Leptospira, Brachyspira* and *Borrelia.*
- *Campylobacter;*
- *Bordetella, Brucella, Morexella, Pseudomonas* and *Burkholderia;*
- Members of *Enterobacteriaceae, Pasteurella, Mannheimia* and *Haemophilus;*
- *Dichelobacter* and *Fusobacterium*
- *Rickettsia, Chlamydia* (*Chlamydophila*) and *Coxiella.*
- *Staphylococcus* and *Streptococcus*
- *Bacillus* and *Clostridium*.
- *Erysipelothrixa* and *Listeria*
- *Actinomyces*, *Corynebacterium* and *Truepurella.*
- Mycobacterium; *Actinomycetes*: *Nocardia* and *Rhodococcus,*
- *Dermatophilus.*
- *Mycoplasma.*

I. Course Title: General Virology
II. Course Code: VMC 603
III. Credit Hours: 2+1

Unit I

Origin and nature of viruses, Morphological structure and chemical composition of viruses, Nomenclature and classification of viruses, Cultivation and purification of viruses, Laboratory diagnosis of viral infections, Viroid and Prions.

Unit II

Replication of DNA and RNA viruses, genetic and non-genetic interactions between viruses.

Unit III

Virus-cell interactions, viral pathogenesis, viral persistence, oncogenic, oncolytic viruses and epidemiology of viral infections.

Unit IV

Immune response to viruses, viral vaccines, viral chemotherapy.

I. Course Title: Systematic Veterinary Virology

II. Course Code: VMC 604

III. Credit Hours: 2+1

Unit I

Double and Single stranded DNA virus families

Poxviridae, *Asfarviridae*, *Herpesviridae*, *Adenoviridae*, *Papilomaviridae*, *Polyomaviridae*, *Parvoviride*, *Circoviridae* and *Hepdnaviridae.*

Unit II

Single stranded Negative sense and Double stranded RNA viruses

Orthomyxoviridae, *Paramyxoviridae, Rhabdoviridae, Bornaviridae, Reoviridae* and *Birnaviridae.*

Unit III

Single stranded Positive sense RNA viruses

Picornaviridae, *Caliciviridae*, *Togaviridae*, *Flaviviridae*, *Coronaviridae*, *Arteriviridae*, *Astroviridae* and *Retroviridae.*

Unit IV

Prions

BSE, Scrapie.

I. Course Title: Principles of Veterinary Immunology

II. Course Code: VMC 605

III. Credit Hours: 2+1

Unit I

Cells and organs of immune system. Types of immunity: Innate and adaptive immune system.

Unit II

Antigen and its characteristics

Characteristic of ideal antigen; Classification of antigens, Factors affecting immunogenicity, Concept of hapten and carrier. Antigenic determinant/ epitope and cross reactivity. B-cell epitope and T cell epitope. Immunoglobulins: Basic structure and function of immunoglobulins, Immunoglobulin diversity and

immunoglobulin classes. Antigen recognition by B cell and T cell: B cell receptor, T cell receptor, receptor diversity, B cell and T cell activation.

Unit III

Major Histocompatibility Complex

General feature, structure, function, gene organization, MHC and immune response. Immune-response development: Phases of humoral and cell mediated immune response. Immunoregulation with B and T cells: Antigen recognition, antigen presentation and processing, antigen recognition by TCR, MHC restriction, Cytokines and chemokines. Cell mediated immune response: General properties of effector T cells, cytotoxic T cells, NK-cells and ADCC. Role of integrin and selectin.

Unit IV

Complement System

Basic concept of complement, mechanism of complement activation, complement pathways and Complement deficiencies. Autoimmunity and autoimmune diseases, immunological tolerance and hypersensitivity: classification, mechanism of induction with examples. Immunodeficiency: Types with examples.

Unit V

Antigen antibody interaction

Antibody affinity, avidity, cross reactivity, precipitation and agglutination test, radio-immunoprecipitation assay (RIPA), ELISA, Western blotting, Monoclonal antibodies and methods for production and characterization of monoclonal antibodies.

I. Course Title: Veterinary Mycology

II. Course Code: VMC 606

III. Credit Hours: 1+1

Unit I

Morphology of fungi: structure and ultra-structure, differentiation, nutrition, physiology, reproduction, spores, cultural characters and classification of fungi of veterinary importance. Fungal immunity. Antifungal agents and important techniques in diagnosis of fungal
infections.

Unit II

Systematic study of animal mycoses:

Aspergillosis, Candidiasis, Cryptococcosis, Epizootic lymphangitis, Rhinosporodiosis, Zygomycosis, Blastomycosis, Sporotrichosis, Histoplasmosis, Coccidioidomycosis, Mycetomas, Dermatophytoses, Dermatomycosis, Mycotoxicosis, Malassezia infections, Mycotic abortion, Mycotic mastitis, and Emerging mycoses.

I. Course Title : Vaccinology

II. Course Code : VMC 607

III. Credit Hours : 2+0

Unit I

Types of vaccines and vaccine components, **New generation vaccines:** subunit vaccines, peptide vaccines, recombinant vaccines, reverse genetics vaccines, Marker and DIVA enabled vaccines and transmission blocking vaccines.

Unit II

Preparation of vaccines

Identification of candidate strain, identification of epitopes, seed and challenge strain maintenance. Classical methods of exaltation and attenuation of pathogens and their molecular basis. Technology of production of different types of vaccines. Multicomponent vaccines. vaccine delivery systems. vaccines adjuvants and mode of action.

Unit III

Standardization of veterinary vaccines as per National and Global standards. Laws and regulatory requirements about veterinary biological and Indian pharmacopoeia.

Unit IV

Vaccine failure and post vaccinal reactions.. Quality control. Scaling up methods of vaccine production.

I. Course Title: Techniques in Microbiology

II. Course Code: VMC 608

III. Credit Hours: 0+2

Unit I

Laboratory biosafety and biosecurity. cultivation and purification of bacteria and fungi and their morphological

and biochemical characterization. Antibacterial sensitivity test by Disc diffusion, broth dilution and MIC determination technique.

Unit II

Cultivation of viruses in embryonated eggs and cell culture. Virus Neutralization test.

Unit III

Agglutination, precipitation, ELISA,

Haemagglutination and Haemagglutination Inhibition

I. Course Title: Techniques in Molecular Microbiology

II. Course Code: VMC 609

III. Credit Hours: 1+2

Unit I

Methods of nucleic acid extraction from pathogenic microorganisms.

Unit II

PCR, and variants of PCR. Principles of primer designing. Gel electrophoresis methods and blotting techniques: Southern blotting, northern blotting, western blotting, dot-blot. Microarrays, nucleic acid sequencing methods. Gene cloning and expression. Development and validation of diagnostic tests.

I. Course Title: Molecular Immunology
II. Course Code: VMC 610
III. Credit Hours: 1+1
Unit I
Molecular Structure and function of PRRs. Ligands of PRRs, signal transduction through PRRs and inflammosome. Cytokines, Lymphocyte markers and CD nomenclature.
Unit II
Molecular structure of Immunoglobulin and class, Isotypes, Synthesis and expression of immunoglobulin, Rearrangement and its organization, Immunoglobulin gene diversity and mechanism of recombination of B cell gene. Theory of antibody generation. Signature molecules of T cell and T regulatory cell. T cell receptor and T cell gene diversity.
Unit III
MHC structure, Genomic organization of the MHC gene haplotype. Concept of congenic and syngeneic, concept of polymorphism of MHC gene, pathway of signal transduction, role of co-stimulators in B cell and T cell activation and recruitment of adaptor proteins. Molecular mechanisms (events) of cell cytotoxicity.
I. Course Title: Mucosal Immunology
II. Course Code: VMC 611
III. Credit Hours: 1+0
Unit I
Innate Mechanisms
Mucosal barrier: Development and physiology of mucosal defense. Cells and lymphoid tissues of mucosal immune system: MALT, GALT, NALT and BALT. Innate immune response at mucosal surfaces: mucus, antimicrobial peptides, role of PPRs, intestinal Dendritic cell, intestinal macrophage, mucosal inductive and effector sites. Antigen uptake and presentation at mucosal sites, transepithelial transport of antigen.
Unit II
Acquired response
Mucosal Immunoglobulin, IgA synthesis and transport to intestinal lumen. Description and role of Paneth cell and crypto patches.M-cells and their functions.Mucosal immune effector mechanisms including secretory IgA response.
Unit III
Applications
Importance and limitations of mucosal immunization. Mucosal adjuvants and delivery systems. Assessment of mucosal immune response and potency testing.
I. Course Title: Introduction to Microbial Bioinformatics
II. Course Code: VMC 612
III. Credit Hours: 1+0

Unit I

Bioinformatics resources and information retrieval system. Nucleic acid sequence databases, Genome databases, Protein sequence databases, Metabolic pathways databases, NCBI, ExPASy and Ensembl Genome browser.

Unit II

Sequence comparison and alignment methods; sequence alignment, Dot plot analysis. BLAST and FASTA programs in DNA and protein sequence analysis, multiple sequence alignment and Phylogenetic analysis CLUSTAL-W.

Unit III

Protein structure and databases, Structure based protein classification, Protein structure database (CASP), Protein structure alignment tools (VAST, DALI), Protein 3-D structure visualization and modeling using SWISS PROT.

Veterinary Pathology

DEPARTMENT OF VETERINARY PATHOLOGY
Course structure for M.V.Sc. degree programme (Semester wise)

Course No.	Course Title	Credit	Semester
VPL-601*	GENERAL PATHOLOGY	2+1	I
VPL -602*	TECHNIQUES IN PATHOLOGY	0+2	I
VPL -603*	ANIMAL ONCOLOGY	1+1	I
VPL -604*	CLINICAL PATHOLOGY	1+1	I
VPL -605*	NECROPSY PROCEDURES AND INTERPRETATIONS	1+1	I
VPL- 606*	NECROPSY CONFERENCE	0+1	II
VPL -607*	SYSTEMIC PATHOLOGY	2+1	II
VPL -608*	PATHOLOGY OF INFECTIOUS DISEASES OF DOMESTIC ANIMALS	2+1	II
VPL -609	TOXICOPATHOLOGY	2+1	I
VPL -610*	AVIAN PATHOLOGY	2+1	II
VPL -611	PATHOLOGY OF WILD/ ZOO AND AQUATIC ANIMAL DISEASES	2+1	II
VPL -612	PATHOLOGY OF LABORATORY ANIMAL DISEASES	2+1	II
VPL -691	MASTER'S SEMINAR	1+0	I, II
VPL -699	MASTER'S RESEARCH	0+30	I, II
* Compulsory Courses			

DEPARTMENT OF VETERINARY PATHOLOGY
Course structure for Ph.D degree programme (Semester wise)

Course No.	Course Title	Credit	Semester
VPL-701*	MOLECULAR AND ULTRASTRUCTURAL BASIS OF CELL INJURY	2+1	I
VPL-702	MOLECULAR BASIS OF INFLAMMATION	1+1	I
VPL-703	MOLECULAR BASIS OF NEOPLASIA	1+1	I
VPL-704*	IMMUNOPATHOLOGY	2+1	I
VPL-705	ADVANCES IN DIAGNOSTIC PATHOLOGY	1+2	II
VPL-706	PATHOLOGY OF NUTRITIONAL AND METABOLIC DISTURBANCES	2+1	II
VPL-707	PATHOLOGY OF IMPORTANT EMERGING AND RE-EMERGING DISEASES OF PETS AND LIVESTOCK	2+1	II
VPL-708*	RESEARCH METHODOLOGY IN PATHOLOGY	1+0	II
VPL-709*	NECROPSY CONFERENCE-I	0+1	I
VPL-790	SPECIAL PROBLEM	0+1	II
VPL-791	DOCTORAL SEMINAR- I	I+0	I, II
VPL-792	DOCTORAL SEMINAR-II	I+0	I, II
VPL-799	DOCTORAL RESEARCH	0+75	I, II
*Compulsory courses			

Course Contents M.V.Sc. in Veterinary Pathology

I. **Course Title : General Pathology**
II. **Course Code : VPL 601**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To acquaint the students with different types of degenerations, cell injuries caused by different types of irritants and inflammation.

V. **Theory**

Unit I

Introduction and principles of Pathology including genetic basis of disease; Cellular responses to injury: Causes and mechanisms of reversible and irreversible cell injury; Morphologic characteristics, Significance and fate of various intracellular (lipids, glycogen, proteins) and extracellular (hyaline material, amyloid, fibrinoid change, gout) accumulations/ degenerations, Endogenous and exogenous pigmentations, Cell death (necrosis, apoptosis and gangrene), Pathologic calcifications and cellular adaptive changes.

Unit II

Inflammation and repair: Introduction to inflammation, Acute inflammation-cellular and molecular events including mediators and heat shock proteins of acute inflammation; Cellular components, Morphologic classification and outcomes of acute inflammation, Chronic inflammation-causes, Morphologic features and cellular components of chronic inflammation, Healing and repair, Systemic effects of inflammation.

Unit III

Disturbances in circulation: Causes, mechanisms, Morphologic features, Significance and fate of hyperemia, Oedema, Haemorrhage, Thrombosis, Embolism, Ischaemia, infarction and shock.

Unit IV

Immune mediated reactions: Introduction to autoimmunity and immune mediated diseases, mechanisms of hypersensitivity reactions.

VI. **Practical**

- To study the morphologic descriptions of lesions and nomenclature of a morphologic diagnosis based on gross

and/ or microscopic lesions of variety of conditions (degenerations, infiltrations, pigmentations, necrosis, circulatory and growth disturbances and different types of inflammation) in the preserved specimens/ slides. Demonstration of post-mortem changes.

- Continuous assessment of students for their skills in the diagnosis of gross lesions during post-mortem examination of different tissues of domestic animals.

Preparation of histopathology slides on the selected cases followed by interaction in the student seminars/ group discussions.

VII. Suggested Reading

- McGavin MD and Zachary JF. 2017. *Pathologic Basis of Veterinary Diseases*. 6th Ed. Elsevier.
- Vegad JL. 2007. *Text Book of Veterinary General Pathology*. 2nd Ed. International Book Distr.

I. Course Title : Techniques in Pathology

II. Course Code : VPL 602

III. Credit Hours : 0+2

IV. Aim of the course

To acquaint the students with different techniques used frequently in Veterinary Pathology.

V. Practical

- Basic histopathological techniques-Collection of tissues, fixation, processing, section cutting and H and E staining of tissue sections. Collection and fixation of tissues for scanning electron microscopy, transmission electron microscopy, histochemical, toxicological, bacteriological and virological examinations. Application of micrometry and special staining techniques. Demonstration of different inclusions, bacteria and fungi in tissues.
- Principles of dark field, phase contrast and fluorescent microscopy; introduction to scanning electron microscopy and transmission electron microscopy.
- Histochemical techniques for demonstration of fat, glycogen, connective tissue, mucopolysaccharides and common enzymes, pigments and minerals Cryosectioning and application of immunohistochemical techniques– immunoperoxidase and immunofluorescence.
- Principles and applications of PCR and its variants.

- Museum specimen preparation and maintenance.

VI. **Suggested Reading**

- Culling CFA. 1969. *Handbook of Histological Techniques*. Butterworths.
- Lillie RD. 1965. *Histopathologic Techniques and Practical Histo-chemistry*. 3rd Ed. McGraw- Hill.
- Culling CFA. 2013. *Handbook of Histopathological and Histochemical Techniques: Including Museum Techniques* PDF, eBook (http://mbooknom.men/go/best.php?id=B01DRY52U8)

I. **Course Title : Animal Oncology**

II. **Course Code : VPL-603**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To acquaint the students with different types of neoplasms of domestic animals, their nature, cause, pathology and diagnosis.

V. **Theory**

Unit I

Tumour-Etiology, Carcinogens and oncogenesis, Nomenclature and classification, characteristics of benign and malignant tumours, Molecular mechanisms, Pathways of spread of tumors and tumor immunology

Unity II

Effects of tumour, Grading, Staging and laboratory diagnosis of tumours. Animal tumour models–experimental induction of neoplasms

Unit III

Pathology of different types of epithelial and connective tissue tumours with their characteristic identification features and epidemiology. Commonly encountered tumours of respiratory, haemopoietic, integumentary, musculoskeletal, gastrointestinal, hepatobiliary, uro-genital, nervous, ocular, ear and endocrine system.

VI. **Practical**

- Cytological diagnosis of tumours via impression smears and Fine Needle Aspiration Cytology.
- To study the gross and microscopic changes in different types of neoplasms.

VII. **Suggested Reading**

- Meuten DJ. 2016. *Tumors in Domestic Animals*. 5th Ed. Wiley-Blackwell

I. **Course Title : Clinical Pathology**

II. **Course Code : VPL 604**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To acquaint the students with clinical alterations in blood, urine, CSF and other body fluids due to different diseases.

V. **Theory**

Unit I

Study of changes in blood/ plasma/ serum including biochemical profile for organ function tests, Cytological examination and examination of urine, Faeces, Cerebrospinal fluid and biopsy specimens and their interpretation.

VI. **Practical**

Analysis of clinical samples (blood/ serum/ plasma, urine, faeces, Biopsy samples (exfoliative/ FNAC) including biochemical profile for organ function tests in different disease conditions in animals/ poultry and their interpretations.

VII. **Suggested Reading**

- Amy C. Valenciano, Rick L. Cowell. 2013. *Cowell and Tyler's Diagnostic Cytology and Hematology of the Dog and Cat*, 4th Ed, Elsevier
- Benzamin MM. 1985. *Outline of Veterinary Clinical Pathology*. 3rd Ed. Ludhiana, Kalyani Publishers.
- Coles EH. 1986. *Veterinary Clinical Pathology*. 4th Ed, WB Saunders.
- Douglas J., Weiss, K and Jane Wardrop. 2010. *Schalm's Veterinary Haematology*, Wiley.

I. **Course Title : Necropsy Procedures and Interpretations**

II. **Course Code : VPL 605**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To acquaint the students with necropsy procedures in large and small animals and study of PM lesions in different diseases and to educate the students about common veterolegal problems and technically simple and legal writing of PM reports.

V. **Theory**

Unit I

General knowledge about the laws relating to veterinary practice, professional discipline and professional etiquettes.

Unit II

Regulations dealing with diseases of animals in India regarding epidemiology, quarantine certificate, issue of soundness certificate, etc.

Unit III

Different manners/ modes of death such as criminal assault, Cruelty to animals, malicious poisoning, Snake bite, Death due to drowning, Lightning strokes during thunderstorms; Veterolegal wounds like electrocution, Gunshot wounds, Automobile accidents, and violent death; Legal implications in animals in above conditions, doping in horses, etc.

VI. Practical

- Detailed necropsy examination of various species of large and small animals including poultry, laboratory animals and wildlife**.** Systematic examination of brain, lungs, heart, endocrine glands, lymph nodes, liver, gastro-intestinal tract, urinary and genital systems for gross pathological and histopathological studies and correlation of the observations to diagnose the disease conditions.
- Necropsy case presentation and report writing/ protocol preparation. Collection, preservation and dispatch of morbid materials for diagnosis of viral, bacterial, protozoan, parasitic diseases, toxic/ poisoning and for histochemistry/ histopathology.

VII. Suggested Reading

- Albert C Strafuss.1988. *Necropsy: Procedures and Basic Diagnostic Methods for Practicing Veterinarians*, Charles C. Thomas Publisher Springfield
- Benjamin Lucio-Martinez and Jodi A Korich. 2010. *Illustrated guide to Poultry Necropsy and diagnosis*, Cornell University (https://www.slideshare.net/heshamkotb/illustrated-guide- to-poultry-necropsy-and-diagnosis)
- D Gopala Krishna Rao. 2005. *Textbook on necropsy and histopathological techniques*, 1st Ed. Academa
- Donald B Feldman and John Curtis Seely. 1988. *Necropsy Guide: Rodents and the Rabbit*, 1st Ed. CRC Press
- Gahlot AK, Sharma SN and Tanwar RA. 2003. *Veterinary Jurisprudence*. 5th Ed. NBS Publishers, Bikaner.
- John M King, David C Dodd and Lois Roth. 2006. *The Necropsy Book,* Fifth Edition, C L Davis Foundation
- Jones TC and Gleiser CA. 1954. *Veterinary Necropsy Procedures*. JB Lippincott.
- Lincoln PJ and Thomson J. 1998. *Forensic DNA Profiling*

Protocols. Humana Press.
- Majó Masferrer, Natàlia, Dolz Pascual, Roser and Shivaprasad HL. 2011. *Atlas of Avian Necropsy: Macroscopic Diagnosis Sampling,* SERVET Publishers
- Rudin N and Inman K. 2002. *An Introduction to Forensic DNA Analysis*. CRC Press.

I. Course Title : Necropsy Conference
II. Course Code : VPL 606
III. Credit Hours : 0+1
IV. Aim of the course

To promote self learning of the students in different necropsy procedures of animals including poultry and description of post-mortem lesions in different diseases/ disease conditions.

V. Practical

- Continuous assessment of students on detailed necropsy examination of various species of large and small animals including poultry; Necropsy associated cytological examinations; Systematic examination of different organs for morphologic description of gross lesions; gross photography; Collection of tissues for histopathology and based on nature of gross lesions, if possible further collection for investigation of viral/ bacterial/ protozoan/ fungal/ parasitic diseases/ toxic or poisoning, etc.
- Morphologic description of microscopic lesions; microscopic photography; correlation of gross and microscopic observations with the results of other parallel investigations to diagnose the disease conditions; presentation of select case(s) in the monthly seminars followed by report writing and final morphologic/ etiologic diagnosis, classification and preservation of microscopic slides.

VI. Suggested Reading

- Albert C Strafuss. 1988. *Necropsy: Procedures and Basic Diagnostic Methods for Practicing Veterinarians*, Charles C. Thomas Publisher Springfield.
- Benjamin Lucio-Martinez and Jodi A Korich. 2010. *Illustrated guide to Poultry Necropsy and diagnosis,* Cornell University (https://www.slideshare.net/heshamkotb/illustrated-guide- to-poultry-necropsy-and-diagnosis)
- D Gopala Krishna Rao. 2005. *Textbook on necropsy and histopathological techniques,* 1st Ed. Academa.

- Donald B Feldman, John Curtis Seely. 1988. *Necropsy Guide: Rodents and the Rabbit*, 1st Ed. CRC Press.
- Jones TC and Gleiser CA. 1954. *Veterinary Necropsy Procedures*. JB Lippincott.
- John M King, David C Dodd and Lois Roth. 2006. *The Necropsy Book*, Fifth Edition, C L Davis Foundation.
- Majó Masferrer, Natàlia, Dolz Pascual, Roser and Shivaprasad HL. 2011. *Atlas of Avian Necropsy: Macroscopic Diagnosis Sampling*, SERVET Publishers.

I. Course Title : Systemic Pathology

II. Course Code : VPL 607

III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about different disease conditions of haemopoietic, circulatory, respiratory, digestive, urinary and genital systems, nervous, musculoskeletal, endocrine glands and special senses.

V. Theory

Unit I

Advanced study of pathological conditions in relation to their etiology, Pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting cardiovascular (heart, blood vessels and lymph vessels), Respiratory (nasal cavity, Larynx, Trachea, Bronchi, Lungs and pleura) and haemopoietic (bone marrow, blood, spleen, lymph node) systems.

Unit II

Advanced study of pathological conditions in relation to their etiology, Pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting different organs of digestive (buccal cavity, pharynx, oesophagus, stomach and intestines), Urinary (kidneys, ureter, urinary bladder and urethra) and genital (male and female organs including mammary gland) systems.

Unit III

Advanced study of pathological conditions in relation to their etiology, Pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting different organs of nervous (brain and spinal cord), endocrine (pituitary, thyroid, parathyroid, pancreas) musculo-skeletal systems (muscles and bones) and organs of special senses (eye, ear), skin and its appendages

(hoof, tail).

VI. **Practical**

- To study the morphologic description of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions in variety of organs in the preserved specimens/ slides.
- Continuous assessment of students for their skills in the morphologic description of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions in variety of organs during post-mortem examination of domestic animals followed by interaction in the student seminars/ group discussions.

VII. **Suggested Reading**

- Grant Maxie. 2015. Jubb, Kennedy & Palmer's *Pathology of Domestic Animals*, 6th Ed. Saunders Ltd.
- Vegad JL and Madhu Swamy. 2010. *A text book of Veterinary Systemic Pathology*, 2nd Ed. Publisher IDBC, Lukhnow

I. **Course Title : Pathology of Infectious Diseases of Domestic Animals**

II. **Course Code : VPL 608**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To teach the students about important infectious disease conditions of domestic animals.

V. **Theory**

Unit I

Study of etiology, Pathology and pathogenesis of various viral diseases-Foot and mouth disease, Vesicular stomatitis, Vesicular exanthema, Vesicular disease, Rinderpest, Bovine viral diarrhoea-Mucosal disease, Bovine malignant catarrhal fever, Infectious bovine rhinotracheitis, Parainfluenza-3, Bovine respiratory syncytial virus infection, Pox diseases, Blue tongue, Contagious ecthyma, PPR, Rabies, Canine distemper, Parvovirus infections, Infectious canine hepatitis, Pseudorabies, Classical swine fever, Swine and Equine influenza, Equine infectious anaemia, African horse sickness, Equine viral arteritis, Equine viral encephalomyelitis, Equine herpesvirus infections, Papillomatosis, Rift Valley fever, Japanese encephalitis, Ovine encephalomyelitis (Louping ill) and Prion diseases.

Unit II

Study of etiology, pathology and pathogenesis of various bacterial diseases- Tuberculosis, Johne's disease, Actinobacillosis, Actinomycosis, Brucellosis, Listeriosis, Pasteurellosis, Leptospirosis, Anthrax, Clostridial group of diseases, Streptococcal and Staphylococcal infections, Campylobacter infections, Swine erysipelas, Glasser's disease, Foot rot, Colibacillosis and Salmonellosis, Glanders, Melioidosis, Nocardiosis, Cutaneous strepthricosis, Corynebactrium infections, Chlamydial and Mycoplasma infections.

Unit III

Study of etiology, Pathology and pathogenesis of various fungal, Rickettsial and parasitic diseases-Aspergillosis, Blastomycosis, Coccidioidomycosis, Histoplasmosis, Epizootic lymphangitis, Rhinosporidiosis, Sporotrichosis, Candidiasis, Crytococcosis, Dermatomycoses;Diseases due to commonly occurring mycotoxins; Important rickettsial diseases-Q-fever, Heart water disease, Ehrlichiosis, Anaplasmosis, Haemobartonellosis; Important protozoan diseases-Coccidiosis, Toxoplasmosis, Babesiosis, Theilariosis, Cryptosporidiosis, Trypanosomiasis and Pathology ofimportant diseases caused by helminths.

VI. Practical

Morphologic description of lesions based on gross and/ or microscopic lesions and thestudy of their correlation with a specific disease in the preserved specimens/ slides.

VII. Suggested Reading

- Jones TC, Hunt RD & King NW. 1997. *Veterinary Pathology*. Blackwell Publishing.
- Grant Maxie. 2015. Jubb, Kennedy & Palmer's *Pathology of Domestic Animals*, 6th Ed. Saunders Ltd.
- Gary Procop and Bobbi Pritt. 2014. *Pathology of Infectious Diseases*, 1st Ed. Saunders

I. Course Title : Toxicopathology

II. Course Code : VPL 609

III. Credit Hours : 2+1

IV. Aim of the course

To teach student about toxicity in livestock due to plants and extraneous poisons.

V. Theory

Unit I

Introduction, classification and mode of action of different poisons.

Unit II

Study of pathogenesis, symptoms, gross and microscopic pathology of diseases caused by toxic plants, Organic and inorganic poisons commonly taken or administered maliciously to different species of domestic animals.

Unit III

Various regulatory bodies and regulatory processes, Protocols in conducting toxicopathological trials; Chronology for conducting preclinical toxicology. OECD- Good Laboratory Practices, Toxicopathological profile including battery of tests for pharmaceutical/ toxic agents.

Unit IV

In-vitro and *In vivo* models for toxicity studies and evaluation parameters.

VI. Practical

- To study gross and histopathological alterations as a result of ingestion of toxic plants and extraneous poisons in domestic animals.
- Assignments on commonly occurring toxic plants of the region; Diagnosis of commonly taken or maliciously administered poisonous substances.

VII. Suggested Reading

- Jones TC, Hunt RD and King NW. 1997. *Veterinary Pathology*. Blackwell Publishing.

I. Course Title : Avian Pathology

II. Course Code : VPL 610

III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about the different disease conditions of poultry.

V. Theory

Unit I

Avian inflammation and immunology, Study of etio-pathology, symptoms, transmission, and diagnosis of infectious diseases of chickens, turkeys, ducks and other birds caused by Bacteria: Salmonella*, Escherichia coli* and Clostridial infections, Infectious coryza, Fowl cholera, Tuberculosis and Spirochaetosis; Chlamydial and Mycoplasmal infections; Viruses: Ranikhet disease, Infectious bursal disease, Infectious bronchitis, Infectious laryngotracheitis, Marek's disease, Leukorsarcoma group of diseases, Reticuloendotheliosis, Fowl pox, Avian influenza, Avian encephalomyelitis, Inclusion body

hepatitis, Hydropericardium syndrome, Egg drop syndrome-76, Chicken infectious anaemia, Avian nephritis, Reovirus infections- Viral arthritis and Infectious stunting syndrome, Duck plague, Duck viral hepatitis, Coronaviral enteritis and Haemorrhagic enteritis of turkeys: Fungi and mycotoxins; Parasites-Coccidiosis, Histomoniasis, Round worm and Tape worm infections; Ecto-parasites of birds.

Unit II

Study of etio-pathology, clinical symptoms, and diagnosis of nutritional deficiencies - Vitamin and Mineral deficiencies; Metabolic diseases-Ascites, Gout, Fatty liver and kidney syndrome, Fatty liver haemorrhagic syndrome, Cage layer fatigue, etc.; Miscellaneous conditions of poultry-Heat stress, Blue comb, Breast blister, Bumble foot, Cannibalism, False layer, Internal layer, Pendulous crop, Round heart disease etc.

Unit III

Emerging and re-emerging diseases of poultry: Introduction to an emerging and a re-emerging pathogen, mechanisms of poultry pathogen's emergence, co-evolution of poultry pathogens with their vaccines and medications, common diseases of poultry susceptible to point mutations and their pathology.

- Necropsy examination of the different species of poultry; morphologic description of gross and/ or microscopic lesions in the preserved specimens/ slides.
- Continuous assessment of students for their skills in the diagnosis of gross lesions in different organs of various systems during post-mortem examination of poultry. Preparation of histopathology slides on the select cases followed by interaction in the student seminars/ group discussions.

VII. Suggested Reading

- Saif YM, Barnes FJ, Glisson JR, Fadly AM, Mc Dougald LR & Swayne D. 2008. *Diseases of Poultry*. 12th Ed. Blackwell Publishing.
- Randall CJ. 1984. *A Colour Atlas of Diseases of the Domestic Fowl and Turkey,* Mosby International.
- Majó Masferrer, Natàlia, Dolz Pascual, Roser and Shivaprasad HL. 2011. *Atlas of Avian Necropsy: Macroscopic Diagnosis Sampling*, SERVET Publishers.
- Benjamin Lucio-Martinez and Jodi A Korich. 2010. *Illustrated guide to Poultry Necropsy and diagnosis*, Cornell University

(https://www.slideshare.net/heshamkotb/illustrated-guide- to-poultry-necropsy-and-diagnosis)

I. **Course Title : Pathology of Wild/ Zoo and Aquatic Animal Diseases**

II. **Course Code : VPL 611**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To teach the pathology and diagnosis of different disease conditions of wild and aquatic animals particularly fish.

V. **Theory**

Unit I: Wild/ Zoo Animal diseases

Etiology, transmission, gross and microscopic pathology of some commonly occurring infectious diseases of wild animals: West Nile fever, Rabies, Foot and mouth disease, Pox, Kyasanaur forest disease, Infectious hepatitis virus, Infectious feline peritonitis, Anthrax, Tuberculosis, Colibacillosis, Clostridial infections Trypanosomosis, Babesiosis, Theileriosis; Etiology, gross and microscopic pathology of commonly occurring non-infectious diseases of Wild/ Zoo animals.

Unit II: Infectious diseases of fish

Study of etiology, gross and microscopic pathology of Bacterial diseases- Bacterial cold water disease, Bacterial fin disease, Fill rot, Furunculosis, Aeromonas septicemia, Epizootic ulcerative syndrome, Yersiniosis, Pseudomoniasis, Alteromoniasis, Pasteurellosis, Enteric septicemia of catfish, Edwardsiellosis, Vibriosis, Streptococcosis, Bacterial kidney disease, Mycobacteriosis, Nocardiosis, Epitheliocystis: Salmonid rickettsialsepticaemia, Columnaris disease; Viral diseases-Spring viremia of carp, Infectious pancreatic necrosis, Viral hemorrhagic septicaemia, Koi herpes virus disease, Infectious spleen and kidney necrosis, Carp pox, Virus nervous necrosis, Lymphocystis disease, Infectious salmon anemia, Salmon alpha virus infections, Infectious hematopoietic necrosis, Herpes viral hematopoeitic necrosis, Chinese grass carp reovirusdisease, Viral hemorrhagic necrosis, Epizootic hemorrhagic necrosis; Fungal diseases- Saprolegniasis, Branchiomycosis (Gill rot), Ichthyosporidiosis, Exophiala infection, Aphanomyces and Fusarium infection; Parasitic and Protozoal diseases-Ich or White spot disease, Costiasis, Trichodiniasis, Velvet disease, Coral fish disease, Epistylis, Red sore disease,

Glossatella, Myxosporidiosis, Whirling disease, Microsporidiosis (Glugea, Pleistophora, Loma), Coccidiosis, Proliferative kidney disease, Cryptosporidiosis.

Unit III: Other diseases of Fish

Nutritional diseases-Nutritional deficiency of protein, lipid, carbohydrate, vitamins and minerals; Neoplastic conditions**-** Melanoma in Platyfish/ Swordtail hybrids, Hepatoma and hepatocellular carcinoma in rainbow trout, Stomatopapilloma of eels (Cauliflower disease), Papilloma of the brown bullhead, Lip Fibroma (Fibropapilloma) of Angel fish, Dermal fibrosarcomas of walleye pike, Lymphosarcoma of pike, Schwannoma/ Neurofibromas of the bicoloured damselfish; Environmental stress-Gas bubble disease, Acidosis/ Alkalosis, Thermal shock, Sun burn disease, Anoxia, Increased in dissolved CO_2 or H_2S or Ammonia concentration in water, Increased in turbidity of pond water, Algal toxicosis disease.

VI. Practical

Post-mortem examination of wild animals including wild birds. Study of gross and microscopic lesions of important infectious and non-infectious diseases of fish and wild animals

VII. Suggested Reading

- Arora BM. 1984. *Wildlife Diseases in India*. Periodical Expert Book Agency.
- Fowler ME. 1978. *Zoo and Wild Animal Medicine*. WB Saunders. Roberts RJ. 1979. *Fish Pathology*. Bailliere Tindall, London

I. Course Title : Pathology of Laboratory Animal Diseases

II. Course Code : VPL 612

III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about pathology and diagnosis of different disease conditions of laboratory animals.

V. Theory

Unit I

Etiology, transmission, gross and microscopic pathology of some commonly occurring diseases of Rabbits: Pasteurellosis, Bordetellosis, Colibacillosis, Tyzzer's disease, Staphyloccal infections, Venereal spirochetosis, (rabbit syphilis, cuniculosis), Proliferative ileotyphilitis,

Salmonellosis, Tularemia, Clostridium infections, Myxomatosis, Rabbit fibroma/ shope fibroma, Rabbit papillomatosis, Viral hemorrhagic disease, Coccidiosis, Enephalotozoonoses, Baylisascarisprocyonis, Cestode, Mites, Fleas and lice, miscellaneous and neoplastic diseases of rabbits.

Unit II

Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Rats: Bacterial diseases- Staphylococcal dermatitis, Pasteurellosis, Streptococcal diseases, Helicobacter infection, CAR bacillus, Mycoplasma pulmonis, Pseudotuberculosis (corynobacteriosis), Tyzzers disease, Salmonellosis, Rat bite fever; Viral diseases- Rat theilo virus (RTV-1), Parvovirus, coronavirus, pneumonia virus of mice, Hantaan virus, Sendai virus, Reovirus-3, Protozoan diseases (Trichomonads, Chilomastixbettencorti, Spironucleusmuris, Giardia muris, Rat sarcodines, Rat enteric coccidian), Arthropods (Mesostigmated mites, lice of rats), Helminths (rat pinworms, Hymenolepid tapeworm, Cestodes with a rat intermediate host, rat threadworms); fungal disease (*Pneumocystis carinii*), other miscellaneous and neoplastic diseases

Unit III

Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Mice: Bacterial diseases- Helicobacter infection, Pasteurellosis, Staphylococcal furunculosis, *Mycoplasma pulmonis*, Cilia associated respiratory bacillus, *Corynebacterium bovis*, *Pseudomonas aeruginosa*, *Citrobacter rodentium*, Tyzzer's disease, Salmonellosis; Viral diseases- Mouse norovirus, Mouse hepatitis virus, Mouse encephalomyelitis virus, Epizootic diarrhoea of infant mice, Parvovirus, Murine cytomegalovirus, Mouse adenovirus, Ectromelia virus, Lymphocytic choriomengitis virus, Pneumonia virus of mice, Lactate dehydrogenase elevating virus, Sendai virus, Mouse thymic virus, Mouse polyoma viruses, Reo-3 virus; Parasitic diseases-Pin worms, Fur mites of mice, Mange mites, Mesostigmatid mites, Lice of mice, Trichomonads, *Chilomastixbettencorti*, *Spironucleusmuris*, *Giardia muris,* Mouse sarcodines, Mouse enteric coccidian, Mouse parentral coccidian, Mouse sporozoans, Hymenolepid tapeworms, Encysted tape worm; Fungal disease (*Pneumocystis* pneumonia) and other miscellaneous and neoplastic

diseases

Unit IV

Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Guinea pigs: Bacterial diseases- Antibiotic-induced enterotoxemia/ haemorrhagic typhlitis, *Bordetella* pneumonia, Streptococcal pneumonia, Cervical lymphadenitis, Pododermatitis, Mastitis, Tyzzer's disease, Salmonellosis; Viral diseases- Guinea pig cytomegalovirus, Adenovirus, Parainfluenza virus, Corona-like virus, Lymphocytic choriomeningitis virus; Parasitic diseases- Coccidia, Fur mites, Helminthes, Lice of guinea pigs, Mange mites, Cryptosporidiosis, Microsporidium parasites and other miscellaneous conditions

Unit V

Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Hamsters, Gerbills and primates

VI. Practical

Post-mortem examination of laboratory animals. Study of gross and microscopic lesions of important infectious and non-infectious diseases of laboratory animals

VII. Suggested Reading

- Beninchka K, Garner FM and Jones TC. 1978. *Pathology of Laboratory Animals.* Vols. I, II. Springer Verlag.

Course Outline-cum-Lecture Schedule for M.V.Sc. Degree Programme

I. Course Title : General Pathology

II. Course Code : VPL 601

III. Credit hours : 2+1

IV. Aim of the course

To acquaint the students with different types of degenerations, cell injuries caused by different types of irritants and inflammation

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction and principles of Pathology including genetic basis of disease	3
2.	Cellular responses to injury: Causes and mechanisms of reversible and irreversible cell injury; morphologic characteristics, significance	

and fate of various intracellular (lipids, glycogen, proteins) and extracellular (hyaline material, amyloid, fibrinoid change, gout) accumulations/ degenerations, endogenous and exogenous pigmentations, cell death (necrosis and apoptosis), pathologic calcifications and cellular adaptive changes 9

3. Inflammation and repair: Introduction to inflammation, acute inflammation-cellular and molecular events including mediators and heat shock proteins of acute inflammation; cellular components, morphologic classification and outcomes of acute inflammation 5
4. Chronic inflammation-causes, morphologic features and cellular components of chronic inflammation, healing and repair, systemic effects of inflammation 5
5. Disturbances in circulation: Causes, mechanisms, morphologic features, significance and fate of hyperemia, oedema, haemorrhage, thrombosis, embolism, ischaemia, infarction and shock 6
6. Immune mediated reactions: Introduction to autoimmunity and immune mediated diseases, mechanisms of hypersensitivity reactions. 4

Practical

1. To study the morphologic descriptions of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions of variety of conditions (degenerations, infiltrations, pigmentations, necrosis, circulatory and growth disturbances and different types of inflammation) in the preserved specimens/ slides. 6
2. Demonstration of post-mortem changes. 2
3. Continuous assessment of students for their skills in the diagnosis of gross lesions during post-mortem examination of different tissues of domestic animals. 4
4. Preparation of histopathology slides on the select cases followed byinteraction in the student seminars/ group discussions. 4

I. **Course Title : Techniques in Pathology**
II. **Course Code : VPL 602**
III. **Credit hours : 0+2**
IV. **Aim of the course**

To acquaint the students with different techniques used frequently in Veterinary Pathology

Lecture/ Practical schedule

S. No. Name of Topic No. of Lectures/ Practicals

Practical

1. Basic histopathological techniques-Collection of tissues, fixation, processing, section cutting and H and E staining of tissue sections. Collection and fixation of tissues for scanning electron microscopy, transmission electron microscopy, histochemical, toxicological, bacteriological and virological examinations. Application of micrometryand special staining techniques. Demonstration of different inclusions, bacteria and fungi in tissues 10
2. Principles of dark field, phase contrast and fluorescent microscopy; introduction to scanning electron microscopy and transmission electron microscopy 5
3. Histochemical techniques for demonstration of fat, glycogen, connective tissue, mucopolysaccharides and common enzymes, pigments and minerals 7
4. Cryosectioning and application of immunohistochemical techniques– immunoperoxidase and immunofluorescence 3
5. Principles and applications of PCR and its variants 2
6. Museum specimen preparation and maintenance 5

I. **Course Title : Animal Oncology**
II. **Course Code : VPL 603**
III. **Credit hours : 1+1**
IV. **Aim of the course**

To acquaint the students with different types of neoplasms of domestic animals,their nature, cause, pathology and diagnosis.

S. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Tumour-Etiology, carcinogens and oncogenesis, nomenclature and classification, characteristics of benign and malignant tumours, molecular mechanisms, pathways of spread of tumors and tumor immunology 4
2. Effects of tumour, grading and staging and laboratory diagnosis of tumours. Animal tumour models–experimental induction of neoplasms 4
3. Pathology of different types of epithelial and connective tissue tumours with their characteristic identification features and epidemiology 2
4. Tumours of respiratory, haemopoietic, integumentary, musculoskeletal, gastrointestinal, hepatobiliary, uro-genital,

nervous, ocular, ear and endocrine system 6

Practical

1. Cytological diagnosis of tumours via impression smears and Fine Needle Aspiration Cytology. 8
2. To study the gross and microscopic changes in different types of neoplasms. 8

I. **Course Title : Clinical Pathology**
II. **Course Code : VPL 604**
III. **Credit hours : 1 + 1**
IV. **Aim of the course**

To acquaint the students with clinical alterations in blood, urine, CSF and other body fluids due to different diseases.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. Study of changes in blood/ plasma/ serum including biochemical profile for organ function tests 8
2. Cytological examination and examination of urine, faeces, cerebrospinal fluid and biopsy specimens and their interpretation 8

Practical

1. Analysis of clinical samples (blood/ serum/ plasma) and their interpretations 4
2. Analysis of clinical samples (urine) and their interpretations 2
3. Analysis of clinical samples (faeces) and their interpretations 2
4. Analysis of biopsy samples (exfoliative/ FNAC) and their interpretations 4
5. Analysis of biochemical profile for organ function tests in different disease conditions in animals 4

I. **Course Title : Necropsy Procedures and Interpretations**
II. **Course Code : VPL 605**
III. **Credit hours : 0+1**
IV. **Aim of the course**

To acquaint the students with necropsy procedures in large and small animals and study of PM lesions in different diseases.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals

Practical

1. Detailed necropsy examination of various species of large and small animals including poultry, laboratory animals and wildlife. 4
2. Systematic examination of brain, lungs, heart, endocrine glands, lymph nodes, liver, gastro-intestinal tract, urinary and genital systems for gross pathological and histopathological studies and correlation of the observations to diagnose the disease conditions. 8
3. Necropsy case presentation and report writing/ protocol preparation. Collection, preservation and dispatch of morbid materials for diagnosis of viral, bacterial, protozoan, parasitic diseases, toxic/ poisoning and for histochemistry/ histopathology. 4

I. **Course Title : Necropsy Conference**
II. **Course Code : VPL 606**
III. **Credit hours : 0 + 1**
IV. **Aim of the course**

To promote self-learning of the students in different necropsy procedures of animals including poultry and description of post-mortem lesions in different diseases/ disease conditions.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals

Practical

1. Continuous assessment of students on detailed necropsy examination of various species of large and small animals including poultry; necropsy associated cytological examinations; systematic examination of different organs for morphologic description of gross lesions; gross photography; collection of tissues for histopathology and based on nature of gross lesions, if possible further collection for investigation of viral/ bacterial/protozoan/ fungal/ parasitic diseases/ toxic or poisoning, etc. 8
2. Morphologic description of microscopic lesions; microscopic photography; correlation of gross and microscopic observations with the results of other parallel investigations to diagnose the disease conditions; presentation of select case(s) in the monthly seminars followed by report writing and final morphologic/ etiologic diagnosis, classification and preservation

of microscopic slides. 8

I. **Course Title : Systemic Pathology**
II. **Course Code : VPL 607**
III. **Credit hours : 2 + 1**
IV. **Aim of the course**

To teach the students about different disease conditions of haemopoitic, circulatory, respiratory, digestive, urinary and genital systems, nervous, musculoskeletal, endocrine glands and special senses.

Lecture/ Practical schedule

S. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting cardiovascular (heart, blood vessels and lymph vessels) and respiratory (nasal cavity, larynx, trachea, bronchi, lungs and pleura). 8
2. Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting digestive (buccal cavity, pharynx, oesophagus, stomach and intestines) and haemopoietic (bone marrow, blood, spleen, lymph node) systems. 8
3. Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting urinary (kidneys, ureter, urinary bladder and urethra) and genital (male and female organs including mammary gland) systems. 8
4. Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting nervous (brain and spinal cord), endocrine (pituitary, thyroid, parathyroid, pancreas) musculo-skeletal systems (muscles and bones) and organs of special senses (eye, ear), skin and its appendages (hoof, tail). 8

Practical

1. To study the morphologic description of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions in variety of organs in the preserved specimens/ slides.

8

2. Continuous assessment of students for their skills in the morphologic description of lesions and nomenclature of a morphologic diagnosis based on gross and/ or microscopic lesions in variety of organs during post-mortem examination of domestic animals followed by interaction in the student seminars/ group discussions. 8

I. **Course Title : Pathology of infectious diseases of domestic animals**
II. **Course Code : VPL 608**
III. **Credit hours : 2 + 1**
IV. **Aim of the course**

To teach the students about important infectious disease conditions of domestic animals.

Lecture/ Practical schedule

S. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Study of etiology, pathology and pathogenesis of various viral diseases- Foot and mouth disease, Vesicular stomatitis, Vesicular exanthema, Vesicular disease, Rinderpest, Bovine viral diarrhoea- Mucosal disease, Bovine malignant catarrhal fever, Infectious bovine rhinotracheitis, Parainfluenza-3, Bovine respiratory syncytial virus infection, Pox diseases, Blue tongue, Contagious ecthyma, PPR 7
2. Study of etiology, pathology and pathogenesis of various viral diseases- Rabies, Canine distemper, Parvovirus infections, Infectious canine hepatitis, Pseudorabies, Classical swine fever, Swine and Equine influenza, Equine infectious anaemia, African horse sickness, Equine viral arteritis, Equine viral encephalomyelitis, Equine herpesvirus infections, Papillomatosis, Rift Valley fever, Japanese encephalitis, Ovine encephalomyelitis (Louping ill) and Prion diseases. 5
3. Study of etiology, pathology and pathogenesis of various bacterial diseases- Tuberculosis, Johne's disease, Actinobacillosis, Actinomycosis, Brucellosis, Listeriosis, Pasteurellosis, Leptospirosis, Anthrax, Clostridial group of diseases, Streptococcal and Staphylococcal infections. 5
4. Study of etiology, pathology and pathogenesis of various bacterial diseases- Campylobacter infections, Swine erysipelas, Glasser's disease, Foot rot, Colibacillosis and Salmonellosis, Glanders, Melioidosis, Nocardiosis, Cutaneous strepthricosis, Corynebactrium

infections, Chlamydial and Mycoplasma infections. 5

5. Study of etiology, pathology and pathogenesis of various fungal diseases-Aspergillosis, Blastomycosis, Coccidioidomycosis, Histoplasmosis, Epizootic lymphangitis, Rhinosporidiosis, Sporotrichosis, Candidiasis, Crytococcosis, Dermatomycoses; Diseases due to commonly occurring mycotoxins 5
6. Important rickettsial diseases- Q-fever, Heart water disease, Ehrlichiosis, Anaplasmosis, Haemobartonellosis; Important protozoan diseases-Coccidiosis, Toxoplasmosis, Babesiosis, Theilariosis, Cryptosporidiosis, Trypanosomiasis and Pathology of important diseases caused by helminthes 5

Practical

1. Morphologic description of lesions based on gross and/ or microscopic lesions and the study of their correlation with a specific disease in the preserved specimens/ slides. 16

I. **Course Title : Toxicopathology**
II. **Course Code : VPL 609**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To teach student about toxicity in livestock due to plants and extraneouspoisons.

Lecture/ Practical schedule

S. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Introduction, classification and mode of action of different poisons. 4
2. Study of pathogenesis, symptoms, gross and microscopic pathology of diseases caused by toxic plants, organic and inorganic poisons commonly taken or administered maliciously to different species of domestic animals 12
3. Various regulatory bodies and regulatory processes, porticos in conducting toxicopathological trials. Chronology for conducting preclinical toxicology. OECD-Good Laboratory Practices, toxicopathological profile including battery of tests for pharmaceutical/toxic agents 8
4. *In-vitro* and *in-vivo* models for toxicity studies and evaluation parameters 8

Practical

1. To study gross and histopathological alterations as a result of ingestion of toxic plants and extraneous poisons in domestic

animals. 8

2. Assignments on commonly occurring toxic plants of the region; Diagnosis of commonly taken or maliciously administered poisonous substances. 8

I. **Course Title : Avian Pathology**
II. **Course Code : VPL 610**
III. **Credit hours : 2 + 1**
IV. **Aim of the course**

To teach the students about the different disease conditions of poultry.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. Avian inflammation and immunology, Study of etio-pathology, symptoms, transmission, and diagnosis of infectious diseases of chickens, turkeys, ducks and other birds caused by Viruses: Ranikhet disease, Infectious bursal disease, Infectious bronchitis, Infectious laryngotracheitis, Marek's disease, Leukorsarcoma group of diseases, Reticuloendotheliosis, Fowl pox, Avian influenza, Avian encephalomyelitis, Inclusion body hepatitis, Hydropericardium syndrome, Egg drop syndrome-76, Chicken infectious anaemia, Avian nephritis,Reovirus infections- Viral arthritis and Infectious stunting syndrome, Duck plague, Duck viral hepatitis, Coronaviral enteritis and Haemorrhagic enteritis of turkeys 12
2. Study of etio-pathology, symptoms, transmission, and diagnosis of infectious diseases of chickens, turkeys, ducks and other birds caused by Bacteria: *Salmonella*, *Escherichia coli* and Clostridial infections, Infectious coryza, Fowl cholera, Tuberculosis and Spirochaetosis; Chlamydial and Mycoplasmal infections; Fungi and mycotoxins; Parasites-Coccidiosis, Histomoniasis, Round worm and Tape worm infections; Ecto-parasites of birds 10
3. Study of etio-pathology, clinical symptoms, and diagnosis of nutritional deficiencies -Vitamin and Mineral deficiencies; Metabolic diseases-Ascites, Gout, Fatty liver and kidney syndrome, Fatty liver haemorrhagic syndrome, Cage layer fatigue, etc.; Miscellaneous conditions of poultry-Heat stress, Blue comb, Breast blister, Bumble foot, Cannibalism, False layer, Internal layer, Pendulous crop, Round heart disease, etc. 6

4. Emerging and re-emerging diseases of poultry: Introduction to an emerging and a re-emerging pathogen, mechanisms of poultry pathogen's emergence, co-evolution of poultry pathogens with their vaccines and medications, common diseases of poultry susceptible to point mutations and their pathology 4

Practical

1. Necropsy examination of the different species of poultry; morphologic description of gross and/ or microscopic lesions in the preserved specimens/ slides. 8
2. Continuous assessment of students for their skills in the diagnosis of gross lesions in different organs of various systems during post-mortem examination of poultry. Preparation of histopathology slides on the select cases followed by interaction in the student seminars/ group discussions. 8

I Course Title : Pathology of Wild/ Zoo and Aquatic Animal Diseases

II. Course Code : VPL 611

III. Credit hours : 2 + 1

IV. Aim of the course

To teach the pathology and diagnosis of different disease conditions of wild and aquatic animals particularly fish

Lecture/ Practical schedule

S. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Wild/ Zoo Animal diseases: Etiology, transmission, gross and microscopic pathology of commonly occurring infectious diseases of wild animals: West Nile fever, Rabies, Foot and mouth disease, Pox, Kyasanaur forest disease, Infectious hepatitis virus, Infectious feline peritonitis, Anthrax, Tuberculosis, Colibacillosis, Clostridial infections Trypanosomosis, Babesiosis, Theileriosis; Etiology, gross and microscopic pathology of commonly occurring non-infectious diseases of Wild/ Zoo animals. 7
2. Infectious diseases of Fish**:** Study of etiology, gross and microscopic pathology of Viral diseases-Spring viremia of carp, Infectious pancreatic necrosis, Viral hemorrhagic septicaemia, Koi herpes virus disease, Infectious spleen and kidney necrosis, Carp pox, Virus nervous necrosis, Lymphocystis disease, Infectious salmon anemia, Salmon alpha virus infections, Infectious hematopoietic necrosis, Herpes viral hematopoeitic necrosis, Chinese grass carp reovirus disease, Viral hemorrhagic necrosis, Epizootic hemorrhagic necrosis; Fungal diseases- Saprolegniasis, Branchiomycosis (Gill rot),

Ichthyosporidiosis, Exophiala infection, Aphanomyces and Fusarium infection. 7

3. Infectious diseases of Fish: Study of etiology, gross and microscopic pathology of Bacterial diseases- Bacterial cold water disease, Bacterial fin disease, Fill rot, Furunculosis, Aeromonas septicemia, Epizootic ulcerative syndrome, Yersiniosis, Pseudomoniasis, Alteromoniasis, Pasteurellosis, Enteric septicemia of catfish, Edwardsiellosis, Vibriosis, Streptococcosis, Bacterial kidney disease, Mycobacteriosis, Nocardiosis, Epitheliocystis: Salmonidrickettsialsepticaemia, Columnaris disease; Parasitic and Protozoal diseases-Ich or White spot disease, Costiasis, Trichodiniasis, Velvet disease, Coral fish disease, Epistylis, Red sore disease, Glossatella, Myxosporidiosis, Whirling disease, Microsporidiosis (Glugea, Pleistophora, Loma), Coccidiosis, Proliferative kidney disease, Cryptosporidiosis. 6
4. Other diseases of Fish: Nutritional diseases- Neoplastic conditions- Melanoma in Platyfish/ Swordtail hybrids, Hepatoma and hepatocellular carcinoma in rainbow trout, Stomatopapilloma of eels (Cauliflower disease), Papilloma of the brown bullhead, Lip Fibroma (Fibropapilloma) of Angel fish, Dermal fibrosarcomas of walleye pike, Lymphosarcoma of pike, Schwannoma/ Neurofibromas of the bicoloured damselfish. 6
5. Other diseases of Fish: Nutritional diseases- Nutritional deficiency of protein, lipid, carbohydrate, vitamins and minerals; Environmental stress- Gas bubble disease, Acidosis/ Alkalosis, Thermal shock, Sun burn disease, Anoxia, Increased in dissolved CO_2 or H_2S or Ammonia concentration in water, Increased in turbidity of pond water, Algal toxicosis disease. 6

Practical

1. Post-mortem examination of wild animals including wild birds. Study of gross and microscopic lesions of important infectious and non-infectiousdiseases of fish and wild animals. 16

I. **Course Title : Pathology of Laboratory Animal Diseases**
II. **Course Code : VPL 612**
III. **Credit hours : 2 + 1**
IV. **Aim of the course**

To teach the students about pathology and diagnosis of different disease conditions of laboratory animals.

Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. Etiology, transmission, gross and microscopic pathology of some commonly occurring diseases of Rabbits: Pasteurellosis, Bordetellosis, Colibacillosis, Tyzzer's disease, Staphyloccal infections, Venereal spirochetosis, (rabbit syphilis, cuniculosis), Proliferative ileotyphilitis, Salmonellosis, Tularemia, Clostridium infections, Myxomatosis, Rabbit fibroma/ shope fibroma, Rabbit papillomatosis, Viral hemorrhagic disease, Coccidiosis, Enephalotozoonoses, Baylisascarisprocyonis, Cestode, Mites, Fleas and lice, miscellaneous and neoplastic Diseases of rabbits 5
2. Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Rats: Bacterial diseases- Staphylococcal dermatitis, Pasteurellosis, Streptococcal diseases, Helicobacter infection, CAR bacillus, Mycoplasma pulmonis, Pseudotuberculosis (corynobacteriosis), Tyzzers disease, Salmonellosis, Rat bite fever; Protozoan diseases (Trichomonads, *Chilomastix bettencorti*, Spironucleusmuris, Giardia muris, Rat sarcodines, Rat enteric coccidian), Arthropods (Mesostigmated mites, lice of rats), Helminths (rat pinworms, Hymenolepid tapeworm, Cestodes with a rat intermediate host, rat threadworms). 5
3. Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Rats: Viral diseases- Rat theilo virus (RTV-1), Parvovirus, coronavirus, pneumonia virus of mice, Hantaan virus, Sendai virus, Reovirus-3 fungal disease (*Pneumocystis carinii*), other miscellaneous and neoplastic diseases 5
4. Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Mice: Bacterial diseases- Helicobacter infection, Pasteurellosis, Staphylococcal furunculosis, *Mycoplasma pulmonis*, Cilia associated respiratory bacillus, *Corynebacterium bovis*, *Pseudomonas aeruginosa*, Citrobacter rodentium, Tyzzer's disease, Salmonellosis; Parasitic diseases-Pin worms, Fur mites of mice, Mange mites, Mesostigmatid mites, Lice of mice, Trichomonads, *Chilomastix bettencorti*, *Spironucleus muris*, *Giardia muris,* Mouse sarcodines, Mouse enteric coccidian, Mouse parentral coccidian, Mouse sporozoans, Hymenolepid tapeworms, Encysted tape worm 5
5. Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Mice: Viral diseases- Mouse norovirus, Mouse hepatitis virus, Mouse encephalomyelitis virus, Epizootic diarrhoea of infant mice, Parvovirus, Murine

cytomegalovirus, Mouse adenovirus, Ectromelia virus, Lymphocytic choriomengitis virus, Pneumonia virus of mice, Lactate dehydrogenase elevating virus, Sendai virus, Mouse thymic virus, Mouse polyoma viruses, Reo-3 virus; Fungal disease (*Pneumocystis* pneumonia) and other miscellaneous and neoplastic diseases 5

6. Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Guinea pigs: Bacterial diseases- Antibiotic- induced enterotoxemia/ haemorrhagic typhlitis, *Bordetella* pneumonia, Streptococcal pneumonia, Cervical lymphadenitis, Pododermatitis, Mastitis, Tyzzer's disease, Salmonellosis; Viral diseases- Guinea pig cytomegalovirus, Adenovirus, Parainfluenza virus, Corona-like virus, Lymphocytic choriomeningitis virus; Parasitic diseases- Coccidia, Fur mites, Helminthes, Lice of guinea pigs, Mange mites, Cryptosporidiosis, Microsporidium parasites and other miscellaneous conditions 5
7. Etiology, transmission, gross and microscopic pathology of commonly occurring diseases of Hamsters, Gerbills and primates 2

Practical

1. Post-mortem examination of laboratory animals. Study of gross and microscopic lesions of important infectious and non-infectious diseases of laboratory animals. 16

Course Contents
Ph.D. in Veterinary Pathology (VPL)

I. **Course Title : Molecular and Ultrastructural Basis of Cell Injury**

II. **Course Code : VPL 701**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To teach the students about different molecular including ultrastructural changes in diseases conditions.

V. **Theory**

Unit I

Study of cells- cell morphology, interpretation of normal and abnormal cells.

Unit II

Overview of Cell injury, Targets of cell injury-Cell membranes, Aerobic respiration, structural proteins and enzymes and genetic apparatus of the cell; Mechanisms of cell injury-hypoxia, Injury by free radicals, Chemical injury, Infectious agents, other forms of cell injury-immune mediated reactions, Genetic derangements; Mechanisms of cell membrane damage; Mechanisms of DNA damage-base loss, Base modification, chemical modification, Replication errors, Inter-strand cross- links, DNA-protein cross-links, Strand breaks. Molecular and immunopathological changes associated with different types of cell injuries.

Unit III

Morphology of Reversible and irreversible cell injury with particular emphasis on ultra structural changes in the cells and organelles: Morphology of cell death- necrosis, Apoptosis and autolysis, Mechanism of apoptosis, Intracellular and extracellular accumulations, Pigment and tissue deposits, Consequences of cell injury Cellular adaptations-hyperplasia, Hypertrophy, Atrophy, Metaplasia and dysplasia.

Unit IV

Mechanism of other types of cell death, viz., Pyroptosis, Ferroptosis, Autophagy, ETOSIS, etc.

VI. **Practical**

Collection and preparation of specimens for electron microscopic studies. Interpretation of ultra-structural changes and their correlation with gross and histopathological findings

VII. Suggested Reading

- Selected articles from journals.

I. Course Title : Molecular Basis of Inflammation
II. Course Code : VPL 702
III. Credit Hours : 1+1
IV. Aim of the course

To teach the students about molecular mechanisms of inflammations.

V. Theory

Unit I

Cellular, molecular and immunopathological changes associated with different types of inflammation. Acute inflammation, Vascular events of acute inflammation, Cellular events in acute inflammation, Leucocyte-endothelial interactions, Leucocyte adhesion molecules, Endothelial adhesion molecule receptors, Leucocyte chemotactic factors, Microbicidal activity of leucocytes, Leucocyte activation.

Unit II

Plasma derived mediators of inflammation-Complement system, Kinin system, Coagulation system and Fibrinolytic system; Cell derived mediators of inflammation-vasoactive amines, lipid mediators, cytokines, chemokines, oxygen radicals and nitric oxide, Cellular components of inflammation, types of exudative inflammation.

Unit III

Chronic inflammation and its types, Elements of chronic inflammation, Healing and repair, Wound healing mediators and their functions, Repair of bone, Repair of nervous tissue and myocardium.

VI. Practical

Molecular alterations and their correlation with gross and microscopic inflammatory changes

VII. Suggested Reading

- Selected articles from journals.

I. Course Title : Molecular Basis of Neoplasia
II. Course Code : VPL 703
III. Credit Hours : 1+1
IV. Aim of the course

To teach the students about molecular mechanisms of neoplasia and diagnostic techniques.

V. Theory

Unit I

Tumour characteristics, differentiation and proliferation, molecular basis of cancer, tumour stromal interaction, molecular mechanisms of invasion and metastasis of tumours, molecular changes underlying tumour progression and heterogeneity, tumour biology and growth.

Unit II

Tumour genetics, immunohistochemical/ including markers associated tumour diagnosis. Application of cytological, histopathological, immunohistochemical and molecular techniques in diagnosis and prognosis of various tumour conditions.

VI. Suggested Reading

- Selected articles from journals.

I. Course Title : Immunopathology

II. Course Code : VPL 704

III. Credit Hours : 2+1

IV. Aim of the course

To teach the students about immune mediated and autoimmune diseases of animals.

V. Theory

Unit I

Principles of immunopathology, Etiopathology of hypersensitivity reactions and immune complex diseases; Autoimmunity, mechanisms of autoimmunity, Genetic, microbial and environmental factors in autoimmunity.

Unit II

Study of etiology, pathology and pathogenesis of commonly encountered Immunoproliferative disorders (Multiple myeloma, lymphoma, leukemia), Hypersensitivity diseases, Autoimmune diseases and immune deficiencies in domestic animals.

VI. Practical

Immune complexes-quantification and determination by various techniques, Enumeration of various populations of lymphocytes by different techniques, Determination of C3 levels, Autoimmune reaction by demonstrating auto-antibodies, Gross and microscopic pathology of hypersensitivity reactions (class IV and others).

VII. Suggested Reading

- Selected articles from journals.

I. Course Title : Advances in Diagnostic Pathology

II. **Course Code : VPL 705**

III. **Credit Hours : 1+2**

IV. **Aim of the course**

To teach the students about current diagnostic techniques for diagnosis of different diseases.

V. **Theory**

Unit I

Principles and applications of Scanning electron microscopy, Transmission electron microscopy, Laser scanning confocal microscopy, Telemicroscopy-Virtual slide microscopy.

Unit II

Current techniques for diagnosis of animal diseases namely ELISA, PCR and its variants, Flow cytometry (FCM), *In-situ* hybridization, Bio chip techniques (DNA chip, Protein microarray, Tissue microarray), Chromatography, Spectrophotometry and Immunodiffusion technique, Biopsy techniques, Use of laboratory animals, etc.

Unit III

In-vitro cell culture techniques (commonly used cell lines, chicken embryo), cytopathic effect of different viruses and their interpretations.

VI. **Practical**

Principles and practice of advance techniques for the diagnosis of animal diseases.

VII. **Suggested Reading**

- Selected articles from journals.

I. **Course Title : Pathology of Nutritional and Metabolic Disorders**

II. **Course Code : VPL 706**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To teach the students about nutritional and metabolic disorder of animals.

V. **Theory**

Unit I

Pathogenesis, gross and microscopic pathology of nutritional imbalances, viz., carbohydrate, protein, fats, vitamins and macro and microelements.

Unit II

Pathogenesis, gross and microscopic pathology of different metabolic diseases namely Milk fever, Ketosis, Pregnancy

toxaemia, Tetany, Azoturia, Equine hyperlipidemia, downer's cow and rheumatism like syndrome and post parturient hemoglobinuria in domestic animals and diabetes mellitus in dogs.

VI. **Practical**

Estimation of certain minerals in sera of natural and experimentally induced deficiencies in domestic animals. To study the haematological, gross and microscopic pathological alterations caused by nutritional and metabolic disorders.

VII. **Suggested Reading**

- Selected articles from journals.

I. **Course Title : Pathology of Important Emerging and Re-Emerging Diseases**

II. **Course Code : VPL-707**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To teach the students about important emerging, re-emerging, transboundary diseases of pets and livestock.

V. **Theory**

Unit I

Advances in pathogenesis and pathology including molecular basis of important viral infections namely Foot and mouth disease, Vesicular stomatitis, Vesicular exanthema, Rinderpest, Bovine malignant catarrhal fever, Infectious bovine rhinotracheitis, Parainfluenza-3, Bovine respiratory syncytial virus infection, Blue tongue, Contagious ecthyma, Pox diseases, Peste des petits ruminants, Rabies,Canine distemper, parvovirus infections, Infectious canine hepatitis, Pseudorabies, Hog cholera/ swine fever, swine influenza, Rift valley fever, Scrapie, Bovine spongiform encephalopathy, Japanese encephalitis, Diseases caused by Nipah virus, Kyasanaur forest disease, West Nile fever, Hendravirus, Ebola virus, Crimean- Congo haemorrhagic fever, Chikungunya virus, Ganjam virus, Marburg virus, etc.

Unit II

Advances in pathogenesis and pathology including molecular basis of important bacterial infections namely Tuberculosis, Johne's disease, Actinobacillosis, Actinomycosis, Brucellosis, Listeriosis, Pasteurellosis, Leptospirosis, Anthrax, Clostridial group of diseases,

Swine erysipelas, Glasser's disease, Colibacillosis and Salmonellosis, *Corynebactrium* infections, Chlamydial and Mycoplasmal infections.

Unit III

Advances in pathogenesis and pathology including molecular basis of important fungal infections namely Aspergillosis, Blastomycosis, Coccidioidomycosis, Histoplasmosis, Rhinosporidiosis, Sporotrichosis, Candidiasis, Crytococcosis, Dermatomycoses, diseases due to commonly occurring mycotoxins-Aflatoxins, Ochratoxin, Zearalenone, T-2 toxins, Rubratoxin, Fumonisin, Moniliformin, etc.

VI. Practical

Study of clinical and gross alterations and histopathology of some important emerging and enzootic diseases.

VII. Suggested Reading

- Selected articles from Journals.

I. Course Title : Research Methodology in Pathology

II. Course Code : VPL 708

III. Credit Hours : 1+0

IV. Aim of the course

To provide exposure to the students on different methodologies indispensable in Pathology research through available scientific literature in world class journals.

V. Theory

Unit I

Literature based study: Use of various experimentation techniques in pathology research, Animal experimentation techniques, Planning and design of various types of experiments through study of literature for selection of appropriate methodology and evaluation parameters including scoring system, Data evaluation methods, etc.

Unit II

Introduction to OECD-GLP guidelines, Reference studies through literature for safety evaluation of drug/ plant/ plant molecules using *In-vitro* and *In vivo* techniques, Determination and calculation of LD_{50}, ID_{50}, MIC, MTD, etc., use of modern molecular techniques in experimental pathology research.

- Selected articles from journals.

I. **Course Title : Necropsy Conference-I**

II. **Course Code : VPL-709**

III. **Credit Hours : 0+1**

IV. **Aim of the course**

To promote self learning of the students in different necropsy procedures of animals including poultry and description of post-mortem lesions in different diseases/ disease conditions.

V. **Practical**

- Continuous assessment of students on detailed necropsy examination of various species of large and small animals including poultry; necropsy associated cytological examinations; systematic examination of different organs for morphologic description of gross lesions; gross photography; collection of tissues for histopathology and based on nature of gross lesions, if possible further collection for investigation of viral/ bacterial/ protozoan/ fungal/ parasitic diseases/ toxic or poisoning, etc.
- Morphologic description of microscopic lesions; microscopic photography; correlation of gross and microscopic observations with the results of other parallel investigations to diagnose the disease conditions; presentation of select case(s) in the monthly seminars followed by report writing and final morphologic/ etiologic diagnosis, classification and preservation of microscopic slides.

VI. **Suggested Reading**

- D Gopala Krishna Rao. 2005. *Textbook on necropsy and histopathological techniques*, 1st Ed. Academa.
- Donald B Feldman, John Curtis Seely. 1988. *Necropsy Guide: Rodents and the Rabbit*, 1st Ed. CRC Press.
- Albert C Strafuss. 1988. *Necropsy: Procedures and Basic Diagnostic Methods for Practicing Veterinarians,* Charles C. Thomas Publisher Springfield.
- Jones TC and Gleiser CA. 1954. *Veterinary Necropsy Procedures*. JB Lippincott.
- John M King, David C Dodd and Lois Roth. 2006. *The Necropsy Book*, Fifth Edition, C L Davis Foundation.
- Majó Masferrer, Natàlia, Dolz Pascual, Roser and Shivaprasad HL. 2011. *Atlas of Avian Necropsy: Macroscopic Diagnosis Sampling*, SERVET Publishers.
- Benjamin Lucio-Martinez and Jodi A Korich. 2010.

Illustrated guide to Poultry Necropsy and diagnosis, Cornell University (https://www.slideshare.net/heshamkotb/illustrated-guide- to-poultry-necropsy-and-diagnosis).

I. **Course Title : Special Problem**
II. **Course Code : VPL 790**
III. **Credit Hours : 0+1**
IV. **Aim of the course**

To provide expertise in handling practical research problems.

V. **Practical**

Short research problem(s) involving contemporary issues and research techniques.

- *American Journal of Veterinary Medical Association*
- *Annals of Nutrition and Metabolism*
- *Annual Review of Nutrition*
- *Avian Diseases*
- *Avian Pathology*
- *Cancer Research*
- *Cellular and Molecular Biology*
- *Current Contents*
- *European Journal of Nutrition*
- *Genomics, Proteomics and Bioinformatics*
- *Indian Journal of Animal Sciences*
- *Indian Journal of Poultry Science*
- *Indian Journal of Veterinary Pathology*
- *Indian Veterinary Journal*
- *Journal of Applied Toxicology*
- *Journal of Comparative Pathology*
- *Journal of Ethnopharmacology*
- *Journal of Immunology and Immunopathology*
- *Journal of Pathology*
- *Journal of Research in Veterinary Science*
- *Phytomedicine*
- *Toxicology Letters*
- *Toxicon*
- *Trends in Immunology*
- *Veterinary Bulletin*
- *Veterinary Immunology and Immunopathology*
- *Veterinary Pathology*

e-Resources

- www.iavp.org (Indian Journal of Veterinary Pathology)

- www.vetpathology.org (Veterinary Pathology)
- www.tandf.co.uk (Avian Pathology)
- www.avdi.allenpress.com (Avian Diseases)
- www.elsevier.com/locate/vetimm (Veterinary Immunology and Immuno- pathology).

Course Outline-cum-Lecture Schedule forDoctoral Degree Programme

I. **Course Title : Molecular and Ultra structural Basis of Cell Injury**
II. **Course Code : VPL 701**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To teach the students about different molecular including ultrastructural changesin diseases conditions.

Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. Study of cells- cell morphology, interpretation of normal and abnormal cells 6
2. Overview of Cell injury, Targets of cell injury-Cell membranes, aerobic respiration, structural proteins and enzymes and genetic apparatus of the cell; mechanisms of cell injury-hypoxia, injury by free radicals, chemical injury, infectious agents, other forms of cell injury-immune mediated reactions, genetic derangements; mechanisms of cell membrane damage; mechanisms of DNA damage-base loss, base modification, chemical modification, replication errors, inter-strand cross-links, DNA-protein cross-links, strand breaks. Molecular and immunopathological changes associated with different types of cell injuries 10
3. Morphology of Reversible and irreversible cell injury with particular emphasis on ultra structural changes in the cells and organelles: Morphology of cell death-necrosis, apoptosis and autolysis, mechanism of apoptosis, intracellular and extracellular accumulations, pigment and tissue deposits, consequences of cell injury 10
4. Cellular adaptations-hyperplasia, hypertrophy, atrophy, metaplasia and dysplasia 4
5. Mechanism of other types of cell death, viz., pyroptosis, ferroptosis, autophagy, ETOSIS, etc. 2

Practical

1. Collection and preparation of specimens for electron microscopic studies.Interpretation of ultra-structural changes and their correlation with gross and histopathological findings 16

I. **Course Title : Molecular Basis of Inflammation**
II. **Course Code : VPL 702**
III. **Credit Hours : 1 + 1**
IV. **Aim of the course**

To teach the students about molecular mechanisms of inflammations.

Lecture/ Practical schedule

Sr. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Cellular, molecular and immunopathological changes associated with different types of inflammation. Acute inflammation, Vascular events of acute inflammation, Cellular events in acute inflammation, Leucocyte-endothelial interactions, Leucocyte adhesion molecules, Endothelial adhesion molecule receptors, Leucocyte chemotactic factors, Microbicidal activity of leucocytes, Leucocyte activation. 6
2. Plasma derived mediators of inflammation-Complement system, Kinin system, Coagulation system and Fibrinolytic system; Cell derived mediators of inflammation-vasoactive amines, lipid mediators, cytokines, chemokines, oxygen radicals and nitric oxide, Cellular components of inflammation, types of exudative inflammation. 6
3. Chronic inflammation and its types, Elements of chronic inflammation, Healing and repair, Wound healing mediators and their functions, Repair of bone, Repair of nervous tissue and myocardium. 4

Practical

1. Molecular alterations and their correlation with gross and microscopic inflammatory changes. 16

I. **Course Title : Molecular Basis of Neoplasia**
II. **Course Code : VPL 703**
III. **Credit Hours : 1 + 1**
IV. **Aim of the course**

To teach the students about molecular mechanisms of neoplasia and diagnostic technique.

Lecture/ Practical schedule

Sr. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Tumour characteristics, differentiation and proliferation, molecular basis of cancer, tumour stromal interaction, molecular mechanisms of invasion and metastasis of tumours, molecular changes underlying tumour progression and heterogeneity, tumour biology and growth. 8
2. Tumour genetics, immunohistochemical/ including markers associated tumour diagnosis. 8

Practical

1. Application of cytological, histopathological, immunohistochemical and molecular techniques in diagnosis and prognosis of various tumour conditions. 16

I. **Course Title : Immunopathology**
II. **Course Code : VPL 704**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To teach the students about immune mediated and autoimmune diseases of animals.

Lecture/ Practical schedule

Sr. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Principles of immunopathology, Etiopathology of hypersensitivity reactions and immune complex diseases; Autoimmunity, mechanisms of autoimmunity, Genetic, microbial and environmental factors in autoimmunity. 16
2. Study of etiology, pathology and pathogenesis of commonly encountered Immunoproliferative disorders (Multiple myeloma, lymphoma, leukemia), hypersensitivity diseases, autoimmune diseases and immune deficiencies in domestic animals. 16

Practical

1. Immune complexes-quantification and determination by various techniques, enumeration of various populations of lymphocytes by different techniques, determination of C3 levels. 8
2. Autoimmune reaction by demonstrating auto-antibodies, gross and microscopic pathology of hypersensitivity reactions (class IV and others). 8

I. **Course Title : Advances in Diagnostic Pathology**
II. **Course Code : VPL 705**
III. **Credit Hours : 1 + 2**
IV. **Aim of the course**

To teach the students about current diagnostic techniques for diagnosis

of different diseases.

Sr. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. Principles and applications of Scanning electron microscopy, Transmission electron microscopy, Laser scanning confocal microscopy, Telemicroscopy-Virtual slide microscopy 4
2. Current techniques for diagnosis of animal diseases namely ELISA, PCR and its variants, Flow cytometry (FCM), *In-situ* hybridization, Bio-chip techniques (DNA chip, Protein microarray, Tissue microarray), Chromatography, Spectrophotometry and Immunodiffusion technique, Biopsy techniques, Use of laboratory animals, etc. 8
3. *In-vitro* cell culture techniques (commonly used cell lines, Chicken embryo), cytopathic effect of different viruses and their interpretations 4

Practical

1. Principles and practice of advance techniques for the diagnosis of animal diseases 32

I. **Course Title : Pathology of Nutritional and Metabolic Disorders**
II. **Course Code : VPL 706**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To teach the students about nutritional and metabolic disorder of animals.

Lecture/ Practical schedule

Sr. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. Pathogenesis, gross and microscopic pathology of nutritional imbalances, viz., carbohydrate, protein, fats, vitamins and macro and microelements 16
2. Pathogenesis, gross and microscopic pathology of different metabolic diseases namely milk fever, ketosis, pregnancy toxaemia, tetany, azoturia, equine hyperlipidemia, downer's cow and rheumatism like syndrome and post parturient hemoglobinuria in domestic animals and diabetes mellitus in dogs 16

Practical

1. Estimation of certain minerals in sera of natural and experimentally induced deficiencies in domestic animals 8
2. To study the haematological, gross and microscopic

pathological alterations caused by nutritional and metabolic disorders 8

I. **Course Title : Pathology of Important Emerging and Re-Emerging diseases**

II. **Course Code : VPL 707**

III. **Credit Hours : 2 + 1**

IV. **Aim of the course**

To teach the students about important emerging, re-emerging, transboundary diseases of pets and livestock.

Lecture/ Practical schedule

Sr. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Advances in pathogenesis and pathology including molecular basis of important viral infections namely Foot and mouth disease, Vesicular stomatitis, Vesicular exanthema, Rinderpest, Bovine malignant catarrhal fever, Infectious bovine rhinotracheitis, Parainfluenza-3, Bovine respiratory syncytial virus infection,Blue tongue, Contagious ecthyma, Pox diseases, Peste des petits ruminants, Rabies, Canine distemper, parvovirus infections, Infectious canine hepatitis, Pseudorabies 8
2. Advances in pathogenesis and pathology including molecular basis of important viral infections namely Hog cholera/ swine fever, swine influenza, Rift valley fever, Scrapie, Bovine spongiform encephalopathy, Japanese encephalitis, Diseases caused by Nipah virus, Kyasanaur forest disease, West Nile fever, Hendravirus, Ebola virus, Crimean-Congo haemorrhagic fever, Chikungunya virus, Ganjam virus, Marburg virus, etc. 8
3. Advances in pathogenesis and pathology including molecular Basis of important bacterial infections namely Tuberculosis, Johne's disease, Actinobacillosis, Actinomycosis, Brucellosis, Listeriosis, Pasteurellosis, Leptospirosis, Anthrax, Clostridial group of diseases, Swine erysipelas, Glasser's disease, Colibacillosis and Salmonellosis, Corynebactrium infections, Chlamydial and Mycoplasmal infections 8
4. Advances in pathogenesis and pathology including molecular basis of important fungal infections namely Aspergillosis, Blastomycosis, Coccidioidomycosis, Histoplasmosis, Rhinosporidiosis, Sporotrichosis, Candidiasis, Crytococcosis, Dermatomycoses, diseases due to commonly occurring mycotoxins-Aflatoxins, Ochratoxin,Zearalenone, T-2 toxins, Rubratoxin, Fumonisin,

Moniliformin, etc. 8

Practical

1. Study of clinical and gross alterations and histopathology of some important emerging and enzootic diseases. 16

I. **Course Title : Research Methodology in Pathology**
II. **Course Code : VPL 708**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

To provide exposure to the students on different methodologies indispensable in Pathology research through available scientific literature in world class journals

Sr. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Literature based study: Use of various experimentation techniques in pathology research, animal experimentation techniques, Planning and design of various types of experiments through study of literature for selection of appropriate methodology and evaluation parameters including scoring system, data evaluation methods, etc. 8
2. Introduction to OECD-GLP guidelines, Reference studies through literature for safety evaluation of drug/ plant/ plant molecules using *In-vitro* and *In vivo* techniques, Determination and calculation of LD_{50}, ID_{50}, MIC, MTD, etc., use of modern molecular techniques in experimental pathology research 8

I. **Course Title : Necropsy Conference I**
II. **Course Code : VPL 709**
III. **Credit Hours : 0 + 1**
IV. **Aim of the course**

To promote self-learning of the students in different necropsy procedures of animals including poultry and description of post-mortem lesions in different diseases/ disease conditions.

Lecture/ Practical schedule

Sr. No. Name of Topic No. of Lectures/ Practicals

Practical

1. Continuous assessment of students on detailed necropsy examination of various species of large and small animals including poultry; necropsy associated cytological examinations; systematic examination of different organs for morphologic

description of gross lesions; gross photography; collection of tissues for histopathology and based on nature of gross lesions, if possible further collection for investigation of viral/ bacterial/ protozoan/ fungal/ parasitic diseases/ toxic or poisoning, etc. 8

2. Morphologic description of microscopic lesions; microscopic photography; correlation of gross and microscopic observations with the results of other parallel investigations to diagnose the disease conditions; presentation of select case(s) in the monthly seminars followed by report writing and final morphologic/ etiologic diagnosis, classification and preservation of microscopic slides 8

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Pathology

Introduction and principles of pathology including genetic basis of disease; Cellular responses to injury: Causes and mechanisms of reversible and irreversible cell injury; Morphological characteristics, significance and fate of various intracellular (lipids, glycogen, proteins) and extracellular (hyaline material, amyloid, fibrinoid change, gout) accumulations/degenerations, Endogenous and exogenous pigmentations, Cell death (necrosis, apoptosis and gangrene), Pathological calcifications and cellular adaptive changes

Inflammation and repair: Introduction to inflammation, Acute inflammation: Cellular and molecular events including mediators, Heat shock proteins of acute inflammation, Cellular components, Morphological classification and outcomes of acute inflammation, Chronic inflammation: Causes, morphological features and cellular components of chronic inflammation, healing and repair, systemic effects of inflammation

Disturbances in circulation: Causes, mechanisms, morphological features, significance and fate of hyperaemia, oedema, haemorrhage, thrombosis, embolism, ischaemia, infarction and shock

Immune mediated reactions: Introduction to autoimmunity and immune mediated diseases, mechanisms of hypersensitivity reactions

Basic histopathological techniques: Collection of tissues, fixation, processing, section cutting and H&E staining of tissue sections; Collection and fixation of tissues for the scanning electron microscopy, transmission electron microscopy, histochemical, toxicologica1, bacteriological and virologica1 examinations

Application of micrometry and special staining techniques, demonstration of different inclusions, bacteria and fungi in tissues; Histochemical techniques for demonstration of fat, glycogen, connective tissue, muco-polysaccharides, common enzymes, pigments and minerals; Cryosectioning and application of immunohistochemical techniques: immunoperoxidase and immunofluorescence; Museum specimen preparation and maintenance

Tumour: Etiology, carcinogens and oncogenesis, nomenclature and classification, characteristics of benign and malignant tumours, molecular mechanisms, pathways of spread of tumors and tumour immunology; effects of tumour, grading, staging and diagnosis of tumours

Pathology of different types of epithelial and connective tissue tumours with their characteristic identification features and epidemiology

Study of changes in blood/ plasma/ serum including biochemical profile for organ function tests, Cytologica1 examination; Examination of urine, faeces, cerebrospinal fluid and biopsy specimens and their interpretation

General knowledge about the laws relating to veterinary practice, professional discipline and professional etiquettes; Regulations dealing with the diseases of animals in India regarding epidemiology, quarantine certificate, issue of

soundness certificate
Different manners/ modes of the death such as criminal assault, cruelty to animals, malicious poisoning, snake bite, death due to drowning, lightning strokes during thunderstorms; Veterolegal wounds like electrocution, gunshot wounds, automobile accidents and violent death; Legal implications in animals in above conditions, doping in horses, etc.
Detailed necropsy examination of various species of large and small animals including poultry, laboratory animals and wildlife.
Systematic examination of brain, lungs, heart, endocrine glands, lymph nodes, liver, gastro-intestinal tract, urinary and genital systems for gross pathological and histopathological studies and correlation of the observations to diagnose the disease conditions
Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting cardiovascular (heart, blood vessels and lymph vessels), respiratory (nasal cavity, larynx, trachea, bronchi, lungs and pleura) and haemopoietic (bone marrow, blood, spleen, lymph node) systems
Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting different organs of digestive (buccal cavity, pharynx, oesophagus, stomach and intestines), urinary (kidneys, ureter, urinary bladder and urethra) and genital (male and female organs including mammary gland) systems
Advanced study of pathological conditions in relation to their etiology, pathology and pathogenesis including examples of specific infectious or non-infectious diseases affecting different organs of nervous (brain and spinal cord), endocrine (pituitary, thyroid, parathyroid, pancreas) musculo-skeletal systems (muscles and bones) and organs of special senses (eye, ear), skin and its appendages (hoof, tail).
Study of etiology, pathology and pathogenesis of various viral diseases: Foot and mouth disease, Vesicular stomatitis, Vesicular exanthema, Vesicular disease, Rinderpest, Bovine viral diarrhoea-Mucosal disease, Bovine malignant catarrhal fever, Infectious bovine rhinotracheitis, Parainfluenza-3, Bovine respiratory syncytial virus infection, Pox diseases, Blue tongue, Contagious ecthyma, PPR, Rabies, Canine distemper, Parvovirus infections, Infectious canine hepatitis, Pseudorabies, Classical swine fever, Swine and Equine influenza, Equine infectious anaemia, African horse sickness, Equine viral arteritis, Equine viral encephalomyelitis, Equine herpesvirus infections, Papillomatosis and Prion diseases
Study of etiology, pathology and pathogenesis of various bacteria1 diseases: Tuberculosis, Johne's disease, Actinobacillosis, Actinomycosis, Brucellosis, Listeriosis, Pasteurellosis, Leptospirosis, Anthrax, Clostridial group of diseases, Streptococcal and Staphylococca1 infections, Campylobacter

infections, Swine erysipelas, Glasser's disease, Foot rot, Colibacillosis, Salmonellosis, Glanders, Melioidosis, Corynebactrium infections, Chlamydial and Mycoplasma infections

Study of etiology, Pathology and pathogenesis of various fungal, Rickettsial and parasitic diseases- Aspergillosis, Blastomycosis, Coccidioidomycosis, Histoplasmosis, Epizootic lymphangitis, Rhinosporidiosis, Sporotrichosis, Candidiasis, Crytococcosis, Dermatomycoses; Diseases due to commonly occurring mycotoxin; Important rickettsial diseases: Q-fever, Heart water disease, Ehrlichiosis, Anaplasmosis; Important protozoan diseases: Coccidiosis, Toxoplasmosis, Babesiosis, Theilariosis, Cryptosporidiosis, Trypanosomiasis and Pathology of important diseases caused by helminths

Avian inflammation and immunology, Study of etiopathology, symptoms, transmission and diagnosis of infectious diseases of chickens, turkeys, ducks and other birds caused by Bacteria: Salmonella, *Escherichia coli* and Clostridial infections, Infectious coryza, Fow1 cholera, Tuberculosis and Spirochaetosis; Chlamydial and Mycoplasmal infections; Viruses: Ranikhet disease, Infectious bursal disease, Infectious bronchitis, Infectious laryngotracheitis, Marek's disease, Leukorsarcoma group of diseases, Reticuloendotheliosis, Fowl pox, Avian influenza, Avian encephalomyelitis, Inclusion body hepatitis, Hydropericardium syndrome, Egg drop syndrome-76, Chicken infectious anaemia, Avian nephritis, Reovirus infections-Viral arthritis and Infectious stunting syndrome, Duck plague, Duck viral hepatitis, Haemorrhagic enteritis of turkeys: Fungi and mycotoxins; Parasites-Coccidiosis, Histomoniasis, Round worm and Tape worm infections; Ecto-parasites of birds

Study of etio-pathology, clinical symptoms, and diagnosis of nutritional deficiencies - Vitamin and Mineral deficiencies; Metabolic diseases- Ascites, Gout, Fatty liver and kidney syndrome, Fatty liver haemorrhagic syndrome, Cage layer fatigue. Miscellaneous conditions of poultry- Heat stress, Blue comb, Breast blister, Bumble foot, Cannibalism, False layer, Internal layer, Pendulous crop, Round heart disease etc.

Veterinary Parasitology

DEPARTMENT OF VETERINARY PARASITOLOGY
Course structure for M.V.Sc. degree programme (Semester wise)

Course No.	Course title	Credit	Semester
VPA 601*	PLATYHELMINTHES – I	1+1	I
VPA 602*	PLATYHELMINTHES – II	1+1	I
VPA 603*	NEMATHELMINTHES AND ACANTHOCEPHALA	2+1	II
VPA 604*	ARTHROPOD PARASITES	2+1	I
VPA 605*	PARASITIC PROTOZOA	2+1	II
VPA 606	DIAGNOSTIC PARASITOLOGY	0+2	I
VPA 607	CLINICAL PARASITOLOGY	1+1	I
VPA 608	MANAGEMENT OF PARASITIC DISEASES	1+1	II
VPA 609	IMMUNOPARASITOLOGY	2+1	I
VPA 610	PARASITIC ZOONOSES	2+0	II
VPA 611	PARASITES OF WILDLIFE	1+1	II
VPA 691	MASTER'S SEMINAR	1+0	1
VPA 699	MASTER'S RESEARCH	0+30	I & II
*Compulsory Courses			

DEPARTMENT OF VETERINARY PARASITOLOGY
Course structure for PhD degree programme (Semester wise)

Course No.	Course title	Credit	Semester
VPA 701	ADVANCES IN HELMINTHOLOGY – I	2+1	I
VPA 702	ADVANCES IN HELMINTHOLOGY – II	2+1	II
VPA 703	ADVANCES IN ENTOMOLOGY AND ACAROLOGY	2+1	I
VPA 704	ADVANCES IN PROTOZOOLOGY	2+1	II
VPA 705*****	IMMUNOLOGY OF PARASITIC DISEASES	1+2	I
VPA 706*****	MOLECULAR DIAGNOSTICS AND VACCINE DEVELOPMENT IN PARASITOLOGY	2+1	II
VPA 707	HOST PARASITE INTERACTIONS	2+0	I
VPA 708	*IN-VITRO* CULTIVATION OF PARASITES	1+2	II
VPA 709	EMERGING AND RE-EMERGING PARASITIC DISEASES	2+0	II
VPA 710	BIOLOGY AND ECOLOGY OF PARASITES	3+0	I
VPA 711	MOLECULAR VETERINARY PARASITOLOGY	2+0	I
VPA 712*****	PARASITE EPIDEMIOLOGY	2+0	II
VPA 790	SPECIAL PROBLEM	0+1	I & II
VPA 791	DOCTORAL SEMINAR-I	1+0	I & II
VPA 792	DOCTORAL SEMINAR-II	1+0	I & II
VPA 799	DOCTORAL RESEARCH	0+75	I & II
*****Compulsory Courses			

Course Contents
M.V.Sc. in Veterinary Parasitology

I. **Course Title : Platyhelminthes-I**

II. **Course Code : VPA 601**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To study the morphology, biology, pathogenesis and control measures for trematode parasites of veterinary importance.

V. **Theory**

Unit I

Introduction, classification, general account and economic importance
of trematodes.

Unit II

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, Treatment and control measures of trematodes belonging to families: Dicrocoeliidae, Opisthorchiidae and Fasciolidae.

Unit III

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of trematodes belonging to families: Echinostomatidae, Heterophyidae, Plagiorchiidae, Troglotrematidae, Prosthogonimidae, Nanophyetidae and Paragonimidae.

Unit IV

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of trematodes belonging to families: Notocotylidae, Brachylemidae, Cyclocoelidae, Paramphistomatidae and Schistosomatidae.

Unit V

Classification, characters of snails and control strategies of molluscs of veterinary importance.

VI. **Practical**

- Collection, preservation/ processing and identification of trematode parasites; their eggs and intermediate hosts.
- Observation on parasitic stages in host tissues and associated pathological lesions.
- Identification of molluscs of veterinary importance and examination of molluscsfor various developmental stages of trematode parasites.

I. **Course Title : Platyhelminthes-II**

II. **Course Code : VPA 602**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To study the morphology, biology, pathogenesis and control measures for cestode parasites of veterinary importance.

Unit I

Introduction, classification, general account and economic importance of cestodes

Unit II

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of cestodes belonging to families: Diphyllobothriidae, Mesocestoididae and Taeniidae.

Unit III

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of cestodes belonging to families: Davaineidae, Hymenolepididae, Dipylidiidae and Dilepididae.

Unit IV

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, Treatment and control measures of cestodes belonging to families: Anoplocephalidae and Thysanosomidae.

V. **Practical**

Collection, preservation/ processing and identification of cestode parasites; their eggs, larval stages and intermediate hosts. Parasitic stages in host tissues and associated pathological lesions.

I. **Course Title : Nemathelminthes and Acanthocephala**

II. **Course Code : VPA 603**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To study the morphology, biology, pathogenesis, diagnosis and control of nematodes and thorny-headed worms of veterinary importance.

V. **Theory**

Unit I

Introduction, classification, general account and economic importance of nematodes and thorny-headed worms.

Unit II

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of

nematodes belonging to families: Ascarididae, Anisakidae, Oxyuridae, Heterakidae and Subuluridae**.**

Unit III

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment, and control measures of nematodes belonging to families: Rhabditidae, Strongyloididae and Strongylidae.

Unit IV

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment, and control measures of nematodes belonging to families: Trichonematidae, Amidostomidae, Stephanuridae, Syngamidae and Ancylostomatidae. Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Filaroididae, Trichostrongylidae, Ollulanidae, Dictyocaulidae and Metastrongylidae.

Unit VI

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Spiruridae, Thelaziidae, Acuariidae, Tetrameridae, Physalopteridae, Gnathostomatidae, Filariidae, Setariidae, Onchocercidae and Dracunculidae.

Unit VII

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Trichinellidae, Trichuridae, Capillariidae and Dioctophymatidae.

Unit VIII

Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of thorny headed worms belonging to families: Polymorphidae, Oligacanthorhynchidae and Gnathobdellidae.

V. Practical

Collection, preservation/ processing and identification of nematode parasites and thorny headed worms; their eggs and larvae and associated pathological lesions.

I. Course Title : Arthropod Parasites

II. Course Code : VPA 604

III. Credit Hours : 2+1

IV. Aim of the course

To study the morphology, biology, vector potential of the arthropods of veterinary importance and their control measures

v. **Theory**

Unit I

Introduction, Classification, Harmful effects and Economic importance of arthropod parasites.

Unit II

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Vector potentiality, Economic significance and control of arthropods belonging to the families: Culicidae, Ceratopogonidae, Simuliidae and Psychodidae.

Unit III

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Vector potentiality, Economic significance and control of arthropods belonging to the families: Tabanidae, Gasterophilidae, Muscidae, Cuterebridae and Glossinidae.

Unit IV

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Vector potentiality, Economic significance and control of arthropods belonging to the families: Oestridae, Sarcophagidae, Calliphoridae and Hippoboscidae. Importance

Unit V

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Economic significance and control of arthropods belonging to the families: Pediculidae, Haematopinidae, Linognathidae, Menoponidae, Philopteridae and Trichodectidae.

Unit VI

Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Economic significance and control of arthropods belonging to the Orders- Siphonaptera and Hemiptera, Cimicidae and Reduviidae.

Unit VII

Distribution, Life cycle, Seasonal pattern, Vector potentiality, Pathogenesis economic significance and control of acarines belonging to the families: Argasidae and Ixodidae.

Unit VIII

Distribution, Morphology, Life cycle, Seasonal pattern,

Pathogenesis, Economic significance and control of acarines belonging to the families: Sarcoptidae, Psoroptidae, Demodicidae, Trombiculidae, Dermanyssidae. Cytoditidae and Linguatulidae.

Unit IX

Chemical, Biological, Immunological control measures and integrated pest management. Detection and mechanisms of acaricidal resistance.

V. Practical

Collection, preservation/ processing, identification, differentiation of arthropod parasites and their developmental stages; associated lesions and skin scraping examination.

I. Course Title : Parasitic Protozoa

II. Course Code : VPA 605

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the morphology, Life cycle, Pathogenesis, Diagnosis and control of protozoan parasites of veterinary importance.

V. Theory

Unit I

Introduction, classification, general account and economic importance of protozoan parasites.

Unit II

Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis, and control measures of protozoan parasites belonging to the families: Trypanosomatidae, Monocercomonadidae, Trichomonadidae, Hexamitidae and Endamoebidae.

Unit III

Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis and control measures of protozoan parasites belonging to the families: Eimeriidae, Cryptosporidiidae and Sarcocystidae.

Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis, Treatment and control measures of protozoan parasites belonging to the families: Plasmodiidae, Babesiidae, Theileriidae, Haemogregarinidae and Balantidiidae.

Unit V

Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis and control measures of Rickettsiales in relation to

haemoprotozoans.

VI. **Practical**

Collection, Preservation/ Processing, Identification of parasitic protozoa in clinical material and host tissues. Special techniques for certain protozoans such as coccidia and Cryptosporidia.

I. **Course Title : Diagnostic Parasitology**

II. **Course Code : VPA 606**

III. **Credit Hours : 0+2**

IV. **Aim of the course**

To learn the techniques associated with isolation, Identification and preservation of the endo and ectoparasites of veterinary importance and their vectors.

V. **Practical**

Microscopy and micrometry, Preparation of Romanowsky stains. Collection, preservation, Processing and examination of faecal and blood samples; Lymph node biopsy, Skin scrapings, Nasal washings, Sputum, genital discharges/ washings and urine samples from animals for parasitological examinations. Quantitative faecal examination, Maintenance of fly and tick colonies in laboratory for experimental purposes and testing of drugs; tick dissection for vector potential. Collection of aquatic snails from field and their examination for the presence of different parasitic stages. Collection, fixation, staining, whole mounts and identification of parasites. Culturing techniques for important parasites, pasture larval count, worm count and assessment of worm burden.Remote Sensing (RS) and Geographic Information System (GIS) as tools for mapping parasitic diseases.

I. **Course Title : Clinical Parasitology**

II. **Course Code : VPA 607**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

Collection, preservation and examination of clinical material for parasitological investigations and interpretations.

V. **Theory**

Unit I

Collection, preservation and dispatch of clinical material to

laboratory for diagnosis

Unit II

History, clinical signs, gross and microscopic examination of diagnostic material. Animal sub-inoculation technique; blood and lymph node biopsy smear examination; histopathology of affected organs.

VI. **Practical**

Identification, observation of parasitic stages in host tissues, excretions, secretions and associated pathological lesions. Special techniques for haemoparasites and coccidians.

I. **Course Title : Management of Parasitic Diseases**
II. **Course Code : VPA 608**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To study the integrated approach for the control of helminths, arthropods and protozoan parasites of veterinary importance.

V. **Theory**

Unit I

Conventional and novel methods for control of helminth infections in livestock – anthelmintics, their mode of action, characteristic of an ideal anthelmintic drug, Anthelmintic resistance, Spectrum of activity, Delivery devices and integrated control method. Immunological control, Deworming schedule, Snail and other intermediate host control. Ethno veterinary practices.

Unit II

Conventional and novel methods of control of protozoan parasites–antiprotozoal drugs, Their mode of action, Integrated control method including immunological control.

Unit III

Conventional and novel methods of control with insecticides/ acaricides. Methods of application, their mode of action, insecticide resistance, biological control, integrated control method, genetic control and immunological control.

VI. **Practical**

In vivo and *in-vitro* detection of efficacy of control agents and resistance to anthelmintics, anticoccidials, insecticides and acaricides**.**

I. **Course Title : Immunoparasitology**
II. **Course Code : VPA 609**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To study the host immune response against endo and ectoparasites of veterinary importance with special reference to immunoprophylaxis and immunodiagnosis.

V. **Theory**

Unit I

Introduction, types of parasite-specific antigens and their characterization.

Types of immunity in parasitic infections.

Unit III

Invasive and evasive mechanisms, immunomodulators and their uses.

Unit IV

Immune responses in helminths, arthropods and protozoa of veterinary importance.

Unit V

Immunological control against parasitic diseases.

VI. **Practical**

Preparation of various antigens (somatic, excretory-secretory) and their fractionation and characterization and demonstration of various immunodiagnostic methods for the diagnosis of parasitic infections.

I. **Course Title : Parasitic Zoonoses**

II. **Course Code : VPA 610**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

To study important parasites of zoonotic significance.

Unit I

Introduction to the concept of Zoonotic infections, Definitions, Various classifications of zoonoses, Host-parasite relationships, Modes of infections and factors influencing prevalence of zoonoses.

Unit II

A detailed study of Transmission, Epidemiology, Diagnosis and Control of common protozoa of zoonotic importance.

Unit III

A detailed study of Transmission, Epidemiology, Diagnosis and Control of common helminths of zoonotic importance.

Unit IV

A detailed study of Transmission, Epidemiology, Diagnosis and Control of common arthropods of zoonotic importance.

I. **Course Title : Parasites of Wildlife**

II. **Course Code : VPA 611**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To study the biology and control measures for major parasitic diseases of zoo and wild animals.

V. **Theory**

Unit I

A detailed study of protozoa of zoo and wild animals with particular emphasis on morphological features, Geographical distribution Epidemiology, Diagnosis and management.

Unit II

A detailed study of arthropod parasites of zoo and wild animals with particular emphasis on morphological features, Geographical distribution, Epidemiology, diagnosis and management.

Unit III

A detailed study of helminth parasites of zoo and wild animals with particular emphasis on morphological features, Geographical distribution, Epidemiology, diagnosis and management.

VI. **Practical**

Methods for investigating parasitic diseases of captive and wild animals. Collection and identification of parasites. Visits to zoos and biological parks/ sanctuaries for collection of samples.

Course Outline-cum-Lecture Schedule forMaster Degree Programme

I. **Course Title : Platyhelminthes-I**
II. **Course Code : VPA 601**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To study the morphology, biology, pathogenesis and control measures for trematodeparasites of veterinary importance

Lecture Topic

Theory

1-2 Introduction, history, classification, general account and economic importance of trematodes

3-4 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Dicrocoeliidae and Opisthorchiidae

5-6 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Strigeidae and Fasciolidae

7-8 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Echinostomatidae, Heterophyidae, Plagiorchiidae and Troglotrematidae

9-10 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Prosthogonimidae, Nanophyetidae and Paragonimidae

11-12 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Notocotylidae, Brachylemidae, and Paramphistomatidae

13-14 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Cyclocoelidae and Schistosomatidae

15-16 Classification and characters of snails and Control strategies of molluscs of veterinary importance

Practicals

1-5 Collection, preservation/ processing and identification of trematode parasites; their eggs and intermediate hosts

6-11 Observation on parasitic stages in host tissues and associated pathological lesions caused by treamtodes

12-16 Identification of molluscs of veterinary importance and examination of molluscs for various developmental stages of trematode parasites.

I. **Course Title : Platyhelminthes-II**
II. **Course Code : VPA 602**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To study the morphology, biology, pathogenesis and control measures for cestode parasites of veterinary importance

Lecture	Topic
Theory	
1-2	Introduction, history, classification, general account and economic importance of cestodes
3-4	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to family: Diphyllobothriidae
5	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to family: Mesocestoididae
6-8	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to family: Taeniidae
9-10	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to families: Davaineidae and Hymenolepididae
11-12	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to families: Dipylidiidae and Dilepididae
13-14	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to family: Anoplocephalidae
15-16	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to family: Thysanosomidae
Practicals	
1-8	Collection, preservation/ processing and identification of cestode parasites; their eggs, larval stages and intermediate hosts.
9-16	Observation on parasitic stages in host tissues and associated pathological lesions

I. **Course Title : Nemathelminthes and Acanthocephala**
II. **Course Code : VPA 603**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the morphology, biology, pathogenesis and control measures of nematodes and thorny-headed worms of veterinary importance

Lecture	Topic
1-2	Introduction, history, classification, general account and economic importance of nematodes and thorny-headed worms
2-4	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to family: Ascarididae
5-6	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Anisakidae and Oxyuridae
7-8	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Heterakidae and Subuluridae
9-10	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Rhabditidae and Strongyloididae
11-12	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to family: Strongylidae.
13-14	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Trichonematidae and Amidostomidae
15-16	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Stephanuridae and Syngamidae
17-18	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to family: Ancylostomatidae.
19-20	Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Filaroididae and Trichostrongylidae

21-22 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Ollulanidae, Dictyocaulidae and Metastrongylidae

23-24 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Spiruridae, Thelaziidae, Acuariidae, Tetrameridae, Physalopteridae, and Gnathostomatidae

25-26 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Filariidae, Setariidae, Onchocercidae and Dracunculidae.

27-28 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Trichinellidae and Trichuridae

29-30 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Capillariidae and Dioctophymatidae

31-32 Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Polymorphidae, Oligacanthorhynchidae and Gnathobdellidae.

Practicals

1-16 Collection, preservation/ processing and identification of nematode parasites and thorny headed worms; their eggs and larvae and associated pathological lesions.

I. **Course Title : Arthropod Parasites**
II. **Course Code : VPA 604**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To study the morphology, biology, vector potential of the arthropods of veterinary importance and their control measures.

Lecture Topic

1-2 Introduction, classification harmful effects and economic importance of arthropod parasites.

3-4 Distribution, morphology, life cycle, seasonal pattern,

pathogenesis, vector potential, economic significance and control of arthropods belonging to the family: Culicidae

5-6 Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the family: Ceratopogonidae

7-8 Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the families: Simuliidae and Psychodidae.

8-9 Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the families: Tabanidae and Gasterophilidae

10-11 Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the families: Muscidae, and Glossinidae

12-14 Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the families: Oestridae, Sarcophagidae, Calliphoridae and Hippoboscidae. Importance of blow flies in forensic entomology and treatment of wounds

15-18 Distribution, morphology, life cycle, seasonal pattern, pathogenesis, economic significance and control of arthropods belonging to the families: Pediculidae, Haematopinidae, Linognathidae, Menoponidae, Philopteridae and Trichodectidae

19-20 Distribution, morphology, life cycle, seasonal pattern, pathogenesis, economic significance and control of arthropods belonging to the order: Siphonaptera and families: Cimicidae and Reduviidae

21-25 Distribution, morphology, life cycle, seasonal pattern, pathogenesis, vector potential, economic significance and control of arthropods belonging to the families: Argasidae and Ixodidae

26-30 Distribution, morphology, life cycle, seasonal pattern, pathogenesis, economic significance and control of acarines belonging to the families: Sarcoptidae, Psoroptidae, Demodicidae, Trombiculidae, Dermanyssidae. Cytoditidae and Linguatulidae.

31-32 Chemical, biological, immunological control measures and integrated pest management. Detection and mechanisms of acaricidal resistance

Practicals

1-16 Collection, preservation/ processing, identification, differentiation of arthropod parasites and their developmental stages; associated lesions and skin scraping examination

I. **Course Title : Parasitic Protozoa**
II. **Course Code : VPA 605**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the morphology, life cycle, pathogenesis, diagnosis and control of protozoan parasites of veterinary importance.

Lecture Theory

1-3 Introduction, History, Classification and General account and economic importance of protozoan parasites.

4-7 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Trypanosomatidae

8-10 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Monocercomonadidae and Trichomonadidae

11-12 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Hexamitidae and Endamoebidae

13-14 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Endamoebidae

15-16 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Eimeriidae.

17-18 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Cryptosporidiidae.

19-22 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Sarcocystidae.

23 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Plasmodiidae.

24-26 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Babesiidae.

27-28 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Theileriidae.

29-30 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the family Haemogregarinidaeand Balantidiidae

31-32 Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of Rickettsiales like *Anaplasma*, *Ehrlichia*, *Haemobartonella* and others.

Practicals

1-4 Collection, preservation/ processing, identification of protozoan parasites based on faecal examination.

5-8 Collection, preservation/ processing, identification of protozoan parasites based on blood examination.

9-12 Observations on parasite stages in host tissues and the attendant pathological lesions.

13-16 Diagnosis of protozoan parasites of Veterinary importance.

I. **Course Title : Diagnostic Parasitology**

II. **Course Code : VPA 606**

III. **Credit Hours : 0+2**

Aim of the course

To learn the techniques associated with isolation, identification and preservation of the endo and ectoparasites of veterinary importance and their vectors.

Lecture Topic

Practical

1-2 Microscopy and micrometry, Preparation of Romanowsky stain.

3-8 Collection, preservation, processing and examination of faecal and blood samples; lymph node biopsy, skin scrapings, nasal washings sputum, genital discharges/ washings and urine samples from animals for parasitological examinations.

9-12 Quantitative faecal examination.

13-16 Maintenance of fly and tick colonies in laboratory for experimental purposes and testing of drugs; tick dissection for vector potential.

17-20 Collection of aquatic snails from field and their

examination for the presence of different parasitic stages.

21-24 Collection, fixation, staining, whole mounts and identification of parasites.

25-28 Culturing techniques for important parasites, pasture larval count, worm count and assessment of worm burden.

29-32 Remote Sensing (RS) and Geographic Information System (GIS) as tools for mapping parasitic diseases.

I. **Course Title : Clinical Parasitology**
II. **Course Code : VPA 607**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

Collection of clinical material, examination/ investigation and its preservation for interpretations.

Lecture Topic

Theory

1-3 Unit I: Collection, preservation and dispatch of clinical material to laboratory for diagnosis.

4-8 Unit II: History, clinical signs, gross and microscopic examination of diagnostic material.

9-10 Unit III: Animal sub-inoculation tests.

11-13 Unit III: Blood and biopsy smear examination.

14-16 Unit III: Histopathology of affected organs.

Practical

1-12 Identification, observation of parasitic stages in host tissues, excretions, secretions and associated pathological lesions.

7-12 Special techniques for *Cryptosporidium* oocysts in faecal samples. Sporulation of coccidial oocysts.

I. **Course Title : Management of Parasitic Diseases**
II. **Course Code : VPA 608**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To study the integrated approach for the control of helminths, arthropods and protozoan parasites of veterinary importance.

Lecture Topic

Theory

1-6 Unit I: Conventional and novel methods of control of helminth infection in livestock– anthelmintics, their mode of action, characteristic of an ideal anthelmintic drug,

anthelmintic resistance, spectrum of activity, delivery devices, integrated control method. Immunological control. Deworming schedule. Snail and other intermediate host control.

7-11 Unit II: Conventional and novel methods of control of protozoan parasites– antiprotozoal drugs, their mode of action, integrated control method including immunological control.

12-16 Unit III Conventional and novel methods of control with insecticides/ acaricides. Methods of application, their mode of action, insecticide resistance, biological control, integrated control method, genetic control and immunological control.

Practical

1-6 In vivo detection of efficacy of and resistance to parasiticidal agents.

7-16 *In-vitro* detection of efficacy of and resistance to parasiticidal agents

I. **Course Title : Immunoparasitology**
II. **Course Code : VPA 609**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the host immune response against the endo and ectoparasites of veterinary importance with special reference to immunoprophylaxis and immunodiagnosis.

Lecture Topic

Theory

1-7 Unit I: Introduction, types of parasite-specific antigens and their characterization. 8-13 Unit II: Types of immunity in parasitic infections.

14-18 Unit III: Invasive and evasive mechanisms, immunomodulators and their uses. 19-27 Unit IV: Immune responses in helminths, arthropods and protozoa of veterinary importance.

28-32 Unit V: Immunological control against parasitic diseases

Practical

1-9 Preparation of various antigens (somatic, fractionation and characterization and excretory-ecretory) and their

10-16 Demonstration of various immunodiagnostic methods for the diagnosis of parasitic infections

I. **Course Title : Parasitic Zoonoses**
II. **Course Code : VPA 610**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To study important parasites of zoonotic significance.

Lecture Topic

Theory

1-3 Unit I: Introduction to the concept of zoonotic infections

4-6 Unit I:Definition and various classifications of zoonoses.

7-10 Unit I: Host-parasite relationships, modes of infections, factors influencing prevalence of zoonoses.

11-18 Unit II: A detailed study of transmission, epidemiology, diagnosis and control of major protozoa of zoonotic importance.

19-25 Unit III: A detailed study of transmission, epidemiology, diagnosis and control of major helminths of zoonotic importance.

26-32 Unit IV: A detailed study of transmission, epidemiology, diagnosis and control of major arthropods of zoonotic importance.

I. **Course Title : Parasites of Wildlife**
II. **Course Code : VPA 611**
III. **Credit Hours : 1+1**
IV. **Aim of the course**

To study the biology and control measures for major parasitic diseases of zoo andwild animals.

Lecture

Theory

1-6 Unit I: A detailed study of protozoa of zoo and wild animals with particular emphasis on morphological features, geographical distribution epidemiology, diagnosis and management.

7-12 Unit II: A detailed study of arthropod parasites of zoo and wild animals with particular emphasis on morphological features, geographical distribution, epidemiology, diagnosis and management.

13-16 Unit III: A detailed study of helminth parasites of zoo and wild animals with particular emphasis on morphological features, geographical distribution, epidemiology, diagnosis and management

Practical

1-6 Methods for investigating parasitic diseases of captive and wild animals.

7-16 Collection and identification of parasites. Visits to zoos and biological parks/sanctuaries for collection of samples.

Course Title with Credit Load Ph.D. in Veterinary Parasitology

Course Contents
Ph.D. in Veterinary Parasitology

I. **Course Title : Advances in Helminthology-I**
II. **Course Code : VPA 701**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

Developments in the area of molecular biology, pathogenesis, diagnosis and control of trematodes and cestodes.

V. **Theory**

Unit I

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of trematodes and their larval stages.

Unit II

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of cestodes and larval stages.

VI. **Practical**

Morphological, Pathological and Immunological studies of trematode and cestode parasites.

I. **Course Title : Advances in Helminthology-II**
II. **Course Code : VPA 702**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the recent developments in the area of molecular biology, pathogenesis, diagnosis of nematode parasites and thorny headed worms with an objective of better control.

V. **Theory**

Unit I

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of nematode parasites and their larval stages.

Unit II

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of thorny-headed worms.

VI. **Practical**

Morphological, Pathological and Immunological studies of

various nematodes and thorny-headed worms.

I. **Course Title : Entomology and Acarology**
II. **Course Code : VPA 703**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the recent scientific developments on biology and control measures for arthropods of veterinary importance.

V. **Theory**

Unit I

Origin, Evolution, Regional/ Seasonal distribution and Forecasting of insect and acarine population.

Unit II

Population dynamics of insects and acarines in relation to biotic and abiotic factors

Unit III

Recent developments pertaining to insects of veterinary importance.

Unit IV

Recent developments pertaining to arachnids of veterinary importance.

Unit V

Chemical, Biological, Herbal and Immunological control measures and integrated pest management. Modulation of vector competence to transmit parasitic infections using molecular genetics by developing transgenic vectors.

VI. **Practical**

Collection and identification of arthropods; Demonstration of the infective stages in vectors. Immuno pathological changes produced in the host tissues due to the infestation of arthropods.

I. **Course Title : Advances in Protozoology**
II. **Course Code : VPA 704**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the recent developments in molecular biology, pathogenesis, diagnosis and control of protozoan parasites of veterinary importance

V. **Theory**

Unit I

Advanced studies on Taxonomy, Molecular biology,

Pathogenesis and Immunology of intestinal protozoa.

Unit II

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of haemoprotozoans.

Unit III

Advanced studies on Taxonomy, Molecular biology, Pathogenesis and Immunology of tissue and other protozoa. Morphological, pathological and immunodiagnosis of protozoan diseases

I. **Course Title : Immunology of Parasitic Diseases**
II. **Course Code : VPA 705**
III. **Credit Hours : 1+2**
IV. **Aim of the course**

To study the immune mechanisms operating in different parasitic infections and to identify the immunodominant/ immunoprotective antigens for diagnosis and control of parasitic diseases.

Unit I

To study the salient features of immune responses in relation to trematode, cestode, nematode and protozoan infections in livestock. Immune responses to arthropod infestations.

Unit II

Principles and applications of immunodiagnostic methods for parasitic diseases.

Unit III

Standardization of immunodiagnostic methods for parasitic diseases.

Unit IV

Identification of candidate antigens for diagnosis and vaccine development.

V. **Practical**

Methods for purification of antigens, fractionation and characterization of antigens, identification of candidate antigens as drug targets, raising of hyperimmune sera, development and standardization of immunodiagnostic methods for the diagnosis and control of parasitic infections.

I. **Course Title : Molecular Diagnostics and Vaccine Development for Parasitic Diseases**
II. **Course Code : VPA 706**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To understand the principles of development of sensitive molecular tools for rapid and field oriented tests. Identification of diagnostic and vaccine targets for detection and control of parasites of livestock and pets.

V. **Theory**

Unit I

Introduction to molecular taxonomy of parasites.

Unit II

Genome organisation in parasites of veterinary importance. Structure and function of nucleic acids.

Unit III

Basic plan of gene cloning, and expression in heterologous host. Production of recombinant protein and downstream processing for diagnostic/ prophylactic applications.

Unit IV

General concept of protein synthesis. Identification and molecular characterization of proteins of diagnostic/ prophylactic relevance of parasitic origin.

Unit V

Nucleic acid based techniques for genetic characterization and sensitive diagnosis of parasitic infections; PCR, LAMP, Nucleic acid hybridization technique, pyrosequencing, Real Time PCR, DNA Microarray, Microsatellite analysis, RNAi, Reverse Genetic Approaches and their applications.

Unit VI

Hybridoma technology. Principle of production of monoclonal antibody. The diagnostic application of monoclonal antibodies of parasitic infection.

Unit VII

DNA vaccine, Vector vaccine, Recombinant protein based vaccine, Subunit vaccine, Principle and Application.

VI. **Practical**

Identification, Characterization, and Purification of Recombinant Protein Antigens; SDS-PAGE and Western Blotting, Extraction and quantification of nucleic acid and PCR and related techniques.

I. **Course Title : Host Parasite Interactions**

II. **Course Code : VPA 707**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

To study different level of host-parasite interactions/ association with an objective of efficient control.

V. **Theory**

Unit I

Introduction, Distribution of parasites on/ in the host, Morphological adaptation for better survival in/ on the host.

Unit II

Behavioural defences, Host immune responses and Genetic resistance to parasites.

Unit III

Establishment of parasites in immune competent, Susceptible, Intermediate and Abnormal hosts, Chronicity of parasitic infections, Immuno evasive strategies of the parasites and host-parasite equilibrium.

Unit IV

Pathological consequences of host parasite interactions in relation to malnutrition and micronutrient metabolism.

I. **Course Title : *In-vitro* Cultivation of Parasites**

II. **Course Code : VPA 708**

III. **Credit Hours : 1+2**

IV. **Aim of the course**

Development and standardization of *in-vitro* techniques for parasite cultivation.

V. **Theory**

Unit I

Introduction, problems and goals of *in-vitro* cultivation of parasites.

Unit II

In-vitro cultivation of genital, Intestinal flagellates and Intestinal ciliates.

Unit III

In-vitro cultivation of intestinal protozoa.

Unit IV

In-vitro cultivation of haemoprotozoa.

Unit V

In-vitro techniques, media and tissue culture for cultivation of helminths and their larval stages.

Unit VI

In-vitro mass rearing and colonization of ticks, flies and other

insects.

VI. **Practical**

Preparation of media, sterilization methods and cultivation of different parasites.

I. **Course Title : Emerging and Re-Emerging Parasitic Diseases**

II. **Course Code : VPA 709**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

To study the emerging and re- emerging parasitic diseases.

V. **Theory**

Unit I

Emerging and re-emerging helminthic diseases.

Unit II

Emerging and re-emerging protozoan diseases.

Unit III

Emerging and re-emerging vector- borne diseases.

I. **Course Title : Biology and Ecology of Parasites**

II. **Course Code : VPA 710**

III. **Credit Hours : 3+0**

IV. **Aim of the course**

Study of the bionomics and ecology of the parasites.

V. **Theory**

Unit I

Ultrastructure, Physiology, Biochemistry and Bionomics of trematodes and cestodesof veterinary importance.

Unit II

Ultrastructure, Physiology, Biochemistry and Bionomics of nematodes of veterinary importance.

Unit III

Ultrastructure, Physiology, Biochemistry and Bionomics of important arthropod parasites.

Unit IV

Ultrastructure, Physiology, Biochemistry and Bionomics of important protozoan parasites.

Unit V

Ecology related definitions, Environmental changes and ecological disturbances due to natural phenomenon and human interventions (demographic, societal and agricultural changes global warming, floods, hurricanes and pollution.

Unit VI

Principles of Remote Sensing, GIS and their role in Veterinary Parasitology.

I. **Course Title : Molecular Veterinary Parasitology**

II. **Course Code : VPA 711**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

To give an insight into molecular biology of parasites of veterinary importance, their transmission and control. Molecular, immunological and genetic aspects of common parasites of veterinary importance and vector-host-parasite interaction.

V. **Theory**

Unit I

Introduction to molecular biology of parasites-Biological molecules (carbohydrate, protein and nucleic acid)- Eukaryotic cell structure, cell membrane and organelles- kinetoplast, apicoplast, cilia, flagella biology-Eukaryotic cell metabolism and cell respiration-Oxidative phosphorylation-anaerobic metabolism in parasites-fatty acid metabolism of parasites-cellular reproduction mendelian genetics in parasites and vectors- Genome of parasites of veterinary importance, genome size- molecular taxonomy-DNA barcoding-phylogenetics.

Unit II

Genetic code- Gene expression-Transcription and Translation-post translational modifications- RNA interference in parasites-CRISPR/ Cas9 inparasites-metagenome-microbiome-transcriptome of parasites-transgenic and para transgenic approach in parasites-drug resistance mechanisms.

Unit III

Molecular biology of helminth parasites such as *Fasciola* spp, *Schistosoma* spp, *Taenia* spp, *Echinococcus* spp, *Toxocara* spp, *Haemonchus* spp., *Dictyocaulus* spp.

I. **Course Title : Parasite Epidemiology**

II. **Course Code : VPA 712**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

To study the disease and transmission characteristics, descriptive epidemiology of infectious diseases.

V. **Theory**

Unit I: Introduction to epidemiological concepts

Definitions, aims and uses of epidemiological studies, Approaches of epidemiology (descriptive, analytical and

experimental), Types of epidemiological studies along with their advantages and disadvantages, Features of parasitic disease epidemiology. Measures of disease frequency: Morbidity and mortality (Rate, Ratio, Proportional rate), Measures of morbidity (Cumulative incidence, Incidence rate, Attack rate, Prevalence-Point and Period) and mortality (Cumulative Mortality, Mortality rate, Death rate, Age/ Sex/ Breed death rate, Case fatality proportion, Cause specific death rate, etc.). The epidemiological triangle, iceberg concept, endemic stability, herd immunity concept, etc.

Unit II: Methods in epidemiology

Cross-sectional, case control and cohort studies. Techniques of epidemiological surveys.

Types of sampling- Non-probability sampling (target sampling, choice sampling, etc.), Probability sampling (Random samples, systemic sampling, stratified sampling. cluster sampling, etc.). Sample size calculation for different epidemiological and experimental studies.

Unit III: Advances in Epidemiological techniques

Sero-epidemiological methods used in important parasitic disease-Uses and limitations, Properties and Evaluation. Molecular epidemiology- Principles, laboratory methods, Bioinformatics in molecular epidemiology. Serological and molecular epidemiology of important parasites. Remote sensing and geographic information system- Scope and applications in Veterinary Parasitology**.**

Unit IV: Epidemiology of Important Parasitic Diseases

Epidemiological factors affecting distribution and transmission of important parasitic diseases of animals and birds- Agent Factors/ Disease Patterns, Environment and Disease Patterns, Social Factors and Disease Patterns, etc. Parasitic disease monitoring and evaluation, outbreak investigations and surveillance. Forecasting of parasitic diseases

VI. Suggested Reading

- Abubakar I, Stagg HR, Cohen T and Rodrigues LC. 2016. *Infectious Disease Epidemiology*, 1st Edn, Oxford University Press.
- Alan Gunn and Sarah Jane Pitt. 2012. *Parasitology: An integrated Approach*, 1st Edition, Wiley.
- Angela ER, Taylor and John R Baker. 1968. *In-vitro cultivation*

of parasites, 1st Edition, Blackwell Scientific Pub.
- Atkinson CT, Thomas NJ and Hunter DB. 2009. *Parasitic diseases of wild birds*, 1st Edition, John Wiley and Sons, Inc
- Bhatia BB, Pathak KML and Juyal PD. 2014. *Textbook of Veterinary Parasitology*, 3rd Edition, Kalyani Publishers
- Boothroyd JC and Komuniecki R. 1995. *Molecular Approaches to Parasitology*. 1st Edition, Wiley-liss Publication, New York.
- Cohen S and Sadun EH. 1976. *Immunology of Parasitic Infections*, 1st Edition, Blackwell Scientific Publications
- David P Huges, Jacques Brodeur and Frederic Thomas. 2012. *Host manipulation by parasites*, Oxford University Press
- Elizabeth A Zeibeg. 2012. *Clinical Parasitology- A practical approach*. 2nd edition, Elsevier Health Sciences
- GW Krantz and DE Walter. 2009. *A manual of Acarology*, 3rdEdition, Texas Tech University Press
- Hendrix CM and Robinson E. 2017. *Diagnostic Parasitology for Veterinary Technicians*. 5th Edition. St. Louis, Missouri: Elsevier Inc
- Joanne P. 2009. *Advances in Parasitology Natural history of host-parasite interactions*-1stedition, Vol 68 Academic Press
- Kennedy MW and Harnett W. 2001. *Parasitic nematodes: molecular biology, biochemistry, immunology*, 2nd Edition, CABI Publishing
- Kettle DS. 1995. *Medical and Veterinary Entomology*, 2nd Edition, CAB International
- Levine ND. 1999. *Veterinary Protozoology*, 1st edition, Wiley-Blackwell
- MA Taylor, RL Coop and RL Wall. 2015. *Veterinary Parasitology*, 3rd Edition, Wiley- Blackwell publishers.
- Marr JJ, Nilsen TW and Komuniecki RW. 2003. *Molecular Medical Parasitology*, 1st Edition, Elsevier
- Mehlhorn H. 2016. *Animal Parasites: Diagnosis, Treatment, Prevention*. 1st Edition, . Springer International Publishing
- Pittaway AR. 1991. *Arthropods of Medical and Veterinary Importance*, 1st Edition, CAB International
- Richard Wall and David Shearer. 1997. *Veterinary Entomology*, 1stEdition, Springer, Dordrecht
- Samuel W, Pybus M and Kocan A. 2001. *Parasitic Diseases of Wild Mammals*, 2nd Edition, Iowa State Univ. Press.

- Smyth JD. 1995. *Introduction to Animal Parasitology*, 3rd Edn., Cambridge University Press
- Soulsby EJL. 1982. *Helminths, Arthropods and Protozoa of Domesticated Animals* 7th Edition, Baillière Tindall, London
- Taylor MA, Coop RL and Wall RL. 2015. *Veterinary Parasitology*, 3rd Edn, Wiley- Blackwell Publishers
- Tibor Kassai. 1999. *Veterinary Helminthology*, 1st Edition, Butterworth-Heinemann publishers
- Urquhart GM, Armour J, Duncan JL, Dunn AM and Jennings FW. 1996. *Veterinary Parasitology,* 2nd Edition, Blackwell Science, London, UK
- Wakelin D. 1996. *Immunity to Parasites*. 2nd Edition, Cambridge University Press
- Walker A. 1994. *Arthropods of Humans and Domestic Animal: A Guide to Preliminary Identification*, 1st Edition, Springer Netherlands
- Zajac AM and Conboy GA. 2012. *Veterinary Clinical Parasitology*, 8th Edition, Wiley- Blackwell.
- Protozoological abstracts
- Advances in Parasitology
- Trends in Parasitology
- Experimental Parasitology
- Relevant Research/ Review articles

Course Outline-cum-Lecture Schedule Doctoral Degree Programme

I. **Course Title : Advances in Helminthology-I**
II. **Course Code : VPA 701**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

Developments in the area of molecular biology, pathogenesis, diagnosis and control of trematodes and cestodes.

Lecture Topics

Theory

1-16 Unit I: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of trematodes and their larval stages.

17-32 Unit II: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of cestodes and larval stages.

Practicals

1-9 Morphological, pathological and immunological studies of trematode parasites.

10-16 Morphological, pathological and immunological studies of cestode parasites.

I. **Course Title : Advances in Helminthology-II**
II. **Course Code : VPA 702**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the recent developments in the area of molecular biology, pathogenesis, diagnosis of nematode parasites and thorny headed worms with an objective of better control.

Lecture Topics

Theory

1-28 Unit I: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of nematode parasites and their larval stages.

30-32 Unit II: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of thorny-headed worms.

Practicals

1-14 Morphological, pathological and immunological studies of various nematodes

15-16 Morphological, pathological and immunological studies of various thorny-headed worms

I. **Course Title : Advances in Entomology and Acarology**
II. **Course Code : VPA 703**
III. **Credit Hours : (2+1)**
IV. **Aim of the course**

To study the recent scientific developments on biology and control measures for arthropods of veterinary importance.

Lecture Topics

Theory

1-5 Unit I: Origin, evolution, regional/ seasonal distribution and forecasting of insect and acarine population

6-14 Unit II: Population dynamics of insects and acarines in relation to biotic and abiotic factors

15-21 Unit III: Recent developments pertaining to insects of veterinary importance.

22-27 Unit IV: Recent developments pertaining to arachnids of veterinary importance

28-32 Unit V: Chemical, biological, herbal and immunological control measures and integrated pest management. Modulation of vector competence to transmit parasitic infections using molecular genetics by developing transgenic vectors

Practicals

1-11 Collection and identification of arthropods; demonstration of the infective stages in vectors

12-16 Immunopathological changes produced in the host tissues due to the infestation of arthropods

I. **Course Title : Advances in Protozoology**
II. **Course Code : VPA 704**
III. **Credit Hours : (2+1)**
IV. **Aim of the course**

To study the recent developments in molecular biology, pathogenesis, diagnosis and control of protozoan parasites of veterinary importance.

Lecture Topics

Theory

1-5 Unit I: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of intestinal protozoa

6-14 Unit II: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of haemoprotozoans

15-21 Unit III: Advanced studies on taxonomy, molecular biology, pathogenesis and immunology of tissue and other protozoa

Practicals

1-16 Morphological, pathological and immunodiagnosis of protozoan diseases.

I. **Course Title : Immunology of Parasitic Diseases**

II. **Course Code : VPA 705**

III. **Credit Hours : (1+2)**

IV. **Aim of the course**

To study the immune mechanisms operating in different parasitic infections and to identify the immunodominant/ immunoprotective antigens for diagnosis and control of parasitic diseases.

Lecture Topics

Theory

1-4 Unit I: To study the salient features of immune responses in relation to trematode, cestode, and nematode infections in livestock

5-7 Unit I: To study the salient features of immune responses to protozoan infections in livestock

8-9 Unit I: To study the salient features of immune responses to arthropod infestations

10-11 Unit II: Principles and applications of immunodiagnostic methods for parasitic diseases

12-13 Unit III: Standardization of immunodiagnostic methods for parasitic diseases

14-16 Unit IV: Identification of candidate antigens for diagnosis and vaccine development

Practicals

1-16 Methods for purification of antigens, fractionation and characterization of antigens, identification of candidate antigens as drug targets,

17-20 Raising of hyperimmune sera

21-32 Development and standardization of immunodiagnostic methods for the diagnosis and control of parasitic infections

I. **Course Title : Molecular Diagnostics and Vaccine**

Development for Parasitic Diseases

II. **Course Code : VPA 706**

III. **Credit Hours : (2+1)**

IV. **Aim of the course**

To understand the principles of development of sensitive molecular tools for rapid and field oriented tests. Identification of vaccine targets for control of parasites of livestock and pets.

Lecture	Topics
Theory	
1-3	Unit I: Introduction. Molecular taxonomy of parasites
4-8	Unit II: Genome organisation in parasites of veterinary importance. Structure and function of nucleic acids
9-14	Unit III: Basic plan of gene cloning, and expression in heterologous host. Production of recombinant protein and downstream processing for diagnostic/ prophylactic applications
15-17	Unit IV: General concept of protein synthesis. Identification and molecular characterization of proteins of diagnostic/ prophylactic relevance of parasitic origin
18-26	Unit V: Nucleic acid based techniques for genetic characterization and sensitive diagnosis of parasitic infections; PCR, LAMP, nucleic acid hybridization technique, pyrosequencing, real time PCR, DNA microarray, microsatellite analysis, RNAi, reverse genetic approaches and their applications, etc.
27-28	Unit VI: Hybridoma technology. Principle of production of monoclonal antibody.The diagnostic application of monoclonal antibodies of parasitic infection
29-32	Unit VII: DNA vaccine, vector vaccine, recombinant protein based vaccine, subunit vaccine, principle and application
Practicals	
1-11	Identification, characterization, and purification of recombinant protein antigens; SDS-PAGE and western blotting,
12-16	Extraction and quantification of nucleic acid and PCR

I. **Course Title : Host Parasite Interactions**

II. **Course Code : VPA 707**

III. **Credit Hours : (2+0)**

IV. **Aim of the course**

To study different level of host-parasite interactions/ association with an objective of efficient control.

Lecture	Topics
Theory	
1-6	Unit I: Introduction, distribution of parasites on/ in the host, morphological adaptation for better survival in/ on the host
7-14	Unit II: Behavioural defences, host immune responses and genetic resistance to parasites
15-26	Unit III Establishment of parasites in immune competent, susceptible, intermediate and abnormal hosts, chronicity of parasitic infections, immunoevasive strategies of the parasites and host-parasite equilibrium
27-32	Unit IV: Pathological consequences of host parasite interactions in relation to malnutrition and micronutrient metabolism

I. **Course Title : *In-vitro* Cultivation of Parasites**

II. **Course Code : VPA 708**

III. **Credit Hours : (1+2)**

IV. **Aim of the course**

Development and standardization of *in-vitro* techniques for parasite cultivation.

Lecture	Topics
Theory	
1-2	Unit I: Introduction, problems and goals of *in-vitro* cultivation of parasites
3-6	Unit II: *In-vitro* cultivation of genital, intestinal flagellates and intestinal ciliates
7-9	Unit III: *In-vitro* cultivation of intestinal protozoa
10-11	Unit IV: *In-vitro* cultivation of haemoprotozoa
12-13	Unit V: *In-vitro* techniques, media and tissue culture for cultivation of helminths and their larval stages
14-16	Unit VI: *In-vitro* mass rearing and colonization of ticks, flies and other insects
Practicals	
1-7	Preparation of media, sterilization methods and cultivation of genital, intestinal flagellates and intestinal ciliates
8-16	Preparation of media, sterilization methods and cultivation

cultivation of intestinal and haemoprotozoa protozoa

17-24 Preparation of media, sterilization methods and cultivation cultivation of helminths and their larval stages

25-32 Preparation of media, sterilization methods and cultivation cultivation of ticks, flies and other insects

I. **Course Title : Emerging and Re-Emerging Parasitic Diseases**

II. **Course Code : VPA 709**

III. **Credit Hours : (2+0)**

IV. **Aim of the course**

To study the emerging and re- emerging parasitic diseases.

Lecture Topics

Theory

1-10 Unit I: Emerging and re-emerging helminthic diseases

11-21 Unit II: Emerging and re-emerging protozoan diseases

22-32 Unit III: Emerging and re-emerging vector- borne diseases

I. **Course Title : Biology and Ecology of Parasites**

II. **Course Code : VPA 710**

III. **Credit Hours : (3+0)**

IV. **Aim of the course**

Study of the bionomics and ecology of the parasites.

Lecture Topics

Theory

1-5 Unit I: Ultrastructure, physiology, biochemistry and bionomics of trematodes of veterinary importance

6-10 Unit I: Ultrastructure, physiology, biochemistry and bionomics of cestodes of veterinary importance

11-20 Unit II: Ultrastructure, physiology, biochemistry and bionomics of nematodes of veterinary importance

21-30 Unit III: Ultrastructure, physiology, biochemistry and bionomics of important arthropod parasites

31-40 Unit IV: Ultrastructure, physiology, biochemistry and bionomics of important protozoan parasites

41-45 Unit V: Ecology related definitions, Environmental changes and ecological disturbances due to natural phenomenon and human interventions (demographic, societal and agricultural changes global warming, floods, hurricanes and pollution

46-48 Unit VI: Principles of Remote Sensing, GIS and

their role in Veterinary Parasitology

I. **Course Title : Molecular Veterinary Parasitology**
II. **Course Code : VPA 711**
III. **Credit Hours : (2+0)**
IV. **Aim of the course**

To give a deep insight into molecular biology of parasites of veterinary importance, their transmission and control. Molecular, immunological and genetic aspects of selected parasites of veterinary importance and vector-host-parasite interaction.

Lecture	Topics
Theory	
1-2	Unit I: Introduction to molecular biology of parasites- Biological molecules (carbohydrate, protein and nucleic acid)
3-6	Unit I: Eukaryotic cell structure, cell membrane and organelles- kinetoplast, apicoplast, cilia, flagella biology
7-11	Unit I: Eukaryotic cell metabolism and cell respiration- Oxidative phosphorylation- anaerobic metabolism in parasites-fatty acid metabolism of parasites-cellular reproduction mendelian genetics in parasites and vectors
12-16	Unit I: Genome of parasites of veterinary importance, genome size- molecular taxonomy-DNA barcoding-phylogenetics
17-22	Unit II: Genetic code- Gene expression-Transcription and Translation-post translational modifications- RNA interference in parasites-CRISPR/ Cas9 in parasites
23-27	Unit II: Metagenome-microbiome-transcriptome of parasites-transgenic and para transgenic approach in parasites-drug resistance mechanism and genetics
28-32	Unit III: Molecular biology of selected helminth parasites (*Fasciola* spp, *Schistosoma* spp, *Taenia* spp, *Echinococcus* spp, *Toxocara* spp, *Haemonchus* spp, *Dictyocaulus* spp etc)

I. **Course Title : Parasite Epidemiology**
II. **Course Code : VPA 712**
III. **Credit Hours : (2+0)**
IV. **Aim of the course**

To study the disease and transmission characteristics, descriptive epidemiology ofinfectious agents.

Lecture	Topics
Theory	
1-4	Unit I: Introduction to epidemiological concepts-Definitions, aims and uses of epidemiological studies, approaches of epidemiology (descriptive, analytical and experimental), types of epidemiological studies along with their advantages and disadvantages, features of parasitic disease epidemiology.
5-8	Unit I: Introduction to epidemiological concepts- Measures of disease frequency: Morbidity and mortality (Rate, Ratio, Proportional rate), Measures of morbidity (Cumulative incidence, Incidence rate, Attack rate, Prevalence-Point and Period) and mortality (Cumulative Mortality, Mortality rate, Death rate, Age/ Sex/ Breed death rate, Case fatality proportion, Cause specific death rate, etc.). The epidemiological triangle, iceberg concept, endemic stability, herd immunity concept, etc.
9-12	Unit II: Methods in epidemiology Cross-sectional, case control and cohort studies. Techniques of epidemiological surveys Types of sampling- Non-probability sampling (target sampling, choice sampling, etc.), Probability sampling (Random samples, systemic sampling, stratified sampling. cluster sampling, etc.). Sample size calculation for different epidemiological and experimental studies
13-16	Unit II: Methods in epidemiology Epidemiological Measures of Association-Strength of association (Relative risk, odds ratio), Effect of association (Attributable rate), effect/ importance of association
17-20	Unit III: Advances in Epidemiological techniques Sero-epidemiological methods used in important parasitic disease-Uses and limitations, properties and evaluation. Molecular epidemiology- Principles, laboratory methods, bioinformatics in molecular epidemiology
21-24	Unit III: Advances in Epidemiological techniques Serological and molecular epidemiology of important parasites. Remote

sensing and geographic information system- Scope and applications in Veterinary Parasitology

25-28 Unit IV: Epidemiology of Important Parasitic Diseases Epidemiological factors affecting distribution and transmission of important parasitic diseases of animals and birds- Agent Factors/ Disease Patterns, Environment and Disease Patterns, Social Factors and Disease Patterns, etc.

29-32 Unit IV: Epidemiology of Important Parasitic Diseases Parasitic disease monitoring and evaluation, outbreak investigations and surveillance Forecasting of parasitic diseases

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Parasitology

- Introduction, classification, general account and economic importance of trematodes.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, Treatment and control measures of trematodes belonging to families: Dicrocoeliidae, Opisthorchiidae and Fasciolidae.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of trematodes belonging to families: Echinostomatidae, Heterophyidae, Plagiorchiidae, Troglotrematidae, Prosthogonimidae, Nanophyetidae and Paragonimidae.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of trematodes belonging to families: Notocotylidae, Brachylemidae, Cyclocoelidae, Paramphistomatidae and Schistosomatidae.
- Classification, characters of snails and control strategies of molluscs of veterinary importance.
- Introduction, classification, general account and economic importance of cestodes
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of cestodes belonging to families: Diphyllobothriidae, Mesocestoididae and Taeniidae.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of cestodes belonging to families: Davaineidae, Hymenolepididae, Dipylidiidae and Dilepididae.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, Treatment and control measures of cestodes belonging to families: Anoplocephalidae and Thysanosomidae.
- Introduction, classification, general account and economic importance of nematodes and thorny-headed worms.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Ascarididae, Anisakidae, Oxyuridae, Heterakidae and Subuluridae.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment, and control measures of nematodes belonging to families: Rhabditidae, Strongyloididae and Strongylidae.

- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment, and control measures of nematodes belonging to families: Trichonematidae, Amidostomidae, Stephanuridae, Syngamidae and Ancylostomatidae.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Filaroididae, Trichostrongylidae, Ollulanidae, Dictyocaulidae and Metastrongylidae.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Spiruridae, Thelaziidae, Acuariidae, Tetrameridae, Physalopteridae, Gnathostomatidae, Filariidae, Setariidae, Onchocercidae and Dracunculidae.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of nematodes belonging to families: Trichinellidae, Trichuridae, Capillariidae and Dioctophymatidae.
- Morphology, Epidemiology, Life cycle, Pathogenesis, Clinical signs, Diagnosis, treatment and control measures of thorny headed worms belonging to families: Polymorphidae, Oligacanthorhynchidae and Gnathobdellidae.
- Introduction, Classification, Harmful effects and Economic importance of arthropod parasites.
- Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Vector potentiality, Economic significance and control of arthropods belonging to the families: Culicidae, Ceratopogonidae, Simuliidae and Psychodidae.
- Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Vector potentiality, Economic significance and control of arthropods belonging to the families: Tabanidae, Gasterophilidae, Muscidae, Cuterebridae and Glossinidae.
- Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Vector potentiality, Economic significance and control of arthropods belonging to the families: Oestridae, Sarcophagidae, Calliphoridae and Hippoboscidae. Importance of blow flies in forensic entomology and treatment of wounds.
- Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Economic significance and control of arthropods belonging to the families: Pediculidae, Haematopinidae, Linognathidae, Menoponidae, Philopteridae and Trichodectidae.
- Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Economic significance and control of arthropods

belonging to the Orders- Siphonaptera and Hemiptera, Cimicidae and Reduviidae.

- Distribution, Life cycle, Seasonal pattern, Vector potentiality, Pathogenesis economic significance and control of acarines belonging to the families: Argasidae and Ixodidae.
- Distribution, Morphology, Life cycle, Seasonal pattern, Pathogenesis, Economic significance and control of acarines belonging to the families: Sarcoptidae, Psoroptidae, Demodicidae, Trombiculidae, Dermanyssidae. Cytoditidae and Linguatulidae.
- Chemical, Biological, Immunological control measures and integrated pest management. Detection and mechanisms of acaricidal resistance.
- Introduction, classification, general account and economic importance of protozoan parasites.
- Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis, and control measures of protozoan parasites belonging to the families: Trypanosomatidae, Monocercomonadidae, Trichomonadidae, Hexamitidae and Endamoebidae.
- Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis and control measures of protozoan parasites belonging to the families: Eimeriidae, Cryptosporidiidae and Sarcocystidae.
- Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis, Treatment and control measures of protozoan parasites belonging to the families: Plasmodiidae, Babesiidae, Theileriidae, Haemogregarinidae and Balantidiidae.

Morphology, Epidemiology, Pathogenesis, Clinical signs, Diagnosis and control measures of Rickettsiales in relation to haemoprotozoans.

Veterinary Public Health and Epidemiology

DEPARTMENT OF VETERINARY PUBLIC HEALTH AND EPIDEMIOLOGY

Course Structure for M.V.Sc. degree programme (Semester wise)

Course No.	Course Title	Credit	Semester
VPE 601*	CONCEPTS IN VETERINARY PUBLIC HEALTH AND ONE HEALTH	2+0	I
VPE 602*	ZOONOSES-I	2+1	I
VPE 603*	ZOONOSES-II	2+1	II
VPE 604*	PRINCIPLES OF EPIDEMIOLOGY	2+1	I
VPE 605*	HYGIENE AND SAFETY OF FOODS OF ANIMAL AND AQUATIC ORIGIN	2+1	II
VPE 606	FOOD-BORNE INFECTIONS AND INTOXICATIONS	2+1	II
VPE 607	FOODSAFETYSTANDARDS,AND REGULATIONS	2+1	II
VPE 608	ENVIRONMENTAL HYGIENE AND SAFETY	2+1	I
VPE 609*	APPLIED EPIDEMIOLOGY	2+1	II
VPE 610	BIOSECURITY,BIOTERRORISM AND DISASTER MANAGEMENT	2+0	II
VPE 611	LABORATORY TECHNIQUES IN VETERINARY PUBLIC HEALTH AND EPIDEMIOLOGY	0+3	I
VPE 612*	VETERINARY CLINICAL EPIDEMIOLOGY	2+1	I
VPE 691	MASTER'S SEMINAR	1+0	I and II
VPE 699	MASTER'S RESEARCH	0+30	I and II
* Compulsory Courses			

DEPARTMENT OF VETERINARY PUBLIC HEALTH AND EPIDEMIOLOGY

Course Structure for PhD degree programme (Semester wise)

Course No.	Course Title	Credit	Semester
VPE 701*	ADVANCES IN VETERINARY PUBLIC HEALTH AND EPIDEMIOLOGY	2+1	I
VPE 702	EMERGING, RE-EMERGING ZOONOSES AND ONE HEALTH	2+1	I
VPE 703	ADVANCES IN FOOD SAFETY AND QUALITY CONTROL OF FOODS OF ANIMAL/AQUATIC ORIGIN	2+1	II
VPE 704	BIOSECURITY AND OCCUPATIONAL HEALTH SAFETY	2+1	II
VPE 705*	RECENT CONCEPTS IN EPIDEMIOLOGY AND DISEASE FORECASTING	2+1	II
VPE 706	RISK ANALYSIS AND PREDICTIVE MODELLING	2+1	I
VPE707	ADVANCES IN ENVIRONMENTAL HYGIENE	2+1	II
VPE 708	HERD HEALTH MANAGEMENT AND DISEASE ECONOMICS	2+1	I
VPE709	EPIDEMIOLOGY OF TRANS-BOUNDARY,NON-INFECTIOUS AND CHRONIC DISEASES	2+1	I
VPE 710	ECOLOGY AND ANIMAL/HUMAN HEALTH	2+0	II
VPE 711	DIAGNOSTIC APPROACHES IN EPIDEMIOLOGY	2+1	II
VPE 712	SURVEYS,SURVEILLANCE AND DATA MANAGEMENT	2+1	I
VPE 713	RESEARCH METHODOLOGY AND PUBLICATION ETHICS IN VPE	2+0	II
VPE 790	SPECIAL PROBLEM	0+1	I
VPE 791	DOCTORAL SEMINAR-I	1+0	I and II
VPE 792	DOCTORAL SEMINAR-II	1+0	I and II
VPE 799	DOCTORAL RESEARCH	0+75	I and II
* Compulsory Courses			

Course Contents
M.V.Sc. in Veterinary Public Health and Epidemiology

I. **Course Title :Concepts in Veterinary Public Health and One Health**

II. **Course Code :VPE 601**

III. **Credit Hours :2+0**

IV. **Aim of the course**

To equip students with One Health concepts and advanced skills in public health aspects of infectious diseases, intelligence, response, prevention and mitigation.

V. **Theory**

Unit-I

VPH administration; organization, administration and implementation of VPH services/ programs; Structure and function of VPH agencies/ organizations of national and international importance.VPH team, administration and functions; responsibilities of veterinarians in public health team.

UnitII

Definition: One Health. Historical emergence of the concept. Scope,Objective and Area of activities of One Health. Strategic frame-work. Purpose for creation of Veterinary Public Health and Epidemiology–NET.

UnitIII

Global burden of disease, Coordinated and systemic disease control response, Ecosystem, Urbanization intensive agriculture and animal husbandry practices, Host-pathogen interaction, Anti-microbial resistance and climatechange.

VI. **Suggeste dreading**

- Calvin W Schwabe. 1984. *Veterinary Medicine and Human health*. Williams and Wilkins
- Sherikar AT, Bachhil V N and Thapliyal DC.2013.*Text book of Elements of Veterinary Public Health*, ICAR, Govt. of India.
- Zinsstag J, Schelling E,Waltner Toews D,Whittaker M and Tanner M.2015. *One Health: the theory and practice of integrated health approaches*. CABI.

I. **Course Title :Zoonoses-I**

II. **Course Code :VPE 602**

III. **Credit Hours :2+1**

IV. **Aim of the course**

To impart knowledge on Epidemiology, Etiology, Transmission pattern, Public health significance, Diagnosis and Management of

important bacterial, Mycotic and Chlamydial zoonotic diseases.

V. **Theory**

Unit I

Definition and classification, Factors affecting the occurrence of zoonoses; Disease management strategies, Disease burden on population and socioeconomic impacts.

Unit II

History, Etiology, Epidemiology, Diagnosis and management of important Bacterial zoonoses, viz., Anthrax, Brucellosis, Tuberculosis, Leptospirosis, Salmonellosis, Borreliosis, Cat scratch disease, Glanders, Lyme disease, Malidiosis, Streptococcosis, Plague, Rat bite fever, Tetanus, Tularemia, Yersiniosis, Staphylococcosis, Vibriosis, Listeriosis, Campylobacteriosis and others

Unit III

History, Etiology, Epidemiology, Diagnosis and Management of important Mycotic zoonoses, viz., Dermatophytosis, Blastomycosis, Coccidioidomycosis, Cryptococcosis, Histoplasmosis, Aspergillosis, Candidiasis, Rhinosporidiosis, Sporotrichosis and others.

Unit IV

History, Etiology, Epidemiology, Diagnosis and Management of Chlamydiosis (Psittacosis and Ornithosis) and Prions diseases, *viz*., Creutzfeldt-Jakob Disease (CJD); Variant Creutzfeldt-Jakob Disease(vCJD), Kuru. Bovine Spongiform Encephalopathy (BSE), Chronic Wasting Disease(CWD) andScrapie.

VI. **Practical**

Isolation Isolation and identification of important Bacterial, Mycotic and Chlamydial agents of public health significance from host, Vehicle and environment.

VII. **Suggested reading**

- BauerfeindR, Bauerfeind R, Graevenitz AV, Kimmig P, Schiefer HG, Schwarz T, Slenczka W and Zahner H. 2016. Zoonoses: infectious diseases transmissible from animals and humans (No. Ed. 4).
- American Society for Microbiology (ASM).
- Mahendra Pal. Zoonoses.
- Narayan KG Epidemiology, Diagnosis and Management of Zoonoses.
- Pedro N Acha and Boris Szyfres. Zoonoses and Communicable Diseases Common to Man and Animals.
- Seyedmousavi S, De Hoog GS, Guillot J and Verweij PE. 2018. Emerging and Epizootic Fungal Infections in Animals. Springereds.

- Thapliyal DC. 1999. Diseases of animals transmissible to man. 1st ed. International Book Distributing Company, Lucknow.
- Zoonoses: Recognition Control and Prevention (Martin E, Jones EH, Hubbart WT and Hagstard HV)

I. CourseTitle: Zoonoses-II

II. Course Code :VPE 603

III. Credit Hours:2+1

IV. Aim of the course

To impart knowledge on Epidemiology, Etiology, Transmission pattern, Public health significance, Diagnosis and Management of important Viral, Rickettsial and Parasitic zoonotic diseases.

V. Theory

Unit I

Disease burden, History, Etiology, Epidemiology, Transmission pattern, Diagnosis and management of important viral zoonoses,*viz*., Japanese encephalitis, Tick-borne encephalitis, Encephalomyelitis, Rabies, Influenza, KFD, Rift valley fever, Chickungunya, FMD, and Enteroviruses.

Unit II

Disease burden, History, Etiology, Epidemiology, Transmission pattern, Diagnosis and management of important viral zoonoses, viz., Crimean-Congo haemorrhagic fever, Dengue, West-Nile fever, Yellow fever, Rift-valley fever, Equine encephalitis, Louping ill, Ebola, Marburg, Hantavirus, Zika, Hendra, Nipah and Corona viruses.

Unit III

Disease burden, History, Etiology, Epidemiology, Transmission pattern, Diagnosis and Management of important Rickettsial zoonoses, viz., Q fever, Typhus fever group.

Unit IV

Disease Disease burden, Etiology, Host range, Epidemiology, Transmission pattern, Diagnosis and Management of important Parasitic zoonoses, *viz*., Hydatidosis, Taeniosis, Trichinosis, Fascioliosis, Fasciolopsiosis, Toxoplasmosis, Trypanosomosis, Cryptosporidiosis, Cysticercosis, Leishmaniosis, Sarcocystosis, Dracunculosis, Paragonimosis and Diphylobothriosis..

Unit VI Practical

Isolation Isolation and identification methods for important viral and parasitic agents of public health significance from host, vehicle and environment.

Unit VII Suggested Reading

- BauerfeindR, Bauerfeind R, Graevenitz AV, Kimmig P, Schiefer HG, Schwarz T, Slenczka W and Zahner H. 2016. Zoonoses:

infectious diseases transmissible from animals and humans (No. Ed. 4).
- American Society for Microbiology (ASM).
- Mackie and Mc. Cartney. Practical Medical Microbiology.
- Parija SC. Text book of Medical Parasitology.
- Pedro N Acha and Boris Szyfres. Zoonoses and Communicable Diseases Common to Man and Animals.
- Soulsby JL Helminthes, Arthropods and Protozoa of Domesticated Animals.
- Steele JL. CRC Handbook series in Zoonoses.
- Thapliyal DC. 1999. Diseases of animals transmissible to man. 1st ed. International Book Distributing Company, Lucknow.

I. **CourseTitle :Principles of Epidemiology**
II. **Course Code :VPE 604**
III. **Credit Hours :2+1**
IV. **Aim of the course**

To impart knowledge on the principles and concepts employed for epidemiological investigation of the diseases.

V. **Theory**

Unit I

Historical perspective and scope of veterinary epidemiology. Theories of disease causation and advancement in the concepts of disease causation, Iceberg concept. Koch's postulates of disease causation. Epidemiological tringles, Disease causing wheels, webs and pies.

Unit II

Definitions: Epidemic, Endemic, Pandemic and Sporadic diseases. Qualitative and quantitative approaches to epidemiology. Measurement of disease. Endemic stability and herd immunity, Basic reproductive ratio, Trends and spatial distribution of disease, Epidemic curve and their utility.

Unit III

Transmission of disease and role of ecology in maintenance of disease agents. Type of epidemiological methods. Landscape and molecular methods used in the epidemiological investigation.

Unit IV

Epidemiological Studies-Observational (Case-control, cohort and cross-sectional studies) and experimental studies (field and clinical trials). Disease surveys, monitoring and surveillance. Epidemiological data bases.

UnitV

Definition, scope and limitation of serological epidemiology and interpretation of results. Characteristics of ideal serological test,

multiple testing and evaluation of tests. Investigation of disease outbreaks. Strategies of disease control and eradication.

VI. **Practical**

Data collection from various sources, analysis and interpretation. Serum collection method demonstration. Analytical diagnostic and relative sensitivity and specificity calculation. Use of software for data analysis.

VII. **Suggested Reading**

- ElliotP, Elliot P, Wakefield JC, Best NG and Briggs DJ. 2000. Spatial Epidemiology: methods and applications; Oxford University Press.
- Martin SW, Meek AH and Willeberg P. 1986. Veterinary Epidemiology: Principles and methods. IOWA State University Press/ Ames, Iowa. USA.
- Pfeiffer D. 1998. Veterinary Epidemiology. An Introduction. Institute of Veterinary, Animal and Biomedical Sciences. Massey University, Palmerston, New Zealand.
- Salman M. 2008. Animal disease surveillance and survey systems: methods and applications. John Wiley and Sonsed.
- Thrusfield M. 1995. Veterinary Epidemiology: Blackwell Science Ltd. Oxford, UK.

I. **CourseTitle :Hygiene and Safety of foods of Animal and Aquatic origin**

II. **Course Code :VPE 605**

III. **Credit Hours :2+1**

IV. **Aim of the course**

To acquaint the students about principles of food hygiene and quality improvement practices..

V. **Theory**

Unit I

Principles of food hygiene in relation to foods of animal and aquatic origin. Importance of food hygiene in public health. Impact of environmental sanitation and other factors on food quality. General principles of prevention of food-borne illnesses, risk analysis

Unit II

Importance and objectives of milk hygiene. Hygienic production, Handling, Transportation, Storage and marketing of milk. Mastitis. Milk spoilage and preservation. Milk-borne diseases of public health significance. Milk allergy-lactose intolerance. Residues of pesticide and antibiotics in milk and its impact on human health. Milk spoilage. Milk adulteration, synthetic milk. Milk plant hygiene

and sanitation.

Unit III

Objectives and importance of meat hygiene. Hygienic practices at farm and during transportation of food animals including poultry. Hygienic meat production-an overview. Adulteration. Speciation, spoilage and preservation of meat. Meat-borne diseases of public health significance. Treatment and safe disposal of slaughter-house
by-products. Hygienic practices in abattoirs.

Unit IV

Fish, fisheries and ichthyology: an introduction. Environmental factors affecting aquatic food hygiene. Hygienic production, Handling, Preservation, Transportation and marketing of aquatic foods. Microbiology and Spoilage of aquatic foods. Safe disposal of fish byproducts. Fish-borne diseases of public health significance.

VI. Practical

Collection Collection of meat/ milk/ egg/ fish samples for determination of physical as well as microbiological quality. Examination of meat/ milk samples for possible adulteration.

VII. Suggested reading

- FAO (Manual No. 79). Manual on simple methods of Meat preservation.
- Marriott NG, Schilling MW and Gravani RB. 2018. Principles of Food sanitation; Springer.
- Nollet LM and Toldrá F. 2016. Safety Analysis of Foods of Animal origin, CRC Press.ed.
- Norer R. 2016. Genetic Technology and Food Safety; Springer International Publishinged.
- Wro and Bruno. Fish Disease and Disorders – Viral Bacterial and Fungal Infections.

I. **CourseTitle: Food-borne Infections and Intoxications**

II. **CourseCode :VPE 606**

III. **CreditHours :2+1**

IV. **Aimofthecourse**

To impart knowledge about illnesses arising due to consumption of contaminated foods.

V. **Theory**

Unit I

Definition: Food borne infection, Food intoxication, Bacterial toxins, Toxi-infection,etc. Classification, Epidemiology, Disease burden and Economics of food-borne diseases. Reservoirs of food-borne pathogens and its mode of transmission. Vehicles of pathogens. Measures employed for prevention and control of food-borne

diseases. Food- poisoning outbreak investigation and management.

Unit II

Epidemiology, Economic, Diagnosis and Management of bacterial food-borne infections and intoxications due to *Salmonella, Campylobacter, Clostridium, Staphylococcus, Listeria monocytogenes, Vibrio parahaemolyticus, E. coli, Bacillus cereus, Shigella, Yersinia enterocolitica* and others. Types of bacterial toxins and its manifestations.

Unit III

Epidemiology, Epidemiology, Economics, Diagnosis and Management of food-borne Viral pathogens: Hepatitis viruses, Entero-viruses, Noroviruses, Rotaviruses and other. Food- borne parasitic and rickettsial infections.

Unit IV

Illness Illness due to food additives, seafood toxins, mycotoxins, biocides, plant origin toxins, heavy metals, veterinary drugs, hormones, etc. in foods. Anti-microbial resistance (AMR) in food-borne pathogens-definition, current status, factors responsible, mechanism of resistance, mode of transmission and control.

VI. Practical

Food-borne disease outbreak investigation. Detection, characterization and quantitation of food-borne pathogens, toxins, antibiotics, pesticides and additives in foods.

VII. Suggestedreading

- Cliver DO, Potter M and Riemann HP. 2011. Food borne Infections and Intoxications; Elsevier.
- D'Mello JPF. Food Safety-Contaminants and Toxins.
- Jay JM, Loessner MJ and Golden DA. 2008. Modern food microbiology; Springer Science and Business Media.
- Hubbert WT. Food Safety and Quality Assurance-Foods of Animal Origin.
- Vernam AH. 1991. Food-borne pathogens; Wolfe Publishing Ltd, London.PotterMandRiemannHP.2011.*FoodborneInfectionsandIntoxications*; Elsevier.

I. CourseTitle :Food Safety Standards and Regulations

II. CourseCode :VPE 607

III. Credit Hours :2+1

IV. Aim of the course

To acquaint the students with various parameters responsible for the production of hygienic and safe foods for human consumption.

V. Theory

Unit I

Indicators of food quality and spoilage (biological and others). Food

plant hygiene and sanitation. Hurdle technique and its relevance. Microbiological criteria for food quality.

Unit II

Foodstandards-National Food standards- National, International, Private standards. GSP, GMP, HACCP and ISO 22000, etc. Genesis of food safety standards, Mechanism of food safety standards formulation, Agencies associated in food standard formulation, Role of WTO, FSSAI, BIS and others in standard formulation. National and international regulations and legislation enacted for quality food production..

Unit III

Food safety regulations in reference to the Pesticides, Veterinary drugs residues, Heavy metals, Hormones and others (MRLs, ADIs, etc.). Traceability system, Organic food production.

VI. Practical

Detection of Pesticides, Veterinary drug residues, Heavy metal in food samples. Visits to the various food processing units for examining the compliance of HACCP/FSSAI regulations and other standards. Microbiological assessment of cleanliness of surface and equipment in abattoir/ meat/ milk plant

VII. Suggested Reading

- Fortin ND. 2016. Food Regulation: law, science, policy, and practice. John Wiley and Sons.
- Joint FAO. 2004. Codex alimentarius: food hygiene basic texts (No. Ed. 3). Food and Agriculture Organization of the United Nations.
- Josling TE, Roberts D and Orden D. 2004. Food Regulation and Trade: toward a safe and open global system; Peterson Institute Press.
- Van Der Meulen and Bernd. 2011. Private Food Law: Governing food chains through contract law, self-regulation, private standards, audits and certification Schemes. The Netherlands: Wageningen Academic Publishers.
- Vos E. 1999. Institutional frameworks of community health and safety legislation: Committees, agencies, and private bodies. Hart.

I. CourseTitle :Environmental Hygiene and Safety

II. Course Code :VPE 608

III. Credit Hours :2+1

IV. Aim of the course

To impart education about environment, environmental pollutants and its manifestations on animal and human health.

V. Theory

Unit I

Introduction to environment, Environmental hygiene, Pollutants

and its impact on animal/ human health. Green-house gasses and its effect. Microbial pollution. Environmental risk assessment and management.

Unit II

Nature and characteristics of various environmental pollutants. Pollutions of soil, air and water and its effects on health. Impact of noise pollution on health.

Unit III

Genetic risk from Environmental agents, Health problems due to nuclear energy, Microwave, Electro-magnetic and other radiation pollution, Environmental estrogens,Pesticides pollution. Industrial pollution as well as pollution due to plastic and petrochemical products.

Unit IV

Role of live-stock in environmental pollution, Dissemination of excreted pathogens,animal-waste and human risk, principles of safe disposal of bio-medical waste and recycling of wastes

Unit V

Contamination Contamination of environment with heavy metals, pesticides, veterinary drug residues and its impact on human health. National and international pollution control agencies and its role in management of environmental pollution. Regulations on control of environmental pollution.

VI. Practical

Determination of portability of drinking water, Estimation and detection of pathogenic microbes in water, air, soil, animal products, sewage, and animal waste; Visit of sewage and waste disposal plants/ sites.

VII. Suggested reading

- Fairman R, Mead CD and Williams WP. 1998. Environmental risk assessment: approaches, experiences and information sources.
- Frumkin H. 2016. Environmental health: from global to local. John Wiley and Sons.ed.
- Levy BS. 2006. Occupational and environmental health: recognizing and preventing disease and injury. Lippincott Williams and Wilkins. ed.
- Linkov I and Ramadan AB. 2004. Comparative risk assessment and environmental decision making (Vol. 38). Springer Science and Business Media.Ed.
- Ray M. Environmental Pollution: Impact of technology on quality of life.
- Richard B Philp. Environmental Hazards and Human

I. **CourseTitle :Applied Epidemiology**

II. **CourseCode :VPE 609**

III. **CreditHours :2+1**

IV. **Aim of the courses**

To impart education on applied aspects of epidemiology.

V. **Theory**

Unit I

Introduction to applied epidemiology. Models, modelling and types of models. Epidemiological and economic models. Principles and classification of models. Deterministic and stochastic models. Empirical and explanatory models. Application of models in disease forecasting. Modelling in disease prevention and control.

Unit II

Disease occurrence, Ecology of disease, Monitoring and surveillance. Outbreak investigation protocol. Path, regression and discriminate analyses. Time series analysis and analysis of variance.

Unit III

Animal Animal disease economics (cost-benefit analysis, internal rate of return, payback period, partial budgeting), decision analysis. Bayesian analysis. Monte-Carlo and Markovian processes and system evaluation. Uses of multivariate analysis.

Unit IV

Disease outbreaks, Participatory epidemiology, Disease reporting system, Tracingand notification. Disease control strategies, Risk assessment, Exotic diseases, Trans-boundarydiseases,Vaccination.

Unit V

Definition; Disease intelligence. Tele-epidemiology. Remote sensing, Geographic information system, Disease surveillance and Early warning system.

VI. **Practical**

Survey, Survey, Sampling and Data presentation. Measurements of disease occurrence, Outbreak investigation and reporting. Use of epidemiological software.

VII. Suggested Reading

- Brownson RC and Petitti DB. 1998. *Applied Epidemiology: theory to practice*. Oxford University Press. Brownson RC and Petitti DB. 1998. Applied Epidemiology: theory to practice. Oxford University Press.
- Durr PA and Gatrell AC. 2004. GIS and spatial analysis in veterinary science. Cabi. Ed.

• Toma B, Dufour B, Sanaa M, Benet JJ, Moutou F, Louza A and Ellis P. 1999. Applied Veterinary Epidemiology and the control of disease in populations. 7 Avenue du Général de Gaulle.
• Twisk JW. 2013. Applied longitudinal data analysis for epidemiology: a practical guide. Cambridge university press.

I. **CourseTitle :Biosecurity, Bioterrorism and DisasterManagement**
II. **CourseCode :VPE 610**
III. **CreditHours :2+0**
IV. **Aim of the course**

To equip the students with latest information of various types of disaster and its management, biological weapons used in bioterrorism, biological hazards and remedial measures, biomedical hazards and their prevention.

V. **Theory**

Unit I

Definition: Bioterrorism. Major agents used as biological weapons, Hazard analysis and combating bioterrorism. Bio-ethics and social ethics, Advisory role of veterinarians during such events.

Unit II

Definitions, Natural and man- made disaster, Impact analysis and classification of disaster scale, Essential preparations to manage disaster, Role of central, State and Local government bodies in disaster management, Role of veterinarians/veterinary public health personnel during emergency/ Disaster and sequence of emergency medical services.

Unit III

Effect of natural disasters like floods, Prolonged draughts, Forest fires, Earthquakes,Tsunami and Tidal damages, Storms, etc. on human as well as animal population, post-disaster disease susceptibility and remedial measures.

Unit IV

Biosecurity– definition, Biosecurity– definition, importance, methods used for pathogen inventory, Food processing/ quarantine units/ animals/ poultry farms, etc. Biomedical hazards and biosafety in the laboratories. Occupational health risk and its management.

VI. **Suggested Reading**

• Antosia R E Antosia RE and Cahill JD. 2006. Handbook of bioterrorism and disaster medicine. Springer.ed.
• Hodgkinson PE and Stewart M. 1991. Coping with catastrophe: A handbook of disaster management. Taylor and Frances/

Routledge.
- Van De Walle B, Turoff M and Hiltz SR. 2014. Information systems for emergency management. Routledge.
- Van Oosterom P, Zlatanova S and Fendel E. 2006. Geo-information for disaster management.

I. **CourseTitle :Laboratory Techniques in Veterinary Public Health and Epidemiology**

II. **CourseCode :VPE 611**

III. **Credit Hours :0+3**

IV. **Aim of the course**

To impart practical exposure of laboratory techniques in Veterinary Public Health and Epidemiology to the students.

V. **Practical**

Unit I

General practices: Use of PPE (Personal Protective Equipment) and biosafety cabinets, Preparation of glass-wares, cultural media, buffer solution, solutions of different molarity and other laboratory materials. Sampling methods for biological materials. Quality analysis of milk, meat, water and other food materials and others.

UnitII

Microbiological techniques: Plate counts, Enumeration and isolation of psychrophilic, Thermophilic and thermoduric organisms in food samples, Enumeration, isolation and identification of important food-borne pathogens, Detection of bacterial toxin involved in food-poisoning, Detection of viral pathogens in various samples. Isolation, identification and enumeration of yeast/ molds/ spores in food samples.

Unit III

Immunological/ Serological Immunological/ Serological and electrophoretic techniques: AGPT, Precipitation tests, Agglutination test, Haem-agglutination test, Polyacrylamide gel electrophoresis, Counter immuno- gel electrophoresis, ELISA, FAT, Intra-dermal inoculation tests and others.

Unit IV

Detection and quantification of residues of pesticides and drugs using immunological and chromatographic methods.

UnitV

Methods for isolation and quantitation of genomic DNA/ RNA from bacterial and other biological specimens using Latest molecular techniques and others. Laboratory records and log books of equipment.

VI. **Suggested Reading**

- Bremner A and Jhonston M. Poultry Meat Hygiene and Inspection.
- Duncan JR and Prasse KW. 1986. Veterinary Laboratory Medicine (No. Ed. 2). Iowa State University Press.
- Garvin ML Infectious Waste Management-A practical guide.
- Gradwohls' Clinical Lab Methods and Diagnosis.
- Jerome KR. 2016. Lennette's laboratory diagnosis of viral infections. CRC (Sonnenwirth and Jarett) Press. ed.
- Prasad J and Neeraj. Principles and Practice of Animal Health and Hygiene.
- Rupprecht C and Nagarajan T. 2015. Current laboratory techniques in rabies diagnosis, research and prevention (Vol. 2). Academic Press.ed.

andJhonstonM.*PoultryMeatHygieneandInspection*.

I. **CourseTitle : Veterinary Clinical Epidemiology**

II. **CourseCode :VPE 612**

III. **CreditHours :2+1**

IV. **Aim of the courses**

To familiarize students with various epidemiological approaches for solving field problems.impart education on applied aspects of epidemiology.

V. **Theory**

UNIT I

Definitions and epidemiological approaches, measuring frequency of clinical events, incidence, prevalence, occurrence etc., principles of accuracy, precision, linearity, diagnostic sensitivity and specificity.

UNIT II

Uses of diagnostic tests, evaluation of diagnostic tests, statistical and epidemiological concepts applied to veterinary epidemiology.

UNIT III

Design and evaluation of clinical trials, cost of disease, cost benefit analysis.

UNIT-IV

Epidemiological approaches for clinical problems faced in the field using practical examples from all species, with particular emphasis on large and small animal medicine, avian medicine etc.

VI. Practical

Diseases of multiple etiology: mastitis, diarrhea, abortions, their diagnosis and prevention. Sampling, isolations and antibiotic/ culture sensitivity etc. statistical evaluation of diagnostic assays, sensitivity and specificity of diagnostic tests.

Course Outline-cum-Lecture Schedule for Master Degree Programme

I. **Course Title : Concepts in Veterinary Public Health and One Health**
II. **Course Code : VPE 601**
III. **Credit Hours : 2+0**

Lecture(s)	Topic
Theory	
1-2	VPH administration: organization, administration and implementation of VPH services/ programs
3-4	Structure and function of VPH agencies/ organizations at national and international levels
5-6	VPH team; administration and functions; responsibilities of veterinarians in the public health team
7	One Health: Definition, historical emergence of the concept. Scope, objectives and activities of One Health
8-9	One Health Umbrella, stewardship of VPH for the implementation of one health activities
10	Strategic framework of One Health activities
11-12	One Health approaches for control of zoonoses and ensuring food safety
13-14	One Health approaches for combating antimicrobial resistance. One health policies, legislations and research
15-16	Transdisciplinary approach of eco-health concepts; one health integrating policy, science and practices
17	Genesis ofveterinary public health and epidemiology as a discipline
18-19	Global burden of disease – need for inter-sectoral and inter-disciplinary collaboration
20-21	Coordinated and systemic disease control response
22	Ecosystems, urbanization, intensive agriculture and animal husbandry practices
23	Exploring host-pathogen interactions for better multi-sectoral responses at the human-animal-ecosystem interface addressing food safety, zoonoses, and other public health threats
24	Climate change and need for multi-sectoral and collateral/ multi-lateral collaborations
25	Sharing of epidemiological data and laboratory information on zoonoses and food safety problems across sectors

26 Integration of one health approaches for the promotion of ecosystem and wildlife health

27 Organizations and agencies working to mitigate health challenges based on 'One Health Approach'

28 One Health Initiative as a union of human and veterinary medicine

29 Local, regional, national and international One Health networks

30 One Health in the paradigm of preventive health care and herd health management

31-32 Case study that integrate veterinary public health with one health

I. Course Title : Zoonoses-I
II. Course Code : VPE 602
III. Credit Hours : 2+1

Lecture(s) Topic

Theory

1 Definition and classification of zoonoses
2 Factors affecting occurrence of zoonoses
3 Disease management strategies
4 Zoonotic disease burden on population
5 Socioeconomic impact of zoonoses
6 Public health implications of bacterial zoonoses
7-9 History, etiology, epidemiology, diagnosis and management of anthrax, brucellosis and tuberculosis
10 History, etiology, epidemiology, diagnosis and management of leptospirosis
11-12 History, etiology, epidemiology, diagnosis and management of plague, rat bite fever, borreliosis and lyme disease
13-14 History, etiology, epidemiology, diagnosis and management of glanders, malidiosis, streptococcosis
15 History, etiology, epidemiology, diagnosis and management of salmonellosis
16 History, etiology, epidemiology, diagnosis and management of campylobacteriosis
17 History, etiology, epidemiology, diagnosis and management of yersiniosis and vibriosis
18-19 History, etiology, epidemiology, diagnosis and management of tetanus, listeriosis, staphylococcosis and tularemia, etc.
20 History, etiology, epidemiology, diagnosis and management of cat scratch disease,

21 History, etiology, epidemiology, diagnosis and management of mycotic zoonoses – General considerations

22-23 History, etiology, epidemiology, diagnosis and management of dermatophytosis, blastomycosis and coccidioidomycosis

24 History, etiology, epidemiology, diagnosis and management of cryptococcosis and histoplasmosis

25 History, etiology, epidemiology, diagnosis and management of aspergillosis and candidiasis

26 History, etiology, epidemiology, diagnosis and management of rhinosporidiosis, sporotrichosis and others

27 History, etiology, epidemiology, diagnosis and management of chlamydiosis (psittacosis and ornithosis)

28 History, etiology, epidemiology, diagnosis and management of prion diseases - Creutzfeldt-Jakob Disease (CJD) and variants

29-30 History, etiology, epidemiology, diagnosis and management of prion diseases - bovine spongiform encephalopathy (BSE), kuru, chronic wasting disease (CWD) and scrapie

31-32 Case studies pertaining to important zoonoses of India

Practical

1. Sampling and laboratory preparedness for handling zoonotic bacterial and fungal agents
2. Isolation, identification and characterization of agents of *Bacillus anthracis* and zoonotic *Mycobacterium* species.
3. Isolation, identification and characterization of zoonotic *Streptococcus* and *Staphylococcus* species.
4. Isolation, identification and characterization of agents of *Clostridium tetani* and zoonotic *Listeria* species.
5. Isolation, identification and characterization of zoonotic *Leptospira* and *Borrelia* species.
6. Isolation, identification and characterization of *Burkholderia mallei* and *Burkholderia pseudomallei*
7. Isolation, identification and characterization of zoonotic *Brucella* species
8. Isolation, identification and characterization of food-borne and zoonotic *Salmonella* species including serotyping of isolates
9. Isolation, identification and characterization of zoonotic *Yersinia* and *Vibrio* species
10. Isolation, identification and characterization of zoonotic

agents responsible for rat bite fever, cat scratch disease, tularemia, etc.

11. Isolation and identification of zoonotic fungal agents of public health significance from the host, vehicle and environment associated with superficial mycozoonoses
12. Isolation, identification and characterization of important mycotic agents of public health significance associated with systemic mycozoonoses – blastomycosis and coccidioidomycosis
13. Isolation, identification and characterization of important mycotic agents of public health significance associated with systemic mycozoonoses – cryptococcosis and histoplasmosis
14. Isolation, identification and characterization of important mycotic agents of public health significance associated with systemic mycozoonoses - aspergillosis, candidiasis, rhinosporidiosis and sporotrichosis
15. Isolation, identification and characterization of important chlamydial agents of public health significance from host, vehicle and environment
16. Laboratory detection of prion diseases

I. **Course Title : Zoonoses-II**
II. **Course Code : VPE 603**
III. **Credit Hours : 2+1**

Lecture(s)	Topic
Theory	
1-3	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Japanese encephalitis, Tick-borne encephalitis and Encephalomyelitis
4-8	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Rabies, Influenza, KFD, Rift valley fever andChikungunya
9	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of FMD and Enteroviruses
10	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Crimean-Congo haemorrhagic fever
11-12	Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of

Dengue, West-Nile fever and Yellow fever

13 Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Rift-valley fever, Louping ill

14 Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of equine encephalitis

15-16 Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Ebola, Marburg and Hantavirus

17-18 Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Hendra Nepah and Zika virus

19 Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of corona viruses

20 Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of important rickettsial zoonoses

21 Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of Q fever

22 Disease burden, history, etiology, epidemiology, transmission pattern, diagnosis and management of typhus fever group

23-25 Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of hydatidosis, taeniosis/ cysticercosis and Trichinosis

26 Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of fasciolosis and fasciolopsiosis

27 Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of Toxoplasmosis

28-29 Disease burden, etiology, host range, epidemiology transmission pattern, diagnosis and management of Trypanosomosis and Leishmaniosis

30 Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of Cryptosporidiosis

31 Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of Sarcocystosis and Dracunculiosis

32 Disease burden, etiology, host range, epidemiology, transmission pattern, diagnosis and management of Paragonimiosis and Diphylobothriosis

Practical

1. Detection and characterization of zoonotic viral and parasitic agents from host, vehicle, environment, etc. - Sampling and laboratory preparations
2. Detection and characterization of Japanese encephalitis, chikungunya and dengue viruses
3. Detection and characterization of encephalomyelitis, Rift valley fever, West-Nile fever, yellow fever, louping ill and equine encephalitis viruses
4. Detection and characterization of rabies and influenza viruses
5. Detection and characterization of FMD and entero-viruses
6. Detection and characterization of KFD, tick-borne encephalitis and Crimean-Congo haemorrhagic fever viruses
7. Detection and characterization of zoonotic Ebola, Marburg, Hanta, Zika, corona, Hendra and Nipah viruses
8. Isolation, identification and characterization of agents responsible for Q fever, typhus fever and other rickettsial zoonoses
9. Detection and characterization of agents responsible for hydatidosis, taeniosis/cysticercsis and trichinellosis
10. Detection and characterization of agents responsible for fascioliosis and fasciolopsiosis
11. Detection and characterization of *Toxoplasma gondii*
12. Detection and characterization of zoonotic *Trypanosoma* species
13. Detection and characterization of zoonotic *Cryptosporidium* species of health significance
14. Detection and characterization of zoonotic *Leishmania* species
15. Detection and characterization of zoonotic *Sarcocystis* species
16. Detection and characterization of zoonotic agents responsible for dracunculiosis, paragonimiosis and diphylobothriosis

I. **Course Title : Principles of Epidemiology**

II. **Course Code : VPE 604**

III. **Credit Hours : 2+1**

Lecture(s)	Topic

Theory

1 Historical perspective and scope of veterinary epidemiology
2 Disease causation -theories of disease causation, recent advancements and iceberg concept
3 Koch's postulates and Evan's rules
4 Epidemiological triangle
5 Epidemic, endemic, pandemic and sporadic diseases
6 Qualitative and quantitative approaches to epidemiology
7 Measurement of disease in populations
8 Endemic stability and herd immunity
9 Basic reproductive ratio
10 Trends in spatial and temporal distribution of disease
11 Epidemic curve and its applications
12 Transmission of disease
13 Role of ecology in maintenance of disease agents
14 Epidemiological methods
15 Landscape epidemiology
16 Molecular epidemiology
17 Epidemiological studies
18 Observational studies - case-control studies
19 Observational studies - cohort studies
20 Observational studies - cross-sectional studies
21 Experimental studies - field trials
22 Experimental studies - clinical trials
23 Disease surveys
24 Monitoring and surveillance
25 Epidemiological databases
26 Definition, scope and limitations of serological epidemiology and interpretation of results
27 Characteristics of ideal disease diagnostic tests
28 Multiple diagnostic testing
29 Evaluation of diagnostic tests
30 Investigation of disease outbreaks
31 Strategies of disease control
32 Disease eradication

Practical

1. Collection of data from various sources, analysis and interpretation
2. Demonstration of sample (serum) collection

3. Evaluation of diagnostic tests
4. Analytical diagnostic and relative sensitivity and specificity calculation
5. Use of software for data analysis
6. Designing and interpretation of a case-control study
7. Designing and interpretation of a cohort study
8. Designing and interpretation of a cross-sectional study
9. Designing and interpretation of a field trials
10. Designing and interpretation of a clinical trials
11. Determination of vaccines effectiveness
12. Designing of a survey
13. Spatio-temporal distribution of disease
14. Outbreak investigation
15. Case study on disease eradication
16. Case study on disease monitoring and surveillance

I. **Course Title : Hygiene and Safety of foods of Animal and Aquatic origin**
II. **Course Code : VPE 605**
III. **Credit Hours : 2+1**

Lecture(s)	Topic
Theory	
1	Importance of food hygiene in relation to the public health
2	Principles of food hygiene in relation to foods of animal origin (including aquatic origin foods)
3	Environmental sanitation in food establishments
4	Food quality - perspectives
5	Prevention of foodborne illnesses - principles
6	Risk analysis
7	Milk hygiene - importance and objectives
8	Hygienic production, handling, transportation, storage and marketing of milk and milk products
9	Mastitis in dairy animals and its public health significance
10	Spoilage of milk
11	Preservation of milk
12	Milk-borne diseases of public health significance
13	Epidemiology of milk allergy and lactose intolerance
14	Public health impact pesticide residues in milk supply chain

15 Antimicrobial residues in milk supply chain and their public health impact
16 Adulteration of milk and dairy products
17 Public health implications of synthetic milk
18 Milk plant hygiene and sanitation
19 Meat hygiene - importance and objectives
20 Hygienic meat production including hygienic practices at abattoirs
21 Hygienic practices at farm and during transportation of food animals including poultry
22 Adulteration of meat and meat speciation
23 Spoilage of meat and meat products
24 Preservation of meat
25 Meat-borne diseases of public health significance
26 Safe disposal of slaughter house byproducts
27 Fish, fisheries and ichthyology
28 Environmental factors affecting aquatic food hygiene
29 Hygienic production, handling, preservation, transportation and marketing of aquatic foods
30 Microbial profile and spoilage of aquatic foods
31 Disposal of fishery waste
32 Fish-borne diseases of public health significance

Practical

1. Collection of samples of meat, milk, egg and fish for physicochemical and microbial analysis
2. Analysis of foods of animal origin for physicochemical quality
3. Analysis of foods of animal origin for microbial quality
4. Detection of adulteration, debasement, substitution and admixing of animal origin foods and products
5. Recent methods of speciation of meat
6. Determination of spoilage in foods of animal origin
7. Extension of shelf life of perishable foods of animal origin
8. Detection of mastitis in dairy animals and linking it to consumer's health
9. Study of supply chains of milk, meat, egg and fish
10. Evaluation of food plant, equipment and the environment for compliance
11. Microbial risk analysis
12. Risk analysis for residues of public health significance in foods of animal origin
13. Source tracing of foodborne outbreaks using molecular, bioinformatics or epidemiological tools

14. Evaluation of fish and aquatic harvest for quality and safety
15. Visit to milk/ meat/ egg/ fish processing unit for the demonstration of food quality and safety checkpoints
16. Study of databases, information communication tools (ICT) and dedicated websites related to quality and safety of animal origin foods

I. Course Title : Food-borne Infections and Intoxications
II. Course Code : VPE 606
III. Credit Hours : 2+1

Lecture(s)	Topic
Theory	
1	Definitions: Foodborne infections, Food intoxications, Toxi-infections, Bacterial toxins, etc.
2-3	Classification, epidemiology, disease burden and economics offoodborne diseases.
4	Fungal toxins
5	Plant, algal, and other toxins
6	Reservoirs of food-borne pathogens
7	Mode of transmission of food-borne pathogens
8	Vehicles of pathogens
9	Measures employed for prevention and control of food-borne diseases
10	10-11 Food- poisoning outbreak investigation
12	Management of food- poisoning outbreak
13-15	Epidemiology, economic, diagnosis and management of bacterial food-borne diseases
16-17	Foodborne disease due to *Salmonella* and *Campylobacter* species
18-19	Foodborne disease due to *Clostridium*, *Staphylococcus*, *Listeria* and *Bacillus* species
20-22	Foodborne diseases due to species of *Vibrio*, *Escherichia*, *Shigella*, *Yersinia*, etc.
23	Types of bacterial toxins and their manifestations
24-25	Epidemiology, economics, diagnosis and management of food-borne viral pathogens
26	Foodborne diseases due to hepatitis viruses and entero-viruses
27	Foodborne diseases due to noroviruses, rotaviruses, etc.
28	Food- borne rickettsial infections
29	Food- borne parasitic infections

30 Illness due to additives in foods, seafood toxins, mycotoxins, biocides and plant origin toxins
31 Illness due to food heavy metals, veterinary drugs, hormones, etc. in foods
32 Anti-microbial resistance (AMR) in food-borne pathogens-definition, current status, factors responsible, mechanism of resistance, mode of transmission and control

Practical

1. Food-borne disease outbreak investigation
2. Detection and characterization of food-borne bacterial pathogens in foods of animal origin
3. Detection and characterization of food-borne viral pathogens in foods of animal origin
4. Detection, quantification and characterization of microbial toxins in foods of animal origin
5. Detection of antimicrobial resistance in foodborne pathogens and their molecular and epidemiological characterization
6. Detection and characterization of rickettsial pathogens in foods of animal origin
7. Detection and characterization of parasites of public health in foods of animal origin
8. Detection, quantification and characterization of toxic compounds in the fish and aquatic food supply chain
9. Detection and quantification of antimicrobials in foods of animal origin
10. Detection and quantification of phytotoxins, biocides, etc. in foods of animal origin
11. Detection and quantification of pesticides residues in foods of animal origin
12. Detection and quantification of residues of metals and other environmental contaminants in foods of animal origin
13. Detection and quantification of additives in foods of animal origin
14. Detection and quantification of veterinary drugs in foods of animal origin
15. Case study on food-borne microbial disease relevant to the region
16. Case study on non-microbial hazard relevant to the region

I. Course Title : Food Safety Standards and Regulations
II. Course Code : VPE 607

III. **Credit Hours : 2+1**

Lecture(s) Topic

Theory

1 Indicators of food quality and safety
2 Food spoilage (biological, chemical, etc.)
3 Food plant hygiene
4 Sanitation program for the food plant
5 Hurdle technique and its relevance
6 Microbiological food quality criteria
7-8 National and international food standards
9 Private food standards
10 Prerequisite programs for food safety - GAP, GMP, etc.
11 Application of ISO 9000 series to food establishments
12-13 HACCP, ISO 22000 Lecture(s) Topic
14 Genesis of food safety standards
15 Mechanisms of food safety standard formulation
16 Agencies associated in food standard formulation
17 Role of WTO and FSSAI in standard formulation
18 Role of BIS and other agencies in standard formulation
19 Role of EIC/ EIA
20 National regulations and legislations related to quality food production
21 International regulations related to quality food production
22-26 Food safety regulations in reference to pesticides, veterinary drug, heavy metals, hormones and other residues (MRL, ADI, etc.)
27 Traceability system for foods of animal origin
28 Organic food production
29 Packaging of foods of animal origin – specifications and standards
30 Public health implications of *in-vitro* and cultured meats as well as meat obtained from genetically modified and unconventional animals
31 SWOT analysis of emerging and novel technologies related to the quality and safety of foods of animal origin
32 Case study related to food standards

Practical

1. Detection of pesticide residues in foods of animal origin
2. Detection of veterinary drug residues in foods of animal origin
3. Detection of heavy metal residues in foods of animal

origin
4. Estimation of MRL/ MPL
5. Estimation of NOEL, ADI, etc.
6. Microbiological assessment of cleanliness of food plant surface
7. Microbiological assessment of equipment in abattoir/ meat/ milk plant
8. Visit to food processing units for examining compliance of HACCP/ FSSAI regulations and other standards
9. Demonstration of traceability system for foods of animal origin
10. Demonstration of compliance of organic production of foods of animal origin
11. Demonstration of registration and licensing of food business operator (FBO) under FSSAI regime
12. Evaluation of detergents and sanitizers used in the food plant
13. Inventory management and hygiene audit of food plant
14. Occupational safety at food plant
15. Case study on HACCP
16. Case study on ISO 22000

I. **Course Title : Environmental Hygiene and Safety**
II. **Course Code : VPE 608**
III. **Credit Hours : 2+1**

Lecture(s) Topic

Theory

1 Introduction to the environment and environmental hygiene
2 Impact of environmental pollutants on animal and human health
3 Characteristics of various environmental pollutants
4 Nature and impact of microbial pollution
5 Nature and impact of pollution due to chemical pollutants
6 Environmental risk assessment (microbial and non-microbial hazards)
7 Pollutions of soil, air and water and their effects on human, animal and environmental health
8 Dissemination of pathogens and pollutants in the environment
9 Global warming, enhanced green-house effect and climate change- impact on human, animal and

environmental health

10 Impact of noise pollution on human and animal health
11 Management of environmental pollution
12 Industrial pollution including impact of plastic and petrochemical products
13 Genetic risk associated with environmental pollutants
14 Health problems due to nuclear energy, microwave, electro-magnetic and other radiation pollutions
15 Pollution due to agrochemicals and pesticides
16-17 Contamination and impact of heavy metals and veterinary drug residues
18 Role of livestock in environmental pollution
19 Public health impact of animal-waste
20 Recycling of wastes
21 Principles of safe disposal of bio-medical waste
22 Food chain consequences of environmental pollutants, contaminants and toxicants
23 Implications of genetically modified organisms on the animal, human and environmental health - regulations and compliance
24 Management of environmental pollution – conventions, treaties, agreements, etc.
25-26 Role of national and international pollution control agencies in the management of environmental pollution.
27 Regulations pertaining to environmental pollution and its control
28 Hygiene and safety at specialized laboratories
29 Designing and maintenance of laboratories that handle high risk pathogens
30 Environmental risk assessment of hazards of regional/ national importance
31 Case studies involving livestock and the environment
32 Case studies indicating human health impact associated livestock

Practical

1. Determination of potability of the drinking water
2. Detection of pollutants in the water
3. Detection of pollutants in the air
4. Detection of pollutants in the soil
5. Detection of pollutants in the animal products
6. Detection of pollutants in the sewage
7. Detection of pollutants in the animal waste

8. Detection and quantification of environmental pollutants, toxicants and contaminants that affect animal, human and environmental health
9. Sustainable methods for animal waste disposal/ economic utilization arising from intensive animal husbandry
10. Cost-benefit analysis of environment friendly animal waste disposal approaches
11. Detection and quantification of genetically modified organisms
12. Structure and function of institutional biosafety committee (IBSC)
13. Environmental monitoring of pollutants – markers and methods
14. Preparation of feasibility report or projects pertaining to selected environmental pollutant(s) of regional importance
15. Visit to sewage/ waste recycling/ disposal plant/ processing unit
16. Case studies on risk mapping, environmental risk assessment, pollution mitigation, etc.

I. **Course Title : Applied Epidemiology**
II. **Course Code : VPE 609**
III. **Credit Hours : 2+1**

Lecture(s)	Topic
Theory	
1	An introduction to applied epidemiology
2	Models, modeling and types of model
3	Epidemiological and economic models
4	Principles and classification of models
5	Deterministic and stochastic models
6	Empirical and explanatory models
7	Application of models in disease forecasting
8	Modeling in disease prevention and control
9-10	Disease occurrence and ecology of disease
11	Monitoring and surveillance
12	Outbreak investigation protocol
13	Path, regression and discriminate analyses
14	Time series analysis
15	Statistical analysis of the data - Analysis of variance
16	Animal disease economics - cost-benefit analysis, internal rate of return payback period, etc.
17	Animal disease economics - partial budgeting

18 Animal disease economics - decision analysis
19 Bayesian analysis
20 Monte-Carlo and Markovian processes and system evaluation
21 Multivariate analysis
22 Disease outbreaks and participatory epidemiology
23 Disease reporting system - tracing and notification
24 Disease control strategies
25 Risk assessment
26 Exotic diseases and trans-boundary diseases
27 Vaccination for prevention of diseases
28 Disease intelligence
29 Tele-epidemiology
30 Application of remote sensing technology
31 Geographic information system
32 Disease surveillance and early warning system

Practical

1. Survey of animal diseases
2. Biostatistics for establishing disease causality, association and measurements.
3. Profanity and non-probability sampling methods
4. Presentation of disease data.
5. Measurements of disease occurrence in populations
6. Outbreak investigation
7. Disease reporting system.
8. Demonstration of epidemiological software.
9. Estimation of disease burden and economics of animals/zoonotic diseases
10. Modelling of animal diseases.
11. Demonstration of cartography and disease mapping using computer software.
12. Demonstration of global positioning system (GPS), remote sensing technology and geographic information system(GIS)
13. Working modality on disease surveillance and monitoring
14. Demonstration of disease early warning system
15. Disease modeling
16. Case study on disease reporting and notifiable disease

I. **Course Title : Biosecurity, Bioterrorism and Disaster Management**
II. **Course Code : VPE 610**
III. **Credit Hours : 2+0**

Lecture(s) Topic

Theory

1. Introduction and definitions related to the bioterrorism
2. Potential biological weapons
3. Categorization agents of bioterrorism
4. Hazard analysis in bioterrorism
5. Strategies for combating bioterrorism
6. Bio-ethics, social ethics and advisory role of veterinarians during the event of bioterrorism
7. Disaster – Definitions, categorization (natural and man-made disasters)
8. Impact analysis of disasters
9. Classification of disaster scale
10. Essential preparations for the management of disasters
11. Role of central, state and local government bodies in disaster management
12. Role of veterinarians/ veterinary public health personnel during emergency/ disasters
13. Sequence of emergency services
14. Effect of natural disasters on human and animal populations
15. Nature and characteristics of disasters - floods, tsunami, tides, etc.
16. Nature and characteristics of disasters - prolonged draughts, forest fires, etc.
17. Nature and characteristics of disasters - earthquakes, storms, etc.
18. Post-disaster disease susceptibility and remedial measures
19. Biosecurity– definition, importance, methods, pathogen inventory, etc.
20. Biosecurity at food processing establishments
21. Biosecurity at livestock/ poultry farms
22. Biosecurity at specialized animal facilities
23. Quarantine measures for disease prevention – structure and functions
24. Biomedical hazards at hospitals, laboratories and special animal handling units
25. Laboratory biosafety – principles, requirements and applications
26. Biosafety at the specialized laboratories
27. Occupational health risk and its management
28. National and international laboratory safety compliance

29. Prediction, early warning or forecasting systems for disasters
30. Case study related to bioterrorism
31. Case study related to biosafety
32. Case study related to disaster

I. **Course Title : Laboratory Techniques in Veterinary Public Health and Epidemiology**
II. **Course Code : VPE 611**
III. **Credit Hours : 0+3**

Lecture(s) Topic

Practical

1 General laboratory practices – safety precautions, hazardous material disposal, maintenance and compliance with existing norms
2 Personal safety and use of PPE (personal protective equipment) in the laboratory
3 Laminar airflows– uses, types of cabinets, SOPs, applications, etc.
4 Biosafety cabinets – uses, types of cabinets, SOPs, applications, etc.
5 Preparation of glassware and plastic wares
6-8 Preparation of culture media
9-10 Preparation of buffers and solutions of different for laboratory use
11-12 Sampling methods
13-14 Techniques for quality analysis of milk and milk product
15-16 Techniques for quality analysis of meat and meat products (including poultry and egg)
17-18 Techniques for quality analysis of food/ feed and environmental samples
19 Analysis of water for quality and safety
20-21 Microbiological techniques: Plate counts - psychrophilic, mesophilic, thermophilic and thermoduric organisms
22-23 Microbiological techniques: enumeration techniques for psychrophilic, mesophilic, thermophilic and thermoduric organisms from samples of foods of animal origin
24-26 Techniques for isolation and identification of foodborne and zoonotic pathogens
27-28 Techniques for detection of microbial toxins associated with food-poisoning and

outbreaks

29-30 Techniques for detection and confirmation of viral pathogens

31-32 Techniques for isolation, identification, enumeration, confirmation and characterization of fungi of public health significance

33-34 Immunological techniques used for the detection of zoonotic agents -hypersensitivity based tests

35-36 Serological techniques: precipitation and agglutination tests, counter immune-electrophoresis, ELISA, etc.

37-38 Electrophoresis (AGE, PAGE, SDS-PAGE, etc.) techniques

39-40 Chromatographic methods

41-42 Techniques for the detection and quantification of pesticides residues

43-44 Techniques for the detection and quantification of drugs using immunological and chromatographic methods

45 Methods for isolation and quantification of nucleic acids from pathogens from diverse biological specimens using latest molecular techniques

46-47 Molecular techniques for the detection and characterization of organisms of veterinary public health significance – PCR and other molecular techniques

48 Maintenance of laboratory records, log books of equipment and laboratory accreditation (NABL)

I. **CourseTitle : Veterinary Clinical Epidemiology**
II. **CourseCode : VPE 612**
III. **CreditHours : 2+1**

Lecture(s) Topic

Theory

1-2 Definitions and epidemiological approaches

3-6 Measuring frequency of clinical events, incidence, prevalence, occurrence etc.

7-10 Principles of accuracy, precision, linearity, diagnostic sensitivity and specificity

11-13 Uses of diagnostic tests

14-16 Evaluation of diagnostic tests

17-20 Statistical and epidemiological concepts applied to veterinary epidemiology.

21-23 Design and evaluation of clinical trials,

24-26 Cost of disease and cost benefit analysis

27-32 Epidemiological approaches for clinical problems faced in the field using practical examples from all species, with particular emphasis on large and small animal medicine, avian medicine etc.

Practical

1-3 Diseases of multiple etiology: mastitis, diarrhea, abortions, their diagnosis and prevention.

4-7 Sampling from affected cases of diseases of multiple etiology

8-12 Isolations and antibiotic/ culture sensitivity of multiple etiology pathogens

13-16 Statistical evaluation of diagnostic tests, sensitivity and specificity of diagnostic tests

CourseContents
Ph.D. inVeterinary Public Health and Epidemiology

I. **CourseTitle :Advances in Veterinary Public Health and Epidemiology**

II. **CourseCode :VPE 701**

III. **CreditHours :2+1**

IV. **Aim of the course**

To To acquaint with current/ contemporary issues concerning the veterinary public health, veterinary epidemiology and the one health

V. **Theory**

Unit I

Contemporary Contemporary status of Veterinary Public Health in India and abroad. Public Health in the 21stCentury.Veterinary public health and its role in the society. Role of veterinary public health professionals in prevention and control of zoonoses. Organization and administration of veterinary public health agencies structure and functions. Data analysis framework in healthcare and social sectors. Evidence based information updates current VPH topics. Global animal disease surveillance.

Unit II

Recent diagnostic tools used for emerging public health problems including zoonoses. Molecular surveillance of recent pandemics of zoonoses. Modes of evolutionary emergence of disease agents pertinent to VPE.

Unit III

Application of bioinformatics, biotechnological and computational tools in food hygiene, safety, quality assurance and environmental health protection. Global pandemic threat preparedness. Emerging Disease Surveillance and Control. Biomedical models in veterinary public health.

VI. **Practical**

Estimation of burden of food-borne zoonotic diseases. Special problems related to field investigations of outbreaks of food poisoning and zoonotic diseases in a community. Application of recent analytical methods and in-silico techniques for public health research. Visits to hospitals to acquaint the students with public health related problems.

VII. **Assignments**

Each student Each student will select at least two recent articles from journals related to the course and discuss the same in the

class through presentation.

VIII. **Suggested reading**

- Eldridge BF and Edman JD. eds., 2012. Medical entomology: A textbook on public health and veterinary problems caused by arthropods. Springer Science and Business Media
- Noordhuizen, Noordhuizen, Josephus Pieter Thérèse Maria K Frankena, Michael V Thrusfield and EA M Graat. Application of quantitative methods in veterinary epidemiology. Wageningen Pers, 2001.
- Schwabe CW, Riemann HP and Franti CE. 1977. Epidemiology in veterinary practice. Lea and Febiger.
- Thrusfield M. 2018. Veterinary epidemiology. John Wiley and Sons.

I. **CourseTitle :Emerging, Re-emerging Zoonoses and One Health**

II. **CourseCode :VPE 702**

III. **CreditHours :2+1**

IV. **Aim of the course**

To acquaint the students with emerging and re-emerging zoonotic diseases.

V. **Theory**

Unit I

Status of Status of emerging and re-emerging zoonotic infections, National and international interests in zoonoses, Measurement and economics of zoonoses, Latest diagnostic and Management planning for zoonoses. Factors responsible for emergence and reemergence of zoonotic diseases. Health threats at the human-animal-ecosystems/ environment interface (HAEI), a tripartite concept of OIE, WHO and FAO.

UnitII

Current challenges and strategies, euzoonoses, xenozoonoses, nosocomial zoonoses, newer zoonotic agents, viz., cat-scratch disease, rat bite fever, Creutzfeld-Jacob disease, Ebola, Marburg, Lassa, Nipah, Menangle, Herpes B, SARS, AI, ZIKA, MERS, etc..

Unit III

Simian and human immunodeficiency, bovine spongiform encephalopathy, hepatitis A and E, Toro, influenza viruses; re-emerging zoonoses with new pathology, viz., neuro-cysticercosis, campylobacteriosis, rabies, Guillain-Barre Syndrome, tuberculosis.

UnitIV

Safety regulations in laboratories, hospitals and biological plants. Use of bio safety cabinets. Biosecurity.

VI. **Practical**

Special problems Special problems related to emerging/ re-emerging/ prevalent zoonotic diseases in India. Status of Brucellosis and Tuberculosis in the India, OIE recommended diagnostic tests, vaccines/ strategies for prevention and control. Visits to rural health centres to acquire status of zoonotic diseases.

VII. **Assignments**

Each student will select at least two recent articles from journals related to course and discuss the same in the class through presentation.

VIII. **Suggestedreading**

- Calvin W Schwabe. 1984. Veterinary Medicine and Human health. Williams and Wilkins
- Rezza G and Ippolito G. eds. 2017. Emerging and Re-emerging Viral Infections. Springer.
- Singh SK. ed. 2015. Human Emerging and Re-emerging Infections. John Wiley and Sons.

I. **CourseTitle: Advances in Food Safety and Quality Control of Foods of Animal/Aquatic**

II. **CourseCode :VPE 703**

III. **CreditHours :2+1**

IV. **Aimofthecourse**

To provide expertise to students the advances in the food safety, quality control and quality assurance of animal origin foods.

V. **Theory**

UnitI

Food supply chain. Food handling practices. New age voluntary and mandatory food standards. Types and evolution of food standards. Characteristics of food safety hazards. Quality control, assurance and food safety specifications for animalorigin foods such as meat, milk, egg and fish. Trends in green technologies in foodproduction and processing. Impacts and performance of organic farming *vis-à-vis* conventional farming.

Unit II

Recent innovations Recent innovations in shelf-life extension, preservation and packaging. Requirements for food testing and calibration Laboratory Mechanism of food spoilage (microbial and non-microbial). Nature of major food-borne infections and intoxications. Traceability system. Waste reduction along the food supply chain.

Unit III

Rapid detection Rapid detection of food safety hazards. Food safety risk assessment. Quality assurance schemes applicable to foods of animal origin. Elements of national food control system. National food control systems. Global considerations and role of committees and agencies associated with food safety, quality control and quality assurance..

Unit IV

Genesis of Genesis of food quality/ safety standard. Food quarantine and export guidelines, specifications and standards. National and international food safety compliances.Traceability of foods of animal origin.

VI. **Practical**

Special problems Special problems on quality and safety of foods of animal origin foods. Detection, enumeration and identification of major food-borne pathogens. Visits to food processing establishments. Environmental impact assessment of production of foods of animal origin.

VII. **Assignments**

Each student will select at least two recent articles from journals related to course and discuss the same in the class through presentation.

VIII. **Suggested reading**

- Marriott Marriott NG, Schilling MW and Gravani RB. 2018. Principles of food sanitation. Springer.
- Nollet LM and Toldrá F. eds., 2016. Safety analysis of foods of animal origin. CRC Press
- Paustenbach DJ. ed., 2015. Human and Ecological Risk Assessment: Theory and Practice (Wiley Classics Library). John Wiley and Sons.
- • Toldrá F and Nollet LM. eds., 2017. Advances in food diagnostics. John Wiley and Sons.

I. **CourseTitle :Biosecurity and Occupational Health Safety**

II. **CourseCode :VPE 704**

III. **CreditHours :2+1**

IV. **Aimofthecourse**

To acquaint students with biosafety and occupational health safety.

V. **Theory**

Unit I

Definitions. Physical, Chemical and Biological hazards. Bio-safety and bio-security. Elements of bio-security and bio-containment. Biosecurity requirements. Containment Barriers. Equipment

safety. Risk assessment. Bio-safety levels. Laboratory safety. Bio-safety in microbiological and biomedical laboratories.

Unit II

Risk groups Risk groups, Classification of organisms by risk groups. Classification of occupational groups. Laboratory designs. Transmission, spread, Maintenance and control of diseases affecting various occupational groups in contact with animals and their public health significance. Diseases associated with various occupations..

Unit III

Occupational Occupational safety and health. Occupational Health and Safety (OHS) management system standard ISO 45001. regulations pertaining to the Occupational safety and health. Occupational Safety and Health Administration. International Labour Organization.

VI. Practical

Diagnosis of occupational diseases of public health significance. Handling of Bio-safety cabinets. Relation of risk group to bio-safety levels, practices and equipment.Visit to BSL-3 and/or BSL-4 laboratories.

VII. Suggested reading

- Fleming DO and Hunt DL. 2006. Biological safety: principles and practices (No. Ed. 4). ASM Press.
- Guillén J. ed. 2017. Laboratory Animals: Regulations and Recommendations for the Care and Use of Animals in Research. Academic Press.
- Rabinowitz PM, Lefkowitz RY, Conti LA, Redlich CA and Weigler BJ. 2015. Occupational health of laboratory animal workers. In Laboratory Animal Medicine (pp. 1381-1402). Academic Press.
- World Health Organization. 2016. Assessment Tool for Key Processes associated with thebDesign, Construction, Operation, Maintenance and Regulation of BSL-3 Facilities in the WHO African Region

I. **CourseTitle :Recent Concepts in Epidemiology and Disease Forecasting**

II. **CourseCode :VPE 705**

III. **CreditHours :2+1**

IV. **Aimofthecourse**

To learn about different epidemiological aspects of major diseases and to develop suitable disease forecasting system.

V. **Theory**

Unit I

Review of epidemiological concepts and applications, recent concepts.

Unit II

Epidemiology of economically important diseases in the region (haemorrhagic septicaemia, foot and mouth disease, surra, brucellosis, PPR, swine fever, IBD, NCD, avian Influenza, sheep pox, contagious ecthyma, etc).

Unit III

Geographical Information System and its applications in epidemiology, various expert systems and their role in epidemiology.

Unit IV

Modelling and application of various models in disease forecasting. Epidemiological software and its applications, global and national early warning system.

VI. **Practical**

Epidemiological exercises of economically important diseases in the region, use of Geographical Information System in epidemiology, various expert systems, modeling and various models used in disease forecasting, development of suitable epidemiological software for the prevailing problems to attend disease outbreaks including laboratory investigations and reporting of routs.

VII. **Suggested reading**

1. BeagleholeR, Beaglehole R, Bonita R and Kjellstrom T. 1993. Basic Epidemiology, World Health Organization, Geneva.
2. Lilienfeld DE and Stolley P. 1994. Fundamentals of Epidemiology, 3rd ed., Oxford University Press, New York
3. Noordhuizen JPTM, Frankena K, van der Hoofd CM and Graat EAM: Application of quantitative methods in Veterinary Epidemiology. Wageningen Pers, Wageningen, The Netherlands. 1997.
4. Raj S Bhopal. 2016. Concepts of Epidemiology: Integrating the ideas, theories, principles and methods of epidemiology. 3rd

Ed., Oxford University Press. Oxford. BonitaRandKjellstromT. 1993.*BasicEpidemiology*,World HealthOrganization,Geneva.

I. **Course Title : Risk Analysis and Predictive Modelling**
II. **Course Code : VPE 706**
III. **Credit Hours : 2+1**
IV. **Aim of the courses**

To Acquaint the students with the latest knowledge on prediction od infections andthe extent of risk in the population

V. **Theory**

Unit 1

Definitions. History of risk analysis. Relevance of risk analysis (RA) to food sector. Principles of risk analysis. Risk analysis components (risk assessment, management and communication). Microbial Risk Assessment (MRA) involving hazard identification, exposure assessment, hazard characterization, and risk characterization. Methodologies used in RA/ MRA. Qualitative and quantitative risk analysis. Quantitative Microbial Risk Assessment (QMRA) for foods of animal origin including water. Application of mathematical models to study propagation of microbial hazards from farm-to-fork. Risk-based decision-making.

Variability and uncertainty inherent to biological data. Measurement and modelling of uncertainty and variability during risk assessment. Risk assessment, risk analysis and HACCP. Linking microbial food safety with risk assessment. Relevance of assumptions and observed data for predictive models. Study of software packages used for risk analysis.

Unit III

Mathematical modelling of microbial growth rate. Predictive modelling tools for food safety management. Microbial modelling for the prediction of product shelf life and safety. Applications of predictive modelling of microbial behaviour in foods.

VI. **Practical**

Modelling of infectious diseases using computational and mathematical methods. Building and analysing models of infectious diseases. Study of population-level processes for infectious diseases of animals and humans. Performing risk analysis for selected food safety hazards using microbial risk analysis tools. Risk assessment using through simulation modelling.

VII. **Suggested reading**

1. Haas CN, Rose JB and Gerba CP. 1999. *Quantitative microbial risk assessment*. John Wiley and Sons.

2. Lelieveld HL, Holah J and Gabric D. eds., 2016. *Handbook of hygiene control in the food industry*. Woodhead Publishing.
3. Pastorok RA, Bartell SM, Ferson S and Ginzburg LR. eds., 2016. *Ecological modeling in risk assessment: chemical effects on populations, ecosystems, and landscapes*. CRC Press.
4. Subramaniam P and Wareing P. eds., 2016. *The stability and shelf life of food*. Woodhead Publishing.

I. Course Title : Advances in Environmental Hygiene

II. Course Code : VPE 707

III. Credit Hours : 2+1

IV. Aim of the course

To update knowledge on modern environmental pollution problem and control.

V. Theory

Unit I

Current status of problems pertaining to environmental hygiene, air, soil andwater pollution, Disinfection procedures, Impact of global warming and other environmental problems leading to change in ecology of diseases and impact on human/ animal health; Carbon footprint, Eco-philosophy, Environmental ethics and Environmental economics, Environmental conflicts and cooperation.

Unit II

Environmental risks their assessment and management and reporting, modern global information, surveillance and monitoring systems, decision making and public awareness. Role of VPH in National Sanitation Programmes such as Swachh Bharat Abhiyan.

Unit III

International environmental management efforts, participatory international organizations and their selected programmes and selected legislations.

VI. Practical

Detection and monitoring/ estimation of air, soil and water pollution; detection of pathogens from environmental sources. Visits to water/ sewage treatment plants.

Assignments

Each student will select at least two recent articles from journals related to course and discuss the same in the class through presentation.

VII. Suggested reading

1. Curtis SE. 1983. *Environmental management in animal*

agriculture. Iowa State University Press.
2. Frumkin H. ed., 2016. *Environmental health: from global to local*. John Wiley and Sons.
3. Paustenbach DJ. ed., 2015. *Human and Ecological Risk Assessment: Theory and Practice* (Wiley Classics Library). John Wiley and Sons.
4. Sparling DW. 2016. *Ecotoxicology essentials: environmental contaminants and their biological effects on animals and plants*. Academic Press.

I. **Course Title : Herd Health Management and Disease Economics**

II. **Course Code : VPE 708**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

Adoption of holistic approach to address issues of herd health without affecting production.

V. **Theory**

Unit I

General principles, interactions between health and production and herd immunity.

Unit II

Dairy cattle: mastitis, brucellosis and haemo-protozoan control and health management of dairy cows and calves.

Unit III

Health and production in swine, sheep, goats and poultry, vaccination, biosecurity practices for prevention and control of diseases.

VI. **Practical**

Visit to various bovine, equine, sheep, goat and poultry farms, assessment of their problems, systematic programmes for prevention and control of specific diseases and its impact, calculation of disease economics. Animal-house hygienic practices.

Assignments

Each student shall select at least two recent articles from journals related to course and discuss the same in the class through presentation.

VII. **Suggested Reading**

- Dijkhuizen AA and Morris RS. 1997. *Animal health economics. Postgraduate Foundation in Veterinary Science*, University of Sydney, Sydney, Australia.
- FAO. 2016. *Economic analysis of animal diseases*. FAO Animal Production and Health

Guidelines. No. 18. Rome.
- Schwabe CW. 1984. *Veterinary Medicine and Human Health, Baltimore*: Williams and Wilkins
- Rushton, Jonathan. 2009. *The economics of animal health and production*. CABI.

I. **Course Title : Epidemiology of Trans-boundary, Non-infectious and Chronic Diseases**

II. **Course Code : VPE 709**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To provide students the expertise in elucidating epidemiology of non-infectious and chronic diseases.

V. **Theory**

Unit I

Establishment of causality and associations in non-infectious and chronic diseases. Characteristics of Koch's/ Henle-Koch postulates and Evans' rules of disease causation. Unified principles of establishing causality for both infectious and non-infectious diseases. Infectious disease and chronic disease connections. Causal role of infectious agents in cancer (relating criteria). Establishment of trends in disease occurrence. Epidemiology of non-infectious and chronic diseases affecting different systems in various animal species.

Unit II

Emerging infectious determinants of chronic diseases- reasons for emergence, range of pathways and epidemiology of chronic non-infectious disease. Study of characteristics of risk factors (genetic, physiological, environmental, behavioral, etc) associated with non-infectious and chronic diseases. Demographic, epidemiological and nutrition transition. Social determinants of non-communicable diseases. Spatial and temporal epidemiology of non-infectious diseases, viz., nutritional, reproductive, chemical poisoning, toxicity (pesticides, poisonous plants), metabolic diseases, toxicities, neoplastic and other miscellaneous diseases.

Unit III

Global status of non-communicable diseases. Modelling of non-infectious non - communicable diseases or chronic diseases. Economic Impact of chronic diseases. Prevention and control: current status and future perspectives.

VI. **Practical**

Measurement of burden of non-infectious and chronic diseases (mortality, morbidity, survival, risk factors, etc.). Controlled trials and short research problem(s) involving contemporary issues and

research techniques. Animal models for the study of non- infectious and chronic diseases. Survey of non-infectious and chronic diseases using animal disease model systems.

VII. Suggested Reading

- Baldock C, Forman T, Geering B and Taylor B. 1999. *New Technologies in the fight against transboundary animal diseases*. In: FAO-Japan Cooperative Project: Collection of Information on Animal Production and Health. Rome, Italy: The Food and Agricultural Organization of the United Nations.
- Fernández PJ and White WR. 2016. *Atlas of transboundary animal diseases*. OIE (World Organisation for Animal Health).
- Martin SW, Meek AH and Willeberg P: *Veterinary epidemiology. Principles and methods*. 1986, IOWA State University Press/ Ames, Iowa, USA
- Noordhuizen JPTM, Frankena K, van der Hoofd CM and Graat EAM: *Application of* quantitative methods in veterinary epidemiology. Wageningen Pers, Wageningen, The Netherlands. 1997.
- Thrusfield M: *Veterinary epidemiology*. 1995.Blackwell Science Ltd. Oxford, UK.

I. Course Title : Ecology and Animal/ Human Health

II. Course Code : VPE 710

III. Credit Hours : 2+0

IV. Aim of the course

To acquaint students about ecological basis of disease.

V. Theory

Unit I

Establishment of links between animal/ human health with the ecosystems. Assessment of changing trends in the environments and its on the animal/ human health. Study of emerging public health threats linked to the changes in the environment. Study of landscape epidemiology of diseases. Study of contemporary issues centered on ecological and evolutionary perspectives of infectious diseases.

Unit II

Animal–human-ecosystem interface. Study of ecological/ environmental factors influencing spatio-temporal occurrence of disease such as temperature, rainfall and other environmental factors. Ecological conditions and evolutionary dynamics. Disease ecology based explanatory and predictive models. Elucidation of natural history and host-parasite interactions linked to the ecological factors.

Unit III

Ecology of vector borne diseases. Vector dynamics and ecology. Study extrinsic incubation period. Understanding of critical risk factors of spread such as timing, distribution, abundance of competent vectors.

Unit IV

Study of cyclical patterns of disease. Mapping environmental conditions with disease. Establishing functional links between environmental modifications and disease. Linking climate change with disease occurrence. Study of dynamics of ENSO with climate change and disease. Evolution of disease alert and forecasting systems. Use of global positioning and remote sensing tools for disease management. Early warning and GIS based disease predictions.

VI. Suggested reading

- Norrgren L and Levengood JM. eds., 2012. *Ecology and Animal Health* (No. 2). Baltic University Press.
- Waltner-Toews, David. 2007. *The Chickens Fight Back: Pandemic Panics and Deadly Diseases that Jump from Animals to Humans*. Vancouver: Greystone Books
- World Health Organization. 2013. "*Zoonoses and Veterinary Public Health*." WHO

I. Course Title : Diagnostic Approaches in Epidemiology

II. Course Code : VPE 711

III. Credit Hours : 2+1

IV. Aim of the course

Learning of recent advanced molecular techniques for establishing disease diagnosis.

V. Theory

Unit I

The concept of molecular basis of a disease, molecular determinants of pathogenicity of infectious agents and their transmissibility to susceptible populations of livestock and poultry.

Unit II

Laboratory biosafety, Antigenic, Genetic and Biological characterization of field isolates of pathogens incriminated in field outbreaks, Differentiation of field and Vaccine strains, the concept of Marker vaccines, and Correlation of pathotypes and genotypes of a pathogen.

Unit III

Immunological tests, immunoblotting techniques and use of

monoclonal antibodies in different ELISAs for antigenic analysis. Application of nucleic acid-based assays, viz., polymerase chain reaction (PCR) assays, nucleotide sequencing, restriction endonucleaseanalysis and RFLP analysis for genomic characterization using the field material directly or after extraction of nucleic acid from small scale cultures, use of radio-actively labelled or non-radioactive oligo-nucleotide probes in dot-blot and Southern hybridizations.

VI. **Practical**

Finger printing of the nucleic acid obtained from field isolates and their comparative analysis. PCR and ELISA for screening of field samples.

VII. **Assignment**

Each student shall select at least two recent articles from journals related to the course and discuss the same in the class through presentation.

VIII. **Suggested reading**

- Boniolo G and Nathan MJ. eds., 2016. *Philosophy of molecular medicine: Foundational issues in research and practice*. Taylor and Francis.
- Pfeiffer D. 1998. *Veterinary Epidemiology. An Introduction. Institute of Veterinary*, *Animal and Biomedical Sciences*. Massey University, Palmerston, New Zealand.
- Stites DP, Stobo JD, Fundenberg HH and Wells JV. 1982. *Basic and Clinical Immunology*, 4th Edition. Lange Medical Publications, Los Altos, USA.
- Thrusfield M. 2018. *Veterinary Epidemiology,* John Wiley and Sons.

I. **Course Title : Surveys, Surveillance and Data Management**

II. **Course Code : VPE-712**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To demonstrate different methodologies and procedures involved in conducting survey and surveillance and collection of data, analysis and interpretation of data. Systematic data collection, analysis and management

V. **Theory**

Unit I

Robust survey: Planning, Statistical models for the same and Surveillance, Purpose and method of sampling, Size of sample, Questionnaires. State, National and International agencies (OIE,

CDC, etc.), their data bases and their management systems.

Unit II

Goals and types of surveillance, monitoring, mechanism of surveillance and surveillance network.

Unit III

Disease/ data recording and reporting, vet. recording schemes, vet. information system and data bases.

Unit IV

Emergence of new diseases and re-emergence of old diseases. Epidemiology of globally and nationally important emerging/ re-emerging diseases and designing of strategies for their prevention and control.

VI. **Practical**

Prepare questionnaires on selective topics, survey for livestock and poultry farmers to find out usefulness/ effectiveness of vaccination/ artificial insemination/ other practices, surveillance of important diseases in different parts of state, data analysis and presentation of data, development of suitable software.

VII. **Assignment**

Each student will select at least two recent articles from journals related to course and discuss the same in the class through presentation.

VIII. **Suggested reading**

- Hawker J, Begg N, Reintjes R, Ekdahl K, Edeghere O and Van Steenbergen JE. 2018. *Communicable disease control and health protection handbook*. John Wiley and Sons.
- Salman M. ed., 2008. *Animal disease surveillance and survey systems: methods and applications*. John Wiley and Sons.
- Thrusfield M. *Veterinary epidemiology*. John Wiley and Sons; 2018 Apr 30.

I. **Course Title : Special Problem**

II. **Course Code : VPE 790**

III. **Credit Hours : 0+1**

IV. **Aim of the course**

To provide expertise in handling practical research problem(s).

V. **Practical**

Short research problem(s) involving contemporary issues and research techniques. Presentation and discussion of novel research papers on the disease or intervention strategies such disease pathogenesis, pathobiology, epidemiology, host-agent-environmental relationships, molecular mechanisms/ diagnostics,

spatio-temporal trends, etc. Planning a short research problem or working on a published research paper or new developments.

Course Outline-cum-Lecture Schedule forDoctoral Degree Programme

I. **Course Title : Advances in Veterinary Public Health and Epidemiology**
II. **Course Code : VPE 701**
III. **Credit Hours : 2+1**

Lecture(s)	Topic
Theory	
1-3	Contemporary status of Veterinary Public Health in India and abroad. Public Health in the Twenty first Century
4	Veterinary public health and its role in the society
5-6	Role of veterinary public health professionals in prevention and control of zoonoses.
7	Opportunities for veterinary public health professionals
8-9	Organization and administration of veterinary public health agencies structure and functions
10-11	Data analysis framework in healthcare and social sectors
12-15	Evidence-based information updates on current VPH topics
16-17	Global animal disease surveillance
18-19	Recent diagnostic tools used for emerging public health problems including zoonoses
20-21	Molecular surveillance of recent pandemics of zoonoses
22-23	Modes of evolutionary emergence of disease agents pertinent to VPH
24-27	Application of bioinformatics, biotechnological and computational tools for food hygiene. food safety quality assurance environmental health protection
28-29	Global pandemic threat preparedness
30-31	Emerging Disease Surveillance and Control
32	Biomedical models in veterinary public health
Practical	
1	Assessment of health status of an individual
2-3	Estimation of disease burdens in a population
4-5	Estimation of burden of food-borne and zoonotic diseases
6	Molecular epidemiology and genetic analysis of agents of VPH significance
7	Case study related to field investigations of outbreaks of food poisoning
8	Case study related to zoonotic diseases in a community
9	Application of recent analytical methods (*in-vitro, invivo* and

in-silico techniques) used for public health research

10 Visits to hospitals to acquaint the students about public health related problems.

11 Health hazards across food supply chain

12 Hygiene of production/ processing of foods of animal origin1

13 Safety management at the large-scale production or processing units of foods of animal origin

14 Longitudinal and integrated food safety assurance

15-16 Assignment: Each student will select at least two recent articles from journals related to the course and discuss in the class through presentation

I. **Course Title : Emerging, Re-emerging Zoonoses and One Health**

II. **Course Code : VPE 702**

III. **Credit Hours : 2+1**

Lecture(s)	Topic
Theory	
1	Definitions – emerging and re-emerging zoonoses. Public health risks of emerging and re-emerging zoonoses
2	Status of emerging and re-emerging zoonotic infections
3	National and international interests in emerging and re-emerging zoonoses
4	Measurement of emerging and re-emerging zoonoses
5	Economics of emerging and re-emerging zoonoses
6	Factors responsible for emergence and re-emergence of zoonotic diseases
7	Role of wildlife in emerging and re-emerging zoonoses
8	Current concepts in the diagnosis of emerging and re-emerging diseases
9	Epidemiology and combating of emerging and re-emerging zoonotic diseases
10	Latest diagnostics and management planning for emerging and re-emerging zoonoses
11-12	Health threats at the human- animal-ecosystems/ environment interface (HAEI) - tripartite (OIE, WHO and FAO) initiatives
13	Comparative medicine and VPH - horizons and perspectives in emerging and re- emerging zoonotic infections
14	Current challenges and strategies in the area of

euzoonoses, xenozoonoses, nosocomial zoonoses and newer zoonotic agents

15-16 Characteristics, host range, epidemiology and management of Cat-scratch disease, Rat bite fever, Ebola and Marburg

17-18 Characteristics, host range, epidemiology and management of Lassa, Nipah, and Menangle viruses

19-20 Characteristics, host range, epidemiology and management of SARS, Toro, ZIKA and MERS virus infections

21 Characteristics, host range, epidemiology and management of zoonotic influenza viruses

22 Characteristics, host range, epidemiology and management of herpes and hepatitis (A and E) viruses

23 Characteristics, host range, epidemiology and management of co-infections, super-infections and syndemics - Simian and human immunodeficiency viruses

24 Characteristics, host range, epidemiology and management of taeniasis/ cysticercosis

25 Characteristics, host range, epidemiology and management of Bovine spongiform encephalopathy

26 Characteristics, host range, epidemiology and management of Creutzfeldt-Jacob disease

27 Characteristics, host range, epidemiology and management of brucellosis, tuberculosis and other emerging bacterial zoonoses

28 Guillain-Barre Syndrome and related sequel due to emerging/ re-emerging zoonoses

29-30 Close collaborations with regional, national and international organizations in the control of emerging/ re-emerging pathogens

31-32 Case study on emerging/ re-emerging zoonotic disease

Practical

1 Application of safety regulations in laboratories, hospitals and biological units for handling emerging/ re-emerging agents

2 Methods to elucidate epidemiology of emerging/ re-emerging zoonoses

3 Approach to establish role of wildlife in emerging/ re-emerging zoonoses

4 Epidemiology of drug resistant emerging/ re-emerging zoonotic agents

5 Establishing genetic basis of bacterial emerging/ re-emerging zoonoses
6 Establishing genetic basis of viral and prion emerging/ re-emerging zoonoses
7 Establishing genetic basis of fungal, rickettsial and chlamydial emerging/ re- emerging zoonoses
8 Recommended diagnostic testing (OIE) for emerging/ re-emerging zoonoses
9 Vaccination and other strategies for the prevention of emerging/ re-emerging zoonoses
10 Application of Novel molecular methods for the understanding of emerging/ re- emerging zoonoses
11 Study abundance, behaviour, profiling and dynamics of vectors associated with emerging/ re-emerging zoonoses
12 Institutional surveillance of emerging/ re-emerging zoonoses
13 Visits to health centre to study of zoonotic diseases and categorization of agents as emerging/ re-emerging zoonosis
14 Special problem related to emerging/ re-emerging or prevalent zoonotic diseases
15-16 **Assignment:** Each student will select at least two recent articles from journals related to course and discuss in the class through presentation

I. **Course Title : Advances in Food Safety and Quality Control of Foods of Animal/ Aquatic Origin**
II. **Course Code : VPE 703**
III. **Credit Hours : 2+1**

Lecture(s) Topic

Theory

1 Food supply chain dynamics
2 Food production, processing and handling practices
3 Food safety and quality assurance of foods of animal origin
4 New age voluntary and mandatory food standards
5 Types and evolution of food standards
6 Characteristics of food safety hazards
7-8 Quality control, assurance and food safety specifications for animal origin foods such as meat, milk, egg and fish
9-10 Recent innovations in shelf-life extension, preservation and packaging

11 Requirements for food testing and calibration Laboratory Mechanism of food spoilage (microbial and non-microbial)
12 Nature of major food-borne infections and intoxications
13 Elimination of food safety hazards from primary production systems
14 Rapid detection of food safety hazards
15 Impact of animal feed on food safety. Prevention and control of risks arising due to animal feeds
16 Coordination of surveillance policies in animal health and food safety
17 Food safety challenges in animal production systems affecting global markets
18 Quality assurance schemes applicable to foods of animal origin
19 Veterinary services for public health and consumer safety
20 Food safety risk assessment
21 National food control systems and its elements
22 Genesis of food quality/ safety standard
23-24 Food quarantine and export guidelines, specifications and standards
25 National and international food safety compliances
26 Traceability system - Traceability of foods of animal origin
27 Global considerations and role of committees and agencies associated with food safety, quality control and quality assurance
28 Trends in green technologies in food production and processing
29 Waste reduction along the food supply chain
30 Impacts and performance of organic farming *vis-a-vis* conventional farming
31 Consumer perspectives of food quality and safety
32 Environmental impact assessment of production of foods of animal origin

Practical

1-2 Detection, enumeration and identification of food safety hazards
3 Pre-requisite programs for ensuring food safety
4 Environmental impact assessment
5 Application of generic traceability system for foods of animal origin

6 Detection of allergens associated with foods of animal origin
7 Emerging technologies for microbial control in food processing
8-9 Methods of management of waste arising from production and processing units (foods of animal origin including aquaculture)
10 Rapid alert system for food and feed
11-12 Visit to food processing establishments
13-14 Special problems on quality and safety of foods of animal origin foods
15-16 Assignment: Each student will select at least two recent articles from journals related to course and discuss in the class through presentation

I. **Course Title : Biosecurity and Occupational Health Safety**
II. **Course Code : VPE 704**
III. **Credit Hours : 2+1**

Lecture(s) Topic

Theory

1 Definitions: Bio-safety, bio-security and bio-containment; physical, chemical and biological hazards
2 Elements of bio-security and bio-containment
3 Nature of physical, chemical and biological hazards at work places
4-5 Bio-security requirements, Containment Barriers
6-7 Laboratory and equipment safety
8 Risk assessment
9 Bio-safety levels
10-11 Bio-safety in microbiological and bio-medical laboratories
12-13 Risk groups, classification of organisms by risk groups
14 Classification of occupational groups
15 Laboratory designs - Biosafety Level 1/ Animal Biosafety Level 1
16 Laboratory designs - Biosafety Level 2/ Animal Biosafety Level 2
17 Laboratory designs - Biosafety Level 3/ Animal Biosafety Level 3
18 Laboratory designs - Biosafety Level 4/ Animal Biosafety Level 4
19-21 Transmission, spread, maintenance and control of diseases affecting various occupational groups in contact with animals and their public health significance

22-23 Diseases associated with various occupations
24 Occupational safety and health
25 Occupational Health and Safety (OHS) management system standard ISO 45001
26 Regulations pertaining to the Occupational safety and health
27 Occupational Safety and Health Administration
28 Risk group classification, Bio-risk Management
29 Classification of infective microorganisms by risk groups
30 Institutional Biosafety Committees (IBCs)
31 The Bio-medical Waste Management (Amendment) Rules, 2018
32 International Labour Organization and its occupational safety provisions, Research Ethics and Compliance

Practical

1 Standard laboratory practices
2 Handling of Bio-safety cabinets
3-4 Detection of occupational diseases of public health significance
5 Relation of risk group to biosafety levels, practices and equipment
6-7 Design of BSL-1 to BSL-4 laboratories
8 Survey of biosafety and biosecurity in biomedical laboratories
9-12 Transportation of dangerous pathogens/ samples – modes, guidelines and regulations
13 Activity spectrum of detergents and disinfectants
14 Personal protection, Bio-risk Assessment Sheet and Material Safety Data Sheet (MSDS)
15 Case study on occupational safety in specialized laboratories
16 Case study on biosafety level 3 or 4 laboratory

I. Course Title : Recent Concepts in Epidemiology and Disease Forecasting
II. Course Code : VPE 705
III. Credit Hours : 2+1

Lecture(s) Topic

Theory

1 Epidemiological concepts of disease occurrence in population
2 Variations in disease by time, place, and animal/ person

3 Recent epidemiological approaches for elucidating cause and effect
4 Variations: Role of error, bias, and confounding
5 The concept of risk/ risk factor in relation to the disease
6 Characterization and quantification of risk in epidemiology
7 Concepts in the measures of disease frequency
8 Analysis and integration of data for epidemiological methods/ techniques
9 Concepts in epidemiological study designs
10 Recent concepts in the epidemiology of economically important bacterial animal diseases of the region (haemorrhagic septicaemia, brucellosis, etc)
11-12 Recent concepts in the epidemiology of economically important viral animal diseases, viz., FMD, Swine fever, Avian Influenza, Sheep Pox, IBD, NCD and others of the region
13-14 Recent concepts in the epidemiology of economically important fungal, parasitic and other animal diseases of the region
15 Geographical Information System (GIS)
16 Advancements in GIS technology for epidemiological application in Veterinary and Animal Sciences
17 Various expert systems and their role in epidemiology
18 Concepts in animal disease modelling, Animal disease modelling, Disease prediction models
19 Modelling of economically important animal diseases
20 Modelling of emerging zoonotic infections
21 Advances in disease forecasting
22 Application of advanced disease forecasting concepts for animal/ zoonotic diseases
23 Disease early warning systems
24 Global and national disease early warning systems
25 Epidemiological softwares and their applications related to animal/ zoonotic infections
26 Common software packages and databases used in veterinary practice
27 Epidemiological Concepts Regarding Disease Monitoring and Surveillance
28 Advances in the practice of Public Health Surveillance
29 Real-time animal tracking using global positioning systems (GPS)
30 Use of advanced computing and remote sensing/ satellite

technology for the study of animal/ zoonotic diseases

31 Case study related to application of recent epidemiological tool

32 Case study related to disease forecasting

Practical

1 Use of Geographical Information System to study epidemiology of disease

2 Disease expert systems for animal/ zoonotic diseases

3 Disease modelling for animal/ zoonotic diseases

4 Model designing for disease forecasting

5 Study of epidemiology of disease outbreaks using advanced epidemiological techniques

6 Investigation of animal/ zoonotic diseases using recent epidemiological tools

7 Advanced disease reporting system

8 Study of animal/ zoonotic diseases using advanced computing tools

9 Study of animal/ zoonotic diseases using remote sensing/ satellite technology

10 Risk mapping for animal/ zoonotic diseases

11-12 Epidemiological exercises of economically important diseases of the region

13 Use of artificial intelligence and neural networks in veterinary epidemiology

14 Integrated disease surveillance system – prototype development

15 Case study related to advanced epidemiological tool

16 Case study related to advanced disease forecasting/ modelling

I. **Course Title : Risk Analysis and Predictive Modelling**

II. **Course Code : VPE 706**

III. **Credit Hours : 2+1**

Lecture(s) Topic

Theory

1 Definitions, History of risk analysis

2 Relevance of risk analysis (RA) to food sector

3 Principles of risk analysis

4 Risk analysis components (risk assessment, management and communication)

5 Risk assessment

6 Risk management

7 Risk communication
8 Microbial Risk Assessment (MRA) involving hazard identification, exposure assessment, hazard characterization, and risk characterization
9 Hazard identification
10 Exposure assessment
11 Hazard characterization
12 Risk characterization
13 Methodologies used in risk analysis (RA)/ Microbial Risk Assessment MRA
14 Qualitative and quantitative risk analysis
15 Qualitative risk analysis
16 Quantitative Microbial Risk Assessment (QMRA) for foods of animal origin including water
17 Application of mathematical models to study propagation of microbial hazards from farm-to-fork
18 Risk-based decision-making
19 Variability and uncertainty inherent to biological data
20 Measurement and modelling of uncertainty and variability during risk assessment.
21 Integration of risk assessment/ risk analysis with HACCP and other quality management or assurance systems
22 Linking microbial food safety with risk assessment
23 Relevance of assumptions and observed data for predictive models
24 Study of software packages used for risk analysis
25 Mathematical modelling of microbial growth rate in food/ feeds
26 Predictive modelling tools for food safety management
27 Microbial modelling for the prediction of product shelf-life and safety
28 Applications of predictive modelling of microbial behavior in foods
29 Meta-analysis in risk analysis of animal/ zoonotic diseases
30 Risk prediction models
31 Multivariate prediction models
32 Case study related to MRA of foods of animal origin

Practical

1. Microbial Risk Assessment (MRA)
2. Risk assessment
3. Risk management
4. Risk communication

5. Qualitative MRA
6. Quantitative MRA
7. Modelling of infectious diseases using computational and mathematical methods.
8. Building and analyzing models of infectious diseases
9. Study of population-level processes for infectious diseases of animals and humans
10. Performing risk analysis for food safety hazards using microbial risk analysis tools
11. Risk assessment using high throughput simulation modelling
12. Investigation of uncertainty, variability and sensitivity analysis techniques using computer models
13. Risk prediction models – study of prototype
14. Meta-analysis – study of prototype
15. Multivariate prediction models – study of prototype
16. Case study on MRA

I. Course Title : Advances in Environmental Hygiene
II. Course Code : VPE 707
III. Credit Hours : 2+1

Lecture(s) Topic

Theory

1 Current status of problems pertaining to environmental hygiene
2 Status, impact and management of air pollution
3 Status, impact and management of global warming
4 Status, impact and management of soil pollution
5 Status, impact and management of water pollution
6 Status, impact and management of environmental problems
7 Impact of pollution on the ecology of diseases
8 Environmental impact of intensive animal husbandry
9 Impact of intensive animal husbandry on the public health
10 Animal sector consequences of carbon footprints
11 Eco-philosophy, policy and advocacy of environmental hygiene with veterinary/ animal husbandry perspectives
12 Environmental economics
13 Environmental conflicts and cooperation
14 Ethics and compliance - sustainable animal husbandry and environmental safety

15 Disinfects and disinfection procedures
16 Environmental risk analysis (assessment and management)
17 Occupational health impact of animal farming
18 Occupational environmental hygiene and safety linked to animals
19 Health risk profiling and risk analysis of animal farming and trade
20 Epidemiology of chronic occupational disease induced by environmental pollution
21 Ecotoxicology of toxicants used in the farming
22 Bio-accumulation, concentration and bio-magnification of pollutants, toxicants and hazardous substances in the environment
23 Reporting of environmental issues and global informatics
24 Environmental hazard surveillance and monitoring systems
25 Decision making and public awareness
26 Role of VPH in National Sanitation Programmes (Swachh Bharat Abhiyan and other governmental programmes)
27 International environmental management efforts
28 International organizations and programmes
29 Legislations on environmental hygiene, safety and policy
30 Case study on ammonia as pollutant from animal sector
31 Case study on hydrogen sulphide as pollutant from animal sector
32 Case study on methane as pollutant from animal sector

Practical

1 Hygiene and sanitization of animals and animal premises
2 Detection and monitoring of pollutants emanating from animals to the air Detection and monitoring of pollutants emanating from animals to the soil
3 Detection and monitoring of pollutants emanating from animals to the water
4 Detection and monitoring of pollutants emanating from animals to other environmental sources
5 Advanced environmental hazard measurement methods
6 Measurement of health effects of environmental toxicants
7 Environmental risk assessment methods
8 Risk analysis of animal contributed ammonia
9 Risk analysis of animal contributed hydrogen sulphide

10 Risk analysis of animal contributed methane
11 Risk analysis of animal contributed other environmental hazards
13-14 Visits to remediation unit, waste water treatment plant, sewage treatment plants, tannery, etc. to study characteristics, impact and mitigation of hazards and associated risks
15-16 Assignments: Each student will select at least two recent articles from journals related to course and discuss in the class through presentation

I. **Course Title : Herd Health Management and Disease Economics**
II. **Course Code : VPE 708**
III. **Credit Hours : 2+1**

Lecture(s) Topic

Theory

1 General principles of herd health
2 Interaction between health and production
3 Health effects of animal and zoonotic infections at the farm level
4 Direct and indirect losses due to zoonotic diseases
5 Components of the economic impact of animal diseases
6 Herd health management and disease economics
7 Linking heard health with economics – margin of returns
8 Health effects of animal and zoonotic infections at the regional/ state/ national/ international level
9 Interactions between health, production and disease
10 General principles of enhancing herd immunity
11 Economic methods of disease control for decision support
12 Herd health management – intervention options and their economic assessment
13 Quantification of financial effects of animal disease
14 Methods for optimizing decisions at individual animal, herd and population levels
15 Determination of costs and benefits of disease control measures
16 Estimation of extent of the disease and potential spread
17 Economic aspects and impact of zoonotic diseases
18 Estimation of cost of animal/ zoonotic disease on livelihoods outcomes (income, health, and trade), including environmental impacts

19 Assessment of the cost-effectiveness of control strategies used to reduce the risk of animal/ zoonotic diseases
20 Identification of factors affecting adoption of zoonotic risk reduction strategies
21 Estimation of disability adjusted life years (DALYs) parameters
22 Herd health management and disease economics of diseases in cattle/ buffalo
23 Herd health management and disease economics of diseases in sheep/ goat
24 Herd health management and disease economics of diseases in swine
25 Herd health management and disease economics of diseases in poultry
26 Herd health management and disease economics of diseases in other livestock
27 Preventive healthcare through vaccination
28 Preventive healthcare through bio-security practices
29 Economic benefits of prevention and control of diseases
30 Zoning and creation of disease-free area
31 Disease eradication and surveillance
32 Case study on eradiation of disease–Economic perspectives

Practical

1 Study of framework of animal health management
2 Steps and methods for assessment of the economic impact of a disease
3 Assessing economic merit of interventions to control disease
4 Decision analysis and decision support systems for promoting animal health
5 Modelling animal health economics
6 Modelling the economics of Veterinary Services at the Farm Level
7 Modelling the economics of National Disease Control Programs
8 Economic modelling techniques (i.e. partial budgeting, cost-benefit analysis, decision analysis, and systems simulation) for veterinary decision making
9 Economic assessment of problems, programmes, prevention/ control measures, impact, etc.
10 Economic evaluation of hygienic practices in the animal house

11 Estimation of burden of animal/ zoonotic diseases
12 Estimation of DALY and other disease parameters
13 Case study on economic impact of zoonotic diseases
14 Visit to various livestock farms, assessment of their problems
15-16 Assignments: Each student shall select at least two recent articles from journals related to course and discuss in the class through presentation

I. Course Title : Epidemiology of Trans-boundary, Non-infectious and Chronic Diseases
II. Course Code : VPE 609
III. Credit Hours : 2+1

Lecture(s) Topic

Theory

1 Definition and characteristics of trans-boundary diseases
2 Global trends in the occurrence of trans-boundary diseases
3 Role of wildlife in emergence of trans-boundary diseases
4 Prevention/ control of trans-boundary diseases
5 Important trans-boundary diseases categorized according to the aetiology
6 Important trans-boundary diseases categorized according to the animal species
7 New Technologies to fight transboundary animal diseases
8 Role of veterinary public health and veterinary services in the management of non-infectious and chronic diseases
9 Establishment of causality and associations in non-infectious and chronic diseases
10 Characteristics of Koch's/ Henle-Koch postulates and Evans' rules of disease causation
11 Unified principles of establishing causality for both infectious and non-infectious diseases
12 Infectious and chronic disease connections
13 Causal role of infectious agents in cancer (relating criteria)
14 Global status of non-communicable diseases
15 Establishment of trends of non-infectious and chronic disease occurrence
16 Epidemiology of non-infectious and chronic diseases affecting different species (livestock/ poultry) and

production systems

17 Determinants of chronic and non-infectious diseases-reasons for emergence range of pathways and epidemiology

18 Study of characteristics of risk factors (genetic, physiological, environmental, behavioural, etc) associated with non-infectious and chronic diseases

19 Demographic, epidemiological and nutritional factors

20 Economic impact of chronic and non-communicable diseases

21 Social determinants of non-communicable diseases

22 Spatial and temporal epidemiology of nutritional and metabolic diseases

23 Spatial and temporal epidemiology of reproductive diseases

24 Spatial and temporal epidemiology of chemical poisonings and toxicities (pesticides, poisonous plants, etc)

25 Spatial and temporal epidemiology of neoplastic and other miscellaneous diseases

26 Modelling of non-infectious non –communicable diseases or chronic diseases

27 Trends in the prevention and control of non-infectious and chronic disease – current status and future perspectives

28 Early detection, notification and surveillance

29 Participatory surveillance

30 Case study on vector-borne trans-boundary diseases

31 Case study on non-infectious chronic livestock disease

32 Case study on emerging/ re-emerging zoonotic trans-boundary diseases

Practical

1 Detection and characterization of trans-boundary diseases

2 Capacity building and training

3 Study of the role of wildlife in trans-boundary animal diseases

4 Wildlife disease surveillance

5 Study of wildlife–livestock interface and disease ecology

6 Disease investigation - data and information collection, collation and sharing

7 Surveillance for trans-boundary diseases

8 Measurement of burden of non-infectious and chronic diseases (mortality, morbidity, survival, risk factors, etc.)

9 Survey of non-infectious and chronic diseases

10 Animal models for the study of non-infectious and chronic

diseases

11 Establishment of evidence/ proof of causation of non-infectious and chronic diseases
12 Study of risk factors associated with non-infectious and chronic diseases
13 Measurement of socioeconomic impacts associated with non-infectious and chronic diseases
14 Controlled trials involving contemporary non-infectious and chronic diseases
15 Undertaking short research problem(s)
16 Case study on trans-boundary/ chronic livestock diseases

I. **Course Title : Ecology and Animal/ Human Health**
II. **Course Code : VPE 710**
III. **Credit Hours : 2+0**

Lecture(s) Topic

Theory

1 Definitions related to ecology and animal or human health
2 Linkage between human/ animal health and the ecosystem
3 Spill-over of diseases – elucidation of social and ecological basis of disease
4 Assessment of changing trends in the environments and its impact on the animal/ human health
5 Study of emerging public health threats linked to the changes in the environment
6 Study of landscape epidemiology of diseases
7 Study of contemporary issues centred on ecological and evolutionary perspectives of infectious diseases
8 Animal–human-ecosystem interface
9 Study of ecological/ environmental factors influencing spatio-temporal occurrence of disease such as temperature, rainfall and other environmental factors
10 Ecological conditions and evolutionary dynamics
11 Disease ecology based explanatory and predictive models
12 Elucidation of natural history and host-parasite interactions linked to the ecological factors
13 Ecology of vector borne diseases
14 Vector dynamics and ecology
15 Study extrinsic incubation period

16 Understanding of critical risk factors of disease spread – timing, distribution, and abundance of competent vectors
17 Study of cyclical patterns of disease
18 Mapping environmental conditions with disease
19 Establishing functional links between environmental modifications and disease
20 Linking climate change with disease occurrence
21 Impact of climate change on disease occurrence
22 Study of dynamics of ENSO with climate change and disease
23 El Niño/ Southern Oscillation (ENSO), influence on global climate variability and disease occurrence
24 Evolution of disease alert and forecasting systems
25 Use of global positioning and remote sensing tools for disease management
26 Early warning and GIS based disease predictions
27 Role of bio-security measures in curtailing transmissible diseases at the animal- animal, animal-human and human-human interface
28 Biology and ecology of vector-borne diseases – ecology of disease – the intersection of human and animal health
29 Impact of ecological/ environmental factors on the emergence of human/ animal diseases
30 Clusters of disease outbreaks
31 Environmental impact of antimicrobial resistance
32 Preparedness for combating the impacts of climate change

I. Course Title : Diagnostic Approaches in Epidemiology
II. Course Code : VPE 711
III. Credit Hours : 2+1

Lecture(s) Topic

Theory

1 Concepts of molecular basis of a disease
2 Molecular epidemiology of diseases/ infections
3 Molecular determinants of pathogenicity and virulence amongst agents
4 Dynamics of disease transmissibility in populations of livestock and poultry
5-6 Epidemiology of antigenic, genetic and biological diversity amongst pathogens associated with disease/ outbreaks
7 Differentiation of field isolates (wild) from vaccine strains

(markers, DIVA, etc).

8 Marker vaccine development

9 Detection and characterization of pathotypes, serotypes, biotypes and genotypes of pathogens

10 Understanding epidemiology of disease using immunological, immunoblotting and monoclonal antibody-based tests

11 Understanding epidemiology of disease using conventional and rapid enzyme immune assays. Use of monoclonal antibodies in different ELISAs for antigenic analysis

12 Understanding epidemiology of disease using pathogen typing methods, viz., polymerase chain reaction, sequencing, RFLP, etc.

13 Understanding epidemiology of disease using radio-actively labelled or non- radioactive oligo-nucleotide probes - dot-blot and Southern hybridizations

14 Evaluation of diagnostic tests/ assays using epidemiological approaches

15 Vaccine efficacy/ effectiveness trails

16 Epidemiology of screening and confirmatory diagnostic assays

17 Estimation of disease burden in populations

18 Estimation of frequency and pattern of health events in a population

19 Designing of epidemiological studies

20 Representation disease data/ information

21 Study of disease databases and online resources

22 Quantification of zoonotic agents using conventional and molecular tools

23 Rapid detection of foodborne and zoonotic agents

24 On-site, on-farm and animal-side detection systems-approaches and applications

25 Phylogenetic analysis of disease agents

26 Use of modern bio-informatics and disease informatics tools for the study of zoonotic and other determinants of public health significance

27 Source tracing of origin of infectious agents

28 Outbreak investigation and disease reporting including notifiable diseases

29 Traceability of livestock and its implications

30 Multi-centric molecular typing and validation of foodborne and zoonotic agents

31 Epidemiology of chronic disease makers
32 Case study on quantitative epidemiological analysis

Practical

1 Molecular fingerprinting of pathogens
2 Molecular epidemiology of foodborne and zoonotic agents
3-4 Detection and characterization of pathogens using nucleic acid based techniques
5 Sero-epidemiology – methods and applications
6-7 Multi-locus sequence typing (MLST), pulsed-field gel electrophoresis (PFGE), and amplified fragment length polymorphism (AFLP) typing of pathogens
8 Source tracing of outbreaks
9 Construction and characterization of epidemic curve
10 Spatio-temporal clustering of diseases
11 Mapping disease and risk factors
12 Calculation of variables and confounders using logistic regression analysis
13 Epidemiological analysis for the disease prediction, early warning and forecasting
14 Epidemiological analysis involving remote sensing, GIS and satellite technologies
15-16 Assignment: Each student shall select at least two recent articles from journals related to the course and discuss in the class through presentation

I. **Course Title : Surveys, Surveillance and Data Management**
II. **Course Code : VPE 712**
III. **Credit Hours : 2+1**

Lecture(s) Topic

Theory

1 Robust survey: planning, statistical models. Survey iceberg (tools and technologies).
2 Structured population-based surveys, types of surveys.
3 Survey design - Sampling, Sampling methods, Sample size, etc.
4 National surveys.
5 Surveillance – definition, goals and types of surveillance system.
6 Principles of surveillance.
7 Critical elements of surveillance.
8 Surveillance methods and approaches.
9 Surveillance for distribution and occurrence of infection.

10 Information architecture for surveillance.
11 Structured non-random surveillance.
12 Surveillance programmes. Designing an active surveillance program.
13 Surveillance to demonstrate freedom from disease or infection.
14 Epidemiological surveillance network.
15 Components of regional or national surveillance system.
16 Statistical models for surveillance.
17 Softwares used for surveillance.
18 State, National and International agencies (OIE, CDC, etc.), databases and management systems.
19-20 Surveillance of emerging and re-emerging diseases
21 Animal health surveillance
22 Data and database
23-24 Data acquisition - Sampling and questionnaires
25 Disease/ data recording and reporting
26 Veterinary data recording schemes and information system (databases)
27 National veterinary epidemiology and disease informatics
28-29 Epidemiology informatics on globally and nationally important emerging/ re- emerging diseases and designing of strategies for their prevention and control.
30 Analysis of disease data using software analysis
31 Study of veterinary epidemiology and disease informatics software (e.g. EpiInfo)
32 Case study on disease surveillance

Practical

1 Data collection, storage and quality control
2 Sampling methods - confidence level, sample unit, sample size, etc.
3 Statistical methods for analysis of disease data
4 Preparation and analysis of questionnaires
5 Questionnaire survey for disease prevalence
6 Data analysis using computer software
7 Data analysis and representation of data pertaining to animal disease/ productivity
8 Survey for livestock and poultry diseases
9 Study/ development of computer software for animal disease/ productivity
10 Evaluation of veterinary/ animal husbandry interventions
11 Evaluation of animal disease surveillance systems
12 Study of national health surveys related to animal/

human disease

13 Surveillance of economically important disease of the region/ state

14 Usefulness/ efficacy/ effectiveness of vaccines/ vaccination

15-16 Assignment: Each student will select at least two recent articles from journals related to course and discuss in the class through presentation

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Public Health and Epidemiology

VPH administration; organization, administration and implementation of VPH services/ programs; structure and function of VPH agencies/organizations of national and international importance. VPH team, administration and functions; responsibilities of veterinarians in public health team. Scope, objective and area of activities of One Health. Purpose for creation of Veterinary Public Health and Epidemiology. Definition and classification of zoonoses, factors affecting the occurrence of zoonoses; disease management strategies, disease burden on population and socioeconomic impacts. To impart knowledge on epidemiology, etiology, transmission pattern, public health significance, diagnosis and management of important prevalent, emerging and re-emerging zoonotic diseases caused by bacteria, viruses, fungi, parasites, rickettsia, chlamydia and prion. Bioterrorism. Major agents used as biological weapons, hazard analysis and combating bioterrorism.

Importance and objectives of milk hygiene. Milk-borne diseases of public health significance. Milk allergy-lactose intolerance. Residues of pesticide and antibiotics in milk and its impact on human health. Milk spoilage. Milk adulteration, synthetic milk. Milk plant hygiene and sanitation. Objectives and importance of meat hygiene. Hygienic practices at farm and during transportation of food animals including poultry. Hygienic meat production, Adulteration, Speciation, spoilage and preservation of meat. Meat-borne diseases of public health significance. Treatment and safe disposal of slaughter-house by-products. Hygienic practices in abattoirs. An introduction to fish, fisheries and ichthyology. Fish-borne diseases of public health significance. Definitions of Food borne infection, food intoxication, bacterial toxins, toxi-infection etc. Measures employed for prevention and control of food borne diseases. Epidemiology, diagnosis and management of bacterial and viral food-borne infections and intoxications. Seafood toxins, mycotoxins, biocides, plant origin toxins, heavy metals, veterinary drugs, hormones etc. in foods. Anti-microbial resistance (AMR) in food borne pathogens, National, international, private standards and regulations and legislation enacted for quality food production. GSP, GMP, HACCP and ISO 22000 etc.

Introduction to environment, environmental hygiene, pollutants, contamination of environment with heavy metals, pesticides, veterinary drug residues and its impact on animal/human health. Microbial pollution. Vector and Reservoir control, Environmental risk assessment and management. Pollutions of soil, air and water and its effects on health. Impact of noise pollution on health. Genetic risk from environmental agents, health problems due to nuclear energy, microwave, electro-magnetic and other radiation pollution, environmental estrogens, pesticides pollution. Dissemination of excreted pathogens, animal-waste and human risk, principles of safe disposal of bio-medical waste and recycling of wastes. National and international pollution

control agencies, regulations and its role in management of environmental pollution. Definitions, natural and man- made disaster, impact analysis and classification of disaster scale, essential preparations to manage disaster, role of central, state and local government bodies in disaster management, role of veterinarians/ veterinary public health personnel during emergency/ disaster and sequence of emergency medical services. Effect of natural disasters like floods, prolonged draughts, forest fires, earthquakes, tsunami and tidal damages, storms etc. on human as well as animal population, post-disaster disease susceptibility and remedial measures.

Historical perspective and scope of veterinary epidemiology. Theories of disease causation and advancement in the concepts of disease causation, Iceberg concept. Koch's postulates of disease causation. Epidemiological triangles, disease causing wheels, webs and pies, definitions of epidemic, endemic, pandemic and sporadic diseases. Qualitative and quantitative approaches to epidemiology. Measurement of disease. Endemic stability and herd immunity, basic reproductive ratio, trends and spatial distribution of disease, epidemic curve and their utility, Transmission of disease and role of ecology in maintenance of disease agents.

Type of epidemiological methods. Landscape and molecular methods used in the epidemiological investigation. Epidemiological Studies-Observational (Case-control, cohort and cross-sectional studies) and experimental studies (field and clinical trials). Disease surveys, monitoring and surveillance. Epidemiological data bases. Definition, scope and limitation of serological epidemiology and interpretation of results. Characteristics of ideal serological test, multiple testing and evaluation of tests. Investigation of disease outbreaks and outbreak investigation protocol. Food- poisoning outbreak investigation and management. Strategies of disease control and eradication.

Introduction to applied epidemiology. Models, modelling and types of models. Epidemiological and economic models. Principles and classification of models. Deterministic and stochastic models. Empirical and explanatory models. Application of models in disease forecasting. Modelling in disease prevention and control.

Disease occurrence, ecology of disease. Path, regression and discriminate analyses. Animal disease economics (cost-benefit analysis, internal rate of return, payback period, partial budgeting), decision analysis. Bayesian analysis. Monte-Carlo and Markovian processes and system evaluation. Uses of multivariate analysis. Disease outbreaks, participatory epidemiology, Disease reporting system, tracing and notification. Disease control strategies, risk assessment, exotic diseases, trans-boundary diseases, vaccination. Disease intelligence. Tele-epidemiology. Remote sensing, geographic information system, disease surveillance and early warning system/disease forecasting.

International organizations and laws regulating animal diseases. Vaccines and vaccination. Biosecurity– definition, importance, methods used for

pathogen inventory, food processing, /quarantine units/animals/poultry farms etc. Biomedical hazards and biosafety in the laboratories. Occupational health risk and its management. Designing of a questionnaire, Disease free zones and zero disease concept. Molecular basis of a disease, application of nucleic acid based assays for genomic characterization of field isolates vis-à-vis vaccine strains. Uses and evaluation of diagnostic assays.

Veterinary Pharmacology and Toxicology

DEPARTMENT OF VETERINARY PHARMACOLOGY AND TOXICOLOGY

Course Structure for M.V.Sc. degree programme (Semester wise)

Course No.	Course title	Credit	Semester
VPT 601*	CONCEPTS OF PHARMACOLOGY, DRUG DESIGN AND DEVELOPMENT	2+0	I
VPT 602*	AUTONOMIC AND AUTACOID PHARMACOLOGY	2+1	I
VPT 603	CNS PHARMACOLOGY	2+1	II
VPT 604	DIGESTIVE AND RESPIRATORY PHARMACOLOGY	2+1	I
VPT 605	CARDIOVASCULAR AND URINARY SYSTEM PHARMACOLOGY	2+0	II
VPT 606	ENDOCRINE AND REPRODUCTIVE PHARMACOLOGY	2+1	II
VPT 607*	CHEMOTHERAPY	2+1	I
VPT 608*	TOXICOLOGY OF XENOBIOTICS	2+1	II
VPT 609	TOXINOLOGY	2+1	I
VPT 610*	PHARMACOLOGICAL TECHNIQUES	0+2	I
VPT 611*	TECHNIQUES IN TOXICOLOGY	0+2	II
VPT 612	ETHNOPHARMACOLOGY	1+1	I
VPT 613	FUNDAMENTALS OF PHARMACOKINETICS	1+1	II
VPT 691	MASTER'S SEMINAR	1+0	I and II
VPT 699	MASTER'S RESEARCH	0+30	I and II
*Compulsory Courses			

DEPARTMENT OF VETERINARY PHARMACOLOGY AND TOXICOLOGY
Course Structure for PhD degree programme (Semester wise)

Course No.	Course Title	Credit Hours	Semester
VPT 701*	MOLECULAR PHARMACOLOGY	3+0	I
VPT 702	ADVANCES IN AUTACOID PHARMACOLOGY	1+0	I
VPT 703	PHARMACOLOGY OF HERBAL DRUGS	2+1	II
VPT 704	BIOTRANSFORMATION OF XENOBIOTICS	2+0	II
VPT 705*	CLINICAL PHARMACOLOGY AND PHARMACOKINETICS	2+1	I
VPT 706	PHARMACOGENOMICS	2+0	I
VPT 707	IMMUNOPHARMACOLOGY AND IMMUNOTOXICOLOGY	2+0	I
VPT 708	MOLECULAR TOXICOLOGY	3+0	II
VPT 709*	CLINICAL TOXICOLOGY	2+1	II
VPT 710	ECOTOXICOLOGY	3+0	II
VPT 711	REGULATORY TOXICOLOGY	2+1	I
VPT 790	SPECIAL PROBLEM	0+1	I and II
VPT 791	DOCTORAL SEMINAR I	1+0	I and II
VPT 792	DOCTORAL SEMINAR II	1+0	I and II
VPT 799	DOCTORAL RESEARCH	0+75	I and II
*Compulsory Courses			

Course Contents

M.V.Sc. in Veterinary Pharmacology andToxicology

I. **Course Title : Concepts of Pharmacology, Drug Design and Development**

II. **Course Code : VPT 601**

III. **Credit Hours : 2+0**

IV. **Aim of the course**

To study the basic concepts of drug actions, and drug design and development.

V. **Theory**

Unit I

Scope of pharmacology, Drugs and other therapeutic agents, Principles of biopharmaceutics and veterinary dosage forms, Dynamics of ADME; Principles of therapeutics; Rationale and Empirical, Various other types of therapeutics.

Unit II

Pharmacodynamics targets for drug actions (enzymes, ion channels, structural and transporter proteins) evidence of drug action through receptor, Signal transduction mechanisms (GPCR, enzyme linked receptor), Regulation and malfunctioning of diseases.

Unit III

Quantitation of drug-receptor interactions and elicited effects, Drug-drug interactions and adverse drug reactions.

Unit IV

Drug invention: Screening, Assaying, Designing and Development of drugs, Clinical trials, Drug safety, Regulations and standards; Gene based therapy and drug delivery system.

I. **Course Title : Autonomic and Autacoid Pharmacology**

II. **Course Code : VPT 602**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To study the pharmacological basis of the rapeutic uses of autonomic and autacoid drugs.

V. **Theory**

Unit I

Anatomical and physiological considerations of autonomic and somatic motor nervous system and Neurohumoral transmission.

Unit II

Agents modulating peripheral nervous system, Non-adrenergic-non cholinergic (NANC) transmission.

Unit III

Pharmacology of adrenergic agonists, Antagonists and Adrenergic neuron blockers.

Unit IV

Pharmacology of cholinergic agonists, Antagonists and cholinergic neuron blockers.

Unit V

Drugs acting at the Neuromuscular Junction and Autonomic Ganglia.

Unit VI

Autacoids: Introduction to immunity and inflammation, Immunostimulants, Immunosuppressants and Tolerogens, Pharmacological aspects of histamine, serotonin, kinins, eicosanoids and platelet activating factor, Angiotensins and other putative autacoids.

VI. **Practicals**

Pharmacological experiments on intact and isolated preparations for studying the effects of various prototype autonomic and autacoids drugs on vascular, intestinal, respiratory, urinary and reproductive smooth muscles, autonomic ganglia, skeletal muscles; blood pressure, ECG, heart, etc.

I. **Course Title : CNS Pharmacology**

II. **Course Code : VPT 603**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To study the pharmacology of drugs acting on central nervous system (CNS).

V. **Theory**

Unit I

Anatomical and physiological considerations and neurohumoral transmission in CNS.

Unit II

Historical development, theories, principles and stages of general anaesthesia.

Unit III

Recent advances in pharmacology of general anaesthetics and therapeutic gases, local anaesthetics, sedatives, hypnotics, neuroleptics, antiepileptics.

Unit IV

Pharmacology of CNS stimulants, analeptics, opioid

agonists and antagonists; non- steroidal anti-inflammatory agents, central muscle relaxants, Pharmacology and regulations of euthanizing agents.

VI. **Practicals**

Study of pharmacodynamics of prototype drugs of each class of drugs in experimental animals.

I. **Course Title : Digestive and Respiratory Pharmacology**
II. **Course Code : VPT 604**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the pharmacological aspects of drugs acting on digestive and respiratory systems.

V. **Theory**

Unit I

Physiological considerations of GIT functions in ruminants and non-ruminants. Pharmacology of drugs acting on gastrointestinal tract. Appetite stimulants, emetics and anti-emetics.

Unit II

Pharmacology of anti-ulcer drugs, modulators of gastric and intestinal motility and secretions.

Unit III

Agents promoting digestive functions; bile acids and pancreatic enzymes, drugs affecting liver; rumen pharmacology.

Unit IV

Gastrointestinal protectant and adsorbents, laxatives and cathartics.

Unit V

Physiological considerations of respiratory functions in animals. Pharmacology of drugs acting on respiratory system: Bronchodilators, Antitussives, Mucolytics, Expectorants, Decongestants. Drugs used in treatment of asthma.

VI. **Practicals**

Study of effects of drugs on digestive and respiratory functions using different *in- vitro* and *in vivo* animal models.

I. **Course Title : Cardiovascular and Urinary System Pharmacology**
II. **Course Code : VPT 605**
III. **Credit Hours : 2+0**

IV. **Aim of the course**

To study the pharmacological aspects of drugs acting on CVS and kidneys.

V. **Theory**

Unit I

Cardiac electrophysiology consideration, Pharmacology of antiarrhythmic drugs, Cardiac glycosides, Myocardial stimulants.

Unit II

Antihypertensive, Antihypotensive and Antihyperlipidaemic drugs.

Unit III

Coagulants and anticoagulants, Thrombolytic agents, Plasma affecting haemopoietic system and antiplatelet drugs.expanders, Drugs

Unit IV

Pharmacology of drugs affecting renal functions and fluid-electrolyte balance: Diuretics, Antidiuretics, Urinary acidifiers, Urinary alkalizers, Urinary antiseptics and Uricosuric and other anti-gout drugs. Principles of acid-base balance, fluid and electrolyte therapy and blood substitutes.

I. **Course Title : Endocrine and Reproductive Pharmacology**

II. **Course Code : VPT 606**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To study the pharmacology of drugs affecting endocrine functions.

V. **Theory**

Unit I

Drugs affecting endocrine functions of hypothalamus, pituitary, thyroid, adrenals and pancreas.

Unit II

Drugs affecting calcium and phosphorus homeostasis.

Unit III

Drugs affecting male reproductive organs, spermatogenesis and erectile dysfunctions.

Unit IV

Drugs affecting female reproductive organs: ovulation, oestrus, conception, gestation and lactation.

Unit V

Oxytocic and other drugs affecting uterus.

VI. **Practicals**

To study the effects of various endocrine agonists and

antagonists in animal models and isolated tissues.

I. **Course Code : VPT 607**
II. **Course Title : Chemotherapy**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the recent advances in chemotherapeutic agents with relevance to their molecular mechanisms and therapeutic aspects.

V. **Theory**

Unit I

General consideration and principles of Chemotherapy, Classification of chemotherapeutic agents; Molecular mechanism of Antimicrobial resistance- development and Prevention strategies; Combination therapy, Therapeutic failure.

Unit II

Systemic and gut acting sulphonamides, diaminopyrimidines, sulfones, quinolones, nitrofurans, nitroimidazoles.

Unit III

Penicillins, Cephalosporins, Carbapenems, Carbacephems, monobactam, beta lactamase inhibitors.

Unit IV

Aminoglycosides, Tetracyclines, Chloramphenicol and its congeners, macrolides, lincosamides.

Unit V

Antitubercular drugs, Glycopeptides, and Polypeptide antibiotics, Methenamine, Carbadox, Novobiocin, Virginiamycin, Spectinomycin, Oxazolidinones and newer agents.

Unit VI

Antiprotozoans, Anthelmintics, Ectoparasiticides

Unit VII

Antifungal agents, Antiviral and Anti-neoplastic drugs.

VI. **Practicals**

Assay of chemotherapeutic agents, Antibiotic sensitivity tests. Determination of minimum inhibitory concentration (MIC), Mutant Prevention Concentration (MPC), Minimum Bactericidal Concentration (MBC) and time kill kinetics. Molecular techniques for intervention of antimicrobial resistance. Determination of anthelmintic properties of drugs using *in-vitro* models.

I. **Course Title : Toxicology of Xenobiotics**
II. **Course Code : VPT 608**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the molecular basis of poisoning and antidotal therapy in animals.

V. **Theory**

Unit I

Principles and scope of toxicology.

Unit II

Molecular mechanism of action of poisons and their detoxification, rational approach for diagnosis and treatment of poisonings.

Unit III

Toxicology of metals, non-metals, agrochemicals, solvents and vapors, common salt, urea and other feed additives. Toxicity of drugs.

Unit IV

Genotoxic and other effects of radiations and radioactive chemicals; toxicogenomics and developmental toxicology; forensic and regulatory aspects of toxicology.

VI. **Practicals**

Extraction, separation and detection of common poisons in toxicological specimens, study of toxicity and antidotal treatment in animals, designing of animal toxicity experiments and general toxicity spot tests.

I. **Course Title : Toxinology**
II. **Course Code : VPT 609**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To impart knowledge of molecular basis of toxicity induced by toxins of plants, microbes and animals origin.

V. **Theory**

Unit I

Classification and identification of different types of toxins.

Unit II

Toxicity induced by abrin, strychnine, dhurin, amygdaline, sanguine, solamine, gossypol, beta-amino propionitryl, beta-oxolyl amino L-alanine, other Phytotoxins

Unit III

Toxin induced Teratogenicity, Thiamine deficiency and Phototoxicity.

Unit IV

Toxicology of mycotoxins: aflatoxins, rubratoxins, ochratoxins, sporidesmin, citrinin, F-2 toxin, trichothecenes, tremorgens and ergot alkaloids.

Unit V

Zootoxins: snake venom, scorpion, spider and insect stings and bufotoxins, Puffer fish and Shell fish toxins. Bacterial toxins (botulinum and tetanus toxins)

VI. **Practicals**

Detection of alkaloids, glycosides, cyanides, nitrate/ nitrite, tannins, saponins, resins and oxalates. Detection of mycotoxins in the samples of feed/ fodder and animal tissue. Identification of toxic weeds and plants of the state/ local area.

I. **Course Title : Pharmacological Techniques**

II. **Course Code : VPT 610**

III. **Credit Hours : 0+2**

IV. **Aim of the course**

To impart the knowledge of various pharmacological techniques and screening methods of drugs.

V. **Practicals**

Unit I

Principles of drug action and bioassay. Construction of dose-response plots and their significance. Determination of EC_{50}, median effective (ED_{50}), toxic (TD_{50}) or lethal doses (LD_{50}) from dose-response plots. Calculation of dissociation rate constants, therapeutic ratio, margin of safety, potency ratio, pAx, pDx and pD'x values.

Unit II

Techniques for setting up isolated and intact preparations, recording of BP in hen/ rat, recording of ECG in rat/ other small animals.

Unit III

Organization of screening programme of drugs; multidimensional screening procedures and gross observational methods. Specific tests for evaluation of tranquillizing, hypnotic, analgesic, anticonvulsant, general and local anaesthetic, muscle relaxant, anti-inflammatory, antipyretic, antiarrhythmic, antihypertensive and antihyperglycemic activities.

Unit IV

Guidelines for safety studies on drugs.

I. **Course Title : Techniques in Toxicology**

II. **Course Code : VPT 611**

III. **Credit Hours : 0+2**

IV. **Aim of the course**

To understand the animal toxicity tests and assessment of various toxicants using specific tests.

V. **Practicals**

Unit I

Designing of animal models in toxicological studies. Introduction to different toxicological guidelines for *in-vitro* and *in vivo* studies (OECD, WHO, EPA, etc.). In silico toxicity prediction.

Unit II

Animal toxicity tests for acute, sub-acute and chronic toxicity.

Unit III

Specific toxicity tests for Neurotoxicity, Immunotoxicity, Behavioural, Reproductive and Developmental, Inhalation Toxicity, Mutagenicity, Carcinogenicity.

Unit IV

Toxicological tests for the study of metabolism, synergism and antagonism. Assay for marker enzymes, analysis of toxicant residues in biological materials.

I. **Course Title : Ethnopharmacology**

II. **Course Code : VPT 612**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To impart the knowledge and importance of traditional Indian medicine.

V. **Theory**

Unit I

Historical aspects of traditional Indian remedies. Alternate systems of medicine in animals. Scope of Ethnopharmacology.

Unit II

Classification and identification of medicinal plants. Classification, Metabolism and interactions of Phytoconstituents.

Unit III

Standardization and clinical validation of bioactive molecules from plant sources. Therapeutic and adverse effects of potential herbal drugs. Indigenous drugs used as glactagogues, carminatives, antiseptics, antidiarrhoeals,

anthelmintics, Immuno- stimulants, antimicrobials, bioenhancers, analgesics, anti-inflammatory agents, etc.

VI. **Practicals**

Identification of medicinal plants. Preparation of plant extracts in various solvents using different techniques. Phytochemical screening of plant extracts. Evaluation of pharmacological activities of extracts using *in-vitro* and *in-vivo* methods.

I. **Course Title : Fundamentals of Pharmacokinetics**

II. **Course Code : VPT 613**

III. **Credit Hours : 1+1**

IV. **Aim of the course**

To study the disposition of drugs and dosage regimen.

V. **Theory**

Unit I

Routes of drug administration, ADME, plasma protein binding, factors modifying ADME

Unit II

Basic concept of pharmacokinetics, Order of pharmacokinetics processes (zero order, first order and mixed order), Models of pharmacokinetics analysis of drugs (compartmental, non-compartmental model)

Unit III

Compartmental models of drug distribution, determinants of absorption, distribution and elimination, rate constants (Cmax, Tmax)

Unit IV

Calculation of pharmacokinetic parameters, dosage regimen and bioavailability based on compartmental analysis, Non-compartmental pharmacokinetic modelling.

VI. **Practicals**

Analysis of pharmacokinetic data and determination of different pharmacokinetic parameters and bioavailability of drugs in normal and diseased animal models.

Course Outline-cum-Lecture Schedule forMaster Degree Programme

I. **Course Title : Concepts of Pharmacology, Drug Design and Development**
II. **Course Code : VPT 601**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To study the basic concepts of drug actions, and drug design and development.

V. **Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1.	Scope of pharmacology, nature and sources of drugs and other therapeutic agents	2
2.	Principles of biopharmaceutics and dosage forms of drugs	2
3.	Principles of Pharmacokinetics-Absorption, distribution, Metabolism and excretion of drugs.	4
4.	Principles of drug action, rational, empirical and various other therapeutics	2
5.	Pharmacodynamics-targets for drug actions (enzymes, ion channels, structural and transporter proteins)	4
6.	Receptor mediated drug action, types of drug receptors, second messengers of drug action and signal transduction	4
7.	Regulation and malfunctioning of diseases.	1
8.	Quantitation of drug-receptor interactions and elicited effects	2
9.	Drug interactions and adverse drug reactions	2
10.	Drugs design and development, Screening and drug assay	3
11.	Clinical drug trials	2
12.	Drug safety, drug standards and regulations	2
13.	Gene therapy and novel drug delivery systems.	2

I. **Course Title : Autonomic and Autacoid Pharmacology**
II. **Course Code : VPT 602**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To study the pharmacological basis of therapeutic uses of autonomic and autacoid drugs.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. Introduction to autonomic nervous system (ANS), Anatomical and physiological considerations of autonomic and somatic motor nervous system 2
2. Neurohumoral transmission 2
3. Exceptions to generalization of ANS, Agents modulating peripheral nervous system, non adrenergic-non cholinergic (NANC) transmission 3
4. Sympathetic nervous system, adrenergic agonists, antagonists and adrenergic neuron blockers 4
5. Therapeutic uses of sympathetic drugs and blockers 1
6. Parasympathetic nervous system, cholinergic agonists, antagonists and cholinergic neuron blockers 4
7. Therapeutic uses of parasympathetic drugs and blockers 1
8. Ganglion stimulating and blocking drugs 2
9. Neuromuscular blocking drugs 1
10. Introduction to immunity and inflammation 2
11. Immunostimulants, immunosuppressants and tolerogens 1
12. Histaminergic and antihistaminics 2
13. Serotonin and antiserotonin agents 1
14. Kinins as mediators of inflammation 2
15. Eicosanoids and platelet activating factor 3
16. Angiotensins and other putative autacoids 2
17. Angiotensins and inhibitors of renin-angiotensin system 1

Practical

1. Effect of sympathetic agonists and antagonists on intact and isolated preparations through experiments/ simulation programmes. 5
2. Effect of sympathetic agonists and antagonists on intact and isolated preparations through experiments/ simulation programmes. 5
3. Effects of autonomic drugs on blood pressure, ECG, etc. 2
4. Effect of autacoids on different systems 4

I. Course Title : CNS Pharmacology

II. Course Code : VPT 603

III. Credit Hours : 2 +1

IV. Aim of the course

To study the pharmacology of drugs acting on central nervous system (CNS)

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to CNS – Physiological and anatomical considerations	1
2.	Drugs action on CNS	1
3.	Central neurotransmitters	2
4.	General anaesthesia – History, theories and stages of general anaesthesia	1
5.	Adjuvants to general anaesthetics	1
6.	Inhalant general anaesthetics	3
7.	Injectable general anaesthetics	3
8.	Local anaesthetics	2
9.	Hypnotics and sedatives	3
10.	Psychotropic drugs and drugs modifying abnormal behaviour of animals	3
11.	Anticonvulsants	2
12.	Opioid agonists (analgesics) and antagonists	3
13.	Non steroidal anti-inflammatory drugs (NSAIDs)	3
14.	CNS stimulants	1
15.	Central muscle relaxants	1
16.	Drugs of abuse	2
17.	Currents topics/ Discussion on library assignments	2
Practical		
1.	Study on general anaesthetics	1
2.	Study on local anaesthetics	2
3.	Study on sedatives and hypnotics	2
4.	Study on anticonvulsants	1
5.	Study on antipyretics	1
6.	Study on analgesics	2
7.	Study on anti-inflammatory drugs	2
8.	Study on psychotropic drugs	2
9.	Study on CNS stimulants	1
10.	Study on central muscle relaxants.	1

I. **Course Title : Digestive and Respiratory Pharmacology**

II. **Course Code : VPT 604**

III. **Credit Hours : 2 + 1**

IV. **Aim of the course**

To study the pharmacological aspects of drugs acting on digestive and respiratory systems.

V. **Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1.	Drugs affecting salivary secretions – Sialics and antisialics	1
2.	Drugs affecting gastric secretion – Stomachics, histamine and gastrin analogues	2
3.	Gastric antisecretory and antiulcer drugs – H_2-receptor antagonists and proton pump inhibitors	2
4.	Antacids	2
5.	Emetics	1
6.	Antiemetics	2
7.	Carminatives and antizymotics	1
8.	Appetizers and digestants	1
9.	Pro-kinetics	2
10.	Cathartics	2
11.	Antidiarrhoeic drugs	2
12.	Physiological basis of renal pharmacology	2
13.	Diuretics	3
14.	Drugs affecting fluid, electrolyte and acid-base balance	2
15.	Drugs affecting urinary pH and tubular transport	1
16.	Antitussives	1
17.	Expectorants	1
18.	Analeptics	1
19.	Bronchodilators and other drugs acting on respiratory system	1
20.	Drugs acting on skin and mucous membrane – Demulcents, emollients, protectants, counterirritants, caustics, keratolytics, and wound cleansing agents	2
21.	Current topics/ Disccusion on library assignments.	2

Practical

1.	Effects of drugs on digestive functions using different *in-vitro* models	4
2.	Effects of drugs on digestive functions using *in vivo* animal models	4
3.	Effects of drugs on respiratory functions using different *in-vitro* models	4
4.	Effects of drugs on respiratory functions using different animal models	4

I. **Course Title : Cardiovascular and Urinary System Pharmacology**

II. **Course Code : VPT 605**

III. **Credit Hours : 2 + 0**

IV. **Aim of the course**

To study the pharmacological aspects of drugs acting on CVS and kidneys.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. ofLectures/ Practicals
Theory		
1.	General considerations to cardiovascular system	2
2.	Myocardial stimulants – Cardiac glycosides and other myocardial stimulants	3
3.	Anti-arrhythmic drugs	3
4.	Vasodilators and antianginal drugs	2
5.	Antihypertensive agents	1
6.	Haemostatics and coagulants	2
7.	Anti-coagulants	2
8.	Fibrinolytic and anti-platelet drugs	1
9.	Heamtaopoietic drugs	2
10.	Blood components and blood substitutes	1
11.	Drugs used in treatment of shock	2
12.	Antihyperlipoproteinemics	1
13.	Physiological basis of renal pharmacology	2
14.	Diuretics	3
15.	Drugs affecting fluid, electrolyte and acid-base balance	3
16.	Drugs affecting urinary pH and tubular transport	2
17.	Current topics/ Disccusion on library assignments	2

I. Course Title : Endocrine and Reproductive Pharmacology

II. Course Code : VPT 606

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the pharmacology of drugs affecting endocrine functions.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1.	General considerations to Endocrine and reproductive systems	2
2.	Pharmacology of drugs affecting endocrine functions of Pituitary gland	3
3.	Pharmacology of drugs affecting endocrine functions of thyroid gland	2
4.	Pharmacology of drugs affecting endocrine functions of adrenals	3
5.	Pharmacology of drugs affecting endocrine functions of the Pancreas	2
6.	Physiological basis of calcium and phosphorus homeostasis	2

7. Hormonal regulation of calcium and phosphorus homeostasis. 2
8. Pharmacology of drugs affecting male reproductive organs, 2
9. Drugs affecting spermatogenesis 2
10. Pharmacology of drugs affecting female reproductive organs 2
11. Drugs affecting ovulation 2
12. Drugs affecting oestrus 1
13. Drugs affecting conception 2
14. Drugs affecting gestation 2
15. Drugs affecting lactation 2
16. Current topics/ Disccusion on library assignments 3

Practical

1. Effects of various hormones in animal models and isolated tissues. 4
2. Effects of various hormones in and isolated tissues 4
3. Effects of different hormone antagonists in animal models 4
4. Effects of different hormone antagonists in isolated tissues 4

I. **Course Title : Chemotherapy**
II. **Course Code : VPT 607**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To study the recent advances in chemotherapeutic agents with relevance to their molecular mechanisms and therapeutic aspects.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. General principles of antibacterial therapy, classification of antibacterial drugs, clinical use of antibiotics, antibiotic combinations. Bacterial resistance 2
2. Sulfonamides 2
3. Penicillins and Beta-lactamase inhibitors 2
4. Cephalosporins 2
5. Aminoglycosides and Aminocyclitols 2
6. Chloramphenicol and Thiamphenicol 2
7. Tetracyclines 2
8. Macrolide antibiotics and Membrane antibiotics 2
9. Quinolones – Spectrum, mechanism, kinetics and uses 2
10. Antifungal agents 2
11. Antiviral agents 2
12. Anticancer agents – General principles, classification, mechanism, toxicity, uses 2

13. Anthelmintics – Antinematodal drugs, Anticestodal drugs, Antitrematodal drugs 2
14. Ectoparasiticides 2
15. Antiprotozoan Drugs 2
16. Antitubercular drugs 2
17. Curent discussions and assignments 2

Practical

1. General methods for assay of chemotherapeutic agents 2
2. Estimation of sulfonamides in biological fluids 2
3. Estimation of penicillins in biological fluids 3
4. Estimation of oxytetracyclines in biological fluids 2
5. Estimation of trimethoprim in biological fluids 2
6. Estimation of nitrofurans in biological fluids 2
7. Antibiotic sensitivity tests 2

I. Course Title : Toxicology of Xenobiotics

II. Course Code : VPT-608

III. Credit Hours : 2 + 1

IV. Aim of the course

To study the molecular basis of poisoning and antidotal therapy in animals.

V. Lecture/ Practical schedule

S. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Introduction, definitions and fields of toxicology 1
2. History and scope of toxicology 1
3. Sources and classification of toxicants 1
4. General modes of action of poisons 1
5. Detoxification of poisons 2
6. Principles and fundamentals of toxicology 3
7. Factors affecting toxicity 1
8. Diagnosis of poisoning 2
9. Treatment and management of poisonings 2
10. Toxicology of metals – Arsenic, mercury, lead, copper, molybdenum, cadmium and iron 5
11. Toxicology of agrochemicals – Insecticides, herbicides, fungicides and rodenticides 5
12. Toxicology of solvents and vapours 2
13. Feed additives – Growth and performance enhancers, non-protein nitrogen compounds, common salt 2
14. Radiations and radioactive chemicals 2
15. Genetic and developmental toxicology 2
16. Regulatory and forensic toxicology 2

17. Current topics/ Discussion of library assignments 2

Practical

1. Collection of material for toxicological investigations 2
2. Dispatch and processing of samples for toxicological investigations 2
3. Extraction and separation of poisons from toxicological specimens 2
4. Identification and detection of common poisons 3
5. Designing and experiments for acute, subacute and chronic toxicities 2
6. Calculation of TD50 and LD50 2
7. Antidotal treatment in animals 2

I. **Course Title : Toxinology**

II. **Course Code : VPT 609**

III. **Credit Hours : 2 + 1**

IV. **Aim of the course**

To impart knowledge of molecular basis of toxicity induced by toxins of plants, microbes and animals origin.

V. **Lecture/ Practical schedule**

S. No. Name of Topic No. of Lectures/ Practicals

Theory

1. Classification, identification and chemical constituents of poisonous plants 2
2. Nitrate/ nitrite poisoning: sources, mechanism of toxicity, clinical findings, diagnosis, treatment and control 2
3. Cyanide poisoning – Causes, cyanogenetic plants: jowar, etc., mechanism of toxicity diagnosis and treatment 2
4. Photosensitization – *Lantana camara*: mechanism of toxicity, clinical signs and treatment 2
5. Bracken fern poisoning – Clinical signs, diagnosis and treatment 2
6. Poisoning due to strychnos nux-vomica, Ricinus communis and kaner – Mechanism of toxicity, clinical signs, diagnosis and treatment 2
7. Toxicity due to dhatura, Abrus precatorius, Ipomoea carnea – Mechanism of toxicity, clinical signs and treatment 2
8. Toxicity due to plants containing oxalate – Mechanism of toxicity, clinical signs and treatment 2
9. Mycotoxins – Hepatotoxins (sporidesmin, aflatoxins and rubratoxins): mechanism of toxicity, symptoms and treatment 2

10. Nephrotoxins (ochratoxin, citrinin) neurotoxins (penitren A and Patulin). Ergot alkaloids, estrogenism and Trichothecene toxins: clinical signs and treatment 3
11. Bacterial toxins – Diphtheria toxins, Botulinum toxin, Cholera toxin, tetanus toxin, E.coli., Enterotoxin, Endotoxin 3
12. Toxicity due to snake venom – Mechanism of toxicity, clinical signs and treatment 3
13. Toxicity due to scorpion – Mechanism of toxicity, clinical signs and treatment 2
14. Toxicity due to spider and insect stings and toad poisoning – Mechanism of toxicity, clinical signs and treatment 2
15. Current topics/ Discussion of library assignments 3

Practicals

1. Detection of alkaloids, glycosides, cyanides, nitrate/ nitrite, tannins, saponins, resins and oxalates in toxic plants 8
2. Phytochemical analysis of toxic plant extracts 2
3. Detection of mycotoxins in the samples of feed/ fodder and animal tissue 2
4. Identification of toxic weeds and plants of the state/ local area 2

I. **Course Title : Pharmacological Techniques**
II. **Course Code : VPT 610**
III. **Credit Hours : 0 + 2**
IV. **Aim of the course**

To impart the knowledge of various pharmacological techniques and screeningmethods of drugs.

V. **Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Lectures/ Practicals

Practical

1. Principles of drug action 1
2. Bioassay.Typs of bioassay, bioassay techniques 3
3. Setting up of an isolated tissue preparation and an intact preparation 2
4. Study of dose response relationship 2
5. Suprmaximal effect by cumulative dose response study 1
6. Study on isolated organ assembly 3
7. Intact frog heart perfusion 1
8. Recording of blood pressure in animals 2
9. Recording of ECG in animals 1
10. Screening Programme of drugs: General and multidimensional 2

11. Gross observational methods in Screening procedures 2
12. Calculation of EC50, potency ratio, PDv, PDx PD values 1
13. Screening of hypnotic activity 1
14. Study of analgesic, antipyretic and anti-inflammatory activity in laboratory animals 2
15. Study of general and local anaesthesia in experimental animals 1
16. Study of anticonvulsant and muscle relaxant effect of drugs 2
17. Study of antiarrythmic and antihypertensive action of test compound 2
18. Study of antihyperglycemic and anticholinesteric acivity 1

I. **Course Title : Techniques in Toxicology**
II. **Course Code : VPT 611**
III. **Credit Hours : 0 + 2**
IV. **Aim of the course**

To understand the animal toxicity tests and assessment of various toxicants using specific tests.

V. **Lecture/ Practical schedule**

S. No. Name of Topic No. of Lectures/ Practicals

Practical

1. Animal models for toxicological studies 2
2. Animal toxicity tests for acute, subacute, and chronic toxicity 2
3. Specific toxicity test for neurotoxicity 1
4. Specific toxicity test for immunotoxicity 1
5. Specific toxicity test for developmental toxicity 1
6. Specific toxicity test for behavioral toxicity 1
7. Specific toxicity test for mutagenecity 1
8. Specific toxicity test for reproductive toxicity 1
9. Specific toxicity test for inhalation toxicity 1
10. Study specific toxicity test for carcinogenecity 1
11. Animal toxicological tests to study metabolism 1
12. Animal toxicological tests for synergism 1
13. Animal toxicological tests for study of antagonisms 1
14. Good laboratory practices in toxicology 2
15. Assays for marker enzymes: AchE, GPx, SOD, Catalase 3
16. Biochemical analysis of suspected toxicity specimens 2
17. Haematological evaluation of toxicological samples 2
18. Determination of pesticide residues using Gas Chromatography 2
19. Analysis of toxicant residues in biological materials 2
20. Recent advances 1

I. Course Title : Ethnopharmacology
II. Course Code : VPT 612
III. Credit Hours : 1 + 1
IV. Aim of the course

To impart the knowledge and importance of traditional Indian medicine.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1.	History, traditional remedies and regional folklore in disease cure.	1
2.	Plant drugs with proven pharmacological and therapeutic efficacy	1
3.	Indigenous drugs used in treatment of various gastrointestinal ailments	1
4.	Indigenous drugs used as antimicrobials	1
5.	Indigenous drugs used as analgesics	1
6.	Indigenous drugs used in cardiovascular disorders	1
7.	Indigenous drugs used in CNS disorders	1
8.	Indigenous drugs used in behavioural disorders	1
9.	Indigenous drugs used in Renal and Urinary tract disorders	1
10.	Indigenous drugs used in eye, ear and skin disorders	1
11.	Therapeutic and adverse effects of potential herbal drugs	2
12.	Alternate systems of medicine in animals – Homeopathy	2
13.	Alternate systems of medicine in animals – Folklore medicine	2
14.	Current topics/ Discussion of library assignments	2
Practical		
1.	Identification of medicinal plants	1
2.	Various processes used in purification and preparation of active constituents from medicinal plants	4
3.	Classification, identification and chemical constituents of medicinal plants	2
4.	Preparation of plant extracts in various solvents using different techniques	2
5.	Phytochemical screening of plant extracts	2
6.	Pharmacological screening of extracts using *in-vitro* methods	2
7.	Evaluation of pharmacological activities of extracts using in Animals	2

I. Course Title : Fundamentals of Pharmacokinetics
II. Course Code : VPT 613
III. Credit Hours : 1 + 1

IV. Aim of the course

To study the disposition of drugs and dosage regimen.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1.	Dosage forms of drugs	1
2.	Routes of drug administration	1
3.	Transfer of drugs across biological membranes	2
4.	Absorption of drugs	1
5.	Distribution of drugs	1
6.	Biotransformation of drugs	2
7.	Excretion of drugs	1
8.	Principles of pharmacokinetics	2
9.	Various Pharmacokinetics models	1
10.	Important pharmacokinetic parameters	2
11.	Dosage regiment	1
12.	*In-vitro* plasma protein binding of drugs	1
Practical		
1.	Various methods of drug assay	2
2.	Microbiological assay for antimicrobial drugs	2
3.	HPLC techniques	4
4.	Bioavailability of drugs	1
5.	Pharmacokinetics in animal disease models	2
6.	*In-vitro* plasma protein binding of drugs	1
7.	Determination of different pharmacokinetic parameters	2
8.	Analysis of pharmacokinetic data	2
9.	PK-PD modelling and Time kill kinetics	1

Course Contents
Ph.D. in Veterinary Pharmacology and Toxicology

I. **Course Title : Molecular Pharmacology**
II. **Course Code : VPT 701**
III. **Credit Hours : 3+0**
IV. **Aim of the course**

To understand the identification and characterization of receptors and drug receptors interactions and underlying mechanisms of drug receptor interactions and its effects.

V. **Theory**

Unit I

Physicochemical properties of drugs, Forces involved in binding of drugs to receptors, Classification of receptors, Molecular structure of receptors, Properties and regulation of receptors, Receptors for physiological regulatory molecules.

Unit II

Receptor conformation and configuration. Structure activity relationship. Ligand binding study of receptors. Cellular mechanism of signal transduction and second messenger systems; Structures, Types and Functions of membrane ion channels.

Unit III

Theories of drug receptor interactions; Analysis of dose response Relationship and molecular mechanisms of drug actions, Quantitation of drug-receptor interactions and effects, receptors as pharmaceutical targets.

Unit IV

Calcium homeostasis within the cells, pharmacology of mitogen-activated protein (MAP) kinases/ extracellular signal-regulated kinases (ERK) and small G proteins. Methods of identification, isolation and characterization of receptors.

I. **Course Title : Advances in Autacoid Pharmacology**
II. **Course Code : VPT 702**
III. **Credit Hours : 1+0**
IV. **Aim of the course**

To study the pharmacodynamics and clinical implications of autacoids.

V. **Theory**

Unit I

Histamine and antihistamines, serotonin and its antagonists.

Unit II

Kinins (Bradykinin, kallikrein, Neurokinin, Substance P, Atrial natriuretic peptides and others). Angiotensins, agonists and antagonists.

Unit IV

Eicosanoids, platelet-activating factors, slow reacting substances of anaphylaxis, Putative neurotransmitters (purine nucleotides, peptides, amino acids and nitric oxide).

Unit V

Pharmacotherapy of inflammation, fever, pain and gout; clinical manifestation of autacoid imbalance.

I. **Course Title : Pharmacology of Herbal Drugs**
II. **Course Code : VPT 703**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study the Pharmacological, Therapeutic and Toxicological aspects of potential medicinal plants.

V. **Theory**

Unit I

Historical aspect, Chemical constituents of medicinal plants and their classification.

Unit II

Identification, Collection, Preservation, Purification, Isolation, Standardization and Clinical validation of bioactive molecules from vegetable sources.

Unit III

Characterization of pharmacological, therapeutic and toxic effects of potential herbal drugs.

Unit IV

Strategies for development of herbal drugs.

VI. **Practical**

Extraction, detection, phytochemical analysis and fractionation of medicinal plant extracts. Screening of plant extracts for potential pharmacological activity; Pharmacological effects of herbal drugs on intact and isolated preparations.

I. **Course Title : Biotransformation of Xenobiotics**
II. **Course Code : VPT 704**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To study the molecular mechanisms of biotransformation of xenobiotics.

V. **Theory**

Unit I

Process of drug biotransformation phase I, phase II, and III, Microsomal and non-microsomal metabolizing enzyme systems. Mechanisms and processes of synthetic biotransformation

Unit III

Chemical, biological, genetic and environmental factors affecting drug biotransformation mechanisms.

Unit IV

Metabolic interactions, Enzyme induction and inhibition. Scope of biotransformation in drug development.

I. **Course Title : Clinical Pharmacology and Pharmacokinetics**

II. **Course Code : VPT 705**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To study the efficacy and disposition of drugs in clinical conditions.

V. **Theory**

Unit I

Scope of clinical pharmacology. Drug discovery and clinical trials. Pharmacovigilance, pharmacoepidemiology and pharmacoeconomics.

Unit II

Various drug delivery systems-ruminal, intravaginal, intramammary, etc. Targeted drug delivery systems-liposomes, microparticles, nanoparticles, etc. Factors modifying drug delivery.

Unit III

Application of pharmacokinetic principles in therapeutics. PK-PD relationship and its applications.

Unit IV

Alterations in pharmacological behaviour of drugs in clinical conditions, neonates and pregnancy. Drug interactions and adverse drug reactions. Therapeutic drug monitoring. Rationale of drug use. Medication control programs in performance animals.

VI. **Practical**

Analysis of pharmacokinetic data and determination of different pharmacokinetic parameters and drugs interactions in normal and diseased animal/ models.

I. **Course Title : Pharmacogenomics**
II. **Course Code : VPT 706**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To study the concepts of genomicsin drug development.

V. **Theory**

Unit I

History, concepts and definitions of pharmacogenomics transcriptomics, proteomics and metabolomics. Genomic basis of species variations in drug response.

Unit II

Genetic polymorphism and its impact on pharmacokinetics, drug target receptorsand disease-drug response.

Unit III

Pharmacogenomics and drug development, Pharmacogenomics in clinical practice,role of bioinformatics in pharmacogenomics.

Unit IV

Concept of gene therapy, gene therapy of inherited diseases, DNA repair andinactivation strategies. Synthesis of therapeutic proteins.

I. **Course Title : Immunopharmacology and Immunotoxicology**
II. **Course Code : VPT 707**
III. **Credit Hours : 2+0**
IV. **Aim of the course**

To study the pharmacological intervention of immune functions.

V. **Theory**

Unit-I

General aspect of immune system and its interaction with nervous and endocrinesystems. Chemical mediators of immune system.

Unit II

Immunomodulators; Immunostimulants, Immunosuppressant and Tolerogens;Immunological basis of drug allergy and drug tolerance.

Unit III

Immunotoxic effects of xenobiotics and environmental pollutants.

Unit IV

Immune deficiencies and autoimmune reactions. Immunotherapeutic applicationsin asthma, arthritis, cancer, dermatology, and organ transplant, etc.

I. **Course Title : Molecular Toxicology**

II. **Course Code : VPT 708**

III. **Credit Hours : 3+0**

IV. **Aim of the course**

To understand the mechanisms and targets of cellular/ molecular toxicity.

V. **Theory**

Unit I

Cellular, sub-cellular and molecular targets and mechanism of toxicity.

Unit II

Cellular dysfunctions and their consequences, Mechanism of cell death in toxicity, repair and disrepair of toxic damage.

Unit III

Molecular mechanisms of target organ directed toxicity of xenobiotics- brain,

Unit IV

Mechanism of chemical mutagenesis, carcinogenesis, teratogenesis and radiation toxicity.

I. **Course Title : Clinical Toxicology**

II. **Course Code : VPT 709**

III. **Credit Hours : 2+1**

IV. **Aim of the course**

To study the concepts of clinical toxicology and forensic toxicology.

V. **Theory**

Unit I

Scope of clinical and forensic toxicology. Toxicological investigation, management and antidotal therapy of poisonings.

Unit II

Clinical aspects of poisoning due metals, non-metals and pesticides.

Unit III

Clinical aspects of poisoning due to mycotoxins, animal and bacterial toxins, solvents and vapours, drugs and other food/ feed contaminants.

Unit IV

Forensic toxicology. GLP in toxicological evaluation.

VI. **Practical**

General screening of biological material for toxicants, analysis of clinical samples for poisons, use of biomarkers

in the assessment of toxicity.

I. **Course Title : Ecotoxicology**
II. **Course Code : VPT 710**
III. **Credit Hours : 3+0**
IV. **Aim of the course**

To impart knowledge regarding ecotoxicology for conservation of healthy eco-system.

V. **Theory**

Unit I

Basic principles of ecotoxicology. Sources of contamination and effects of pollutants on eco-health.

Unit II

Chemical contamination of air, water, soil and food by major agricultural and industrial chemicals – pesticides, hydrocarbons and metals. Fate of chemicals in the environment and target species.

Unit III

Toxic effects of radiations. Marine and wildlife as monitors of environmental quality, Bioaccumulation and Biomagnifications of toxicants.

Biomarkers of monitoring the impact of environmental pollutants, Environmental hazard and Risk identification from Mixture of chemicals, Contamination control and approaches to rehabilitating damaged ecosystems, Nanoparticle ecological emergencies.

I. **Course Title : Regulatory Toxicology**
II. **Course Code : VPT 711**
III. **Credit Hours : 2+1**
IV. **Aim of the course**

To study acts and regulations and risk assessment regarding use of drugs, chemicals and cosmetics.

V. **Theory**

Unit I

Principles of risk assessment. Test protocols for toxicity studies of various national and international regulatory agencies.

Unit II

Regulatory essential dose levels in chemical risk assessment (NOEL, NOAEL, LOEL, LOAEL and AOEL). Recommended acceptable levels of environmental pollutants.

Unit III

Risk assessment in practice. Classification and marking/ branding of chemicals. Monitoring/ surveillance of chemicals. Exposure assessment and modelling.

Unit IV

Quality control in safety research (GLP). Operation of product register.

VI. **Practical**

Good laboratory practice in toxicological research. Screening procedures in regulatory toxicology. Determination of MRL, ADI, NOEL, NOAEL, LOEL, LOAEL and AOEL. Visit to nearest industrial area.

I. **Course Title : Special Problem**

II. **Course Code : VPT 790**

III. **Credit Hours : 0+1**

IV. **Aim of the course**

To provide expertise in handling practical research problem(s).

V. **Practical**

Short research problem(s) involving contemporary issues and research techniques.

Course Outline-cum-Lecture Schedule forDoctoral Degree Programme

I. **Course Title : Molecular Pharmacology**
II. **Course Code : VPT 701**
III. **Credit Hours : 3 + 0**
IV. **Aim of the course**

To understand the identification and characterization of receptors and drug receptors interactions and underlying mechanisms of drug receptor interactions and its effects.

V. **Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1.	Concept of receptors and forces involved in binding of drugs to receptors	2
2.	Methods of identification, isolation and characterization of receptors.	2
3.	Quantitative aspects and theories of drug-receptor interactions	2
4.	Signal transduction mechanisms: transducers, effectors and second messengers	2
5.	Classification and structures of receptors – Receptor conformation and configuration – Iono-receptors	2
6.	G-protein coupled receptors	2
7.	Enzymatic receptors	2
8.	Steroid receptors	2
9.	Molecular mechanisms of drug actions	2
10.	Receptors for physiological regulatory molecules	2
11.	Receptors as pharmaceutical targets.	2
12.	Hepatic and extra-hepatic metabolism of drugs	3
13.	Structures, types and functions of membrane ion channels.	3
14.	Role of cytochrome P450 isozymes in drug metabolism	2
15.	Metabolic enzyme induction and inhibition	2
16.	Factors affecting drug metabolism	2
17.	Mechanism of bioactivation and cytotoxicity – Electrophilic metabolites, free radicals and reactive oxygen species	3
18.	Drug induced mechanism of cell death – Necrosis and apoptosis	2
19.	Cytoprotective mechanisms against bioactive substances – Role of glutathione and other protectants	2
20.	Calcium homeostasis within the cells	2
21.	Pharmacology of mitogen-activated protein (MAP) kinases/	

extracellular signal-regulated kinases (ERK) and small G proteins 3

22. Current topics/ Discussion of library assignments 2

I. **Course Title : Advances in Autacoid Pharmacology**
II. **Course Code : VPT 702**
III. **Credit Hours : 1 + 0**
IV. **Aim of the course**

To study the pharmacodynamics and clinical implications of autacoids.

V. **Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1	Histamine and antihistamines	2
2	5-Hydroxytryptamine and anti-5-HT drugs	2
3	Serotonin and its antagonists	2
4	Kinins	1
5	Angiotensins and inhibitors of renin-angiotensin system	2
6	Lipid-derived autacoids-prostaglandins and leukotrienes	2
7	Platelet activating factor	1
8	Cytokines and other autacoids	2
9	Neurohumoral transmission – purine nucleotides, peptides, amino acids and nitric oxide	2
10	Current topics/ Discussion on library assignments	1

I. **Course Title : Pharmacology of Herbal Drugs**
II. **Course Code : VPT 703**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To study the pharmacological, therapeutic and toxicological aspects of potential medicinal plants.

V. **Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction to indigenous pharmacology – History, definitions and scope	1
2.	Basic requirements and classification of indigenous drugs	2
3.	Collection and preparations of indigenous drugs	1
4.	Extraction of drugs	2
5.	Purification of drugs by heat processes – Distillation, evaporation, sublimations,	2

6. Filtration and clarification 1
7. Plant drugs with proven pharmacological and therapeutic efficacy 1
8. Indigenous drugs used in treatment of various gastrointestinal ailments 2
9. Indigenous drugs used as antimicrobials 1
10. Indigenous drugs used as analgesics 1
11. Indigenous drugs used in cardiovascular and CNS disorders 2
12. Indigenous drugs used in behavioural disorders 1
13. Indigenous drugs used in Renal and Urinary tract disorders 2
14. Indigenous drugs used in Gastrointestinal tract disorders 1
15. Indigenous drugs used in eye, ear and skin disorders 3
16. Indigenous drugs used in reproductive disorders 1
17. Therapeutic and adverse effects of potential herbal drugs 1
18. Alternate systems of medicine in animals – Homeopathy 1
19. Alternate systems of medicine in animals – Ayurvedic concepts 2
20. Alternate systems of medicine in animals – Folklore medicine 1
21. Alternate systems of medicine in animals – Unani medicine 1
22. Discussion on few review articles on herbal drugs from journals 2

Practical

1. Fundamental techniques in indigenous pharmacology 2
2. Extraction and purification of drugs from medicinal plants 4
3. Bioassay of indigenous drugs 3
4. Pharmacological screening of indigenous drugs – Effect on isolated smooth muscle of ileum 2
5. Effect on skeletal muscle 1
6. Effect on perfused heart 1
7. Effect on uterus 1
8. Effect on trachea 1

I. Course Title : Biotransformation of Xenobiotics

II. Course Code : VPT 704

III. Credit Hours : 2 + 0

IV. Aim of the course

To study the molecular mechanisms of biotransformation of xenobiotics.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1	Introduction, importance of drug metabolism. Mechanisms and processes of drug biotransformation	1
2	Synthetic and non-synthetic pathways of drug metabolism. Phase reactions- oxidative, reductive, and hydrolytic reactions	1
3	Phase II reactions- conjugation (glucuronidation, sulfation, methylation, acetylation), conjugation with glutathione, aminoacids and thiosulfates	1
4	Oxidation- molecular details, cytochrome P 450 system. Types of CYP enzymes with special reference to CYP 3A4, 1A2, 2D6, 2E1	1
5	Important drugs metabolized by different CYP isoforms- molecular mechanisms involved	1
6	Nuclear receptor mediated transcriptional regulation of cytochrome P 450 system- Nuclear receptors and their ligands	1
7	7-ethoxy-resorufin O-deethylation (EROD) and 7-methoxyresorufin O-demethylation (MROD) as markers of Cytochrome P450-1 activities in hepatic microsomes	1
8	Activity of liver enzymes during the acute and chronic phases of diseases- role of Total bilirubin, Aspartate transaminase (AST), AST/ ALT ratio, Alkaline phosphatase (ALP), Gamma glutamyl transpeptidase (GGT)	1
9	Use S9 liver fraction from animals for the prediction of *in vivo* drug metabolism, Chemical inhibition assays of S9 fraction	1
10	Xenobiotic response systems- AhR (aryl hydrocarbon receptor), ER (estrogen receptor), PPAR (peroxisome proliferator-activated receptor)	1
11	Response systems - VDR (Vitamin-D-Receptor), FXR (farsenoid-X-receptor), HNF4 (hepatocyte nuclear factor), Nrf2-Keap1.	1
12	Concept of orphan nuclear receptors in different phases of metabolism	1
13	Role of Pregnane-X-Receptor (PXR), Constitutive-Androstane-Receptor (CAR), Liver-X-Receptor (LXR) in metabolism of commonly used drugs. Cross-talk in metabolism pathways	1
14	Role of genetically modified animals in drug metabolism studies	1
15	Specific studies on PXR, CAR, LXR involving gene knockout mice, transgenic mice. Cholesterol and bile acid homeostasis. Search for new response elements	1

16 Reduction reactions- molecular details with specific reaction examples of drugs undergoing reduction: of hydrogenation, decarboxylation, amination 1

17 Hydrolysis- molecular details with specific reaction examples of drugs undergoing hydrolysis with enzymes like esterases, peptidases, and amidases 1

18 Glucuronidation- mechanism, sites, general influencing factors 1

19 Glucuronidation affected drugs – metabolism of morphine, oxazepam carbamazepine, acetaminophen, testosterone, zidovudine), inhibitors and inducers of glucuronidation (barbiturates, ibuprofen, etc. 1

20 Sulfation-Tyrosine sulfation (function, Regulation, Posttranslational modification) 1

21 Acetylation- Ultrastructural Aspects of the Heterogeneous Acetylation 1

22 Phase II Biotransformation Reactions-Glutathione-S-Transferase, Glutathione S-conjugates as prodrugs to target drug-resistant tumors 1

23 Phase III – further modification and excretion- detoxification of endogenous reactive metabolites such as peroxides and reactive aldehydes, sites 1

24 Membrane transport – permeability barriers and detoxification, receptor mediated transcytosis, role of the solute carrier (SLC) and the ATP-binding Cassette (ABC) transporters; implications in drug resistance 1

25 Drug metabolism in organs other than liver- role of kidney, intestine and placenta 1

26 Drug metabolism in fetus and new born. *In-vitro* and *in-vivo* studies in drug metabolism; metabolic schemes of selected drugs 1

27 Factors influencing drug metabolism: Steriochemical, Physicochemical and biological factors 1

28 Strain difference in biotransformation, sex, age, environment factors, Genetic factors (pharmacogenetics) heritable factors recognized by use of drugs 1

29 Pathological states- Effect of liver dysfunction on the metabolism of drugs; effect on dosage regimens 1

30 Effect of renal dysfunction on the metabolism of different drugs 1

31 Chemical, biological, genetic and environmental factors. Species variations affecting drug biotransformation mechanisms 1

32 Biotechnology involved in drug metabolism studies- Electrophoretic Mobility Shift Assay (EMSA), northern, western/ southern blotting,

PCR, real-time PCR 1

33 Preparation and Analysis of Total RNA Extracted from Hepatocytes for metabolism studies. Sulfation assay using P^{32}, Site-directed Mutagenesis, etc. 1

34 Methods to determine glutathione in liver and blood. Importance of Gamma-glutaylcysteine (GGC) as the immediate precursor to GSH 1

35 Cell lines as tools for drug metabolism studies. Predicting *in-vivo* drug metabolism fron *in-vitro* studies, Cultured hepatocytes (cryopreserved or fresh) for induction and down-regulation studies 2

I. **Course Title : Clinical Pharmacology and Pharmacokinetics**

II. **Course Code : VPT 705**

III. **Credit Hours : 2 + 1**

IV. **Aim of the course**

To study the efficacy and disposition of drugs in clinical conditions.

V. **Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction and general principles of pharmacokinetics including absorption, distribution, metabolism and excretion	3
2.	Graphical plotting and interpretation of kinetic data	2
3.	Calculation of pharmacokinetic constants	2
4.	Pharmacokinetic models and their application	2
5.	Determination of pharmacokinetic parameters and their significance	3
6.	Computation of dosage regimen	2
7.	Plasma protein binding of drugs	2
8.	Erythrocyte penetration of drugs	2
9.	Factors modifying pharmacokinetics of drugs	2
10.	Pharmacokinetics of drugs in diseased models	3
11.	Urinary excretion of drugs	1
12.	Kinetics following single and multiple doses	2
13.	Non-compartmental pharmacokinetic modelling	2
14.	Application of pharmacokinetics in clinical practice	2
15.	Drug therapy in neonate and geriatric animals	2
16.	Current topics/ Discussion on library assignments	2
Practical		
1.	Estimation of drugs by chemical and microbiological assays	3
2.	Graphical representation of plasma levels of drugs	1

3. Determination of pharmacokinetic models 1
4. Calculation of kinetic constants and parameters 2
5. Calculation of dosage regimen 1
6. Renal clearance studies of drugs 1
7. *In-vitro* experiments on plasma protein binding 2
8. Calculation of constants of plasma protein binding 1
9. *In-vitro* erythrocytic penetration of drugs 1
10. Pharmacokinetic parameters and adjustment of dosage regimen in diseased conditions 2

I. Course Title : Pharmacogenomics
II. Course Code : VPT 706
III. Credit Hours : 2 + 0
IV. Aim of the course

To study the concepts of genomicsin drug development.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals
Theory		
1.	Introduction- basic pharmacogenomic nomenclature and principle	1
2.	Pharmacogenomics and bioinformatics: past, present and future,species variations affecting drug responses	1
3.	Optimized drug development- Pharmacogenomics impacts on pharmacokinetics and pharmacodynamics	1
4.	Increased and decreased responsiveness to drug effects/ toxicities and novel drug effects- prediction through databases	1
5.	Personalized medicine using genotyping technologies- Optimized drug therapy	1
6.	Challenges of PharmacogenomicTesting access feasibility, cost	1
7.	Genetic basis of disease – Impact of genetic variations on drug metabolism	1
8.	Ethical applications, social and economic implications	1
9.	Genetic polymorphism- Relevance to a drug, Relevance to a disease, Types of nomenclature- Star Nomenclature, Genotype Nomenclature,Haplotype Nomenclature	1
10.	Genetic polymorphism types-Single nucleotide polymorphism (SNP), Variable number tandem repeat, Gene deletion, Copy number variant	1
11.	Single Nucleotide Polymorphism (SNP)- Synonymous polymorphism, Non-synonymous polymorphism, Variable Number Tandem Repeat: UGT1A1	2
12.	Gene Deletions and Copy Number Variants- Ultra-rapid metabolizers, Extensive metabolizers, Intermediate	

metabolizers, Poor metabolizers 1

13. Potential Roles for Healthcare Professionals- Implications for Clinical Practice 1
14. Pharmacogenomic Resources- Centers for Disease Control and Prevention (CDC), Food and Drug Administration (FDA), 1
15. Gene therapy: gene transfer technology, viral vectors, natural delivery strategies. 1
16. Transient and Stable Transfection, Transfection Methods- Lipid-mediated method 1
17. Calcium-phosphate mediated method of transfection, diethylaminoethyloethyl-dextran mediated method of transfection 1
18. Electroporation- Steps of the electroporation transfection, Biolistics (Gene gun/ microparticle bombardment), Laser transfection 1
19. Drugs and gene therapy of inherited diseases- approaches, cell types, vectors 1
20. Genetic inactivation strategies- key concepts.RNA Interference (RNAi), Chemical modification on siRNA 1
21. Engineered nucleases- zinc finger nucleases (ZFNs), transcription activator like effector nucleases (TALENs), clustered regularly interspaced short palindromic repeat associated (CRISPR associated) system 1
22. DNA repair- Sources of damage –Nuclear versus mitochondrial, Senescence and apoptosis. Mechanisms- Direct reversal, Single-strand damage, Double-strand breaks, Translesion synthesis, Medicine and DNA repair modulation 2
23. Cancer gene therapy- Immunotherapy, Oncolytic virotherapy- history, current clinical trials, future directions 1
24. Boosting the immune response, Gene therapies to make cancer treatments effective 1
25. Pro drug gene therapy, Blocking processes that protect cancer cells, Using altered viruses 1
26. Role of bioinformatics in pharmacogenomic- Bioinformatics and drug discovery, Barriers to bioinformatics progress in drug design process 1
27. Pharmacogenomics in drug discovery and development- Personalized/ effective medication. 1
28. Reviving orphan drug, Barriers to pharmacogenomics progress in drug designing and development. 1
29. Clinical applications of bioinformatics, genomics, and pharmacogenomics, Relationships and exchange of information with other resources 1

30. Time dependent inhibition of genes involved in cytochrome P450 (CYP450) enzymes (single point, IC 50 shift) 1

I. **Course Title : Immunopharmacology and Immunotoxicology**
II. **Course Code : VPT 707**
III. **Credit Hours : 2 + 0**
IV. **Aim of the course**

To study the pharmacological intervention of immune functions.

V. **Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Lectures/ Practicals
	Theory	
1.	Introduction to immunology	1
2.	General aspect of Immune system	3
3.	Cellular components of immune system	2
4.	General principles of immunopharmacology	1
5.	Immunomodulators and their use in animals	2
6.	Immunostimulants and their role in animal health and diseases	2
7.	Immunosuppressants, and tolerogens – clinical applications	2
8.	Immunological basis of drug allergy and drug tolerance	2
9.	Neuroendocrine immune interactions	2
10.	Iimmunotoxic effects of environmental and other pollutants	3
11.	Molecular mechanisms of immunotoxicity	2
12.	Immunomodulatory effect of xenobiotics	2
13.	Implications of immune alterations in health and disease	2
14.	Immune defiencies, autoimmune response to xenobiotics,	2
15.	Immunoregulants and their therapeutic applications in asthma, arthritis, cancer, dermatology and organ transplant etc	2
16.	Other immunological drugs	2
17.	Current discussions and assignments	2

I. **Course Title : Molecular Toxicology**
II. **Course Code : VPT 708**
III. **Credit Hours : 3+0**
IV. **Aim of the course**

To understand the mechanisms and targets of cellular/ molecular toxicity.

V. **Lecture/ Practical schedule**

S. No.	Name of Topic	No. of Lectures/ Practicals
	Theory	
1.	Cellular, sub-cellular and molecular targets and mechanism of toxicity	2

2. Concept of receptors and forces involved in binding of xenobiotics to receptors 3
3. Quantitative aspects and theories of xenobiotic-receptor interactions 3
4. Signal transduction mechanisms: transducers, effectors and second messengers 2
5. Classification and structures of receptors – Receptor conformation and configuration – Iono-receptors 2
6. G-protein coupled receptors 2
7. Enzymatic receptors 2
8. Steroid receptors 2
9. Biophysics of toxicants 2
10. Hepatic and extra-hepatic metabolism of xenobiotics 3
11. Metabolic enzyme induction and inhibition 3
12. Mechanism of bioactivation and cytotoxicity – Electrophilic metabolites, free radicals and reactive oxygen species 3
13. Molecular mechanisms of target organ directed toxicity of xenobiotics- brain, hematopoietic system, GIT, liver, lungs, kidneys, reproductive system, skin, etc. 4
14. Cellular dysfunctions and their consequences 2
15. Repair and disrepair of toxic damage 2
16. Xenobiotic induced mechanism of cell death – Necrosis and apoptosis 3
17. Risk Assessment 2
18. Mechanism involved in carcinogenesis, mutagenesis, teratogenesis 2
19. Radiation toxicity 2
20. Current topics/ Discussion of library assignments 2

I. Course Title : Clinical Toxicology
II. Course Code : VPT 709
III. Credit Hours : 2 + 1
IV. Aim of the course

To study the concepts of clinical toxicology.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. Introduction, history, definition and scope of clinical toxicology 1
2. Importance and processes of forensic toxicology 1
3. Toxicological investigations 1
4. Management and antidotal therapy of poisonings 1
5. Toxicity of metals – Arsenic, lead, mercury, selenium,

molybdenum, and other metals 3
6. Toxicity of non-metals – Fluoride, nitrite/ nitrate, sodium chloride,phosphorus 3
7. Toxicity of insecticides – Chlorinated hydrocarbons, organophosphates, carbamates, pyrethroids, and botanical and newer insecticides 3
8. Toxicity of fumigants 1
9. Toxicity of herbicides 2
10. Toxicity of fungicides 1
11. Toxicity of rodenticides 2
12. Toxicity of fertilizers 2
13. Toxicity of solvents and vapours 2
14. Toxic plants – Plants causing cyanide poisoning, photosensitization, thiamine deficiency and oxalate poisoning 3
15. Mycotoxins 2
16. Venomous stings and bites – Snake, scorpion, spider, bees and wasps 2
17. Toxicity of therapeutic agent 2
18. GLP in toxicological evaluation 2

Practical

1. Extraction, separation and detection of various poisons in suspected materials 3
2. Use of blood and tissue biomarker enzymes in assessment of toxicity, viz., acetylcholinesterase, carboxylesterase, etc. 3
3. Demonstration of poisoning and their antidotal treatment 3
4. Evaluation of antioxidant profile of toxicosed animals 2
5. Analysis of poisons in biological samples 2
6. Use of biomarkers in the assessment of toxicity 1
7. Good laboratory practices evaluation 1
8. Identification and collection of poisonous plants 1

I. Course Title : Ecotoxicology

II. Course Code : VPT 710

III. Credit Hours : 3 + 0

IV. Aim of the course

To impart knowledge regarding ecotoxicology for conservation of healthy eco-system.

V. Lecture/ Practical schedule

S. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. Introduction and basic principles of ecotoxicology 2
2. Sources of environmental contamination 2

3. Effects of pollutants on eco-health 2
4. Fate of chemicals in the environment and target species 2
5. General aspects of hazards associated with Air and water pollutants 2
6. Radiation and its hazards 2
7. Toxicity of pesticides in relation to environmental contamination 3
8. Toxicity of metals related to agriculture 3
9. Nanoparticle toxicology 2
10. Ecological emergencies 2
11. Residues of agrochemicals in food and ecosystem 2
12. Marine and wildlife as monitors of environmental quality 2
13. Bioaccumulation and biomagnifications of toxicants 1
14. Forensic and regulatory toxicology as related to agrochemicals 3
15. Hazards of toxicants in domestic and wild life 3
16. Biomarkers of monitoring the impact of environmental pollutants 3
17. Environmental hazard and risk identification from mixture of
18. chemicals 2
19. Contamination control measures 3
20. Approaches to rehabilitating damaged ecosystems 3
21. Ethical, moral, and professional issues in toxicology 2

I. **Course Title : Regulatory Toxicology**
II. **Course Code : VPT 711**
III. **Credit Hours : 2 + 1**
IV. **Aim of the course**

To study acts and regulations and risk assessment regarding use of drugs, chemicals and cosmetics.

S. No.	Name of Topic	No. of Lectures/ Practicals

Theory

1. Introduction to toxicology; scope and industrial application 1
2. Drug and development in modern industry 1
3. Regulatory toxicology and pre-clinical pharmaceutical testing services-linkage 2
4. Principles of Hazard Identification 1
5. Different guidelines for safety assessments 1
6. Methods of toxic dose estimation 2
7. Risk assessment and post marking surveillance 2
8. Procedure for acute, sub-acute and chronic toxicity study 3
9. Toxicity test guidelines and different routes 2
10. Guidelines for herbal safety risk assessment evaluation 1

11. Working principle of FDA and Indian legislations 1
12. Schedules of drugs and classification of industrial chemicals 1
13. Approaches to hazard identification-carcinogenicity 2
14. Modern concept tolerance: classification, evaluation 2
15. Dose-response assessment LOEL, LOAEL and AOEL, NOEL, NOAEL, ADI, etc. 3
16. Guidelines for registration of medicines 2
17. Specific aspects of drug registration legislation abroad 1
18. Central drugs standard control organization – CDSCO- India 2
19. Concept of GLP India and abroad; Role of GLP in toxicological evaluation 2

Practical

1. Introduction to good laboratory practices in toxicology 2
2. Screening procedures in regulatory toxicology 3
3. Evaluation of acceptable daily intake 2
4. Determination of No-observable effect level and NOAEL 2
5. Determination of Low-observable effect level and LOAEL 2
6. Determination of AOEL 2
7. Mandatory toxicity testing protocols 2

Suggested Reading

- Baggot JD (Ed). 2001. *The Physiological Basis of Veterinary Clinical Pharmacology*. Blackwell Science.
- Barile FA (Ed). 2013. *Principles of Toxicology Testing*. CRC Press.
- Bisset NG (Ed). 1994. *Herbal Drugs and Phytopharmaceuticals*. CRC Press.
- Brunton LL (Ed). 2018. *Goodman and Gilman's The Pharmacological Basis of Therapeutics*. 13th Ed. McGraw-Hill.
- Chopra SR, Badhwar RL and Ghosh S. 1984. *Poisonous Plants of India*. 1st Ed., Academic Publishers, Jaipur.
- Derelanko MJ and Holinger MA. (Eds). 2002. *CRC Hand Book of Toxicology*, 2nd Ed. CRC Press.
- Fowler BA (Ed). 2013. *Computational Toxicology: Methods and Applications for Risk Assessment*. Academic Press.
- Ghosh MN (Ed). 2015. *Fundamentals of Experimental Pharmacology*. 4th Ed. Hilton and Co.
- Gibaldi M and Perrier D (Eds). 1982. *Pharmacokinetics*, 2nd Ed. Taylor and Francis.
- GibaldiM and PrescottLF (Eds). 1983. *Handbook of Clinical Pharmacokinetics*. ADIS Health Science Press.
- Hayes AW and Kruger CL (Eds). 2014. *Hayes' Principles and Methods of Toxicology*, 6th Ed. CRC Press.

- Klaassen CD and Watkins JB (Ed). 2015. *Casarett and Doull's Essentials of Toxicology*. 3rd Ed. McGraw-Hill.
- Klassen CD (Ed). 2018. *Casarett and Doull's Toxicology: Basic Sciences of Poisons*. 9th Ed., McGraw-Hill.
- Kulkarni SK (Ed). 2004. *Handbook of Experimental Pharmacology*. 3rd Ed. Vallabh Prakashan.
- Medhi B and Prakash A (Eds). 2010. *Practical Manual of Experimental and Clinical Pharmacology*. Jaypee Brothers.
- Riviere JE and Papich MG (Eds). 2018. *Veterinary Pharmacology and Therapeutics*. 10th Ed. Iowa State Univ. Press.
- Southwood R, Fleming VH and Huckaby G (Eds). 2018. *Concepts in Clinical Pharmacokinetics*. American Society of Health-System Pharmacists.
- Srivastava AK, Verma PK and Dumka VK (Eds). 2013. *Veterinary Toxicology*. Satish Serial Publishing House, New Delhi.
- Stine KE and Brown TM. (Eds). 2015. *Principles of Toxicology*. 3rd Ed. CRC Press.
- Vogel HG and Voge WH (Eds). 1997. *Drug Discovery and Evaluation: Pharmacological Assays*. Springer.

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Veterinary Pharmacology and Toxicology

Scope of pharmacology, Drugs and other therapeutic agents, principles of biopharmaceutics and Veterinary dosage forms, principles of therapeutics. Quantitation of drug-receptor interactions and elicited effects, drug-drug interactions and adverse drug reactions. Screening, assaying, designing and development of drugs, clinical trials, drug safety, gene based therapy and drug delivery system.

Neurohumoral transmission. agents modulating peripheral nervous system. non-adrenergic-non cholinergic (NANC) transmission. Pharmacology of adrenergic agonists and antagonists, adrenergic neuron blockers, pharmacology of cholinergic agonists and antagonists, cholinergic neuron blockers, drugs acting at the neuromuscular junction and autonomic ganglia. Pharmacology aspects of histamine, serotonin, kinins, eicosanoids and platelet activating factor, angiotensins and other putative autacoids.

Stages of general anaesthesia, general anaesthetics and therapeutic gases, local anaesthetics, sedatives, hypnotics, neuroleptics, antiepileptics. CNS stimulants, analeptics, opioid agonists and antagonists, nonsteroidal anti-inflammatory drugs, central muscle relaxants, euthanizing agents.

Antiarrhythmic drugs, cardiac glycosides, myocardial stimulants, antihypertensive, antihypotensive, coagulants and anticoagulants, thrombolytic agents, drugs affecting haemopoietic system and antiplatelet drugs. Diuretics, antidiuretics, urinary acidifiers and alkalizers, urinary antiseptics, uricosuric and other anti-gout drugs.

Principles of Chemotherapy, classification of chemotherapeutic agents, antimicrobial resistance, combination therapy, therapeutic failure, systemic and gut acting sulphonamides, diaminopyrimidines, sulfones, quinolones, nitrofurans, nitroimidazoles, penicillins, cephalosporins, carbapenems, carbacephems, monobactam, beta lactamase inhibitors, aminoglycosides, tetracyclines, chloramphenicol and its congeners, macrolides, lincosamides, antitubercular drugs, glycopeptides, polypeptide antibiotics, methenamine, antiprotozoans, anthelmintics, ectoparasiticides, antifungal agents, antiviral and anti-neoplastic drugs.

Principles and scope of toxicology, mechanism of action of poisons and their detoxification, diagnosis and treatment of poisonings. Toxicology of metals, non-metals, agrochemicals, solvents and vapors, common salt, urea and other feed additives. Toxicity of drugs. Genotoxic and other effects of radiations and radioactive chemicals; toxicogenomics and developmental toxicology; forensic and regulatory aspects of toxicology.

Principles of drug action and bioassay. Dose-response plots and their significance. EC_{50}, median effective (ED_{50}), lethal doses (LD_{50}), therapeutic ratio, margin of safety, potency ratio, pAx, pDx and pD'x. Setting up isolated and intact preparations of guinea pig ileum and rat uterus. Organization of screening

programme of drugs; multidimensional screening procedures and gross observational methods. Specific tests for evaluation of tranquillizing, hypnotic, analgesic, anticonvulsant, general and local anaesthetic, muscle relaxant, anti-inflammatory, antipyretic and anti-hyperglycemic activities.

Animal models in toxicological studies. Animal toxicity tests for acute, sub-acute and chronic toxicity. Specific toxicity tests for neurotoxicity, immunotoxicity, behavioural, reproductive and developmental toxicity, mutagenicity, carcinogenicity.

Alternate systems of medicine in animals, scope of ethnopharmacology, standardization and clinical validation of bioactive molecules from plant sources, therapeutic and adverse effects of potential herbal drugs. Indigenous drugs used as glactagogues, carminatives, antiseptics, antidiarrhoeals, anthelmintics, Immunostimulants, antimicrobials, bioenhancers, analgesics, anti-inflammatory agents

Basic concept of pharmacokinetics, order of pharmacokinetics processes (zero order, first order and mixed order), compartmental and non-compartmental models of pharmacokinetics. Pharmacokinetic parameters, dosage regimen and bioavailability based on compartmental analysis, Non-compartmental pharmacokinetic modelling.

Animal Genetics and Breeding

DEPARTMENT OF ANIMAL GENETICS AND BREEDING
Course structure for M.V.Sc. degree programme (Semester wise)

Course No.	Course Title	Credit Hours	Semester
AGB 601*	ANIMAL CYTOGENETICS AND IMMUNOGENETICS-I	2+1	I
AGB 602*	MOLECULAR GENETICS-I	2+1	II
AGB 603*	POPULATION AND QUANTITATIVE GENETICS	2+1	I
AGB 604*	SELECTION METHOD AND BREEDING SYSTEM	2+1	II
AGB 605*	BIOMETRICAL GENETICS I	2+1	II
AGB 606	CONSERVATION OF ANIMAL GENETICS RESOURCES	2+0	I
AGB 607	CATTLE AND BUFFALO BREEDING	2+1	I
AGB 608	SHEEP AND GOAT BREEDING	2+0	II
AGB 609	POULTRY BREEDING	2+1	I
AGB 610*	LABORATORY ANIMAL AND RABBIT BREEDING	2+0	I
AGB 611	SWINE BREEDING	1+0	I
AGB 612	PET ANIMAL BREEDING (DOGS AND CATS)	1+0	II
AGB 613	WILD ANIMAL GENETICS AND BREEDING	1+0	II
AGB 614	EQUINE BREEDING	1+0	I
AGB 615	CAMEL BREEDING	1+0	I
AGB 616	YAK AND MITHUN BREEDING	1+0	II
AGB 617	STATISTICAL METHODS IN ANIMAL BREEDING	2+1	I
AGB 691	MASTERS' SEMINAR	1+0	I and II
AGB 699	MASTERS' RESEARCH	0+30	I and II
*Compulsory courses			

DEPARTMENT OF ANIMAL GENETICS AND BREEDING
Course structure for Ph.D. degree programme (Semester wise)

Course No.	Course Title	Credit Hours	Semester
AGB 701*	MOLECULAR GENETICS II	2+0	I
AGB 702*	TRENDS IN ANIMAL BREEDING	2+0	II
AGB 703*	BIOMETRICAL GENETICS II	2+1	II
AGB 704*	ADVANCES IN SELECTION METHODOLOGY	2+1	I
AGB 705	BIOINFORMATICS IN ANIMAL BREEDING	1+1	I
AGB 706	ANIMAL CYTOGENETICS AND IMMUNOGENETICS II	2+0	I
AGB 707	STATISTICAL SOFTWARE IN ANIMAL BREEDING	1+1	II
AGB 791	DOCTORAL SEMINAR - I	1+0	I and II
AGB 792	DOCTORAL SEMINAR - II	1+0	I and II
AGB 799	DOCTORAL RESEARCH	0+75	I and II
*Compulsory courses			

Course Contents
M.V.Sc. in Animal Genetics and Breeding

I. **Course Title : Animal Cytogenetics and Immunogenetics I**

II. **Course Code : AGB 601**

III. **Credit Hours : 2+1**

IV. **Why this course?**

To provide basic and advanced theoretical and practical training in animal cytogenetics and immunogenetics with an ulterior aim of enhancing animal production.

V. **Aim of the course**

This course is aimed to train students in identifying genetic/ chromosomal abnormalities and reviewing genetic mechanisms responsible for the generation of diversity in genes for immunoglobulin, TLR and MHC, etc., facilitating the better application of both classical and molecular cytogenetics and immunogenetics for animal improvement.

VI. **Theory**

Unit I (7 Lectures)

Physical and chemical basis of heredity; Development in animal cytogenetics and immunogenetics of farm animals; Inborn errors of metabolism and inherited disorders; immunoglobulin and their types; Antigen-antibody interactions; Immune response; ELISA.

Unit II (10 Lectures)

Chromatin structure of eukaryotes; Chromosome number and morphology in farm animals; Karyotyping and banding; Chromosomal abnormalities and genetic syndromes; DNA packing in chromosomes; Types of DNA; FISH chromosome painting and PRINS; SCH and RH panel mapping.

Unit III (10 Lectures)

Genetic variants in blood group systems of farm animals; Major histocompatibility complex: BoLA, BuLA; Genetics of biochemical variants and their applications; Immune response genes and concepts of disease resistance including major genes; Hybridoma and its significance; Concept of immunofertility; TLRs and interleukins.

Unit IV (3 Lectures)

Mutation and assays of mutagenesis; Sister chromatid exchanges.

VII. **Practical (15 Classes)**

Identification of Barr bodies; *In-vitro* and *in vivo* preparation of somatic metaphase chromosomes; Screening of chromosomal abnormalities; Microphotography and karyotyping; Banding

procedures for comparing the chromosomal complement; FISH and PRINS; ELISA; Immunocompetence tests.

VIII. **Teaching methods**

Blackboard; PPT-animations; Hands-on practical training; application based practical approach; Visit labs specialising in animal cytogenetics and immunogenetics; Research article discussion in the classroom.

IX. **Learning outcome**

Upon successful completion, the students will be able to understand the immune response (IR) and its role in disease resistance along with the role of allelic variations in IR genes in animal production in addition to the advances in the field of animal cytogenetics and immunogenetics.

X. **Suggested Reading**

- Gersen SL and Keagle MB. 2013. *The Principles of Clinical Cytogenetics*. Springer.
- Hare WCD and Singh EL. 1999. *Cytogenetics in Animal Reproduction.* CABI.
- Panayi GS and David CS. 1984. *Immunogenetics*. Elsevier.
- Roitt I. 1997. *Essential Immunology.* Blackwell.
- Summer AT and Chandley AC. 1993. *Chromosome Today*. Chapman and Hall.

I. **Course Title : Molecular Genetics-I**

II. **Course Code : AGB 602**

III. **Credit Hours : 2+1**

IV. **Why this course?**

To provide basic and advanced concepts of molecular genetics and their application to different species of animals

V. **Aim of the course**

This aim of this course is to study genes and their functions to understand their role in animal breeding and selection. Also aimed at the genetics of populations including quantitative genetics and its applications in animal breeding.

VI. **Theory**

Unit I (8 Lectures)

Basic concepts in molecular genetics; Concepts of proteomics and genomics; Genesis and importance of molecular techniques; Genome organization: physical and genetic map, current status of genome maps of livestock; Gene expression and control.

Unit II (8 Lectures)

Molecular markers and their applications; RFLP, RAPD, Microsatellite/ Minisatellite markers, SNP marker, DNA

fingerprinting.

Unit III (7 Lectures)

DNA sequencing; Genome sequencing; Genomic Library; Polymerase Chain Reaction (PCR) and its types (PCR-RFLP, AS-PCR, etc.) and applications; Transgenesis and methods of gene transfer; Recombinant DNA technology and applications.

Unit IV (7 Lectures)

Analysis of molecular genetic data; Quantitative Trait Loci (QTL) mapping and its application in animal breeding: Genome scan, candidate gene approach.

VII. Practical (15 Classes)

Extraction and purification of genomic DNA; Gel electrophoresis; Restriction enzyme digestion of DNA and analysis; PCR-RFLP; PCR-SSCP; Bioinformatics tool for DNA sequence analysis; Isolation of RNA; cDNA synthesis; Statistical methods for analyzing molecular genetic data. Blackboard; PPT-animations; Web-courses (if available); Hands-on practical training; Application based practical skills; Visit labs specialising in molecular genetics critical discussion of articles in the area.

IX. Learning outcome

Upon successful completion, the students will have an understanding of how genes control biological functions from cellular activities to development, techniques used to manipulate gene functions in addition to genomics, proteomics and their applications in livestock improvement.

X. Suggested Reading

- Akano IE. 1992. *DNA Technology.* IAP Academic Press.
- Brown TA. 2006. *Genome 3*. Garland Science Publishers.
- Clark D and Pazdernik N. 2012. *Molecular Biology*, 2nd ed. Elsevier.
- Micklos DA, Fryer GA and Crotty DA. 2003. *DNA Science.* Cold Spring Harbor.
- Setlow JK. 2006. *Genetic Engineering – Principles and Methods,* Springer.

I. Course Title : Population and Quantitative Genetics

II. Course Code : AGB 603

III. Credit Hours : 2+1

IV. Why this course?

To study the genetic structure of the animal population and the importance of genetic variation and covariation among quantitative traits.

V. Aim of the course

To impart knowledge on the general structure of animal population and factors affecting it and estimation of genetic and phenotypic parameters of different quantitative traits.

VI. Theory

Unit I (15 Lectures)

Genetic structure of population; Hardy Weinberg Law; Idealized population; Factors affecting changes in gene and genotypic frequencies; Systematic processes; Approach to equilibrium under different situations: Single autosomal locus with two alleles, single sex-linked locus, two pairs of autosomal linked and unlinked loci; Linkage equilibrium and disequilibrium; Combined effect of all forces changing gene frequency.

Unit II (10 Lectures)

Dispersive process - small population: random genetic drift; Effective population size; Regular and irregular inbreeding systems; Founder effect and bottleneck; Effective number of founders and ancestors.

Unit III (10 Lectures)

Quantitative genetics: Gene effects, population mean, breeding value; Variance and its partitioning; Genotype-environment interaction and correlation; Resemblance between relatives.

Genetic and phenotypic parameters (heritability, repeatability, correlations): Methods of estimation, uses, possible biases, precision, optimal designs; Scale effects and threshold traits.

VII. Practical (15 Classes)

Estimation of gene and genotypic frequencies under different conditions; Estimation of inbreeding in regular and irregular systems; Estimation of effective population size; Computation of quantitative genetic effects; Estimation of variance components; Computation of heritability, repeatability, genetic, phenotypic and environmental correlations and their standard errors.

VIII. Teaching methods

Lectures; PPT-Presentations; MS-Excel for estimation of data.

IX. Learning outcome

Understanding the effect of gene and genotype frequencies on the genetic structure of populations, and estimation of genetic variation and covariation among different quantitative traits.

X. Suggested Reading

- Bulmer MG. 1980. *The Mathematical Theory of Quantitative Genetics.* Clarendon Press.
- Crow JF and Kimura M. 2009. *An Introduction to Population Genetics.* Harper and Row.
- Falconer DS and Mackay TFC. 1996. *An Introduction to*

Quantitative Genetics. Longman.
- Jain JP. 1982. *Statistical Techniques in Quantitative Genetics.* Tata McGraw-Hill.
- Pirchner F. 1983. *Population Genetics in Animal Breeding*. Springer.

I. **Course Title : Selection Method and Breeding System**
II. **Course Code : AGB 604**
III. **Credit Hours : 2+1**
IV. **Why this course?**

To explain the methodology of selection and breeding systems for improvement of livestock and poultry.

V. **Aim of the course**

To study different methods of selection and factors affecting it, various mating systems and their use in animal genetics and the concepts of recent selection techniques.

VI. **Theory**

Unit I (6 Lectures)

Types of selection and their genetic consequences; Response to selection: Prediction and improvement.

Unit II (12 Lectures)

Theoretical aspects of accuracy and efficiency of selection bases; Prediction of breeding value using different criteria; Combined selection; Correlated response and efficiency of indirect selection.

Unit III (12 Lectures)

Selection for several traits; Different types of selection indices; Evaluation of short term and long term selection experiments: bidirectional selection, asymmetry of response, selection limit.

Unit IV (15 Lectures)

Different mating systems: assortative mating, inbreeding, out-breeding; Genetic and phenotypic consequences and applications of various mating systems in animal improvement; Heterosis; Selection for general and specific combining abilities; Genetic polymorphism and its application in genetic improvement: Basic concepts of marker-assisted selection (MAS) and genomic selection.

VII. **Practical (15 Classes)**

Prediction of direct and correlated response; Computation of realized heritability and genetic correlation; Computation of selection index; Estimation of breeding values from different sources of information; Determining the accuracy of selection; Estimation of heterosis for different types of crosses; Estimation of GCA and SCA.

VIII. **Teaching methods**

Blackboard; PPT-animations; Hands-on practical training; application based practical approach; Visit labs specialising in animal cytogenetics and immunogenetics; Research article discussion in the classroom.

IX. **Learning outcome**

Good knowledge of the application of selection methods and mating systems in animal improvement, and application of selection for combining abilities.

X. **Suggested Reading**

- Falconer DS and Mackay TFC. 1996. *An Introduction to Quantitative Genetics.* Longman.
- Jain JP. 1982. *Statistical Techniques in Quantitative Genetics.* Tata McGraw-Hill.
- Tomar SS. 1996. *Text Book of Population Genetics,* vol. I. *Qualitative Inheritance.* Universal Publishers.
- Tomar SS. 2010. *Text Book of Animal Breeding.* Universal Publishers.
- Tomar SS. 2014. *Text Book of Population Genetics,* vol II. *Quantitative Inheritance.* Universal Publishers.

I. **Course Title : Biometrical Genetics I**

II. **Course Code : AGB 605**

III. **Credit Hours : 2+1**

IV. **Why this course?**

To educate about the various biometrical techniques for data analysis and their applications

V. **Aim of the course**

To impart knowledge about common diseases and disorders of poultry, diagnosis, vaccination, prevention, control and treatment.

VI. **Theory**

Unit I (8 Lectures)

Nature and structure of animal breeding data; Source of variation; Adjustment of data; Outliers and their removal; Basic concepts in statistical inference and experimental designs.

Introduction to matrix algebra; Types of matrices and their operations; Determinants and their properties; Matrix inversion and its applications.

Unit III (15 Lectures)

Multiple regression and correlations; Fisher's discriminant function and its application; D^2 statistics in divergent analysis; Cluster analysis; Fixation index; Genetic distance estimation and

phylogeny construction; Linear models and their types; Least-squares (LS) analysis; Generalized LS and weighted LS; BLUE, BLUP; Methods of estimation of variance components: ANOVA, ML, REML, MINQUE, MIVQUE; Bayesian approach.

Unit IV (15 Lectures)

Animal model; Reduced animal model; Sire model; Maternal grandsire model; Maternal effects model; Repeatability model; Random regression model; Threshold model; Multidimensional scaling (MDS) and principal component analysis (PCA); Database management and use of software in animal breeding.

VII. Practical (15 Classes)

Collection, compilation, coding and transformation of animal breeding data; Matrix applications, determinant and inverse of matrices; Building of models for various types of data; Least-squares analysis of data; Estimation of BLUE and BLUP solutions; Formation of numerator relationship, dominance and identical by descent matrix; Estimation of variance components.

VIII. Teaching methods

Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom.

IX. Learning outcome

Students will develop skills in analyzing breeding data using different biometrical techniques.

X. Suggested Reading

- Henderson CR. 1984. *Application of Linear Models in Animal Breeding.* University of Guelph Press.
- Mather K and Jinks JL. 1977. *Introduction to Biometrical Genetics.* Chapman and Hall.
- Searle SR. 2014. *Linear Models.* John Wiley and Sons.
- Singh RK and Chaudhary BD. 2012. *Biometrical Methods in Quantitative Genetic Analysis*. Kalyani Publishers.

I. Course Title : Conservation of Animal Genetics Resources

II. Course Code : AGB 606

III. Credit Hours : 2+0

IV. Why this course?

To study the concepts of conservation of animal genetic resources (AnGR)

V. Aim of the course

To impart knowledge on AnGR in India and their characterization, concepts and methods of conservation and national and international strategies for conservation of AnGR.

VI. **Theory**

Unit I (12 Lectures)

Domestic animal diversity in India: Origin, history and utilization; Present status and flow of AnGR and its contribution to livelihood security; Methodology for phenotypic and genotypic characterization of livestock and poultry breeds through systematic surveys; Management of breed; Physical, biochemical and performance traits and uniqueness of animals of a breed; Social, cultural and economic aspects of their owners/ communities rearing the breed.

Unit II (12 Lectures)

Methods for increasing effective population size of endangered breed/ species: Effective number of alleles, inbreeding effective size, variance effective size, minimum viable population size; Methodology for characterization of AnGR; nuDNA and mtDNA based diversity analysis and relationship among the breeds; Concept of conservation: *In-situ* and *ex-situ* (in-*vivo* and *in-vitro*); Models of conservation; Prioritization of breeds for conservation; Strategies for conservation of livestock and poultry genetics resources; Gene bank concept; Preservation of ecosystem.

Unit III (6 Lectures)

Status, opportunities and challenges in the conservation of AnGR; IPR issues on animal genetic resources/ animal products or by-products; Registration of livestock breeds and protection of livestock owner's rights in India; Breed societies and their role in conservation.

VII. **Practical**

VIII. **Teaching methods**

Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom

IX. **Learning outcome**

Conservation strategies of AnGR, their characterization and methods of conservation to protect biodiversity

X. **Suggested Reading**

- Nivsarkar AE, Vij RK and Tantia MS. 2000. *Animal Genetic Resources of Indian Cattle and Buffaloes.* ICAR.
- Oldenbroek K. 2007. *Utilisation and Conservation of Farm Animal Genetic Resources.* WA Publishers.
- Sahai R and Vij RK. 1997. *Domestic Animal Diversity, Conservation and Sustainable Development.* SI Publishers.
- Van Vleck LD, Pollak E and Bltenacu EAB. 1987. *Genetics for*

Animal Sciences. WH Freeman.

I. **Course Title : Cattle and Buffalo Breeding**

II. **Course Code : AGB 607**

III. **Credit Hours : 2+1**

IV. **Why this course?**

To educate the concept of cattle and buffalo breeding and improvement in dairy production

V. **Aim of the course**

To impart knowledge on different breeds of cattle and buffalo and their economic traits, sire evaluation methods and breeding systems and different cattle and buffalo breeding programmes.

VI. **Theory**

Unit I (15 Lectures)

History of dairy cattle and buffalo breeding; Evolution of cattle and buffalo breeds and their characteristics; Population dynamics and production systems; Inheritance of important economic traits; Recording and handling of breeding data; Standardization of records; Computation of correction factors for the adjustment of the data; International Committee on Animal Recording (ICAR) and INAPH.

Unit II (12 Lectures)

Progeny testing under farm and field conditions; Evaluation of bulls by different models; Estimation of breeding values of the cows; Nucleus breeding system; Marker- assisted selection and genomic selection.

Unit III (12 Lectures)

Crossbreeding in cattle in India and abroad; Development of new breeds; Conservation of threatened breeds of cattle and buffaloes; Role of breed associations in dairy improvement; Breeding policy: national and state.

Unit IV (6 Lectures)

Import of exotic germplasm for breeding cattle in the tropics; Appraisal of buffalo and cattle breeding programme; Role of breed associations in dairy improvement.

VII. **Practical (15 Classes)**

Performance recording; Standardization of records; Estimation of economic traits; Computation of genetic parameters; Genetic gain; Sire evaluation methods; Estimation of heterosis; Culling and replacement.

VIII. **Teaching methods**

Blackboard; PPT-Presentations; Application based practical approach; Research article discussion in the classroom

IX. **Learning outcome**

After completion of the course, the students get good knowledge of different breedsof cattle and buffalo and breeding programmes

X. Suggested Reading

- Chakravarty AK and Vohra V. 2011. *Sustainable Breeding in Cattle and Buffalo. Satish Serial Publications.*
- Lasley JF. 1972. *Genetics of Livestock Improvement*. IBH.
- Oldenbroek K and van der Waaij L. 2014. *Text book of Animal Breeding and Genetics*.Wageningen University and Research Centre (Free Online).
- Schmidt GM, Van Vleck LD and Hutjens MF. 1988. *Principles of Dairy Science.* WH Freeman.
- Van Vleck LD, Pollak EJ and Bltenacu EAB. 1987. *Genetics for Animal Sciences.* WH Freeman.

I. Course Title : Sheep and Goat Breeding

II. Course Code : AGB 608

III. Credit Hours : 2+0

IV. Why this course?

To educate about sheep and goat breeding concepts and development in small ruminants.

To impart knowledge on different breeds of sheep and goat and their economic traits, breeding systems and selection strategies, and different sheep and goat breeding policies.

VI. Theory

Unit I (8 Lectures)

Breeds; Economic traits; Population dynamics and production systems; Prolificacy; Breeding records and standardization; Computation of correction factors.

Unit II (12 Lectures)

Genetic parameters; Selection of males and female; Selection indices for sheep and goat; Breeding systems; Breeding strategies for improvement of production (meat, milk and wool) and reproduction (fertility and fecundity); Inbreeding and its effects on production traits; Group breeding schemes; Development of new breeds; Strategies for introgression of genes (fecundity and growth).

Unit III (10 Lectures)

Breeding policy; Sheep and goat improvement programme in India; Conservation of breeds; Culling and replacement; Equivalent Animal Death Rate (EADR).

VII. Teaching methods

Blackboard; PPT-presentations

VIII. Learning outcome

After completion of the course, the students get a good knowledge of different breeds of sheep and goat and their breeding policies

IX. Suggested Reading

- Jindal SK. 2013. *Goat Production and Health Management*. New India Publishers.
- Karim SA. 2010. *Climate Change and Stress Management: Sheep and Goat Production*. Satish Serial Publications.
- Mulugeta A. 2016. *Sheep and Goat Production Text Book*. Lambert Academic Publishers.
- Prasad J. 2018. *Goat, Sheep and Pig, Production and Management*. Kalyani Publishers.
- Ross CV. 1988. *Sheep Production and Management*. Prentice-Hall.

I. Course Title : Poultry Breeding

II. Course Code : AGB 609

III. Credit Hours : 2+1

IV. Why this course?

To educate about advances in poultry breeding practices

V. Aim of the course

To impart knowledge on different species of poultry and their economic traits, selection criteria and selection indices, and conservation of poultry genetic resources.

VI. Theory

Unit I (10 Lectures)

Origin and history of poultry species: Chicken, turkey, duck and quail; Poultry classes and breeds; Important qualitative traits in poultry including lethal; Economic traits of egg and meat-type chicken and their standardization; Different mating systems. Selection criteria and selection indices; Response to selection; Genetic controls; Genotype and environment interaction; Inbreeding and its effects on production traits in egg and meat-type chickens; Development of inbred lines and strains; Strain and line crosses; Introduction to diallel cross; Utilisation of heterosis and reciprocal effect; Recurrent selection, reciprocal recurrent selection and modified RRS; Specialized sire and dam lines; Genetic improvement programs in poultry; Selection strategies for the improvement of layers and broilers; Performance testing of commercial strains; Backyard poultry.

Unit III (4 Lectures)

Industrial breeding; Artificial insemination in chicken; Auto-sexing; Random Sample Test.

Unit IV (6 Lectures)

Biochemical variants and immunogenetics of poultry; Use of

molecular genetics in poultry breeding; Quantitative trait loci; Marker-assisted selection and genomic selection; Conservation of poultry genetic resources.

VII. **Practical (15 Classes)**

Inheritance of qualitative traits; Economic traits of egg-type and meat-type chicken; Procedures of standardization; Estimations of heritability, the correlation between various production traits; Inbreeding co-efficient and heterosis; Selection of sires and dams; Osborne index; Restricted selection index; Collection and evaluation of semen and insemination; Estimation of GCA and SCA.

VIII. **Teaching methods**

Blackboard; PPT-presentations

IX. **Learning outcome**

Students get acquainted with different poultry species, applications of selection methodology and molecular genetics in poultry for higher productivity.

X. **Suggested Reading**

- Brereton G and Roadnight S. 2000. *21st Century Poultry Breeding*. Gold Cockerel Books.
- Crawford RD. 1990. *Poultry Breeding and Genetics.* Elsevier.
- Hutt FB. 2003. *Genetics of Fowl.* Norton Greek Press.
- Muir WM and Aggrey SE. 2003. *Poultry Genetics, Breeding and Biotechnology.* CABI.
- Singh RP and Kumar J. 1994. *Biometrical Methods in Poultry Breeding.* Kalyani Publishers.

I. **Course Title : Laboratory Animal and Rabbit Breeding**

II. **Course Code : AGB 610**

III. **Credit Hours : 2+0**

IV. **Why this course?**

To educate about laboratory animal breeding principles and commercial rabbit breeding.

V. **Aim of the course**

To impart knowledge on different laboratory animals and their importance, selection and mating methods, and commercial rabbit production and management.

VI. **Theory**

Unit I (6 Lectures)

Introduction to laboratory animal genetics; Breeding colonies of mice, rats, hamsters, guinea pigs and rabbits and their maintenance; Use of primates in animal research.

Unit II (4 Lectures)

Selection methods and mating systems: Monogamous, polygamous and others.

Unit III (12 Lectures)

Development of genetically controlled laboratory animals; Rules for nomenclature: Inbred strains, outbred stocks, mutant stocks, recombinant inbred strains, transgenic strains; Gene targeting and production of 'gene knock-out' animals; Production and use of specific pathogen-free animals; Guidelines and SOPs for the establishment of lab animal house; Genetic control and monitoring; Record-keeping; Ethics of laboratory animal research: FELASA, CPCSEA and IAEA regulations.

Unit IV (8 Lectures)

Rabbit production and management systems; Rabbit breeds for meat and wool; Economic traits and their inheritance; Breeding records and standardisation; Selection methods and breeding systems.

VII. Teaching methods

Blackboard; PPT-presentations

VIII. Learning outcome

Students get a view on breeding importance of laboratory animals and their applications in animal genetics. Additionally, knowledge of commercial rabbit production will also be developed

IX. Suggested Reading

- Hafez ESE. 1970. *Reproduction and Breeding Techniques for Laboratory Animals.* Philadelphia.
- Peter RC, Nephi MP, Steven DL and James IM. 1987. Rabbit Production, 6th ed. Vero Media Inc.
- Shinde AK, Swarnkar CP and Naqvi SMK. 2013. *Sheep and Rabbit Production and Utilization Technologies*. CSWRI Publications.
- Sirosis M. 2004. *Laboratory Animal Breeding: Principles and Procedures.* Elsevier.
- Tuffery AA. 1995. *Laboratory Animals: An Introduction for Animal Experimenters.* J Wiley and Sons.
- USDA. 2014. *A Complete Hand Book of Backyard and Commercial Rabbit Production*. Peace Corps (Free Online).
- Van Vleck LD, Pollak EJ and Bltenacu EAB. 1987. *Genetics for Animal Sciences.* WH Freeman.
- Weichbrod RH, Thompson GAH and Norton JN. 2018. *Management of Animal Care and Use. Programs in Research, Education, and Testing*, 2nd ed. CRC Press.

I. Course Title : Swine Breeding

II. Course Code : AGB 611

III. **Credit Hours : 1+0**

IV. **Why this course?**

To educate about swine breeding principles and swine improvement programme in India

To impart knowledge on different breeds of swine and their economic traits, breeding systems and selection methods, and breeding policies and conservation methods.

VI. **Theory**

Unit I (7 Lectures)

History and development of swine industry; Different breeds of pigs; Economic traits; Breeding records and standardization; Computation of correction factors; Culling and replacement; Equivalent Animal Death Rate (EADR).

Unit II (6 Lectures)

Genetic parameters; Bases and methods of selection; Selection of boars and sows; Breeding systems; Breeding strategies for improvement of indigenous and pure exotic breeds; Inbreeding and its effects on performance traits; Exploitation of heterosis; Development of synthetic varieties/ breeds.

Unit III (2 Lectures)

Swine breeding policy; National swine improvement programme; Conservation of breeds.

VII. **Teaching methods**

Blackboard: PPT-presentations: Research article discussion in the classroom

VIII. **Learning outcome**

Get acquainted with different breeds of swine, breeding methods and swine improvement programmes in India

IX. **Suggested Reading**

- ATARI. 2019. *Pig Farming: Promising Agri-business in Punjab.* ATARI-I Publication (Free Online).
- Board E. 2008. *Handbook of Pig Farming*, Engineers India Research Institute Publications.
- Das A, Tamuli AK, Mohan NH and Thomas R. 2013. *Handbook of Pig Husbandry,* Today and Tomorrow Printers.
- Das A, Tamuli, MK, Thomas R and Banik S. 2012. *Scientific Pig Production Practices*, NRC on Pig Publication.
- FAO. 2009. *Farmer's Hand Book on Pig Production.* FAO Publication.
- Oldenbroek K and van der Waaij L. 2014. *Text Book of Animal Breeding and Genetics*. Wageningen University and Research Centre (Free Online).

I. **Course Title : Pet Animal Breeding (Dogs and Cats)**

II. **Course Code : AGB 612**

III. **Credit Hours : 1+0**

IV. **Why this course?**

To educate about pet animal breeding principles which are contemporary in the defence establishment and affluent civic society

V. **Aim of the course**

To impart knowledge on different breeds of cats and dogs besides the principles of breeding management.

VI. **Theory**

Unit I (9 Lectures)

Breeds of dogs: Classification of breeds, important Indian and exotic breeds; Pedigree breeding and maintenance of breeding records; Kennel Club; Breed associations; Breeding management of dog.

Unit II (6 Lectures)

Breeds of cats: Classification of breeds, important Indian and exotic breeds; Pedigree breeding and maintenance of breeding records; Breeding management of cat.

VII. **Teaching methods**

Blackboard; PPT-animations; research article discussion in the classroom

VIII. **Learning outcome**

Different breeds of cats and dogs and their breeding management

IX. **Suggested Reading**

- Battaglia CL. 1990. *Dog Genetics: How to Breed Better Dogs*. TFH Publications.
- Harmer H. 1974. *Dogs and How to Breed Them*, 2nd ed. Gifford Publications.
- Hedberg K. 1992. *The Dog Owner's Manual on Selecting, Raising and Breeding Dogs*.Watermark Press.
- Moore AS. 1981. *Breeding Purebred Cats: A Guide for the Novice and Small Breeder*. Abraxes Publication.
- Robinson R. 1997. *Genetics of Cat Breeders*. Science Direct Publications.
- Vella CM and McGonagle JJ. 1997. *Breeding Pedigreed Cats*. Howell Book House.
- Vella C and Shelton L. 1999. *Genetics for Cat Breeders and Veterinarians*. Elsevier.
- Vine LL. 1977. *Breeding, Whelping and Natal Care of Dogs*. Acro Publication, NY.

- White K. 1980. *Dog Breeding: A Guide to Mating and Whelping*. Bartholomew Publications.

I. **Course Title : Wild Animal Genetics and Breeding**
II. **Course Code : AGB 613**
III. **Credit Hours : 1+0**
IV. **Why this course?**

To educate about wild animal breeding

V. **Aim of the course**

To impart knowledge on wildlife biodiversity in India, wild animal breeding in nature and captivity, and conservation of wild animals.

VI. **Theory**

Unit I (4 Lectures)

Wildlife biodiversity of India; Adaptation and natural selection; Species and speciation; Population dynamics; Variation; Loss of genetic variation; Hardy- Weinberg equilibrium.

Unit II (6 Lectures)

Inbreeding: Inbreeding depression, effective population size, demographic bottleneck; Genetic considerations in the translocation of wild animals; Wild animal breeding in nature and captivity; Captive breeding projects and principles; Concept of landscape genetics.

Conservation of wild animals; Cryopreservation of semen and embryos of endangered species; Frozen zoo concept; Genetic markers; Application of molecular and cytogenetic techniques in wildlife breeding; Genetic defects in wild animals; Wildlife Protection Act.

VII. **Teaching methods**

Blackboard; PPT-animations; research article discussion in the classroom

VIII. **Learning outcome**

Breeding and conservation methods of wild animals

IX. **Suggested Reading**

- Devera GK, Katerina VT and Charlotte KB. 2012. *Wild Animals in Captivity: Principles and Techniques of Zoo Management*. University of Chicago Press.
- Kleiman DG, Allen ME, Thompson KV and Lumpkin S. 1997. *Wild Mammals in Captivity-Principles and Techniques.* Chicago Press.
- Linda JS. 2017. *A Field Guide of Tracking Mammals in North East*. Countryman Press.
- Nicholas FW. 1987. *Veterinary Genetics.* Oxford Science Publication.

- Parragon. 2006. *The Encyclopaedia of Wildlife*. Parragon Books Service Ltd.
- Ranjitsinh MK. 2017. *A Life with Wildlife: From Princely India to the Present*, Harper Collins Publications.
- Saha GK and Mazumdar S. 2017. *Wildlife Biology: An Indian Perspective*. PHI Learning Pvt Ltd.

I. **Course Title : Equine Breeding**

II. **Course Code : AGB 614**

III. **Credit Hours : 1+0**

IV. **Why this course?**

To educate about breeding practices in equines

V. **Aim of the course**

To impart knowledge on classification of light and work-horses, breeding management and selection strategies in equines, and biotechnology in equine breeding programmes requirements of poultry and factors influencing the same.

VI. **Theory**

Unit I (4 Lectures)

Equine population in India; Domestic diversity, its origin, history and utilization; Breeds of native and exotic horses; Types and classes of light and work-horses.

Unit II (6 Lectures)

Cytogenetics of horses and donkeys; Breeding of horses and donkeys and production of mules; Foaling and care of foal; Important quantitative and qualitative traits and their inheritance; Recording and handling of breeding data; Standardization of records.

Unit III (5 Lectures)

Stallion and mare complementation; Judging criteria for elite animals; Conservation strategies; Selecting the mare and the stallion for breeding; Ongoing breed improvement programmes; Biotechnology in equine breeding programmes. Blackboard; PPT-presentations

VIII. **Learning outcome**

Breeding and conservation methods of equines

IX. **Suggested Reading**

- McKinnon AO, Squres EL, Vaala WE and Varner DD. 2011. *Equine Reproduction.* Wiley Blackwell.
- Morel MCGD. 2008. *Equine Reproductive Physiology, Breeding and Stud Management.* CABI.
- Samper JC. 2008. *Equine Breeding Management and Artificial Insemination*. Science Direct Publications.

I. **Course Title : Camel Breeding**

II. **Course Code : AGB 615**

III. **Credit Hours : 1+0**

IV. **Why this course?**

To educate about camel breeding, an emerging economically important species of livestock

V. **Aim of the course**

To impart knowledge on breeding management of camels, breed improvement programmes, and application of molecular genetic methods in camel breeding.

VI. **Theory**

Unit I (7 Lectures)

Population dynamics and economic importance; Breeds of the camel; Production systems and herd structure; Inheritance of important economic traits; Recording and handling of breeding data; Standardization of records; Cytogenetics of the camel; Behaviour and breeding management.

Unit II (5 Lectures)

Judging criteria for elite animals; Selection of breeding stock; Breeding seasons; Methods for detection of heat; Natural service and artificial insemination; Breed improvement programmes.

Unit III (3 Lectures)

Conservation strategies; Immune status of camel; Molecular genetics in camel breeding.

VII. **Teaching methods**

Blackboard; PPT-presentations; Research article discussion in the classroom

VIII. **Learning outcome**

Breeding and conservation methods of camels

IX. **Suggested Reading**

- Dmitriez NG and Ernst LK. 1989. *Animal Genetic Resources of the USSR*. FAO.
- Wilson RT. 1984. *The Camel*. Longman.
- Selected Research Articles

I. **Course Title : Yak and Mithun Breeding**

II. **Course Code : AGB 616**

III. **Credit Hours : 1+0**

IV. **Why this course?**

To educate about Yak and Mithun breeding

V. **Aim of the course**

To impart knowledge on breeds/ types of Yak and Mithun,

production systems in Yaks and Mithun, their behaviour and breeding management including conservation strategies and molecular genetics in Yak and Mithun breeding.

VI. **Theory**

Unit I (7 Lectures)

Population dynamics and economic importance; Breeds/ types of yak and mithun; Production systems; Inheritance of important economic traits; Recording and handling of breeding data; Standardization of records; Cytogenetics of yak and mithun; Behaviour and breeding management.

Unit II (5 Lectures)

Judging criteria for elite animals; Selection of breeding stock; Breeding seasons; Methods for detection of heat; Natural service and artificial insemination; Breed improvement. programmes

Unit III (3 Lectures)

Conservation strategies; Molecular genetics in yak and mithun breeding.

VII. **Teaching methods**

Blackboard; PPT-presentations; Research article discussion in classroom

VIII. **Learning outcome**

Breeding and conservation methods of yak and mithun

IX. **Suggested Reading**

- Das PJ, Deori S and Deb SM. 2017. *Arunachali Yak.* NRC on Yak, Dirang, India.
- Gupta SC, Gupta N and Nivsarkar AE. 1996. *Mithun - A Bovine of Indian Origin*.
- Nivsarkar AE, Gupta SC and Gupta N. 1997. *Yak Production*. ICAR Publication.
- Pal RN. 2003. *The Yak,* 2nd ed. FAO; RAP Publication.
- *Selected Research Articles.*

I. **Course Title : Statistical Methods in Animal Breeding / Statistics for Biological Sciences**

II. **Course Code : AGB 617/ BST 612**

III. **Credit Hours : 2+1**

IV. **Why this course?**

To educate about Statistical Methods in Animal breeding

V. **Aim of the course**

To impart knowledge on the transformation of data, sampling, standard error and importance, basics of statistical inferences, and analysis of variance.

VI. **Theory**

Unit I (12 Lectures)

Measures of central tendency; Measures of dispersion; Correlation and regression; Probability; Theory of distributions; Transformation of data; Sampling: Theory, need and properties; Estimators: Concept, standard error and importance.

Unit II (8 Lectures)

Basics of statistical inferences; Parametric tests: *Z*, *t* and *F* distribution; Non- parametric test: c^2 sign test, run test and rank test; Confidence interval.

Unit III (10 Lectures)

Analysis of variance: One and two way; Experimental designs: CRD, RBD and LSD; Missing plot techniques; Analysis of covariance.

VII. **Practical (15 Classes)**

Measures of central tendency; Measures of dispersion; Correlation and regression; Transformation of data; Probability; Z, t, F and c^2 tests; CRD, RBD and LSD; Analysis of covariance

VIII. **Teaching methods**

Blackboard; PPT-presentations

IX. **Learning outcome**

Application of statistical methods in animal breeding

X. **Suggested Reading**

- Gianola D and Hammond K. 1990. *Advances in Statistical Methods for Genetic Improvement of Livestock*. Springer.
- Gupta SC and Kapur VK. 2014. *Fundamentals of applied statistics.* Sultan Chand and Sons.
- Gupta SC. 2016. *Fundamentals of Statistics.* Himalaya Publishing House Pvt Ltd.
- Pillai SK and Sinha HC. 1968. *Statistical Methods for Biological Workers*. Ram Prasad and Sons.
- Snedecor GW and Cochran WG. 1989. *Statistical Methods.* Wiley India Publications.

Course Contents
Ph.D. in Animal Genetics and Breeding

I. **Course Title : Molecular Genetics II**

II. **Course Code : AGB 701**

III. **Credit Hours : 2+0**

IV. **Why this course?**

To educate about the latest tools and techniques of animal genetics and their uses in animal sciences

V. **Aim of the course**

To impart knowledge on the eukaryotic genome, gene editing, gene knock-out and silencing, transgenic animals their benefits in livestock production, and genomic selection.

VI. **Theory**

Unit I (10 Lectures)

Eukaryotic genome: Gene families, pseudogenes, SnRNPs; Types of RNA including miRNA; Gene conversion; Tandem repeats; Minisatellites and microsatellites; Sequencing of EST.

Unit II (10 Lectures)

Transposable elements; Transcription and RNA processing; Translation; Regulation of gene expression; Differential expression analysis; Serial analysis of gene expression; Selective gene amplification; The proteasome and longevity of proteins; Gene editing; Gene targeting; Gene knock-out and silencing.

Unit III (10 Lectures)

Transgenic animals: Application, ethical issues; Gene therapy; Bio-pharming; Cloning; Genome imprinting; Epigenetic modification; Creation of SNP chips and microarray technology; Next-generation sequencing; Genomic selection.

VII. **Teaching methods**

Blackboard; PPT-animations; Research article discussion in classroom

VIII. **Learning outcome**

Epigenetic Modification and transgenic animal production

IX. **Suggested Reading**

- Brown TA. 2006. *Genome 3*. Garland Science Publishers
- Clark DP. 2012. *Molecular Biology*. Academic Cell
- Hugo van den Berg. 2015. *Cell Biology and Molecular Genetics*. IPO Publishers
- Pasternak JJ. 2005. An Introduction to Human Molecular Genetics*: Mechanisms of Inherited Diseases*. Wiley
- Puehler A and Timmis KN. 1984. *Advanced Molecular Genetics*. Springer
- Watson, JD, Tania AB, Bell SP, Gann A, Levine A and Losick R. 2017. *Molecular Biology of the Gene*. Pearson Education Publication

I. **Course Title : Trends in Animal Breeding**

II. **Course Code : AGB 702**

III. **Credit Hours : 2+0**

IV. **Why this course?**

To acquaint with recent trends in animal breeding and designing of need-based breeding strategies

V. Aim of the course

To impart knowledge on identification of novel traits and their role in breed improvement programme, development of mixed model equations, formulation of detailed breeding plans and advanced techniques in genetic manipulation for multiplication and improvement of livestock species.

VI. Theory

Unit I (12 Lectures)

Identification of novel traits and their role in breed improvement programme; Development of mixed model equations; Advancement in biometrical methods including artificial neural network and Bayesian approach; Detection of QTL; Ancestry informative markers for admixture analysis.

Unit II (10 Lectures)

Formulation of detailed breeding plans; Breeding for disease resistance and functional traits; Breeding for climate resilience; Inheritance of animal behavior traits; Breeding for animal welfare; Impact analysis of different breed improvement programme in various livestock species.

Unit III (8 Lectures)

Advanced techniques in genetic manipulation for multiplication and improvement of livestock species: Use of sexed semen, gene introgression, and cloning, etc.

VII. Teaching methods

Blackboard; PPTs; Research article discussion in the classroom

VIII. Learning outcome

Breeding for disease resistance and functional traits; Breeding for climate resilience

IX. Suggested Reading

- Brah GS. 2016. *Animal Breeding: Principles and Applications. Kalyani Publishers.*
- Lynch M and Walsh B. 1998. *Genetics and Analysis of Quantitative Traits.* Oxford University Press.
- Morde RA and Thompson R. 2014. *Linear Models for the Prediction of Animal Breeding Values*. CABI.
- Oldenbroek K and van der Waaij L. 2014. *Text book of Animal Breeding and Genetics*.Wageningen University and Research Centre (Free Online).
- Tomar SS. 2010. *Textbook of Animal Breeding*. Universal Publishers.
- Zeggini E and Morris A. 2010. *Analysis of Complex Disease*

Association Studies. Academic Press.

I. **Course Title : Biometrical Genetics II**
II. **Course Code : AGB 703**
III. **Credit Hours : 2+1**
IV. **Why this course?**

To impart knowledge about recent advances in population genetic theory and application in animal breeding.

V. **Aim of the course**

To impart knowledge on multivariate analysis, QTL gene mapping, mating designs and other advanced biometrical techniques pertaining to animal breeding.

VI. **Theory**

Unit I (8 Lectures)

Multivariate analysis; Discriminant function; D^2 analysis; Principal component analysis; Path analysis.

Unit II (8 Lectures)

Mating designs: Basis, diallel, partial diallel, NCD-1, 2, 3 for reciprocal and maternal effects.

Unit III (5 Lectures)

Prediction of recombinant inbred lines using genetic parameters; Advances in genotype-environment interaction and selection indices.

Unit IV (9 Lectures)

QTL mapping; Analysis of SNP data for genomic selection; Advances in the estimation of variance component and prediction of breeding value: Threshold, dominance, random regression and survival models.

VII. **Practical (15 Classes)**

Discriminant function; D^2 analysis; Principal component analysis; Path analysis; Estimation of GCA and SCA through diallel, partial diallel, NCD-1, 2, 3; Advances in construction of selection indices; QTL mapping; Analysis of SNP data for genomic selection; Advances in estimation of variance components.

VIII. **Teaching methods**

Blackboard; PPTs; Research article discussion in the classroom

IX. **Learning outcome**

Students can analyze data on Animal Genetics using different Biometrical Techniques

X. **Suggested Reading**

- Choudhuri S. 2014. *Bioinformatics for Beginners.* Academic Press.

- Daniel S and Daniel G. 2012. *Likelihood, Bayesian, and MCMC Methods in Quantitative Genetics.* Springer.
- Kute N and Shinde G. 2016. *Principles of Biometrical Genetics*. Daya Publications.
- Marther K. 1997. *Biometrical Genetics*. Springer.
- Michael JK and Harpal SP. 1996. *The Genetical Analysis of Quantitative Traits*. Springer.
- Pawar IS and Singh S. 2010. *Theory and Application of Biometrical Genetics*. CBS Publications.
- Weller JI. 2016. *Genomic Selection in Animals*. John Wiley and Sons.
- Womack JE. 2012. *Bovine Genomics*. John Wiley and Sons.

I. **Course Title : Advances in Selection Methodology**

II. **Course Code : AGB 704**

III. **Credit Hours : 2+1**

IV. **Why this course?**

To educate about the latest advances in selection theory and their application in animal breeding

V. **Aim of the course**

To impart knowledge on design of selection experiments, information on single and multiple trait animal models, construction of various selection indices and their relationship with BLUP including the fundamentals of MAS and gBLUP.

VI. **Theory**

Unit I (8 Lectures)

Fundamental theorem of natural selection; Selection in finite populations; Effect on genetic structure experiments for testing and variance; Design of selection selection theory.

Unit II (6 Lectures)

Measurement of genetic and environmental trends; Advances in selection indices: Multistage, restricted and retrospective selection indices.

Unit III (6 Lectures)

Empirical evaluation of selection theory: genetic slippage, limits to the selection, asymmetry of response, selection experiments, the effect of selection on variance.

Unit IV (10 Lectures)

Selection for threshold traits; Selection under single and multiple trait animal models; Direct and correlated response through various selection indices; Relationship between BLUP and selection index; Selection using markers and entire genome; Methods for analysing GS data like RR-BLUP, Bayes-1, 2 and

3, etc.

VII. **Practical (15 Classes)**

Determination of culling levels and selection intensity; Estimation of direct and correlated response; Estimation of relative economic values; Construction of various selection indices; Prediction of breeding value using advance methods; QTL analysis using LDMAS and LEMAS.

VIII. **Teaching methods**

Blackboard; PPT; Research article discussion in classroom

IX. **Learning outcome**

They will be acquainted with all the theoretical techniques of the advanced selection methodology

X. **Suggested Reading**

- Balakrishnan N, Nagaraja HN and Kannan N. 2007. *Advances in Ranking, Multiple Comparisons and Reliability*. Springer.
- Cameron ND. 1997. *Selection Indices and Prediction of Genetic Merit in Animal Breeding*. CABI.
- Daniel S and Daniel G. 2012. Likelihood, Bayesian and MCMC *M*ethods in *Q*uantitative *G*enetics. Springer.
- Draper NR and Smith H. 1998. Applied *R*egression *A*nalysis. J Wiley and Sons.
- Henderson CR. 1984. *Applications of Linear Models in Animal Breeding*. CABI.
- Legarra A, Lourenco DAL and Vitezica ZG. 2018. *Bases for Genomic Prediction*. INRA (Free Online).
- Morde RA and Thompson R. 2014. *Linear Models for the Prediction of Animal Breeding Values*, CABI.

I. **Course Title : Bioinformatics in Animal Breeding**

II. **Course Code : AGB 705**

III. **Credit Hours : 1+1**

IV. **Why this course?**

To educate about basic concepts of bioinformatics and their applications in animal breeding

V. **Aim of the course**

To impart knowledge on the concepts of bioinformatics, information resources for protein and genome databases, genetic characterization and selection using bioinformatic tools, and modern bioinformatic tools like GWAS.

VI. **Theory**

Unit I (4 Lectures)

Overview of bioinformatics; Database concepts; Algorithms; Information resources for protein and genome databases: GenBank, EMBL, SWISSPROT, PROSITE.

Unit II (5 Lectures)

Nucleotide and protein sequence analysis; Pair-wise and multiple sequence alignments; Phylogeny; Big SNP data analysis methods; Micro-array processing; Clustering; Software for secondary database search and analysis.

Unit III (6 Lectures)

Genetic characterization; Use of bioinformatics tools for identifying QTL and selection of elite germplasm; GWAS; Development of DNA chips; NGS data analysis.

VII. Practical (15 Classes)

Database development; Algorithms; Nucleotide and protein sequence analysis; Pair- wise and multiple sequence alignments; Phylogeny and dendrogram; Micro-array processing; Clustering; Secondary database search and analysis; Genetic characterization; Identification of QTL; GWAS; NGS data analysis.

VIII. Teaching methods

Blackboard; PPT-animations; Research article discussion in the classroom

IX. Learning outcome

Nucleotide and protein sequence analysis and phylogenetic analysis

X. Suggested Reading

- Attwood TK and Parry-Smith DJ. 2001. *Introduction to Bioinformatics*. Benjamin-Cummings Publishing Company.
- Bishop M. 1999. *Genetics Databases.* Elsevier.
- Jiang R, Zhang X and Zhang MQ. 2013. *Basics of Bioinformatics.* Springer.
- Luke A. 1997. DNA Sequencing: From Experimental Methods to Bioinformatics. BIOS Scientific Publishers.
- Ramsden J. 2009. *Bioinformatics: An Introduction*. Springer.
- Stekel D. 2003. Microarray *Bioinformatics.* Cambridge University Press.
- Wu CH and McLarty JW. 2000. *Neural Networks and Genome Informatics*. Elsevier Science.
- Xiong J. 2006. *Essential Bioinformatics*. Cambridge University Press.

I. Course Title : Animal Cytogenetics and Immunogenetics II

II. Course Code : AGB 706

III. Credit Hours : 1+1

IV. **Why this course?**

To educate about the advances in cytogenetics and their application in animal genetics and breeding

V. **Aim of the course**

To impart knowledge on somatic cell genetics, stem cell genetics, image analysis of advanced karyotyping techniques, and molecular cytogenetics and gene mapping techniques.

VI. **Theory**

Unit I (8 Lectures)

Structure of eukaryotic chromosomes; Evolution of karyotype; Various *in- vitro* cell culture techniques; Cell lines and utility; Genotoxicity

Unit II (10 Lectures)

Somatic cell genetics; Stem cell genetics; Molecular cytogenetics and gene mapping; Linkage mapping; ISH; FISH; Radiation hybrid mapping; Fibre-FISH; PRINS; Positional cloning; Spectral karyotyping

Unit III (12 Lectures)

Image analysis; Chromosome painting; Chromosome walking; Micro-dissection of chromosomes; Structure and functions of major histocompatibility complex; T Cell receptor; CD4; Interleukins; Toll-like receptors and their functions

VII. **Teaching methods**

Blackboard; PPT-animations; Research article discussion in the classroom

VIII. **Learning outcome**

Students get a good grip on different gene mapping techniques and image analysis

X. **Suggested Reading**

- Agarwal S and Naik S. 2008. *Fundamentals of Immunogenetics Principles and Practices.* IBD Publisher.
- Christiansen FT and Tait BD. 2012. *Immunogenetics: Methods and Applications in Clinical Practice.* Springer.
- Gersen SL and Keagle MB. 2013. *The Principles of Clinical Cytogenetics.* Springer.
- Litwin SD. 1989. *Human Immunogenetics.* CRC Press.
- Tyagi R. 2009. *Textbook of Cytogenetics.* Discovery Publishers.

I. **Course Title : Statistical Software in Animal Breeding**

II. **Course Code : AGB 707**

III. **Credit Hours : 1+1**

IV. **Why this course?**

To educate about the standard statistical software packages in

animal breeding

V. Aim of the course

To impart knowledge on the use of software for computation of different statistical data

VI. Theory

Unit I (4 Lectures)

Data preparation and job control commands for statistical analysis of data; Introduction to statistical and standard software packages.

Unit II (6 Lectures)

Use of software for t-test, Chi-squares test, F-test, ANOVA (CRD, RBD and LSD), correlation and regression (simple, multiple, curvilinear, stepwise) and discriminant analysis.

Unit III (5 Lectures)

Graphic features of the software packages; Linear programming using appropriate software package; Least-squares analysis; Data mining techniques such as neural networks, genetic algorithms and fuzzy logic for predictive modelling.

VII. Practical (15 Classes)

Data preparation and generation; Import and export of data from spreadsheet and database packages; Use of software for t-test, Chi-squares test, F-test, ANOVA (CRD, RBD and LSD), correlation and regression (simple, multiple, curvilinear, stepwise) and discriminant analysis; Graphic features of the software packages; Use of software for linear programming problem; Least-squares analysis; Use of software for neural networks and fuzzy logic models for prediction.

VIII. Teaching methods

Blackboard; PPTs; Research article discussion in the classroom

IX. Learning outcome

Students get an idea on the availability of different statistical and standard software packages and their application in Animal Breeding.

X. Suggested Reading

- Balding DJ, Bishop M and Cannings C. 2001. *Handbook of Statistical Genetics*. J Wiley and Sons.
- Boldman K, Kriese LA, Van Vleck LD, Van Tassell CP and Kachman SD. 1995. *Manual for Use of MTDFREML*. ARS, USDA (Free online).
- Dempfle L. 1990. *Statistical Aspects of Design of Animal Breeding Programs*. Springer.
- Freund RJ, Mohr D and William WJ. 2010. *Statistical Methods*.

Academic Press.
- Henderson CR. 1984. *Applications of Linear Models in Animal Breeding.* University Guelph Press.
- Isik F, Holland J and Maltecca C. 2017. Genetic *Data Analysis for Plant and Animal Breeding*. Springer.
- Lynch M and Walsh B. 1990. *Genetics and Analysis of Quantitative Traits.* Oxford.

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Animal Genetics and Breeding

Physical and chemical basis of heredity; Development in animal cytogenetics and immunogenetics of farm animals; Inborn errors of metabolism and inherited disorders; immunoglobulin and their types; Antigen-antibody interactions; Immune response; ELISA. Chromatin structure of eukaryotes; Chromosome number and morphology in farm animals; Karyotyping and banding; Chromosomal abnormalities and genetic syndromes; DNA packing in chromosomes; Types of DNA; FISH chromosome painting and PRINS; SCH and RH panel mapping. Genetic variants in blood group systems of farm animals; Major histocompatibility complex: BoLA, BuLA; Genetics of biochemical variants and their applications; Immune response genes and concepts of disease resistance including major genes; Hybridoma and its significance; Concept of immunofertility; TLRs and interleukins. Mutation and assays of mutagenesis; Sister chromatid exchanges.

Basic concepts in molecular genetics; Concepts of proteomics and genomics; Genesis and importance of molecular techniques; Genome organization: physical and genetic map, current status of genome maps of livestock; Gene expression and control. Molecular markers and their applications; DNA fingerprinting. DNA sequencing; Genome sequencing; Genomic Library; Polymerase Chain Reaction (PCR) and its types and applications; Transgenesis and methods of gene transfer; Recombinant DNA technology and applications. Analysis of molecular genetic data; Quantitative Trait Loci (QTL) mapping and its application in animal breeding: Genome scan, candidate gene approach.

Genetic structure of population; Hardy Weinberg Law; Idealized population; Factors affecting changes in gene and genotypic frequencies; Systematic processes; Approach to equilibrium under different situations: Single autosomal locus with two alleles, single sex-linked locus, two pairs of autosomal linked and unlinked loci; Linkage equilibrium and disequilibrium; Combined effect of all forces changing gene frequency. Dispersive process - small population: random genetic drift; Effective population size; Regular and irregular inbreeding systems; Founder effect and bottleneck; Effective number of founders and ancestors. Quantitative genetics: Gene effects, population mean, breeding value; Variance and its partitioning; Genotype-environment interaction and correlation; Resemblance between relatives. Genetic and phenotypic parameters (heritability, repeatability, correlations): Methods of estimation, uses, possible biases, precision, optimal designs; Scale effects and threshold traits.

Types of selection and their genetic consequences; Response to selection: Prediction and improvement. Theoretical aspects of accuracy and efficiency of selection bases; Prediction of breeding value using different criteria; Combined selection; Correlated response and efficiency of indirect selection.

Selection for several traits; Different types of selection indices; Evaluation of short term and long term selection experiments: bidirectional selection, asymmetry of response, selection limit. Different mating systems, Genetic and phenotypic consequences and applications of various mating systems in animal improvement; Heterosis; Selection for general and specific combining abilities; Genetic polymorphism and its application in genetic improvement: Basic concepts of marker-assisted selection (MAS) and genomic selection.

Nature and structure of animal breeding data; Source of variation; Adjustment of data; Outliers and their removal; Basic concepts in statistical inference and experimental designs. Introduction to matrix algebra; Types of matrices and their operations; Determinants and their properties; Matrix inversion and its applications. Multiple regression and correlations; Fisher's discriminant function and its application; D^2 statistics in divergent analysis; Cluster analysis; Fixation index; Genetic distance estimation and phylogeny construction; Linear models and their types; Least-squares (LS) analysis; Generalized LS and weighted LS; BLUE, BLUP;

Methods of estimation of variance components: ANOVA, ML, REML, MINQUE, MIVQUE; Bayesian approach. Animal model; Reduced animal model; Sire model; Maternal grandsire model; Maternal effects model; Repeatability model; Random regression model; Threshold model; Multidimensional scaling (MDS) and principal component analysis (PCA); Database management and use of software in animal breeding.

Introduction to laboratory animal genetics; Breeding colonies of mice, rats, hamsters, guinea pigs and rabbits and their maintenance; Selection methods and mating systems. Development of genetically controlled laboratory animals; Rules for nomenclature: Inbred strains, outbred stocks, mutant stocks, recombinant inbred strains, transgenic strains; Gene targeting and production of 'gene knock-out' animals; Production and use of specific pathogen-free animals; Guidelines and SOPs for the establishment of lab animal house; Genetic control and monitoring; Record-keeping; Ethics of laboratory animal research: FELASA, CPCSEA and IAEA regulations.

Present status and flow of AnGR and its contribution to livelihood security; Methodology for phenotypic and genotypic characterization of livestock and poultry breeds through systematic surveys. Concept of conservation: *In-situ* and *ex-situ* (in-*vivo* and *in-vitro*); IPR issues on animal genetic resources/ animal products or by-products

Population dynamics and breeds of different livestock species including poultry, Inheritance of important economic traits in livestock and poultry, Different breeding policies, strategies and programmes for genetic improvement of livestock and poultry. Evolution of cattle and buffalo breeds and their characteristics. Progeny testing under farm and field conditions; Crossbreeding; Development of new breeds

Introduction to diallel cross, Utilization of heterosis and reciprocal effect;

Recurrent selection, reciprocal recurrent selection and modified RRS; Specialized sire and dam lines in poultry

Breeds of dogs and cats: Pedigree breeding and maintenance of breeding records. Population dynamics of wild animals, Wild animal breeding in nature and captivity; Captive breeding projects and principles; Cryopreservation of semen and embryos of endangered species; Frozen zoo concept.

Animal Nutrition

DEPARTMENT OF ANIMAL NUTRITION
Course Structure for M.V. Sc. Degree Programme (Semester Wise)

Course No.	Course Title	Credit	Semester
ANN 601*	NUTRITIONAL BIOCHEMISTRY	2+0	I
ANN 602*	ENERGY AND PROTEIN NUTRITION	2+0	I
ANN 603*	MINERALS AND VITAMIN NUTRITION AND FEED ADDITIVES	3+1	I
ANN 604*	FEED AND FODDER TECHNOLOGY	1+1	II
ANN 605*	RUMINANT NUTRITION	3+1	I
ANN 606*	NON-RUMINANT NUTRITION	3+1	I
ANN 607*	RESEARCH METHODOLOGY IN ANIMAL NUTRITION	1+2	II
ANN 608	COMPANION ANIMAL NUTRITION	1+0	II
ANN 609	NUTRITION OF LABORATORY, WILD AND ZOO ANIMALS	2+1	II
ANN 610	NON-CONVENTIONAL FEED RESOURCES	1+1	II
ANN 611	INTRODUCTORY CLINICAL NUTRITION	1+0	II
ANN 612	RUMEN BIOTECHNOLOGY	1+0	II
ANN 691	MASTER'S SEMINAR	1+0	I & II
ANN699	MASTERS' RESEARCH	0+30	I & II
* Compulsory courses			

DEPARTMENT OF ANIMAL NUTRITION
Course Structure for Ph.D. Degree Programme (Semester Wise)

Course No.	Course Title	Credit	Semester
ANN 701*	MODERN CONCEPTS IN FEEDING OF RUMINANTS	2+0	I
ANN 702*	FORAGES IN ANIMAL NUTRITION	1+0	I
ANN 703*	RECENT CONCEPTS IN FEEDING OF NON-RUMINANTS	2+0	I
ANN 704*	ADVANCES IN RUMEN METABOLISM	1+1	I
ANN 705*	ADVANCES IN MINERAL AND VITAMIN NUTRITION	2+0	I
ANN 706*	ADVANCED CLINICAL NUTRITION	3+1	II
ANN 707	ADVANCED TECHNIQUES IN NUTRITIONAL RESEARCH	1+1	II
ANN 708	ADVANCES IN FEED TECHNOLOGY	1+0	II
ANN 709	TOXICANTS AND ANTI-METABOLITES IN ANIMAL NUTRITION	1+0	II
ANN 710	NUTRIGENOMICS IN ANIMAL NUTRITION	1+0	II
ANN 711	EQUINE NUTRITION	1+ 0	II
ANN 791	DOCTORAL SEMINAR-I	1+0	I & II
ANN 792	DOCTORAL SEMINAR-II	1+0	I & II
ANN 799	DOCTORAL RESEARCH	0+75	I & II
* Compulsory courses			

Course Contents for M.V.Sc. in Animal Nutrition

I. **Course Title : Nutritional Biochemistry**
II. **Course Code : ANN 601**
III. **Credit Hours : 2+0**
IV. **Why this course?**

Biochemistry is the mother of all sciences. To understand the mechanism of nutrient metabolism a clear understanding of the various biochemical events is essential for a student specialising in animal nutrition.

V. **Aim of the course**

To help to develop the concepts of biochemical pathways involving nutrient metabolism.

VI. **Theory**

Unit I (12 Lectures)

Classification of carbohydrates and their functions. Digestion and metabolism of carbohydrate in ruminants and non-ruminants. Carbohydrate synthesis.

Unit II (8 Lectures)

Classification and properties of fats and their functions. Digestion and metabolism of fat in ruminants and non-ruminants. Fat synthesis

Unit III (12 Lectures)

Classification, structure, properties and function of proteins, amino acids and nucleic acids. Digestion and metabolism of proteins and other nitrogenous compounds in ruminants and non-ruminants. Protein synthesis. Control of metabolism

VII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. **Learning outcome**

Understanding of biochemical basis of nutrient metabolism.

IX. **Suggested Reading**

- Cheeke PR and Dierenfeld E. 2010. *Comparative Animal Nutrition and Metabolism*. CAB International.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of The Chicken*, 4th ed. University Books.
- Maynard LA, Loosli JK, Hintz HF and Warner RG. 1987. *Animal Nutrition*. Tata McGraw-Hill.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA,

Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- Nelson DL and Cox MM. 2017. *Lehninger Principles of Biochemistry*, 7th ed. Macmillan Learning.

I. **Course Title : Energy and Protein Nutrition**
II. **Course Code : ANN 602**
III. **Credit Hours : 2+0**
IV. **Why this course?**

Energy and protein constitute the major nutrients driving the maintenance and production in farm animals. A clear understanding of underlying concepts is key to the application of the same under practical feeding situation.

V. **Aim of the course**

To understand the metabolic pathways involved in energy and protein utilization including their requirements for various classes of animals for different physiological functions.

VI. **Theory**

Unit I (8 Lectures)

Measures of feed energy. Partitioning of feed energy. Energy balance, Fasting catabolism. Direct and indirect calorimetry. Efficiency of energy and protein utilization.

Unit II (12 Lectures)

Rumen degradable protein (RDP), and rumen undegradable protein (UDP) and fermentation kinetics. Protein turnover. Quantification of microbial protein synthesis. Protein quality determination in ruminants and monogastrics. Supplementary value of amino acids. NPN metabolism, urea fermentation potential and metabolizable protein. Amino acids imbalance, antagonism and toxicity.

Unit III (12 Lectures)

Feeding standards: comparative appraisal and limitations. Determination of energy and protein requirements. Nutrients metabolism with special reference to milk, meat and wool production. Energy and protein requirement for maintenance, growth, pregnancy and lactation in farm animals.

VII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. **Learning outcome**

Development of comprehensive knowledge of basic nutrition involving energy and protein.

IX. Suggested Reading

- Blaxter K. 1989. *Energy Metabolism in Animal and Man*. Cambridge University Press.
- Bondi A. 1987. *Animal Nutrition*. Wiley InterScience.
- Cheeke PR and Dierenfeld E. 2010. *Comparative Animal Nutrition and Metabolism*. CAB International.
- Crampton EW and Harris LE. 1969. *Applied Animal Nutrition*. WH Freeman.
- Dryden GM. 2008. *Animal Nutrition Science*, 1st ed. CAB International.
- Maynard LA, Loosli JK, Hintz HF and Warner RG. 1987. *Animal Nutrition*. Tata McGraw-Hill.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Singh UB. 1987. *Advanced Animal Nutrition for Developing Countries*. Indo-Vision.

I. Course Title : Minerals and Vitamin Nutrition and Feed Additives

II. Course Code : ANN 603

III. Credit Hours : 3+1

IV. Why this course?

Mineral and vitamins are key drivers of intermediary metabolism besides playing an important role in health and production

V. Aim of the course

To impart knowledge on sources, functions, analysis, signs of deficiency and signs of toxicity of various minerals and vitamins

VI. Theory

Unit I (12 Lectures)

General role of minerals, factors affecting mineral requirements. Macro-minerals and micro-minerals, their, distribution, metabolism, physiological functions,deficiencies and minerals. excesses,and sources and requirements. Probable essential

Unit II (12 Lectures)

Mineral interactions. Chelated minerals and concept of nano-minerals. Bioavailability studies in minerals. Impact of minerals on reproduction, fertility, and immunity. Soil-plant-animal-human relationship, development of area-specific minerals. Toxic minerals; their role in health and production of farm animals.

Newly recognized trace minerals.

Unit III (12 Lectures)

Definition, history, classification, chemistry, functions, deficiencies and excesses, requirements and sources of water-soluble and fat-soluble vitamins. Role of vitamins in energy metabolism. Vitamin-mineral interrelationship. Vitamin toxicosis. Role of vitamins in reproduction, fertility and immunity.

Unit IV (12 Lectures)

Feed additives and nutraceuticals. Probiotics, prebiotics and synbiotics; eubiotics. Feed enzymes. Phytochemical feed additives; polyphenols and essential oils; organic acids and acidifiers.

VII. Practical (16 Classes)

General principles of mineral estimation. Sampling and processing techniques. Use of atomic absorption spectrometry and ICP in mineral estimation. Estimation of macro- and micro-minerals. Formulation of mineral mixture for various species. Estimation of some important vitamins (vitamin A, E and C). Purified diets for mineral and vitamin studies. Calculation of mineral and vitamin requirements.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

- Comprehensive knowledge about mineral and vitamin metabolism and their requirements for farm animals
- Capacity for estimation of various minerals and vitamins using advanced analytical techniques

X. Suggested Reading

- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- McDowell RL. 1989. *Vitamins in Animal Nutrition*. Academic Press.
- McDowell RL. 2003. *Minerals in Animal and Human Nutrition*, 2nd ed. Elsevier Science.
- Suttle NF. 2010. *Mineral Nutrition of Livestock*, 4th ed. CAB International.

I. **Course Title : Feed and Fodder Technology**

II. **Course Code : ANN 604**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Processing of feed and fodder are important means to augment the utilization for efficient animal production.

V. **Aim of the course**

To understand various technological options available for processing of classes of food, feeds and fodders and their potential application in feeding management offarm animals.

VI. **Theory**

Unit I (4 Lectures)

Various feed mill equipment and their handling; layout and operations in feed mill (small, medium and large feed plants); automated feed mill: merits and demerits. Procurement of feed ingredients: specification and guidelines. Quality control of feed ingredients and finished feeds. BIS standard.

Unit II (4 Lectures)

Principles and process of material handling, weighing, grinding, mixing, pelleting, packaging and other major processing operations. Crumbling, flaking, popping and extrusion. Premixes. Codex Alimentarius, HACCP.

Unit III (4 Lectures)

Feed and fodder processing and preservation techniques. Densification, chemical and biological treatment of feeds/ fodders. Fodder conservation through hay and silages; Microbiological evaluation of processed and preserved feeds; Effect of preservation on the nutritional value of feed.

Unit IV (4 Lectures)

Feed storage and godown management; goods sanitation and hygiene of go-down. Traditional and modern farm-level storage structures. Factors affecting feedstuffs during storage. Liquid feed ingredients. Storage losses; insect pests and rodents control measures; Mycotoxins in feedstuffs and its control measures.

Quality control and inspection of feed materials. Qualitative tests for adulterantsurea, urease, thiram. Identification of insect pests and fungi in stored products. Feed microscopy. Formulation and preparation premixes. Quality evaluation of silage and hay, Laboratory preparation of silage. Visit to feed plant: Hands-on training on preparation of feed and mineral mixture. Preparation of project report on plant layout and design, problems related to feasibility, record-keeping in different sections of a feed mill.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Practical understanding and application of feed processing technologies

X. Suggested Reading

- Dryden G. 2008. *Animal Nutrition Science*. CAB International.
- Kundu SS, Mahanta SK, Singh S and Pathak PS. 2016. *Animal Feed Technology*. Satish Publishers
- Perry TW, Cullison AE and Lowrey RS. 2003. *Feeds and Feeding*, 6th ed. Pearson.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Schofield EK (Ed.). 2005. *Feed Manufacturing Technology V*. American Feed Industry Association, Arlington.

I. Course Title : Ruminant Nutrition

II. Course Code : ANN 605

III. Credit Hours : 3+1

IV. Why this course?

Ruminants possess unique digestive capabilities involving rumen microbes that utilize diverse feed resources which are otherwise not fit for monogastric animals.

V. Aim of the course

To develop an understanding of the rumen metabolism and its manipulation for improving nutrient utilization for enhancing ruminant production.

VI. Theory

Unit I (6 Lectures)

Functional anatomy of the digestive system of ruminants. Introduction to rumen microflora and fauna. Development of rumen. Feeds and fodders for ruminant feeding.

Unit II (12 Lectures)

Water requirements. Nutrient requirements and feeding of calves, heifers, dry, pregnant and lactating cows, buffaloes, sheep and goat. Peculiarities of digestive physiology, nutrition and feeding management of camels.

Unit III (6 Lectures)

Voluntary feed intake. Determination of digestibility, factors affecting digestibility. Manipulation of rumen fermentation.

Unit IV (12 Lectures)

Concept of complete feed and total mixed ration. Precision feeding. Phase feeding. Limiting nutrients and strategic feeding of high yielding ruminants. Concept of by- pass nutrients and their impact on production, reproduction and immune status.

Unit V (12 Lectures)

Nutritional approaches for increasing the functional properties of milk: role of CLA, omega fatty acids. Different systems of feeding buffalo for beef production. Feeding during stress and natural calamities. Feeding management of migratory/ nomadic small ruminants.

VII. Practical (16 Classes)

Design and planning of feeding experiments. Identification of feed and fodder based on its composition. Ration formulation for large and small ruminants for different physiological stages. Estimation of digestibility and nutritive value of feeds and fodders by metabolism trial in dairy cattle. Determination of nutritive value of pastures by the use of range techniques. Collection and processing of rumen liquor. Estimation of rumen metabolic profile (pH, ammonia, lactate, and TVFA, etc.). Estimation of purine derivatives.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

In-depth knowledge of feeding ruminants in light of their metabolic peculiaritiesFeed evaluation based on an assessment of various rumen functions

X. Suggested Reading

- Church DC. 1988. *The Ruminant Animal: Digestive Physiology and Nutrition*, 2nd ed. Prentice-Hall.
- Dehority BA. 2003. *Rumen Microbiology*. Nottingham University Press.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Givens D, Axford R and Owen E. (Ed.). 2000. *Forage Evaluation in Ruminant Nutrition*. CAB International.
- Hynd PI. 2019. *Animal Nutrition: From Theory to Practice*. CAB International.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press.

- Moran J. 2005. *Tropical Dairy Farming: Feeding Management for Small Holder Dairy Farmers in the Humid Tropics*. Landlinks Press
- NRC. 2001. *Nutrient Requirements of Dairy Cattle*, 7th rev. ed. National Research Council. National Academies Press.
- NRC. 2016. *Nutrient Requirements of Beef Cattle*, 8th rev. ed. National Academies of Sciences, Engineering, and Medicine. National Academies Press.
- NRC. 2007. *Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids*. National Research Council. National Academy Press.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Shirley RL. 2012. *Nitrogen and Energy Nutrition of Ruminants*. Academic Press.10. Van Soest PJ. 1994. *Nutritional Ecology of the Ruminant*. Cornell University Press.

I. **Course Title : Non-Ruminant Nutrition**

II. **Course Code : ANN 606**

III. **Credit Hours : 3+1**

IV. **Why this course?**

The nutritional attributes of non-ruminants differ among various species as well as their characteristic digestive physiology.

V. **Aim of the course**

To impart knowledge on the nutrient metabolism of various classes of monogastric animals involving poultry, swine, equines and rabbits under different physiological stages.

VI. **Theory**

Unit I (20 Lectures)

Feeding of poultry for meat and egg production. Ideal protein concept. Standard ileal digestible amino acids. Nutrient requirements for broilers and layers. Feeding of breeder hens; nutritional factors affecting hatchability. Feeding systems for poultry. Feed additives for poultry. Nutritional approaches for designer egg and meat production. Nutritional disorders in poultry and the role of nutrition in diseases prevention. Water intake and quality in poultry production.

Unit II (16 Lectures)

Nutrition and feeding of swine in different stages of growth and production. Nutritional factors affecting the quality of the products: lean meat production. Water intake and quality in pig production.

Unit III (12 Lectures)

Feeding of equines. Feeding of rabbits. Hindgut fermentation and

its importance. Nutrient requirements of equines. Special features of equine feeding management. Nutritional management of colic and other health disorders. Nutrient requirements of rabbits for wool and meat production. Nutrition-related disorders in rabbits.

VII. Practical (16 Classes)

Design and planning for poultry and swine feeding experiments. Calculation of nutrient requirements for broilers and layers. Formulation and compounding of general and least-cost rations, determination of the nutritive value of poultry and swine feeds by balance experiments. Formulation of rations for horses and rabbits. Visit poultry and piggery units, feed and fodder stores. Calculation of different measures of protein quality.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Knowledge of practical feeding management of various classes of non-ruminant species.

X. Suggested Reading

- Adamo G and Costanza A (Eds.). *Rabbits Biology, Diet and Eating Habits and Disorders*. Nova Biomedical.
- Cheeke PR. 1987. *Rabbit Feeding and Nutrition*. Academic Press, Inc.
- Chiba LI (Ed.). 2012. *Sustainable Swine Nutrition*. Wiley-Blackwell.
- de Blas C and Wiseman J. (Eds.). 2010. *Nutrition of the Rabbit*, 2nd ed. CAB International.
- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Frape D. 2010. *Equine Nutrition and Feeding*, 4th ed. Wiley-Blackwell.
- Hynd PI. 2019. *Animal Nutrition: From Theory to Practice*. CAB International.
- Leeson S and Summers JD. 2009. *Commercial Poultry Nutrition*, 3rd ed. Nottingham University Press.
- Leeson S and Summers JD. 2019. *Scott's Nutrition of The Chicken*, 4th ed. CBS Publishers and Distributors.
- NRC. 2007. *Nutrient Requirements of Horses*, 6th Rev. ed. National Research Council. National Academy Press.
- NRC. 1994. *Nutrient Requirements of Poultry*, 9th Rev. ed. National Research Council.

National Academy Press.
- NRC. 2012. *Nutrient Requirements of Swine*, 11th Rev. ed. National Research Council. National Academy Press.
- Varga M. 2013. *Textbook of Rabbit Medicine*, 2nd ed. Butterworth-Heinemann.

I. **Course Title : Research Methodology in Animal Nutrition**
II. **Course Code : ANN 607**
III. **Credit Hours : 1+2**
IV. **Why this course?**

Nutritional evaluation involving feed analysis and nutrient metabolism is vital in the interpretation of the outcomes of nutritional studies.

V. **Aim of the course**

Preparedness in part of the students to understand the basics of various analytical techniques and their application in nutritional research.

VI. **Theory:**

Unit I (16 Classes)

Principles of animal research. experimentation. Common statistical tools for nutritional Experiments. Specialized feed compounding. Introduction and principle of GLC, HPLC, AAS, tracer technique, flame photometer, NIR, SF6, amino acid analyzer. Importance and principle of various techniques in estimating chemical and biochemical constituents and toxic principles in feeds, fodders. Importance, principles and procedures for estimating chemical and biochemical constituents in blood, milk, rumen liquor, meat, wool

VII. **Practical**

Unit I (6 Classes)

Principles of animal research. experimentation. Common statistical tools for nutritional

Unit II (20 Classes)

Preparation of standard solutions. Proximate analysis of feeds and fodders. Cell- wall partitioning using Van Soest methods. Markers in digestibility determination. *In-vitro*/ *in sacco* determination of digestibility and digestion kinetics. Determination of energy content of feed, faeces and urine using bomb calorimeter. Determination of blood metabolic profile.

Unit III (6 Classes)

Introduction and principles of GC, HPLC, AAS, ICP, tracer technique, flame photometer, NIR, SF_6, rumen-simulation technique, and amino acid analyzer.

VIII. Teaching methods/ activities

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on training of laboratory techniques
- Capacity building of the students to undertake animal nutrition research.

IX. Suggested Reading

- Bate ST and Clark RA. 2014. *The Design and Statistical Analysis of Animal Experiments*. Cambridge University Press.
- Hofmann A and Clokie S (Eds.). *Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology*, 8th ed. Cambridge University Press.
- Maynard LA, Loosli JK, Hintz HF and Warner RG. 1987. *Animal Nutrition*. Tata McGraw-Hill.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- Pounis G. 2018. *Analysis in Nutrition Research*. Academic Press.

I. Course Title : Companion Animal Nutrition

II. Course Code : ANN 608

III. Credit Hours : 1+0

IV. Why this course?

The philosophy of companion animal nutrition is altogether different from that of the farm animals.

V. Aim of the course

To impart knowledge in the fundamental and applied aspects of the nutrient metabolism for ensuring health and wellbeing of companion animals.

VI. Theory

Unit I (4 Lectures)

Philosophy of companion animal nutrition. Digestion and absorption of nutrients in dogs and cats. Nutrient requirements for dogs and cats during different life stages: energy, protein, fat, minerals and vitamins. Critical nutrients for cats.

Unit II (4 Lectures)

Common feed ingredients and supplements for pets. Homemade diets. Commercial pet foods: types and nutritional profile. Processing techniques in pet food manufacturing. Pet food evaluation and quality control.

Unit III (4 Lectures)

Feeding management for dogs and cats of different age groups, viz., pregnancy, lactation, neonatal puppies and kitten, growth,

adult maintenance, stress and geriatrics including feeding behaviour. Water requirements.

Unit IV (4 Lectures)

Deficiencies and excesses of nutrients. Nutritionally responsive disorders: inherited disorders of nutrient metabolism, diabetes mellitus, obesity, urinary tract health and kidney diseases. Parenteral nutrition for hospitalized pets.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Understanding of the nutritional concepts for feeding management of companion animals.

IX. Suggested Reading

- Buffington C, Holloway C, Abood S. 2004. *Manual of Veterinary Dietetics*. Elsevier.
- Case LP, Daristotle L, Hayek MG, Raasch MF. 2010. *Canine and Feline Nutrition: A Resource for Companion Animal Professionals*, 3rd ed. Elsevier.
- Case LP. 2005. *The Dog: Its Behavior, Nutrition, and Health*, 2nd ed. Blackwell Publishing.
- McNamara JP. 2013. *Principles of Companion Animal Nutrition*, 2nd ed. Pearson.
- NRC. 2006. *Nutrient Requirements of Dogs and Cats*. National Research Council. National Academy Press.

I. Course Title : Nutrition of Laboratory, Wild and Zoo Animals

II. Course Code : ANN 609

III. Credit Hours : 2+1

IV. Why this course?

The nutrition of laboratory animals is important to ensure their health performance making them ready for use in biomedical research. On the contrary, wild and zoo animals as a part of the ecosystem call for an entirely different approach in terms of their nutritional management.

V. Aim of the course

To understand the mechanism involved in the nutrient metabolism in laboratory and wild animals and their diverse applications for effective health management and wellness.

VI. Theory

Unit I (12 Lectures)

Digestive structure and functions of laboratory animals: rats, mice, and guinea pigs. Nutritional requirements of various species

of laboratory animals. Feeding of laboratory animals. Concept of purified diets in laboratory animals. Nutrition of non-human primates.

Unit II (10 Lectures)

Natural dietary habits of zoo animals. Feeding schedules of various classes captive and zoo animals and birds. Feeding orphan and neonates. Role of nutrition in the management of health disorders in zoo animals. Feeding of sick and old animals: parenteral nutrition.

Unit III (10 Lectures)

Feeding habits, and behaviour of wild animals. General aspects of digestive physiology of herbivores and carnivores. Nutrition of semi-wild animals like mithun and yak. Nutritive characteristics of forages for wild animals. Adequacy of forage plants for wild and zoo animals.

VII. Practical (16 Classes)

Formulation and preparation of hygienic, balanced diets and feeding of laboratory animals. Characteristics of ration formulation and feeding schedules wild and zoo animals. Visit zoological parks and wildlife sanctuary, and collection of information on the feeding schedule of different categories of captive animals.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Understanding of nutritional management of the laboratory, wild and zoo animals

X. Suggested Reading

- Barboza PS, Parker KL and Hume ID. 2008. *Integrative Wildlife Nutrition*. Springer.
- Clemons DJ and Seeman JL. 2011. *The Laboratory Guinea Pig*, 2nd ed. CRC Press/ Taylor and Francis.
- Gordon IJ and Prins HHT. 2008. *The Ecology of Browsing and Grazing*. Springer.
- Lane-Patter W and Pearson AEG. 1971. *The Laboratory Animal: Principles and Practice*, 2nd ed. Academic Press.
- NRC. 1995. *Nutrient Requirements of Laboratory Animals,* 4th rev. ed. National Research Council. National Academy Press.
- NRC. 2003. *Nutrient Requirements of Nonhuman Primates*. National Research Council. National Academy Press.
- NRC. 2011. *Guide for the Care and Use of Laboratory Animals,*

8th ed. National Research Council. National Academy Press.
- Pond WG, Church DB, Pond KR and Schoknecht PA. 2004. *Basic Animal Nutrition and Feeding*, 5th ed. Wiley.
- Robbins C. 1993. *Wildlife Feeding and Nutrition*, 2nd ed. Elsevier.
- Weichbrod RH, Thompson GAH and Norton JN (Eds.). 2018. *Management of Animal Care and Use Programs in Research, Education, and Testing*, 2nd ed. CRC Press/ Taylor and Francis.

I. Course Title : Non-Conventional Feed Resources

II. Course Code : ANN 610

III. Credit Hours : 1+1

IV. Why this course?

Exploration of alternative feed resources for farm animals is a continuous process considering the scarcity of quality feeds and fodders for efficient livestock production.

V. Aim of the course

To build-up concepts involving the availability and potential use of various classes of non-conventional feed resources including ameliorative measures to ensure feed and food safety.

VI. Theory

Unit I (8 Lectures)

Present and future feed requirements and current availability for livestock and poultry. Use of non-conventional feeds; By-products of agricultural, industrial, food processing units and forest by-products. Slaughterhouse by-products, aquatic weeds. Permissible levels of inclusion of various non-conventional feeds in the ration of different kinds of livestock. Formulation of economical rations using the non-conventional feed. Classification of toxic principles in animal feedstuffs. Chemico-physical properties of various anti-nutritional factors (ANFs). Rumen microbial adaptation to various ANFs. Effect of anti-nutritional factors on health and production indifferent species of livestock.

Unit III (3 Lectures)

Detoxification of toxin principles by various physical, chemical and biological techniques. Insecticide and pesticide residues, heavy metals residues in feeds and fodders.

VII. Practical (16 Classes)

Qualitative methods for the presence/ detection of ANFs in feedstuffs. Estimation of mycotoxins in various feeds and fodders. Estimation nitrates, HCN, oxalates, protease inhibitors, tannins, saponins, gossypol, mimosine and heavy metals.

VIII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Comprehensive knowledge on the integration of alternative feed resources in practical farm animal production.

X. Suggested Reading

- Devendra C. 1985. *Non-conventional Feed Resources in Asia and the Pacific*, 2nd ed. APHCA, FAO.
- FAO. 1995. *Tropical Feeds and Feeding Systems*. Proceedings of the First FAO Electronic Conference. Food and Agriculture Organization of the United Nations, Rome.
- FAO. 2004. *Assessing Quality and Safety of Animal Feeds*. Food and Agriculture Organization of the United Nations, Rome.
- Liner IE. 1980. *Toxic Constituents of Animal Food Stuffs*, 2nd ed. Academic Press.
- Singh UB. 1987. *Advanced Animal Nutrition for Developing Countries*. Indo-Vision.
- Speedy A and Sansoucy R. 1991. *Feeding Dairy Cows in the Tropics*. Food and Agriculture Organization of the United Nations, Rome.
- *Select articles from journals*

I. Course Title : Introductory Clinical Nutrition

II. Course Code : ANN 611

III. Credit Hours : 1+0

IV. Why this course?

Nutrition forms the basis of health and therefore could be strategically used for prevention and/ or therapeutic management of various diseases.

V. Aim of the course

To understand the role of nutrients in the development of various disease processesTo elucidate the potential of various nutrients and nutraceuticals in amelioration and management of disease of diverse nature.

VI. Theory

Unit I (8 Lectures)

Metabolic disorders and peri-parturient diseases: milk fever, ketosis, downer cow syndrome, retained placenta, sub-acute ruminal acidosis, laminitis, abomasal displacement, mastitis. Nutrient parasite interaction. Enterotoxaemia

Unit II (8 Lectures)

Nutritional amelioration of biotic and abiotic stress: heat and cold stress, transportation stress. Potential plant toxicity to grazing animals. Toxicity of grazing animals: signs of poisoning. Nitrite poisoning, toxic effects of goitrogens, glucosinolates. Nutritional management of reproductive disorders.

VII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. **Learning outcome**

Understanding of nutritional management of health disorders.

IX. **Suggested Reading**

- Constable P, Hinchcliff KW, Done S and Gruenberg W. 2016. *Veterinary Medicine*, 11th ed. Saunders Ltd.
- Knight AP and Walter R. 2001. *A Guide to Plant Poisoning of Animals in North America*. Teton NewMedia.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press.
- Select articles from Journals

I. **Course Title : Rumen Biotechnology**

II. **Course Code : ANN 612**

III. **Credit Hours : 1+0**

IV. **Why this course?**

Rumen being a distinctive digestive organ typical to ruminants harbouring diverse microbial communities offers opportunities for their manipulation using molecular biological approaches.

V. **Aim of the course**

To understand the basics of rumen metabolism employing molecular biology tools

VI. **Theory**

Unit I (8 Lectures)

Rumen ecology. Manipulation of rumen fermentation for better utilization of fibrous feeds and reduction in methane production. Biotechnological applications for lignin degradation. Role of feed additives, chemicals, antibiotics and probiotics and their effect on rumen metabolism. Degradation of anti-nutritional factors in the rumen.

Unit II (8 Lectures)

Genetic manipulation, DNA recombinant technology for improvement in rumen fermentation. Factors influencing the fate of introduced microbes. Metagenomics for microbial diversity: concept and

application.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Basic knowledge of molecular biology as applicable to rumen functions.

IX. Suggested Reading

- Dehority BA. 2003. *Rumen Microbiology*. Nottingham University Press.
- Dijkstra J, Forbes J and France J. 2005. *Quantitative Aspects of Ruminant Digestion and Metabolism*. CAB International.
- Kebreab E, Dijkstra J, Bannink A, Gerrits W and France J. 2006. *Nutrient Digestion and Utilization in Farm Animals*. CAB International.
- Millen DD, Arrigoni MDB and Pacheco RDL. (Eds.). 2016. *Rumenology*. Springer Nature.
- Van Soest PJ. 1994. *Nutritional Ecology of the Ruminant*. Cornell University Press.

Course Contents Ph.D. in Animal Nutrition

I. **Course Title : Modern Concepts in Feeding of Ruminants**
II. **Course Code : ANN 701**
III. **Credit Hours : 2+0**
IV. **Why this course?**

The feeding management of ruminants is undergoing rapid changes because of scientific and technological advances to augment productivity.

V. **Aim of the course**

To understand the emerging concepts involving feeding management of high producing ruminant animals.

VI. **Theory**

Unit I (20 Lectures)

Developments in ruminant digestive physiology. Advanced concepts in the determination of energy and protein requirements. Importance of energy and protein quality for milk and meat production. Recent concepts in protein and energy systems like CNCPS, net energy, metabolizable and available protein. Methods of estimation of energy and protein values of feeds for different physiological functions of livestock. Kinetics of nutrient metabolism. Hindgut fermentation. Efficiency of nutrient utilization for different production purposes. Hormonal regulation of nutrient partitioning.

Unit II (12 Lectures)

Concept of limiting amino acids for high yielders. Strategic feeding of high yielding dairy cows and meat-producing ruminants. Concept of phase feeding and precision feeding. Feeding during the transition period. Bypass nutrient technology. Rumen manipulation to optimize productivity and reduce methanogenesis.

VII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. **Learning outcome**

Knowledge of the newer concepts for its application in the feeding management of ruminants.

IX. **Suggested Reading**

- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA and Wilkinson RG. 2011. *Animal Nutrition*, 7th ed. Benjamin Cummings.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm*

Climates. Academic Press.
- NRC. 2001. *Nutrient Requirements of Dairy Cattle*, 7th rev. ed. National Research Council. National Academies Press.
- NRC. 2016. *Nutrient Requirements of Beef Cattle*, 8th rev. ed. National Academies of Sciences, Engineering, and Medicine. National Academies Press.

I. **Course Title : Forages in Animal Nutrition**
II. **Course Code : ANN 702**
III. **Credit Hours : 1+0**
IV. **Why this course?**

Forages are the principal component of the animal feeding system and therefore their effective utilization is the key for efficient animal production.

V. **Aim of the course**

To impart knowledge on the fodder management including different forage production systems and their utilization.

VI. **Theory**

Unit I (10 Lectures)

Forages in ruminant production. Improvement in productivity of fodders and pasture: feed-food crops, silvi-pasture, horti-pasture, shrubs. Use of conserved forages in ruminant feeding. Factors affecting the nutritive value of cultivated and conserved forages. Hydroponics as an alternate to green fodder production.Top feeds, fodder trees and their effective utilization. Tree leaves as a source of condensed tannins: role in protein protection and GI parasite control.

Unit II (6 Lectures)

Methods in forage evaluation: calculated *in-vitro* DOMD and ME by using *in-vitro* gas production technique. Pasture consumption and evaluation studies.

VII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. **Learning outcome**

Understanding of various aspects of forage production, fodder evaluation and their integration into the different animal production system.

IX. **Suggested Reading**

- Givens D, Axford R and Owen E. (Ed.). 2000. *Forage Evaluation in Ruminant Nutrition*. CAB International.
- McDowell RL. 2012. *Nutrition of Grazing Ruminants in Warm*

Climates. Academic Press.
- Minson D. 1990. *Forage in Ruminant Nutrition*. Academic Press.
- Shirley RL. 2012. *Nitrogen and Energy Nutrition of Ruminants*. Academic Press.

I. **Course Title : Recent Concepts in Feeding of Non-Ruminants**

II. **Course Code : ANN 703**

III. **Credit Hours : 2+0**

IV. **Why this course?**

Increased consumer awareness has necessitated a relook into the feeding management of food animals leading to the production of safe and healthy food.

To derive knowledge regarding the nutritional manipulation of food animals for the production of quality food for human consumption.

VI. **Theory**

Unit I (18 Lectures)

Latest concepts in nutrition and feeding in different phases of broiler, layer and breeder stocks. In-ovo and early chick nutrition. Nutritional disorders in modern poultry production and their amelioration. Nutritional factors affecting egg quality and hatchability in poultry. Feeding strategies for the production of designer eggs and meat. Omega fatty acids. Recent trends in amino acid nutrition. Advances in new generation feed and feed additives.

Unit II (14 Lectures)

Nutrition and feeding of pigs in various stages of production. Modern concepts in amino acids nutrition in swine production. Emerging concepts in feeds and feed additive for pigs. Role of vitamins and minerals in health and disease. Nutritional manipulation for lean meat and designer pork production. Carcass modifiers.

VII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. **Learning outcome**

Comprehensive knowledge on the scope of nutritional management of non-ruminant animals for the production of healthy food.

IX. **Suggested Reading**

- Chiba LI (Ed.). 2012. *Sustainable Swine Nutrition*. Wiley-Blackwell.

- D'Mello JPF. 2003. *Amino Acids in Animal Nutrition*, 2nd ed. CAB International.
- Hendriks WH, Verstegen MWA and Babinszky L. (Eds.). 2019. *Poultry and Pig Nutrition: Challenges of the 21st Century*. Wageningen Academic Publishers.
- Leeson S and Summers JD. 2001. *Scott's Nutrition of The Chicken*, 4th ed. University Books.
- Lewis AJ and Southern LL. 2000. *Swine Nutrition*, 2nd ed. CRC Press.

I. **Course Title : Advances in Rumen Metabolism**

II. **Course Code : ANN 704**

III. **Credit Hours : 1+1**

IV. **Why this course?**

An in-depth of the understanding of the rumen function is key to devise strategies for augmenting the efficiency of production besides ensuring environmental sustainability.

V. **Aim of the course**

To understand the metabolic aspects of rumen function and its application for eco- friendly ruminant production.

VI. **Theory**

Unit I (8 Lectures)

Rumen development. Rumen microflora: classification and their role in fermentation

and digestion, microbial interactions, rumen kinetics, the nutrient requirement of rumen microbes. Dynamics of nitrogen metabolism in the rumen.

Unit II (8 Lectures)

Manipulation of rumen fermentation: physical, chemical and biological approaches. Trans-faunation and defaunation. Concept of metagenomics in rumen manipulation. Green-house gas production from rumen and mitigation strategies

VII. **Practical (16 Classes)**

Rumen microbial and protozoal count. Estimation of rumen microbial protein. Estimation of nitrogen-fractions in rumen liquor. Volatile fatty acid fractionations. Rumen enzymes assay. Extraction of nucleic acids and quantification of rumen microbes by PCR.

VIII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. Learning outcome

Comprehensive knowledge of various concepts of rumen metabolism for efficient ruminant production.

X. Suggested Reading

- Dehority BA. 2003. *Rumen Microbiology*. Nottingham University Press.
- Dijkstra J, Forbes J and France J. 2005. *Quantitative Aspects of Ruminant Digestion and Metabolism*. CAB International.
- Kebreab E, Dijkstra J, Bannink A, Gerrits W and France J. 2006. *Nutrient Digestion and Utilization in Farm Animals*. CAB International.
- Millen DD, Arrigoni MDB and Pacheco RDL. (Eds.). 2016. *Rumenology*. Springer Nature.
- Van Soest PJ. 1994. *Nutritional Ecology of the Ruminant*. Cornell University Press.

I. Course Title : Advances in Mineral and Vitamin Nutrition

II. Course Code : ANN 705

III. Credit Hours : 2+0

IV. Why this course?

Molecular mechanisms driving the metabolism of minerals and vitamins have opened up a new vista in the nutrition of farm animals.

V. Aim of the course

To understand advances in mineral and vitamin metabolism for its application in ensuring optimized health and efficient production in farm animals.

VI. Theory

Unit I (18 Lectures)

Role of minerals in nutrient metabolism. Mineral absorption, transport, metabolism and its regulation. Bio-availability of macro and micro minerals: factors affecting the bioavailability; bio-markers for mineral status. Mineral interactions. Dietary cation-anion difference (DCAD). Identification and correction of deficiencies and toxicities of minerals. Mineral tolerance in animals. Mineral requirements for growth, reproduction and lactation. Mineral toxicities concerning livestock feeding and their amelioration. Methods of mineral supplementation.

Unit II (14 Lectures)

Chemical nature of fat-soluble and water-soluble vitamins. Role of vitamins in nutrient metabolism. Advances in physiological functions and metabolism of vitamins. Vitamin deficiency: clinical signs and their management. Antimetabolites to vitamins.

Hypervitaminosis. Vitamins as antioxidants. Role of vitamins in immunity and stress. Dietary supplementation of vitamins: forms, storage and stability.

VII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. **Learning outcome**

Knowledge on the latest understanding of mineral and vitamins and its application in practical feeding conditions.

IX. **Suggested Reading**

- McDowell RL. 1989. *Vitamins in Animal Nutrition*. Academic Press.
- McDowell LR. 2003. *Minerals in Animal and Human Nutrition*, 2nd ed. Elsevier Science B.V.
- Suttle N. 2010. *The Mineral Nutrition of Livestock*, 4th ed. CAB International.

I. **Course Title : Advanced Clinical Nutrition**

II. **Course Code : ANN 706**

III. **Credit Hours : 3+1**

IV. **Why this course?**

Approaches involving preventive, therapeutic and convalescent nutrition have been recognized as a sustainable means of ensuring health and wellbeing of animals besides the production of safe and healthy food.

V. **Aim of the course**

To understand the disease-induced alterations in nutrient metabolism and the potential of select nutrients to prevent and/ or support disease management in prone animals.

VI. **Theory**

Unit I (16 Lectures)

Metabolic disorders in farm animals. Modern concepts in the metabolic alterations leading to production diseases, viz., milk fever, ketosis, downer cow syndrome, retained placenta, sub-acute ruminal acidosis, laminitis, abomasal displacement and mastitis Optimum nutrition for peri-parturient dairy animals.

Unit II (16 Lectures)

Metabolic effects of infection: metabolism of carbohydrates, fats, protein and amino acids and minerals during various infection and inflammatory diseases. Role of cytokines in nutrient homeorrhesis. Nutrition-immunity interaction: Role of nutrients (fats, amino acids, minerals and vitamins) in the immune response. Metabolic

Unit III (16 Lectures)

Nutritional manipulation and feeding of sick and hospitalized animals. Preventive and therapeutic nutrition. Optimum nutrition for the management of diseases of the hepatic, renal and gastrointestinal system. Convalescence diet. Feeding management of pre- and post-operated animals.

VII. **Practical (16 Classes)**

Assessment of immunity: humoral immune response, cell-mediated immune response. Assessment of antioxidant status: Superoxide dismutase, Catalase, Glutathione peroxidase, reduced glutathione (GSH), lipid peroxides. Formulation of diet for sick and diseased animals.

VIII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

IX. **Learning outcome**

Understanding the potential of nutrition for prophylaxis and therapeutic purposes.

X. **Suggested Reading**

- Cheeke PR and Dierenfeld E. 2010. *Comparative Animal Nutrition and Metabolism*. CAB International.
- Constable P, Hinchcliff KW, Done S and Gruenberg W. 2016. *Veterinary Medicine*, 11th ed. Saunders Ltd.
- Naylor JM and Ralston SL. 1991. *Large Animal Clinical Nutrition*. Mosby Inc.
- Walker S, Beckett G, Rae P and Ashby P. 201. *Clinical Biochemistry: Lecture Notes*, 9th ed. Wiley-Blackwell

I. **Course Title : Advanced Techniques in Nutritional Research**

II. **Course Code : ANN 707**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Cutting edge technologies in analytical science have revolutionized food science research.

V. **Aim of the course**

To become conversant with the use of advanced techniques in nutritional research.

VI. **Theory**

Unit I (16 Lectures)

Good laboratory practices. Analytical equipment in animal nutrition

research. Estimation of minerals using atomic absorption spectrophotometer and ICP. Principles and applications and of GC, HPLC, amino acid analyzer, SF6, and electron microscopy. Remote sensing and geographic information system (GIS) in animal nutrition research. Analysis of feeds and fodders using NIR. Faecal inoculum as an alternative to rumen liquor for *in-vitro* studies.

VII. Practical (16 Classes)

RUSITEC. Estimation of minerals by atomic absorption spectrophotometer. Estimation of mycotoxins, oxalate, nitrates and tannin. Fatty acid analysis. Vitamin estimation.

VIII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments
- Hands-on training of laboratory techniques

VIII. **Learning outcome**

Skill development in terms of efficient use of modern analytical techniques related to animal nutrition research.

IX. **Suggested Reading**

- Kaneko J, Harvey J, Bruss M.(Eds.) 2008. *Clinical Biochemistry of Domestic Animals*, 6th ed. Academic Press.
- Krishna 2012. *Livestock Nutrition- Analytical Techniques*. New India Publishing Agency.

I. **Course Title : Advances in Feed Technology**

II. **Course Code : ANN 708**

III. **Credit Hours : 1+0**

IV. **Why this course?**

The translation of nutritional knowledge for its wider application involves industrial- scale technological adaptations.

V. **Aim of the course**

To understand the basic as well as applied aspects of various feed processing technologies.

VI. **Theory**

Unit I (10 Lectures)

Good manufacturer practices (GMP) in feed plants. Planning and designing of feed plants of different capacities. Recent developments in feed processing: particle size reduction, pelleting, extrusion, expanding, conditioning, micronizing. Post pelleting applications. Automation in feed processing. Flow charts for preparation of feeds for various species. Mixer efficiency test, pellet durability test. Densification of bulk feeds. Silos of various capacity, silage preparation and silage additives.Laws and regulations of the feed

manufacturing industry. Introduction to labour laws and standards, planning and production programme. Record-keeping.

Unit II (6 Lectures)

Roughage processing. Whole plant processing. Solid-state fermentation technology. Preparation of complete feeds and its processing.Formulation of premixes. Carriers and diluents. Liquid feed handling. Latest concepts in feed microscopy. Qualitative tests for rancidity.

VII. Teaching methods

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

Skill development in terms of increased employment and entrepreneurship

IX. Suggested Reading

- Langham J. 2013. *Recent Advances in Animal Feed Technology*. Random Exports.
- Moughan PJ and Hendricks WH. (Eds.). 2018. *Feed Evaluation Science*. Academic publishers.
- Perry TW, Cullison AE and Lowrey RS. 2003. *Feeds and Feeding*, 6th ed. Pearson.
- Schofield EK (Ed.). 2005. *Feed Manufacturing Technology V*. American Feed Industry Association, Arlington.

I. Course Title : Toxicants and Anti-Metabolites in Animal Nutrition

II. Course Code : ANN 709

III. Credit Hours : 1+0

IV. Why this course?

In-feed anti-metabolites in incriminating factor poses a threat not only to the animal health but also for human health and safe food production.

V. Aim of the course

To impart knowledge on the various toxicants and anti-metabolites in the feeding system and their amelioration.

VI. Theory

Unit I (12 Lectures)

Classification of toxicants in animal feeds. Plant origin toxicants, microbial origin toxicants, acquired toxicants (heavy metals, pesticide residues, drug residues), and their effects on animal health and production. Ameliorative measures. Detoxification of plant origin toxicants. Residual effects on animal products and the

environment.

Unit II (4 Lectures)

Anti-metabolites in animal feedstuffs. Effects of anti-metabolites on animal health and production. Anti-vitamins

VII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. **Learning outcome**

Safe use of animal feed resources for ensuring food safety.

IX. **Suggested Reading**

- Cheeke PR and Shull LR. 1985. *Natural Toxicants in Feeds And Poisonous Plants*. AVI Publishing Company Inc.
- FAO. 2004. *Assessing Quality and Safety of Animal Feeds*. Food and Agriculture Organization of the United Nations, Rome.
- Gremmels JF (Ed.). 2010. *Animal Feed Contamination Effects on Livestock and Food Safety*. Woodhead Publishing Ltd.
- Keeler RF, Van Kampen KR and James LF. 1978. *Effects of Poisonous Plants on Livestock.* Academic Press.
- *Knight AP and Walter R. 2001. A Guide to Plant Poisoning of Animals in North America. Teton NewMedia.*
- Liner IE. 1980. *Toxic Constituents of Animal Food Stuffs*, 2nd ed. Academic Press.
- Osweiler G. (Ed.) 2011. *Ruminant Toxicology*. *An issue of Veterinary Clinics: Food Animal Practice*. Elsevier.

I. **Course Title : Nutrigenomics in Animal Nutrition**

II. **Course Code : ANN 710**

III. **Credit Hours : 1+0**

IV. **Why this course?**

The establishment of a functional relationship between nutrition and gene expression has become recognized as a tool to unravel the mechanisms involving the role of nutrition in health and disease.

V. **Aim of the course**

To impart the knowledge on the basics of nutrigenomics and its application in nutrition.

VI. **Theory**

Unit I (4 Lectures)

Basic concepts of genetics and molecular biology. Nucleic acid structure and replication, transcription and translation.

Unit II (8 Lectures)

Introduction to nutrigenomics and nutrigenetics. Nutritional regulation of gene expression. Introduction to epigenetics, and its influence on early life nutrition and health.

Unit III (4 Lectures)

Concepts of proteomics and metabolomics. Microbiome and diseases of nutritional importance. Dietary influences on the microbiome.

VII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. **Learning outcome**

Development of concepts on nutrigenomics.

IX. **Suggested Reading**

- Carlberg C, Ulven SM and Molnár F. 2016. *Nutrigenomics*. Springer
- Caterina RDE, Martinez, JA and Kohlmeier M.(Eds.) 2020. *Principles of Nutrigenetics and Nutrigenomics*. Elsevier Inc.
- Dodds JW and Laverdure DR. 2015. *Canine Nutrigenomics - The New Science of Feeding Your Dog for Optimum Health*. Dogwise Publishing.
- Select articles from Journals

I. **Course Title : Equine Nutrition**

II. **Course Code : ANN 711**

III. **Credit Hours : 1+0**

IV. **Why this course?**

Nutrition of equines calls for special attention considering their use for mankind.

V. **Aim of the course**

To impart a comprehensive knowledge on the nutrition of horses and other equids.

VI. **Theory**

Unit I (8 Lectures)

Digestive function and metabolism of nutrients. Nutrient requirements of equines in different physiological stages. Feed ingredient for horses. Digestive disorders.

Unit II (8 Lectures)

Feeding foal, yearlings, mares and stallions for production and reproduction. Feeding for performance and nutrient metabolism during exercise. Nutritional management of race-horses. Diet formulation for all classes of horses.

VII. **Teaching methods**

- Classroom lectures using audio-visual aids
- Instructional conversations and discussions
- Hands-on learning and assignments

VIII. Learning outcome

In-depth knowledge of equine nutrition including its application.

IX. Suggested Reading

- Frape D. 2010. *Equine Nutrition and Feeding*, 4th ed. Wiley-Blackwell.
- Geor R, Harris P and Coenen M (Eds). 2013*. Equine Applied and Clinical Nutrition*. Saunders, Elsevier.
- NRC. 2007. *Nutrient Requirements of Horses*, 6th Rev. ed. National Research Council.
  National Academy Press.
- Pagan JD. (Ed.). 2009. *Advances in Equine Nutrition IV*. Kentucky Nutrition Research.

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Animal Nutrition

- Digestion and metabolism of carbohydrate, protein & fat in ruminants and non-ruminants.
- Feeds and fodders for ruminant feeding. By-products of agricultural, industrial, food processing units and forest by-products Feeding standards: comparative appraisal and limitations.
- Energy and protein requirement for maintenance, growth, pregnancy and lactation in farm animals.
- Nutrient requirements and feeding of calves, heifers, dry, pregnant and lactating cows, buffaloes, sheep and goat. Nutritional approaches for increasing the functional properties of milk: role of CLA, omega fatty acids
- Measures of feed energy. Partitioning of feed energy. Energy balance, Fasting catabolism. Direct and indirect calorimetry. Efficiency of energy and protein utilization. Protein quality determination in ruminants and monogastrics. Amino acids imbalance, antagonism and toxicity
- Macro-minerals and micro-minerals, their, distribution, metabolism, physiological functions, deficiencies and excesses, Cheated minerals and concept of nano-minerals. Toxic minerals; their role in health and production of farm animals and poultry.
- Water-soluble and fat-soluble vitamins, their requirements, deficiencies and excesses in livestock and poultry. Role of vitamins in energy metabolism. Vitamin-mineral interrelationship. Vitamin toxicosis. Role of vitamins in reproduction, fertility and immunity in livestock and poultry.
- Introduction to rumen microflora and fauna. Development of rumen. Manipulation of rumen fermentation for better utilization of fibrous feeds and reduction in methane production. Role of feed additives, chemicals, antibiotics and probiotics and their effect on rumen metabolism
- Rumen degradable protein (RDP) and rumen undegradable protein (UDP) and fermentation kinetics. Concept of bypass nutrients and their impact on production, reproduction and immune status.
- Determination of digestibility, factors affecting digestibility. Markers in digestibility determination. *In-vitro*/ *in-sacco* determination of digestibility and digestion kinetics.
- Feed and fodder processing and preservation techniques. Densification, chemical and biological treatment of feeds/ fodders. Crumbling, flaking, popping and extrusion. Premixes. Alimentarius, HACCP. Concept of complete feed and total mixed ration. Precision feeding. Fodder conservation through hay and silages. Factors affecting feedstuffs during storage. Liquid feed ingredients. Storage losses; insect pests and rodents control measures.

- Quality control of feed ingredients and finished feeds. BIS standard. Classification of toxic principles in animal feedstuffs. Chemico-physical properties of various anti-nutritional factors (ANFs). Detoxification of toxin principles by various physical, chemical and biological techniques. Mycotoxins in feedstuffs and its control measures
- Metabolic disorders and peri-parturient diseases: milk fever, ketosis, downer cow syndrome, retained placenta, sub-acute ruminal acidosis, laminitis, abomasal displacement, mastitis.
- Feeding and Nutrient requirements for broilers, layers & breeder hens. Nutritional approaches for designer egg and meat production. Nutritional factors affecting hatchability.
- Feed additives and nutraceuticals. Probiotics, prebiotics and synbiotics; eubiotics. Feed enzymes. Phytochemical feed additives; polyphenols and essential oils; organic acids and acidifiers for poultry.
- Nutritional disorders in poultry and the role of nutrition in diseases prevention
- Nutrition and feeding of swine in different stages of growth and production.
- Feeding of equines. Nutrient requirements of equines. Nutritional management of colic and other health disorders.
- Feeding of rabbits. Nutrition-related disorders in rabbits.
- Nutrient requirements for dogs and cats during different life stages: energy, protein, fat, minerals and vitamins. Critical nutrients for cats. Common feed ingredients and supplements for pets. Deficiencies and excesses of nutrients. Nutritionally responsive disorders.
- Feeding & Nutritional requirements of various species of laboratory animals. Concept of purified diets in laboratory animals.
- Characteristics of ration formulation and feeding schedules of various classes captive and zoo animals and birds.
  Introduction and principles of GC, HPLC, AAS, ICP, tracer technique, flame photometer, NIR, SF6, rumen-simulation technique, and amino acid analyzer.

Livestock Production and Management

DEPARTMENT OF LIVESTOCK PRODUCTION MANAGEMENT
Course Structure for M.V.Sc degree programme (Semester Wise)

Course Code	Course Title	Credit Hours	Semester
LPM 601*	CATTLE AND BUFFALO PRODUCTION MANAGEMENT	2+1	I
LPM 603*	SWINE PRODUCTION MANAGEMENT	1+1	I
LPM 605*	BEHAVIOUR AND WELFARE OF FARM ANIMALS	1+1	I
LPM 607*	COMPANION ANIMAL PRODUCTION MANAGEMENT	1+1	I
LPM 609	INTEGRATED LIVESTOCK FARMING SYSTEMS	1+1	I
LPM 611	LABORATORY ANIMAL PRODUCTION MANAGEMENT	1+1	I
LPM 613	LIVESTOCK FARM MACHINERY MANAGEMENT	0+2	I
LPM 615	REGIONAL ANIMAL PRODUCTION MANAGEMENT	1+1	I
LPM 602*	SHEEP AND GOAT PRODUCTION MANAGEMENT	2+1	II
LPM 604*	CLIMATOLOGY AND LIVESTOCK PRODUCTION	1+1	II
LPM 606*	EQUINE PRODUCTION MANAGEMENT	1+1	II
LPM 608	FARM HYGIENE AND WASTE MANAGEMENT	1+1	II
LPM 610	MANAGEMENT AND CONSERVATION OF WILD AND ZOO ANIMALS	1+1	II
LPM 612	LIVESTOCK BUSINESS MANAGEMENT	1+1	II
LPM 614*	POULTRY FARM AND HATCHERY MANAGEMENT	1+1	II
LPM 691	MASTER'S SEMINAR	1+0	I & II
LPM 699	MASTER'S RESEARCH	0+30	I & II
*Compulsory Courses			

DEPARTMENT OF LIVESTOCK PRODUCTION MANAGEMENT
Course Structure for Ph.D degree programme (Semester Wise)

Course Code	Course Title	Credit Hours	Semester
LPM 701*	RECENT DEVELOPMENTS IN LARGE RUMINANTS PRODUCTION MANAGEMENT	2+1	I
LPM 703*	RECENT DEVELOPMENTS IN SWINE PRODUCTION MANAGEMENT	1+1	I
LPM 705*	ORGANIC LIVESTOCK PRODUCTION	1+0	I
LPM 707	ENTREPRENEURSHIP IN LIVESTOCK PRODUCTION	1+1	I
LPM 709*	RECENT DEVELOPMENTS IN POULTRY PRODUCTION MANAGEMENT	2+1	I
LPM 702*	RECENT DEVELOPMENTS IN SMALL RUMINANTS PRODUCTION MANAGEMENT	2+1	II
LPM 704*	LIVESTOCK AND ENVIRONMENT	1+0	II
LPM 706	RECENT DEVELOPMENTS IN WELFARE OF FARM ANIMALS	1+0	II
LPM 708	PRECISION LIVESTOCK FARMING	1+1	II
LPM 791	DOCTORAL SEMINAR - I	1+0	I & II
LPM 792	DOCTORAL SEMINAR - II	1+0	I & II
LPM 799	DOCTORAL RESEARCH	0+75	I & II
*Compulsory Courses			

Course Contents
M.V.Sc. in Livestock Production and Management

I. **Course Title : Cattle and Buffalo Production Management**
II. **Course Code : LPM 601**
III. **Credit Hours : 2+1**
IV. **Why this course?**

Important species of livestock are a source of employment and cater to nutritional demands and socio-economic upliftment of people.

V. **Aim of the course**

To acquaint students with basic aspects of dairying in India comparing with developed countries, problems and prospects of dairying, detailed aspects of care and management of different categories of dairy cattle and buffaloes.

VI. **Theory**

Unit I (2 Lectures)

Development of dairy industry in India and the world. Present status and future prospects of dairying in India and the world. SWOT analysis of the dairy sector in different agro-climatic zones. Production systems in vogue under Indian conditions. Breeds of cattle and buffalo with more emphasis on breeds of economic importance.

Unit II (6 Lectures)

Housing/ Shelter management. Housing and equipment requirements for different classes of cattle and buffaloes. Layout plans and construction details for different sized farms in different climatic zones of India. Ventilation and lighting systems in dairy farms.

Unit III (8 Lectures)

Feed and fodder resources used for feeding cattle and buffaloes. Scientific technique and regimen of feeding and watering of different categories of cattle and buffaloes. Feed and fodder requirements of different categories of cattle and buffaloes. Supply of green fodder round the year. Enrichment of poor quality roughages. Non- conventional feeding resources. Pasture management.

Unit IV (8 Lectures)

Traits of economic importance and their inter-relationships. Selection and methods of breeding. Reproduction management - Pre-natal and post-natal care and management of dams. Care of neonates and young calves. Management strategies for reducing mortality in calves, optimizing age at first calving and calving interval. Improving breeding efficiency of dairy animals.

Unit V (8 Lectures)

Farm management - Routine management practices and farm labour management. Milking management - Machine milking and hand milking. Clean milk production- Techniques of harvesting clean milk, cooling and transportation. Different laws and practices governing the dairy sector to produce quality products on par with international standards. Health management of dairy animals. Summer and winter management of dairy animals. Draughtability and management of draught animals.

VII. Practical (16 Classes)

Visits to different sized dairy farms and assessment of routine managemental practices. Analysis of various farm records for economic evaluation. Computation of practical and economical rations. Layout plans and housing details. Housing, milking, calf, heifer and adult management. Dairy Cattle and Buffalo judging and body condition scoring (BCS). Project preparation for commercial farms.

VIII. Teaching methods

Blackboard, ICTs, success stories, group discussions and farm visits

IX. Learning outcome

By the end of this course, the student will come out with practical knowledge of cattle and buffalo production management aspects, entrepreneurship skills.

X. Suggested Reading

- Arora SP. 1997. *Feeding of Dairy Cattle and Buffaloes*. Kalyani Publication.
- Dutta G. 1994. *Care and Management of Dairy Cattle and Buffaloes*, 3rd ed. ICAR.
- Flanders F and Gillespie J. 2015. *Modern Livestock and Poultry Production*, 9th ed. Delmar Cengage Learning Edition.
- Gupta PR. 2017. *Dairy India-2017*, 7th ed. Dairy India Yearbook, Thomson Press Ltd.
- ICAR. *Livestock Production and Management* - ICAR eCourse PDF eBook (online free).
- Phillips CJC. 2011. *Principles of Cattle Production*. CABI Publishing.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Thomas CK, Sastry NSR and Ravikiran G. 2012. *Dairy Bovine Production*, 2nd ed. Kalyani

Publishers.

- Tyler HD and Ensminger ME. 2006. *Dairy Cattle Science*, Pearson Prentice Hall Publishing.
- Selected articles from journals.

I. **Course Title : Sheep and Goat Production Management**
II. **Course Code : LPM 602**
III. **Credit Hours : 2+1**
IV. **Why this course?**

To know the production and management of small ruminants. Important species of livestock provide employment and supplementary income besides meeting the nutritional demands and are of commercial importance.

V. **Aim of the course**

To acquaint students on the status of sheep and goat farming in India, principles of housing and feeding, breeding management to improve the reproductive efficiency and detailed account on care and management of different classes of sheep and goat.

VI. **Theory**

Unit I (2 Lectures)

Population structure and importance. Sheep farming under different systems of management. Advantages and limitations of sheep and goat farming. Genetic resources of sheep and goats with special emphasis on breeds of economic importance. Shelter management. Housing and equipment requirements for different classes of sheep and goats. Designing feeders and waterers. Layout plans and construction details for different size farms in different agro-climatic zones of India.

Unit III (8 Lectures)

Feed and fodder resources for small ruminants. Common property resources (CPR's) and their management. Principles and systems of feeding and watering different categories of sheep and goat. Pasture utilization and improvement.

Unit IV (8 Lectures)

Breeding Management, Traits of economic importance and their inter-relationship. Breeding seasons. Selection of breeding animals. Methods of detection of heat, use of teaser, flushing, tupping. Estrous synchronization, Natural Service, artificial insemination and off-season breeding in small ruminants. Care and management of pregnant animals and breeding stock. Culling.

Unit V (4 Lectures)

Disease Management. Prevention and control measures including

vaccination, deworming, dipping and spraying, etc. Transportation of small ruminants.

Unit VI (4 Lectures)

Meat, Methods of slaughter, dressing percentage. Wool: Shearing methods. Importance of wool, wool quality. Goat fibers: mohair, pashmina - Marketing of goat fibers/ wool. Milk, Milking, avoidance of goaty odour in milk, clean milk production and its therapeutic uses.

VII. Practical (16 Classes)

Visits to modern sheep and goat farms and critical analysis of various managerial practices under different conditions. Study of practical housing management. Diseases control management. Shearing management. Record keeping and economics of sheep and goat farming for mutton/ chevon, wool/ fibre and milk. Preparation of project for commercial farming. Daily and periodical farm operations. Dipping and vaccination.

VIII. Teaching methods

Blackboard, ICTs, success stories, group discussions and farm visits

IX. Learning outcome

By the end of this course, the students get practical exposure to different aspects of sheep rearing, production and management.

X. Suggested Reading

- Bhat PN and Khan BU. 2009. *Goat Production*. Studium Press (India) Pvt. Ltd.
- Bhatt PN and Arora CL. 2009. *Sheep Production*. Studium Press (India) Pvt. Ltd.
- Devendra C and McLeroy GB. 1982. *Goat and Sheep Production in Tropics*. Longman.
- Devendra C and Burns M. 1983. *Goat Production in the Tropics*. CABI Publishing.
- Gupta JL. 2006. *Sheep Production and Management*. BS Publ.
- ICAR. 2014. *Handbook of Animal Husbandry*, 3rd ed. ICAR.
- Jindal SK. 2013. *Goat Production and Health Management*. New India Publishing Agency.
- Kaushik SK. 2017. *Sheep Production*. ICAR Publ.
- Peacock CP. 1996. *Improving Goat Production in the Tropics: A Manual for Development Workers*, OXFam, UK.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- *Solaiman SG. 2010. Goat Science and Production. Wiley-Blackwell.*

- *Selected articles from journals.*

I. **Course Title : Swine Production Management**
II. **Course Code : LPM 603**
III. **Credit Hours : 1+1**
IV. **Why this course?**

Majority of people are rearing pigs under traditional and small scale production.

V. **Aim of the course**

To impart knowledge on various aspects of swine farming in India, principles of housing, breeding, feeding and health care of pigs, management practices at different stages of growth and economic pig production systems.

VI. **Theory**

Unit I (2 Lectures)

Population dynamic, Economic contribution of pigs, Advantages and limitations of swine rearing, Systems of management. Breeds of economic importance.

Unit II (2 Lectures)

Housing and rearing systems. Housing and equipment requirements for different classes of swine, layout plans and construction for different sized farms.

Unit III (3 Lectures)

Feeding principles and nutritional requirement of different classes of swine. Feeding schedule for different classes of swine. Traditional and scientific methods of swine feeding.

Unit IV (4 Lectures)

Traits of economic importance and their interrelationship. Selection of breeding stock. Reproductive parameters of swine. Methods for detection of heat. Mating systems. Care and management of pregnant sows, piglets, growers and boar. Summer management in swine.

Unit V (3 Lectures)

Health Management, Prevention and control measures including sanitation, vaccination, deworming, etc. Piglet anaemia and its management.

Unit VI (2 Lectures)

Methods of slaughter, dressing percentage, Methods of marketing and transportation. Use of by-products from the swine industry

VII. **Practical (16 Classes)**

Visit modern piggeries and critical analysis of various types of managemental practices. Practical feeding and breeding management, disease control measures, Judging. Record-keeping.

Economics of pig production. Formulation of economic rations for different classes of swine. Project formulation of commercial swine production.

VIII. **Teaching methods**

Blackboard, power point presentations, ICT, Group discussions and farm visits The students will come up with scientific principles, production and management techniques in swine production.

X. **Suggested Reading**

- Acharya RM and Puneet Kumar. 2017. *Pig Production*. Satish Serial Publishing, Delhi
- Beyno N. 2014. *Pigs: A Guide to Management*, 2nd ed. Replika Press Ltd.
- Boden E. 1995. *Swine Practice*. WB London.
- ICAR. 2014. *Hand Book of Animal Husbandry*, 3rd ed. ICAR
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Sharda DP. 2000. *Swine Production*. ICAR publication
- *Selected articles from journals.*

I. **Course Title : Climatology and Livestock Production**

II. **Course Code : LPM 604**

III. **Credit Hours : 1+1**

IV. **Why this course?**

This course is important to know the climatic changes that affect the health and production of livestock and vice versa.

V. **Aim of the course**

To familiarize students on climate, weather, various climatic factors and their role in production and health of animals in both temperate and tropics, micro and macroclimatic conditions of the animal house and assessing the heat tolerance of bovines.

VI. **Theory**

Unit I (4 Lectures)

Climatology and agro-climatic regions of India. Study of climatic factors and their measurement. Climatic stress in livestock (heat stress/ cold stress): effects, measurement and amelioration. Temperature-humidity index and thermo-neutral zone. Adaptation and acclimatization.

Unit II (4 Lectures)

Light: natural and artificial, photoperiod, mechanism of light action and responses. Application in livestock production.

Unit III (4 Lectures)

Performance of livestock introduced in different climates. Micro-climate modification in animal houses. Livestock and global warming.

Unit IV (4 Lectures)

Climate-resilient livestock production systems. Natural disasters-effects on livestock and mitigation measures.

VII. Practical (16 Classes)

Visit modern weather forecast stations. Assessment of climate: Microclimatic conditions within the animal house, Measurement of Temperature, Relative humidity, wind velocity and intensity of light. Ambient temperature. Construction of climographs and hythergraphs. Heat tolerance test in bovines.

Blackboard, power point presentations, ICT, Group discussions and farm visits.

IX. Learning outcome

The student is expected to know the different climatic conditions and adaptations for better production and managing livestock.

X. Suggested Reading

- Collier RJ and Collier JL. 2012. *Environment Physiology of Livestock*. Wiley-Blackwell Co.
- Lal DS. 1998. *Climatology*. Sharda Pustak Bhavan, Allahabad.
- McDowell RE. 1972. *Improvement of Livestock Production in Warm Climates*. WH Freeman.
- Payne WJ and Wilson RT. 1999. *An Introduction to Animal Husbandry in the Tropics*. Blackwell Publishing, USA.
- Rainwater MCF. 1962. *Animal Climatology*. Indian Veterinary Research Institute, Izatnagar.
- Sejian V, Gaughan J, Baumgard L and Prasad C. 2015. *Climate Change Impact on Livestock: Adaptation and Mitigation*, 5th ed. Springer.
- Siddhartha K and Roger B. 1996. *Atmosphere, Weather and Climate*. ELBS.
- *Selected articles from journals.*

I. Course Title : Behaviour and Welfare of Farm Animals

II. Course Code : LPM 605

III. Credit Hours : 1+1

IV. Why this course?

Improving the behaviour of livestock for better productivity and welfare.

V. Aim of the course

To acquaint students on principles of farm animal behaviour concerning environmental influence, group formation, social

behaviour and behavioural adaptations under domestication.

VI. **Theory**

Unit I (4 Lectures)

Introduction to Animal behaviour. Evolution of animal behaviour: Theories of animal behaviour. Importance of animal behaviour studies. Physiological basis of behaviour. Natural selection, proximate and ultimate causes, fitness, optimality theory, selfish genes, kin selection, and game theory. Influence of genetic, environmental and physiological influence. Daily and seasonal cycles of behaviour. Patterns of behaviour. Favourable and unfavourable behaviours of domestication.

Unit II (4 Lectures)

Ethogram construction for general behaviour management – interpretation - behaviour assisted animal management - flight zone, Animal learning and training- conditioning- operant and classical, animal behaviour based housing designs – Methods of studying animal behaviour- Vices – causes and prevention.

Unit III (2 Lectures)

Group formation. Social relationships like hierarchy and aggression, the process of socialization, locality and behaviour. Behavioural characters for management practices.

Unit IV (6 Lectures)

Animal welfare – concepts – animal rights – animal freedoms – animal welfare organizations Measurement of animal welfare: - indicators of animal welfare- improvement of animal welfare through selection- the welfare of livestock in commercial farms and captivity, environmental enrichment- Welfare of livestock during various management activities such as handling, transportation, etc., Legislation and regulations of animal welfare – welfare and economics.

VII. **Practical (16 Classes)**

Behavioural characters for managemental practices. Behavioural adaptations under domestication. Analysis of behaviour in relation to climate. Analysis of social behaviour. Preparation of ethogram (time budgeting).

VIII. **Teaching methods**

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. **Learning outcome**

The student will apply the understanding of animal behaviour to draw conclusions about animal welfare, Consider how common management practices for livestock influence behaviour and welfare, Interpret and critically evaluate scientific literature in the

field of animal behaviour

X. **Suggested Reading**

- Agarwal VK. 2013. *Animal Behaviour* (Ethology) S. Chand and Company
- Albright JL and Arave CW. 1997. *The Behaviour of Cattle*. CAB International.
- Arora MP. 1995. *Animal Behaviour*. WB London.
- Benson BJ and Rollin BE. 2004. *The Well-being of Farm Animals: Challenges and Solutions*. Blackwell Publishing, USA.
- Bouenger EG. 1994. *Animal Behaviour*. WB London.
- Broom DM and Fraser AF. 2007 *Domestic Animal Behaviour and Welfare*, 4th ed. CABI.
- Fraser AF and Broom DM. 1990. *Farm Animal Behaviuor and Welfare*. CAB international
- Hafez ESE. 1969. *The Behaviour of Domestic Animals*, 2nd ed. Balliere, Timdall and Cassell.
- Houpt KA. 2018. *Domestic Animal Behavior for Veterinarians and Animal Scientists*. 6th ed. Wiley Blackwell.
- Kumar V. 1996. *Animal Behaviour*. WB London.
- Selected articles from journals.

I. **Course Title : Equine Production Management**

II. **Course Code : LPM 606**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Equines are important sports and pack animals

V. **Aim of the course**

To make the students become familiarize with principles of housing, breeding, feeding and health care of different classes of horse, stable routines and measures to reduce the mortality in young ones at different seasons.

VI. **Theory**

Unit I (2 Lectures)

Scope of equine husbandry in India. Equine population dynamics. Types and classes in equines. Breeds of economic importance.

Unit II (2 Lectures)

Housing and stable management, behaviour, stable vices and their management Feeding and breeding of equines. Care and management of stallion, broodmare, pregnant mare and foal.

Unit IV (2 Lectures)

Stud farms, Race clubs, Race-horses and their care, training, exercising, doping and horsemanship.

Unit V (4 Lectures)

Foot care and dental care in equines. General health management and diseases control. Colic, equine azoturia - prevention and management. Regulatory acts in equine disease control and welfare.

Unit VI (2 Lectures)

Transportation, Laws governing the import and export of equines, Horse passport and trading

VII. **Practical (16 Classes)**

Visit institutional stables. Identification, ageing, soundness and selection. Passing of nasogastric tube, Shoeing and covering. Saddle fitting, Gaits of horses and horse colours.

VIII. **Teaching methods**

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. **Learning outcome**

By the end of the course, the student gains knowledge on management practicesof equine production

X. **Suggested Reading**

- Blanchard T, Varner D, Love C, Brinsko S, Rigby R and Schumacher J. 2002. *Manual of Equine Reproduction*. Mosby.
- Brown JH and Powell-Smith V. 1984. *Horse and Stable Management*. Blackwell Science.
- Frape D. 1986. *Equine Nutrition and Feeding*. Blackwell.
- Kacker RN and Panwar BS. 1996. *Text Book of Equine Husbandry*. Vikas Publ.
- Mills DS and Nankervis KJ. 1998. *Equine Behaviour: Principles and Practice*. Blackwell.
- Panwar BS and Yadav KN. 2010. *Equine Husbandry and Equestrian Sports*. IBDC Publishers.
- Pilliner S. 1994. *Care of the Competition Horse*. BT Batsford.
- Rose RJ and Hodgson DR. 2000. *Manual of Equine Practice*. WB Saunders.

I. **Course Title : Companion Animal Production Management**

II. **Course Code : LPM 607**

III. **Credit Hours : 1+1**

IV. **Why this course?**

To know the different practices of dog and cats

V. **Aim of the course**

To acquaint with dog and cat breeds their feeding, breeding, health management and socialization.

Theory

Unit I (4 Lectures)

Various companion animals, evolutionary history, the process of domestication of dog and cat. Breeds of dogs and cats. Ownership. Selection of dog, cat and other companion animals. Dogs/ cat body: structure, movement and special senses.

Unit II (4 Lectures)

Reproduction and breeding management, care of newborn, weaning, reproductive problems of bitch/ queen, Socialization.

Unit III (4 Lectures)

Principles of the feeding of dog and cat, Feeding during different life stages and disease conditions, feeding behaviour, common nutritional problems and their preventive measures.

Unit IV (4 Lectures)

Basic Kennel and health management. Principles of training of dogs/ cats. Dog shows. Preparation for the shows, kennel clubs, important characters for judgment. Vaccination/ deworming schedules.

VI. Practical (16 Classes)

Recognizing various breeds. Handling and Restraining of dogs/ cats, Routine management practices of dogs/ cats. Detection of oestrus, mating, whelping/ kittening (through demonstration). Kennel/ cattery design and management. Hygiene of kennel/ pens. Licensing and identification of companion animals. Visit dog hostels and dog park/ shows.

VII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and visits to kennels

VIII. Learning outcome

By the end of the course, the student will be able to gain knowledge on different aspects of breeds and management of companion animals.

IX. Suggested Reading

- Case LP, Daristotle L, Hayek MG and Raasch MF. 2011. *Canine and Feline Nutrition: A Resource for Companion Animal Professionals*. 3rd ed. Mosby Elsevier Publishing.
- Chakrabarti A. 2006. *Train Your Dog: At Work and Show*, 2nd ed. Kalyani Publishers.
- Chakrabarti A. 2014. *Dogs their Care and Treatment*, 4th ed. Kalyani Publishers.
- Sharma MC, Pathak NN and Bhat PN. 1993. *Dogs, Breeding, Nutrition, Diagnosis, and Health Management*. CBS Publishers

and Distributors.

- Smith FWK. 2012. *Veterinary Medical Guide to Dog and Cat Breeds*. Teton New Media, NY.
- Selected articles from journals.

I. **Course Title : Farm Hygiene and Waste Management**

II. **Course Code : LPM 608**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Maintenance of farm hygiene and proper waste management promotes animal health To familiarize students on principles of air and water hygiene concerning impurities and inclusions of water, collection and disposal of waste from the animal house, modern techniques in manure disposal and biosecurity measures to be adapted for hygienic production of livestock products.

VI. **Theory**

Unit I (4 Lectures)

Animal air hygiene. Measure air pollutants and their sources. Factors affecting outdoor and indoor pollution. Methods to control these factors.

Unit II (4 Lectures)

Water Hygiene. Sources of drinking water-Impurities and inclusions. Hygienic requirements and standards for drinking water. Purification of water. Water conservation.

Unit III (4 Lectures)

Manure, Quantity of manure voided by domestic animals. Animal excreta a factor in the spread of disease. Hygienic and economic disposal of farm wastes. Drainage in livestock farms. Lagoons, Sewers, septic tanks, drains and traps.

Unit IV (2 Lectures)

Environmental protection act: Air (Prevention and control of pollution) act and water (Prevention and control of pollution) act.

Unit V (2 Lectures)

Factors affecting environmental pollution and their effect on livestock and livestock products for human consumption. Controlling measures thereof.

VII. **Practical (16 Classes)**

Assessment of air pollutants on animal health and production. Collection of water samples: Physical, chemical, bacteriological and microscopic examination. Bio- security measures. Modern techniques used in the disposal of farm wastes. Value- added products from farm wastes. Visit water filtration plants and study of filtration systems (rapid and slow-sand, etc.). Testing of drains in livestock farms.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of the course, the students know the practical knowledge and experiences in hygiene and waste management and control methods.

X. Suggested Reading

- Baba MD. 2007. *Environmental Changes and Natural Disasters*. New India Publ.
- Overcash MR. 1983. *Livestock Waste Management*. CRC Press.
- Thapliyal DC and Misra DS. 1996. *Fundamentals of Animal Hygiene and Epidemiology*. International Book Distr. Co.

I. Course Title : Integrated Livestock Farming Systems

II. Course Code : LPM 609

III. Credit Hours : 1+1

IV. Why this course?

To know the Integration of livestock farming systems which in turn helps improves the overall profitability of the livestock system.

V. Aim of the course

To familiarize students on various aspects, viz., scope and limitations of integrated livestock farming system, recent approach and economic feasibility of different integration models for sustainable production

VI. Theory

Unit I (4 Lectures)

Classification of livestock-based farming systems. Principles, Scope, drivers and tradeoffs in integrated livestock farming systems. Sustainability and ecological advantages of integrated livestock farming systems and their economic importance.

Unit II (4 Lectures)

Integration of various components of farming systems. Livestock-fish, arable farming, plantation crops and different livestock enterprises (cattle, buffalo, sheep, goat, pig, rabbit, poultry, beekeeping, silkworm, etc.) along with the bio-gas plant, FYM, vermicompost, solar and wind energy utilization

Unit III (4 Lectures)

New approach for changing farming systems in the light of global warming, carbon sequestration and mitigation of GHGs (reducing carbon and water footprints)

Unit IV (4 Lectures)

Project formulation and evaluation of various integrated livestock enterprises in light of reducing poverty, livelihood diversification, environmental sustainability and resource conservation.

VII. **Practical (16 Classes)**

Visit modern integrated livestock farming units. Critical analysis of different subunits, economic analysis and preparation of feasibility reports

VIII. **Teaching methods**

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. **Learning outcome**

By the end of the course, the students are expected to know with different integrated farming systems and their application in the field of their study.

X. **Suggested Reading**

- Ghosh B. 2007. *Integrating Crops and Livestock*, 1st ed. Gene-Tech Books.
- Little DC and Edwards P. 2003*. Integrated Livestock-fish Farming Systems*. FAO.
- Mukherjee TK, Moi PS, Panandam JM and Yang YS. (Eds.) 1992. *Integrated Livestock Fish Production Systems*. FAO/ IPT Workshop on Integrated Livestock-Fish Production Systems, University of Malaya, Kuala Lumpur.
- Raman KV and Balaguru T. (Eds.). 1992. *Farming Systems Research in India: Strategies for Implementation*. NAARM, Hyderabad.
- Rana SS. 2015. Recent Advances in Integrated Farming Systems. CSK HPKV, Palampur.
- Rangasamy A and Annadurai K. 2002. Farming System in the Tropics. Kalyani Publishers.
- Renard C. (Ed.). 1997. Crop Residues in Sustainable *Mixed Crop/ Livestock Farming Systems*. CABI.
- Speirs M and Opsen O. 1992. *Indigenous Integrated Farming System in the Sahel*. World Bank.
- Sunil Kumar and DR Palsaniya DR and Kiran Kumar T. 2017. *Farming systems: Issues and Strategies*. Satish Serial Publishing, New Delhi.
- Selected articles from journals.

I. **Course Title : Management and Conservation of Wild and Zoo Animals**

II. **Course Code : LPM 610**

III. **Credit Hours : 1+1**

IV. **Why this course?**

The course is useful to know about the zoo, wild animals and their biodiversity conservation

V. **Aim of the course**

To acquaint students with the principles and concepts of wildlife sanctuaries and national parks, classification of wild animals, the role of authorities in conservation and management of wild animals in captivity.

VI. **Theory**

Unit I (2 Lectures)

Taxonomy and distribution of important Indian wild animals and birds – Ecology of wildlife sanctuaries and National parks - Principles and concepts of Zoo and captive wild animals- Status of forest in India - Biological and ecological basis of management of wildlife

Unit II (2 Lectures)

Rules and regulations of Zoo Authority of India - Wildlife protection act - Conservation of wild animals – feeding of captive animals and birds- Habitat Components-Cover, food, water, space and their development and conservation

Unit III (6 Lectures)

Wildlife health control - Population dynamics- and it's manipulation Movements – Corridors, – Mortality - Predator and prey relationship - Human-animal conflict - Refuge rehabilitation

Unit IV (6 Lectures)

Principles for the protection of wild and zoo animals - Breeding seasons - Breeding characteristics – puberty - pregnancy - parturition - postnatal survival of the young. Social factors among various species. Miscellaneous management procedures. Wildlife Census methods- captive animal breeding

VII. **Practical (16 Classes)**

Visit wildlife sanctuary/ national park/ biosphere reserves/ conservation breeding centre and zoo. Restraining methods. Funding agencies for wildlife research and preparation of project proposals, Habitat analysis and design. Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. **Learning outcome**

By the end of the course, the students gain knowledge in zoo animals and wildlife management and conservation methods.

X. **Suggested Reading**

- Agrawal KC. 2000. *Wildlife of India: Conservation and Management*. Nidhi Publishers.
- Berwick SH and Saharia VB. (Eds.). 1995. *The Development of*

International Principles and Practices of Wildlife Research and Management. Oxford University Press.
- Bobbins CT. 1983. *Wildlife Feeding and Nutrition*. Daya Publ. House.
- Giles RH, Jr. 1978. *Wildlife Management*. WH Freeman.
- Giles RH, Jr. 1984. *Wildlife Management Techniques*, 3rd ed. Wildlife Society, Washington, DC.
- Hosetti BB. 2005. *Concepts in Wildlife Management*, 2nd ed. Daya Publ. House.
- Saha GK and Mazumdar S. 2017. *Wildlife Biology: an Indian Perspective*. PHI Learning Pvt. Ltd.
- Santra AK. 2008. *Handbook on Wild and Zoo Animals: A Treatise for Students of Veterinary,*
  Zoology, Forestry and Environmental Science. International Book Distributing Co.
- Sinclair ARE, Fryxel JM and Caughley G. 2006. *Wildlife Ecology, Conservation and Management*, 2nd ed. Blackwell.
- Singh SK. 2005. *Text Book of Wildlife Management*. International Book Distributing Co.
- Wildlife (Protection) Act 1972 (as amended up to 1991). Natraj Publ.
- *Selected articles from journals.*

I. **Course Title : Laboratory Animal Production Management**
II. **Course Code : LPM 611**
III. **Credit Hours : 1+1**
IV. **Why this course?**

Laboratory animals are important components of research for conducting animal experiments.

V. **Aim of the course**

To familiarize the students with various aspects of lab animals, problems and prospectus, principles of housing, breeding, feeding and health care of rabbits, rats, mice and guinea pigs, measures to reduce the mortality in young ones at different seasons.

VI. **Theory**

Unit I (2 Lectures)

Importance of rabbit, rats, mice, hamster and guinea pigs as laboratory animals.

Unit II (4 Lectures)

Systems of housing, layout and design for laboratory animals house. Feeding management of laboratory animals. Feeding regimen, Types of diets.

Unit III (6 Lectures)

Production of laboratory animal models for various experiments. Management of specific pathogen-free, gnotobiotic and germ-free animals. Concepts related to the welfare of laboratory animals. Sanitary and hygienic measures. Common diseases and their control measures. Biosecurity measures. Transportation. Breeding, growth, sexual maturity, mating, gestation, parturition, litter size, weaning. Selection of breeding stock for replacement.

VII. Practical (16 Classes)

Visit to laboratory animal house and critical analysis of various types of managerial practices. Handling and restraining of laboratory animals. Practical breeding methods. Disease control and special management. Ageing and identification. Economics of production.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and experimental lab visits

IX. Learning outcome

By the end of the course, the students get practical exposure on different experimental laboratory animals, their production and management.

X. Suggested Reading

- Anonymous.1993. *Rabbit Management*. IBH and Oxford
- Banday MT, Shrivastava HP and Hamdani H. 2014. *Rabbit Production and Management*. New India Publishing Agency.
- Chakrabarti A and Biswas S. 2014. *Rabbit Health and Production*. Kalyani Publishers.
- Hau J and Van Hoosier GL, Jr. 2002. *Handbook of Laboratory Animal Science*, 2nd ed. CRC Press.
- ICAR. 2014. *Hand Book of Animal Husbandry*, 3rd ed. ICAR, New Delhi.
- NRC. 2011. *Committee for the Update of the Guide for the Care and Use of Laboratory Animals. Guide for the Care and Use of Laboratory Animals*, 8th ed. National Research Council, National Academy Press, Washington, DC.
- Rao TKS, Chauhan IS and Chauhan A. 2018. *Handbook of Laboratory Animal Production Management*. Kalyani Publishers.
- Reddy DV. 2007. *Applied Nutrition: (Livestock, Poultry, Human, Pet, Rabbit and Laboratory Animal Nutrition)*. IBH and Oxford.
- Ronald N and Penman S. 1991. *A Manual for Small Scale Rabbit Production*. South Asia Publ.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM

Publication.

- Selected articles from journals.

I. **Course Title : Livestock Business Management**

II. **Course Code : LPM 612**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Study of livestock business management will improve marketing of livestock and livestock products and enhance the profitability

V. **Aim of the course**

To acquaint students with knowledge in principles, planning, technical approach and preparing financial statement in Livestock Business Management and preparing projects for financing.

Theory

Unit I (3 Lectures)

Management principles, Planning Techniques, strategic planning, organization structure, co-ordination and controlling techniques, Approaches to management.

Unit II (5 Lectures)

Key economic concepts, factors of production, farm enterprises, cost of production, opportunity cost, value of production, gross margin, farm profit, net farm family income, substitution, and efficiency: return to scarce resources, risk. SWOT analysis for different livestock species and products, Livestock production economics, theory of supply and demand, production relationships, production function, cost input variables, profit maximization.

Unit III (4 Lectures)

Economics and the market, market intelligence, newer concepts in marketing, market research and opinion polling, advertising research, market surveillance, etc.

Unit IV (3 Lectures)

Marketing channels, Marketing of livestock and livestock products and laws governing them, Pricing strategies, supply chain management, marketing agencies.

I. **Practical (16 Classes)**

Accounting records, fund flow statement, Cost and benefit analysis. Budgeting and control. Preparation of financial statements, depreciation accounting methods, trend and variance analysis, cost-volume profit analysis. Financial planning and forecasting. Estimation of working capital requirement. Break even analysis. Visit to livestock business firms and banks. Preparing projects for financing.

II. **Teaching methods**

Blackboard, power point presentations, ICT, Group discussions and farm visits

III. **Learning outcome**

By the end of course the students gain knowledge in planning and handling business records.

IV. **Suggested Reading**

- Acharya RM and Kumar P. 2013. *Dairy Production and Business Management*. Satish Serial Publishing, New Delhi.
- Bardhan D. 2013. *Textbook on Livestock Economics, Marketing and Business*. Satish Serial Publishing House.
- Bhaskaran S and Mohanty S. 2007*. Marketing of Livestock and Livestock Products in India*. ICFAI University Press.
- Das N. 2009. *Forage for Sustainable Livestock*. Satish Serial Publishing House.
- Gangadhar KS. 2009. *Livestock Economics: Marketing, Business Management and Accountancy*. New India Publishing Agency.
- George RP and Raj Kamal PJ. 2015. *Farm Economics, Entrepreneurship and Marketing*. Satish Serial Publishing, New Delhi.
- Kahan D. 2008. *Economics for Farm Management Extension*. FAO, Rome.
- Koontz H and O'Donnel C. 1999. *Essentials of Management*. Tata McGraw Hill.
- Kotler P. 2000. *Marketing Management - Analysis, Planning and Control*. Prentice Hall of India.
- Maheswari SN. 1998. *Management Accounting*. Tata McGraw Hill.
- Massie JL. 1995. *Essential of Management*. Prentice Hall of India.
- Moran J. 2009. Business Management for Tropical Dairy Farmers. Land Links Publishing.
- Srinivasan NP. 1998. *Management Accounting*. Sterling Publications.
- Selected articles from journals.

I. **Course Title : Livestock Farm Machinery Management**

II. **Course Code : LPM 613**

III. **Credit Hours : 0+2**

IV. **Why this course?**

The course will facilitate effective utilization and maintenance of farm machinery with their practical knowledge.

V. Aim of the course

To familiarize the students with different farm machines and milking machine, different parts and their functions for better utilization

VI. Practical

Unit I (2 Lectures)

Visit to Instructional Livestock Farm Complex, Identification of various livestock farm machineries

Unit II (2 Lectures)

Familiarization with different parts and their functions of tractor and power tiller (for tillage implements for fodder land development).

Unit III (2 Lectures)

Irrigation of fodder field. Familiarization with different electric motors and diesel engines, use of sprinkler for irrigation.

Unit IV (2 Lectures)

Non-conventional energy source-Wind energy and its utilization in livestock farm.

Unit V (2 Lectures)

Post-harvest equipment/ machineries. Common terms used in harvesting of fodder crops; hay and forage harvesting equipment, mowers, field choppers, chaff cutters for silage making, different types of silos, forage harvesters, mechanical hay driers, conventional balers, hay stackers, straw combine.

Unit VI (2 Lectures)

Familiarization with different parts of milking/ shearing machines, handling, operation and cleaning after use, instruments used for milk packaging. Automatic feeders and waterers

Unit VII (2 Lectures)

Milk storing equipment, pasteurization equipment and transportation of milk, handling of equipment for preparation traditional milk products.

Unit VIII (2 Lectures)

Forage densifying machine/ Feed block machine and its use-preparation of complete feed block (CFB).

Unit IX (2 Lectures)

Visit to feed mill- use and maintenance of feed grinder and mixture machines in

VII. Teaching methods

Practical demonstration of prescribed machinery in different farms/ processing plants

VIII. Learning outcome

By the end of course the students get knowledge on different farm

machineries including milking machine.

IX. **Suggested Reading**

- Kutz M. 2007. *Handbook of Farm, Dairy, and Food Machinery*. William Andrew Inc.
- Malhotra K. 2012. *Handbook of Farm, Dairy, and Food Machinery*. Centrum Press.
- Selected articles from journals.

I. **Course Title : Poultry Farm and Hatchery Management**

II. **Course Code : LPM 614**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Poultry rearing provides employment opportunities and is an important component of food security

V. **Aim of the course**

To impart knowledge on housing, flooring and management of poultry. They also learn incubation and hatching of eggs.

VI. **Theory**

Unit I (4 Lectures)

Poultry housing systems - cage vs floor system, litter management and lighting for poultry, rearing turkey, duck and quails, backyard poultry.

Unit II (4 Lectures)

Management of chicks, growing, laying and breeding flocks, broiler production, selection and culling of laying flocks. Health management. Management of birds during disease outbreaks.

Unit III (3 Lectures)

Procuring, care and pre-incubation storage of hatching eggs - Method of incubation, sanitation disinfection and management of hatchery. Biosecurity in poultry farms

Unit IV (2 Lectures)

Embryonic development and factors affecting fertility and hatchability of eggs.

Unit V (3 Lectures)

Chick sexing, packing and hatchery business - Transporting management of farm and hatchery waste.

VII. **Practical (16 Classes)**

Observation and recording of Poultry Farm management - Brooding of chicks; selection of laying flocks - Disease preventive measures - Selection and care of hatching eggs; incubator operation, fumigation and candling setting and hatching, packaging of chicks - Waste management - Marketing of products. Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

By the end of the course, the students gain knowledge on poultry farm management, brooding and hatching management including health.

X. Suggested Reading

- Ensminger ME. 1992. *Poultry Science*. International Book Distr. Co.
- Hued LM. 2003. *Modern Poultry Farming*. Greenworld.
- Powell-Owen W. 2008. *Poultry Farming and Keeping*. Daya Books.
- Prasad J. 2005. *Poultry Production and Management*. Kalyani Publication
- Singh RA. 1996. *Poultry Production*. 3rd ed. Kalyani Publication

I. Course Title : Buffalo Production Management (Regional Animal Production Management)

II. Course Code : LPM 615

III. Credit Hours : 1+1

IV. Why this course?

Buffaloes are a source of sustainable farming, employment and cater to nutritional demands and socio-economic upliftment of people.

V. Aim of the course

To acquaint students with basic aspects of buffalo farming in India comparing with developed countries, problems and prospects of dairying, detailed aspects of care and management of different categories of buffaloes.

VI. Topics (Theory)

Unit I (3 Lectures)

Evolution and history of buffalo and Demographic distribution of buffaloes worldwide; Economic importance of buffalo industry and buffalo production trend in India; Recognized buffalo breeds and their production potential.

Unit II (3 Lectures)

Buffalo development programmes in the country, resources and organizational setup; Environment and their interaction on buffalo performance. Important economic traits in buffalo.

Unit III (4 Lectures)

Advances in Prenatal and postnatal care and management of buffaloes. Advances in care and management practices of neonates and growing male, salvaging of male calves and care of female calves. Principles of heifers and bull management; Management practices of dry lactating and pregnant buffaloes.

Unit IV (3 Lectures)

Management strategies for reducing calf mortality, age at first calving interval and increasing milk production and reproduction efficiency in buffaloes; milking management, clean and hygienic milk production, mastitis in buffalo - Its prevention and control.

Unit V (3 Lectures)

Advances in Buffalo housing: herd registration. Buffalo farm records; Buffalo marketing and insurance; Preparation of feasibility reports on buffalo farming units of different herd size, vices and its impact on buffaloes.

VII. Practical (16 Classes)

Visit to buffalo farm and livestock fair; Advances in Identification in buffalo; Criterion for Judging and selection of buffalo for dairy, meat and work; Transportation of buffalo, Farm records; Use of preventive measures of diseases on buffalo farm; To observe behaviour of different categories of buffalo on the farm; Feeding and other management practices on the buffalo farms for different categories of buffalo; Formulation of ration for different categories of buffalo; Tip's to start specialized buffalo farm.

VIII. Teaching methods

Blackboard, ICTs, success stories, group discussions and farm visits.

IX. Learning outcome

By the end of this course, the student will come out with practical knowledge of cattle and buffalo production management aspects, entrepreneurship skills.

X. Suggested Reading

- Arora SP. 1997. Feeding of Dairy Cattle and Buffaloes. Kalyani Publication.
- Dutta G. 1994. Care and Management of Dairy Cattle and Buffaloes, 3rd ed. ICAR.
- ICAR. Livestock Production and Management - ICAR eCourse PDF eBook (online free).
- Sastry NSR. 2016. Livestock Production Under Diverse Constraints - Indian Experience in its Management. ISAPM Publication.
- Thomas CK, Sastry NSR and Ravikiran G. 2012. Dairy Bovine Production, 2nd ed. Kalyani Publishers.
- Selected articles from journals.

The course content will be developed as per the need of the university

Course Contents
Ph.D. in Livestock Production and Management

I. **Course Title : Recent Developments in Large Ruminants Production Management**

II. **Course Code : LPM 701**

III. **Credit Hours : 2+1**

IV. **Why this course?**

Large ruminants are a source of employment and cater to nutritional demands and socio-economic upliftment of people.

V. **Aim of the course**

To know modern trends on housing, feeding, health and milking management in dairy bovines.

VI. **Theory**

Unit I (2 Lectures)

Present status of dairying in India *vis-à-vis* Global and south Asian scenarios, Production dynamics, Recent policy initiatives in dairy development. Conservation of indigenous germplasm

Unit II (4 Lectures)

Advances in housing management, viz., design, layout, construction materials, cost of construction suits to various agro-climatic zones of India. Low-cost houses for large ruminants. Ideal shelter management practices for better productivity, Advances in manure and waste disposal.

Unit III (6 Lectures)

Recent approaches in breeding and reproductive Management of dairy animals, Optimization of reproductive traits, Estrus synchronization, MOET, Sexed semen, Cloning and IVF.

Unit IV (4 Lectures)

Recent approaches in Feeding, Phased feeding, Transition period, Hydroponic fodder, Eco-feeding, standards for drinking water and water hygiene.

Unit V (4 Lectures)

Advances in health management of dairy animals, preventive measures for production-related diseases, bio-security measures, etc.

Unit VI (4 Lectures)

Milking management, automation, Sanitary and phytosanitary standards for the production of quality milk, post-harvest processing.

Unit VII (4 Lectures)

Establishing a Dairy Enterprise suitable for various economic strata

with different sizes, SWOT analysis. Computerization of dairy enterprises, Best management practices.

Advances in herd management and data analysis, Advances in the management aspects of buffaloes, salvaging of buffalo calves, Advances in work animal management.

Practical (16 Classes)

Critical analysis of various types of managerial practices at farms. Preparation of layout and designs for construction of sheds of various sizes in different agro- climatic zones. Cost analysis of dairy bovine housing. Organization of milking machines. Dairy Cattle and Buffalo judging – BCS. Farm record analysis. Project report preparation for commercial dairy farms.

VII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

VIII. Learning outcome

By the end of the course, the student gain knowledge and experience in different aspects of advanced methods of large ruminants management in different fields of housing, feeding, breeding and milking of dairy animals.

IX. Suggested Reading

- Clarence HE. 2007. *Dairy Cattle and Milk Production*. Daya Publ. House.
- Moran J and Chamberlain P. 2017. *Blueprints For Tropical Dairy Farming: Milk Production in Developing Countries*. CSIRPO Publishing.
- Moran J. 2013*. Tropical Dairy Farming: Feeding Management for Small Holder Dairy Farmers in the Humid Tropics*. Landlinks Press.
- Singh U, Kumar S, Kumar A, Deb R and Sharma A. 2013. *Advances in Cattle Research*. Satish Serial Publishing House, New Delhi.
- Thomas CK, Sastry NSR and Ravi Kiran. 2012. *Dairy Bovine Production*, 2nd ed. Kalyani Publishers.

I. Course Title : Recent Developments in Small Ruminants Production Management

II. Course Code : LPM 702

III. Credit Hours : 2+1

IV. Why this course?

Small ruminants are an important source of livelihood security to rural masses and study/ application of recent advances will

improve the profitability of small ruminant rearing.

V. Aim of the course?

To familiarize the students with advanced methods of housing, feeding, breeding, reproduction and health management.

VI. Theory

Unit I (4 Lectures)

Relevance of small ruminants in the Indian economy. Population and production dynamics of small ruminants. Systems of rearing. Needs and possibilities for research in future.

Unit II (8 Lectures)

Recent approaches in breeding and reproductive management. Management during the breeding season, Mating seasons and their control. Recent approaches in reproductive biotechnologies, MOET, Cloning, transgenic, genomics and accelerated lambing.

Unit III (6 Lectures)

Recent approaches in feeding management, Pasture and grazing management, Phase feeding, Feed resources and feeding techniques under different systems.

Unit IV (6 Lectures)

Recent approaches in housing systems with reference to different agro-climatic zones and rearing systems.

Unit V (6 Lectures)

Prospects of management under stall-fed conditions, management of small ruminates during scarcity periods, Migratory pattern and flock management. Recent approaches in exploiting goat's, milk quality, safety and production aspects of dairy goats. Wool/ fibre production and its quality.

Unit VI (2 Lectures)

Recent approaches in health care management, Parasitic control in present ecological and environmental changes.

VII. Practical (16 Classes)

Critical analysis of various farm practices, Preparation of layout and designs for construction of sheds of various sizes in different agro-climatic zones. Cost analysis of housing. Organization of shearing. Sheep and goat judging – BCS. Farm record analysis. Disease control management. Scorecard and grading of wool. Project report preparation for commercial sheep and goat units.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. Learning outcome

The students gain knowledge and experience on different advance management aspects of small ruminants.

X. **Suggested Reading**

- Devendra C and McLeroy GB. 1983. *Goat and Sheep Production in the Tropics*. Agrodok.
- Gupta JL. 2006. *Sheep Production and Management*. CBS.
- Jansen C and van den Burg K. 2004. *Goat Production in the Tropics*. 4th ed. © Agromisa Foundation, Wageningen.
- Karim SA. 2008. *Small Ruminant Production in India*. Satish Serial Publishing, New Delhi.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Selected articles from journals

I. **Course Title : Recent Developments in Swine Production Management**

II. **Course Code : LPM 703**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Study of recent developments will facilitate their application for better growth of the swine industry

To impart knowledge on recent advances in the improvement of swine housing, feeding, reproduction and health management.

VI. **Theory**

Unit I (2 Lectures)

Trends in population and production in India and world, Production systems followed in developed countries.

Unit II (6 Lectures)

Recent approaches in improvement of economic traits, Prenatal and postnatal development, care of newborn, Growth, breeding and reproduction, analysis of mating systems, Farrowing and lactation.

Unit III (3 Lectures)

Strategic management measures in feeding, Phase feeding, Split sex feeding and individual feeding. Automatic feeding and watering techniques, Feed resources and feeding systems.

Unit IV (2 Lectures)

Recent approaches in housing, environmental physiology, summer management, approaches in manure management.

Unit V (2 Lectures)

Strategies to reduce mortality in different classes, common diseases, health management, Biosecurity measures.

VII. **Practical (16 Classes)**

Critical analysis of various types of managerial practices at farms. Preparation of layout and designs for construction of sties for the

backyard and commercial piggeries. Judging and BCS, Farm record analysis. Preparation of Project report for commercial and backyard piggeries. Marketing Analysis

VIII. **Teaching methods**

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. **Learning outcome**

By the end of the course, the students will gain knowledge on modern aspects swine practices and management including health.

X. **Suggested Reading**

- Katingi E. 2012. *Raising Pigs – Manuals and Other Useful Resources*. ICARDA and ILRI Publications. https://livestockfish.cgiar.org/2012/06/13/raising-pigs-manuals-and-other-useful-resources/
- Selected articles from journals.

I. **Course Title : Livestock and Environment**

II. **Course Code : LPM 704**

III. **Credit Hours : 1+0**

IV. **Why this course?**

There is an urgent need for governments and institutions to develop and enact appropriate policies, at the national and international levels, that focus more on

V. **Aim of the course**

To impart knowledge related to the application of technologies that improve the efficiency of land use and feed use can mitigate the negative effects of livestock production on biodiversity, ecosystems and global warming. Technologies that increase livestock efficiency include improved breeds, improved grazing-land management, improved herd-health management, etc.,

VI. **Theory**

Unit I (4 Lectures)

Effect of livestock on the environment- Role of ruminants in global warming, Slaughterhouse waste, Tannery waste, Stray and fallen animal impact. Strategies for mitigation of methane emission from the livestock sector, animal waste management. A life cycle assessment of the environmental impacts of livestock in different production systems.

Unit II (4 Lectures)

Effect of environment on livestock and quality of products: Heat and cold stress, Pollution, Heavy metals, Pesticide residues, etc., Management of micro and macro- environment with respect to

animal well-being,

Unit III (4 Lectures)

Concept of Water, Carbon footprints and carbon sequestration of farm animals and products. Thermal load indices, Livestock comfort zones. Carbon trading, mechanisms and opportunities in the livestock sector.

Unit IV (4 Lectures)

Selection of breeds of livestock for hot climate. Recent advances in shelter management practices under the impending climate change scenario. Climate and reproduction. Environment and diseases.

VII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions.

VIII. Learning outcome

By the end of the course, the students gain knowledge about the interaction between livestock and the environment. They also acquire knowledge of the greenhouse effect and mitigation.

IX. Suggested Reading

- Cheeke PR. 1993. *Impacts of Livestock Production on Society, Diet/ health, and the Environment*. Interstate Publishers.
- FAO. 2009. *Livestock in the Balance*, FAO, Rome.
- ICAR. 2014. *Handbook of Animal Husbandry*. ICAR, New Delhi.
- Mudgal VD, Singhal KK and Sharma DD. 2003. *Advances in Dairy Animal Production*, 2nd ed. International Book Distributing Co.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Sejain V, Naqvi SMK, Ezeji T, Lakritz J and Lal R. 2012. *Environmental Stress and Amelioration in Livestock Production*. Springer
- Sirohi SK, Walli TK, Singh B and Singh N. 2013. *Livestock Greenhouse Gas: Emissions and Options For Mitigation*. Satish Serial Publishing, New Delhi.
- Selected articles from journals

I. Course Title : Organic Livestock Production

II. Course Code : LPM 705

III. Credit Hours : 1+0

IV. Why this course?

Organic livestock production offers an effective means of satisfying consumer demand for healthy and safe foods and reducing the environmental pressure of agricultural production. There is a need to know the organic production of livestock products and by-

products.

V. Aim of the course

To impart knowledge on key considerations, organic farming standards, certifying agencies, the role of organic livestock farming in environmental protection and biodiversity enhancement and economics of organic livestock products.

VI. Theory

Unit I (2 Lectures)

Historical background and origin, Organic livestock farming vis-a-vis conventional livestock farming, the current status of organic farming in India and world- objectives and importance of organic livestock farming. Opportunities and Problems of organic livestock farming in India.

Unit II (6 Lectures)

Key consideration, selection of animals, housing, feeding, breeding, health care, record keeping, processing and labelling and marketing. Conversion of livestock farm into an organic farm. ITKs used in organic livestock production.

Unit III (4 Lectures)

Organic farming standards in India and the world. IFOAM basic standards, WHO/ FAO Codex Alimentarius, NSOP of India, etc. Role of organic livestock farming in environmental Protection and biodiversity enhancement.

Unit IV (4 Lectures)

Accreditation of inspection and certification agencies. Organic certification mark. Guidelines for organic certification of livestock modalities in the certification of organic products. The economic value of organic livestock products, pricing strategy and marketing of organic products.

VII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions

VIII. Learning outcome

By the end of the course, the student will be acquainted with organic livestock production, economics and marketing of organic products.

IX. Suggested Reading

- Balasubramaniam R, Balakrishnan K and Sivasubramaniam K. 2013. *Principles and Practices of Organic Farming.* Satish Serial Publishing House, New Delhi.
- ICAR. 2014. *Handbook of Animal Husbandry*. ICAR, New Delhi.
- Paajanen T. 2011. *The Complete Guide to Organic Livestock Farming*. Atlantic Publishing Group Inc.
- Katherine M. 2009 *The Organic Dairy Handbook*. Northeast Organic Farming Association.

- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- Singh M, Sharma DK and Mishra UK. 2011. *Organic Dairy Farming*. Satish Serial Publishing House, New Delhi.
- Selected articles from journals.

I. **Course Title : Recent Developments in Welfare of Farm Animals**

II. **Course Code : LPM 706**

III. **Credit Hours : 1+0**

IV. **Why this course?**

Now there are big movements on ethical animal production all over the World. Hence a doctoral student of LPM has to be prepared on this issue too.

V. **Aim of the course**

To familiarize students with the concept and practice of ethical livestock production and production from content ended animals - Animal Welfare Management;

VI. **Theory**

Unit I (2 Lectures)

Ethology: species-specific behaviour, changing with the season, physiological condition of animals, as a guide to animal welfare; not driving animals beyond their natural capacity, for better performance;

Unit II (6 Lectures)

Amelioration of climatic stress and avoidance of unnecessary injury, pain and stress to animals in animal houses, during handling, before and during slaughter, carting bullocks, feeding, milking, shearing, transportation, etc., including deprivance of quality feeds and water; this being a common feature;

Unit III (4 Lectures)

Providing safety, healthcare, feed and water to unproductive animals let off to free roam and injured or orphaned pets, birds and others; monkeys being common – Good management of goshalas and safe shelters for such animals – Conversion of their wastes into VAP to meet part costs of running shelters; Education of the general public, especially children to avoid wanton harm to animals via *Lectures* in schools, TV and radio talks, leaflets, etc.

Unit IV (4 Lectures)

Evaluation of animal welfare measures as an 'instrument' of good animal husbandry, production of quality products and enhanced income to farmers.

VII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits

VIII. Learning outcome

By the end of this course, the student will be familiarized with species-specific behaviour, amelioration of climatic stress and evaluation of animal welfare measures.

IX. Suggested Reading

- *Animal Rights and Animal Welfare Publications* 1896-2009. https://www.lib.ncsu.edu/ findingaids/mc00440
- Appleby MC, Mench JA, Anna Olsson I and Hughes BO. 2018. *Animal Welfare*. CABI.
- AWBI. Animal Protection Laws, Newsletters, etc. of Animal Welfare Board of India; http://www.awbi.org/section/4/publications/2
- GoI Gazzete. Order on Animal Welfare - http://www.moef.nic.in/legis/awbi/awbi18.html
- Phillips C. 2009. *The Welfare of Animals*: *The Silent Majority*. Springer.
- Webster J. 2005. *Animal Welfare: Limping Towards Eden*. Blackwell Publishing.
- Selected articles from journals.

I. Course Title : Entrepreneurship in Livestock Production

II. Course Code : LPM 707

III. Credit Hours : 1+1

IV. Why this course?

Livestock production has huge scope vis a vis income generation. Study of concepts of entrepreneurship will ensure awareness towards the possibilities of taking livestock production as a business unit.

I. Aim of the course

To understand livestock entrepreneurship, concept, incubation centre, PPP perspective in the animal husbandry sector, business communication, inter-personnel skills for establishing an enterprise.

II. Theory

Unit I (2 Lectures)

Understanding livestock entrepreneurship, Concept and characteristics of Entrepreneurship, Role of entrepreneur in relation to enterprise, Functions of the entrepreneur in the economy,

Unit II (4 Lectures)

Process of entrepreneurship development. Barriers in entrepreneurship. The institutional interface in the development of entrepreneurship, incubation centres, startups, PPP Prospective in the animal husbandry sector.

Unit III (6 Lectures)

Essential criteria for the development of entrepreneurship in livestock sector - basic requirements for entrepreneurship initiatives in livestock and allied sectors (i.e. techno-economic feasibility of the enterprises under different conditions, training and management skills, business acumen, business communication, inter-personnel skills for establishing an enterprise, etc.).

Unit IV (4 Lectures)

Entrepreneurial training/ development programmes at the State and National level, Livestock Insurance, Bank and Government support for entrepreneurship, Financial credit and financial management: general principles and practices, analyzing project appraisals and reports, capital, expenditure decisions, reinvestment and payback.

Unit V (2 Lectures)

Preparing projects for bank appraisal, banking requirements, Assessing project profits, Procurement management quality issues, standardisation, grading and packaging.

III. **Practical (16 Classes)**

Visit incubation centres, extrapolation of existing financial models in livestock entrepreneurship, Approach to the preparation of Entrepreneurial Project on livestock, Bankable project for a dairy enterprise (small/ large dairy unit), Bankable project for a sheep/ goat/ Ram lamb enterprise, Bankable project for a pig-enterprise, Bankable project for a Broiler enterprise (small/ medium/ large unit), Bankable project for a layer-enterprise

IV. **Teaching methods**

Blackboard, power point presentations, ICT, Group discussions and farm visits

V. **Learning outcome**

The student acquires knowledge in entrepreneurship initiatives in livestock and allied sectors, financial management and assessment of project profit.

VI. **Suggested Reading**

- George RP and Raj Kamal PJ. 2015. *Farm Economics, Entrepreneurship and Marketing*. Satish Serial Publishing, New Delhi.
- Kahan D. 2012. *Entrepreneurship in Farming*. FAO, Rome.

- Zama MMS, Rashid M and Kumar S. 2014. *Handbook of Livestock Entrepreneurship*. Narendra Publishing House.
- *Selected articles from journals.*

I. **Course Title : Precision Livestock Farming**
II. **Course Code : LPM 708**
III. **Credit Hours : 1+1**
IV. **Why this course?**

Precision Livestock Farming is a combination of developing animal sensing (sensors) tools and decision-making process at the farm level. This information is very much needed for the students in the present technology of the world.

V. **Aim of the course**

To educate the students with a concept of precision in livestock farming, implementation of the sensor system, automation, use of software and analysis

VI. **Theory**

Unit I (2 Lectures)

Concepts of Precision Livestock Farming-Scope and limitations. Utilities of Precision tools in Livestock Farming, the present level of usage of precision tools in India

Unit II (6 Lectures)

Implementation of sensor systems and ICTs in animal health, productivity and welfare, Animal identification and tracking- Radio frequency identification (RFID), Livestock identification and traceback system (LITS), etc. Geo-tagging, Virtual fencing, GPS and GIS in the exploration of feeding resources and grasslands.

Unit III (6 Lectures)

Automation in water resource management. Development and evaluation of early warning and disease support systems for animal health and welfare.

Unit IV (2 Lectures)

Use of software's for database creation of the livestock farms, computation and analysis.

VII. **Practical (16 Classes)**

GPS/ GIS Application in the exploration of breeding tracts of livestock, forage and grassland profiles. Exposure visit to precision livestock farms with automation, use of tools in reproduction and health care, use of different software in farm routines.

VIII. **Teaching methods**

Blackboard, power point presentations, ICT, Group discussions and farm visits

IX. **Learning outcome**

By the end of this course, the students will gain knowledge in precision livestock farming.

X. Suggested Reading

- Halachmi I. 2015. *Precision Livestock Farming Applications*. Wageningen Academic Pub.
- Sastry NSR. 2016. *Livestock Production Under Diverse Constraints - Indian Experience in its Management*. ISAPM Publication.
- *Selected articles from journals.*

I. Course Title : Recent Developments in Poultry Production Management

II. Course Code : LPM 709

III. Credit Hours : 2+1

IV. Why this course?

The poultry industry is growing at a very fast rate. Students have to remain aware of the recent developments in the sector

V. Aim of the course

To educate the students on recent developments on the management of farms and hatcheries, egg, meat and policy developments in poultry.

VI. Theory

Unit I (8 Lectures)

Planning, organization, executive and management of poultry farms and hatcheries of various sizes - an alternative in poultry production

Unit II (4 Lectures)

Demand, supply, the present status of poultry production in India.

Unit III (10 Lectures)

Problems and new management techniques in poultry for egg and meat in India vis-à-vis in other countries of the world - Automation in poultry houses, management of specific pathogen-free flocks.

Unit IV (10 Lectures)

Poultry development policies and planning for higher production constraints in development and solutions, Ethology in relation to avian welfare in intensive poultry production.

VII. Practical (16 Classes)

Planning and preparation of research and commercial projects on broiler and layer production management.

VIII. Teaching methods

Blackboard, power point presentations, ICT, Group discussions and farm visits By the end of this course, the student acquires knowledge in advances of modern poultry farm and hatchery

management

x. Suggested Reading

- DAHD. 2015. *Poultry Farm Manual: A Reference Guide for Central and State Poultry Farms*. 2014-15. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India.
- FAO. 2003. Live bird marketing. In: *Egg Marketing - A Guide for the Production and Sale of Eggs.* http://www.fao.org/3/Y4628E/y4628e09.htm#bm9
- Sreenivasaiah PV. 2006. *Scientific Poultry Production: A Unique Encyclopaedia*. International Book Distribution Co.
- *Selected articles from journals.*

Present status and future prospects of dairying in India and the world. SWOT analysis of the dairy sector. Breeds of cattle and buffalo. Housing and equipment requirements for different classes of cattle and buffaloes. Layout plans and construction details for different sized farms in different climatic zones of India. Ventilation and lighting systems in dairy farms. Feed and fodder resources used for feeding cattle and buffaloes. Scientific technique and regimen of feeding and watering of different categories of cattle and buffaloes. Feed and fodder requirements of different categories of cattle and buffaloes. Supply of green fodder round the year. Enrichment of poor quality roughages. Non-conventional feeding resources. Pasture management. Traits of economic importance and their inter-relationships. Selection and methods of breeding. Reproduction management - Pre-natal and post-natal care and management of dams. Care of neonates and young calves. Management strategies for reducing mortality in calves, optimizing age at first calving and calving interval. Improving breeding efficiency of dairy animals. Farm management - Routine management practices and farm labour management. Milking management - Machine milking and hand milking. Clean milk production. Health management of dairy animals. Summer and winter management of dairy animals.

Population structure, importance and Sheep farming under different systems of management. Advantages and limitations of sheep and goat farming. Genetic resources of sheep and goats with special emphasis on breeds of economic importance. Shelter management. Housing and equipment requirements for different classes of sheep and goats. Layout plans and construction details for different size farms in India. Feed and fodder resources for small ruminants. Principles and systems of feeding and watering different categories of sheep and goat. Pasture utilization and improvement. Breeding Management, Traits of economic importance. Selection of breeding animals. Methods of detection of heat, use of teaser, flushing, tupping. Estrous synchronization, Natural Service, artificial insemination and off-season breeding in small ruminants. Care and management of pregnant animals and breeding stock. Culling. Prevention and control measures including vaccination, deworming, dipping and spraying, etc. Wool: Shearing methods. Importance of wool, wool quality. Goat fibers: mohair, pashmina.

Population dynamic and Economic contribution of pigs. Advantages and limitations of swine rearing, Systems of management. Breeds of economic importance. Housing and rearing systems. Housing and equipment requirements for different classes of swine, layout plans and construction for different sized farms. Feeding principles and nutritional requirement of different classes of swine. Feeding schedule for different classes of swine. Traditional and scientific methods of swine feeding. Traits of economic importance and their

interrelationship. Selection of breeding stock. Reproductive parameters of swine. Methods for detection of heat. Mating systems. Care and management of pregnant sows, piglets, growers and boar. Summer management in swine. Health Management, Prevention and control measures including sanitation, vaccination, deworming, etc. Piglet anaemia and its management.

Climatology and agro-climatic regions of India. Study of climatic factors and their measurement. Climatic stress in livestock (heat stress/ cold stress): effects, measurement and amelioration. Temperature-humidity index and thermo-neutral zone. Adaptation and acclimatization. Light: natural and artificial, photoperiod. Micro-climate modification in animal houses. Livestock and global warming. Climate-resilient livestock production systems. Natural disasters-effects on livestock and mitigation measures.

Introduction to Animal behaviour. Evolution of animal behaviour. Influence of genetic, environmental and physiological influence. Daily and seasonal cycles of behaviour. Patterns of behaviour. Favourable and unfavourable behaviours of domestication. Behaviour assisted animal management - flight zone, Animal learning and training conditioning- operant and classical, animal behaviour based housing designs – Methods of studying animal behaviour- Vices – causes and prevention. Group formation. Social relationships like hierarchy and aggression, the process of socialization, locality and behaviour. Animal welfare – concepts – animal rights – animal freedoms – animal welfare organizations. Indicators of animal welfare, improvement of animal welfare through selection- the welfare of livestock in commercial farms and captivity, environmental enrichment- Welfare of livestock during various management activities such as handling, transportation, etc., Legislation and regulations of animal welfare – welfare and economics.

Scope of equine husbandry in India. Equine population dynamics. Types and classes in equines. Breeds of economic importance. Housing and stable management, behaviour, stable vices and their management. Feeding and breeding of equines. Care and management of stallion, broodmare, pregnant mare and foal. Stud farms, Race clubs, Race-horses and their care, training, exercising, doping and horsemanship. Foot care and dental care in equines. General health management and diseases control. Colic, equine azoturia - prevention and management.Transportation, Laws governing the import and export of equines, Horse passport and trading.

Various companion animals, evolutionary history, the process of domestication of dog and cat. Breeds of dogs and cats. Ownership. Selection of dog, cat and other companion animals. Dogs/ cat body: structure, movement and special senses. Reproduction and breeding management, care of newborn, weaning, reproductive problems of bitch/ queen, Principles of the feeding of dog and cat, Feeding during different life stages and disease conditions, common nutritional problems and their preventive measures. Basic Kennel and health management. Principles of training of dogs/ cats. Dog shows. Preparation for the shows, kennel

clubs, important characters for judgment. Vaccination/ deworming schedules.
Animal air hygiene. Factors affecting outdoor and indoor pollution. Methods to control these factors. Water Hygiene. Hygienic requirements and standards for drinking water. Water conservation. Manure, Quantity of manure voided by domestic animals. Drainage in livestock farms. Factors affecting environmental pollution and their effect on livestock and livestock products for human consumption and controlling measures thereof.
Classification of livestock-based farming systems. Principles, Scope, drivers and tradeoffs in integrated livestock farming systems. Sustainability and ecological advantages of integrated livestock farming systems and their economic importance. Integration of various components of farming systems. Livestock-fish, arable farming, plantation crops and different livestock enterprises (cattle, buffalo, sheep, goat, pig, rabbit, poultry, beekeeping, silkworm, etc.) along with the bio-gas plant, FYM, vermicompost, solar and wind energy utilization, global warming, carbon sequestration and mitigation of GHGs (reducing carbon and water footprints).
Distribution of important Indian wild animals and birds – Ecology of wildlife sanctuaries and National parks - Principles and concepts of Zoo and captive wild animals- Status of forest in India - Biological and ecological basis of management of wildlife - Wildlife protection act - Conservation of wild animals – feeding of captive animals and birds- Habitat Components-Cover, food, water, space and their development and conservation .Wildlife health control – Corridors, – Mortality - Predator and prey relationship - Human-animal conflict - Refuge rehabilitation. Principles for the protection of wild and zoo animals - Breeding seasons - Breeding characteristics – puberty - pregnancy - parturition - postnatal survival of the young. Social factors among various species. Miscellaneous management procedures. Wildlife Census methods- captive animal breeding
Importance of rabbit, rats, mice, hamster and guinea pigs as laboratory animals. Systems of housing, layout and design for laboratory animals house. Feeding management of laboratory animals. Types of diets. Production of laboratory animal models for various experiments. Management of specific pathogen-free, gnotobiotic and germ-free animals. Concepts related to the welfare of laboratory animals. Sanitary and hygienic measures. Common diseases and their control measures. Biosecurity measures. Transportation. Breeding, growth, sexual maturity, mating, gestation, parturition, litter size, weaning. Selection of breeding stock for replacement.
Management principles, Planning Techniques, strategic planning, organization structure, co-ordination and controlling techniques, Key economic concepts, factors of production, farm enterprises, cost of production, opportunity cost, value of production, gross margin, farm profit, net farm family income, substitution, and efficiency: return to scarce resources, risk. SWOT analysis for different livestock species and products, Marketing channels, Marketing of livestock and livestock products and laws governing them, Pricing strategies, supply chain management,

marketing agencies.
Poultry housing systems - cage vs floor system, litter management and lighting for poultry, rearing turkey, duck and quails, backyard poultry. Management of chicks, growing, laying and breeding flocks, broiler production, selection and culling of laying flocks. Management of birds during disease outbreaks. Procuring, care and pre-incubation storage of hatching eggs - Method of incubation, sanitation disinfection and management of hatchery. Biosecurity in poultry farms Embryonic development and factors affecting fertility and hatchability of eggs. Chick sexing, packing and hatchery business - Transporting management of farm and hatchery waste.

Livestock Products Technology

DEPARTMENT OF LIVESTOCK PRODUCTS TECHNOLOGY
Course Structure for M.V.Sc. degree programme (Semester Wise)

Course No.	Course Title	Credits	Semester
LPT 601*	ABATTOIR PRACTICES AND MEAT PLANT OPERATIONS	2+1	I
LPT 602*	FRESH MEAT TECHNOLOGY	1+1	I
LPT 603*	PROCESSING AND PRESERVATION OF MEAT	2+1	I
LPT 604*	PROCESSING OF MILK AND MILK PRODUCTS	1+1	I
LPT 605*	PACKAGING AND MARKETING OF LIVESTOCK PRODUCTS	1+1	II
LPT 606*	MICROBIOLOGY AND QUALITY CONTROL OF LIVESTOCK PRODUCTS	1+1	II
LPT 607*	SLAUGHTERHOUSE BY-PRODUCTS TECHNOLOGY	1+1	II
LPT 608	IN-PLANT TRAINING	0+2	I and II
LPT 609	EGG AND EGG PRODUCTS TECHNOLOGY	1+1	I
LPT 610	MARKET MILK PROCESSING AND DAIRY PLANT PRACTICES	1+1	I
LPT 611	PROCESSING AND MARKETING OF WOOL	1+1	II
LPT 612	BIOTECHNOLOGY OF FOODS OF ANIMAL ORIGIN	1+1	II
LPT 613	FISH AND FISH PRODUCTS TECHNOLOGY	1+1	II
LPT 691	MASTERS SEMINAR	1+ 0	I and II
LPT 699	MASTERS RESEARCH	0+30	I and II
*Compulsory courses			

DEPARTMENT OF LIVESTOCK PRODUCTS TECHNOLOGY
Course Structure for Ph.D. degree programme (Semester Wise)

Course No.	Course Title	Credits	Semester
LPT 701*	MODERN ABATTOIR PRACTICES AND ANIMAL BY-PRODUCTS TECHNOLOGY	1+1	I
LPT 702*	ADVANCES IN MEAT PRODUCTION AND FRESH MEAT TECHNOLOGY	1+1	I
LPT 703*	DEVELOPMENTS IN PROCESSED MEAT TECHNOLOGY	1+1	II
LPT 704*	CURRENT TRENDS IN PROCESSING OF MILK AND MILK PRODUCTS	1+1	I
LPT 705	BIOTECHNOLOGICAL TECHNIQUES AND QUALITY CONTROL OF LIVESTOCK PRODUCTS	1+1	I
LPT 706	ETHNIC AND ORGANIC MEAT AND MILK PRODUCTS	1+1	II
LPT 707	INDUSTRIAL AND ENTREPRENEURIAL TRAINING	0+2	I and II
LPT 708	CURRENT TRENDS IN DISPOSAL AND UTILIZATION OF WASTE FROM MEAT AND DAIRY INDUSTRY	1+1	II
LPT 709	ADVANCES IN EGG AND EGG PRODUCTS TECHNOLOGY	1+1	II
LPT 791	DOCTORAL SEMINAR I	1+0	I and II
LPT 792	DOCTORAL SEMINAR II	1+0	I and II
LPT 799	DOCTORAL RESEARCH	0+75	I and II
*Compulsory courses			

Course Contents
M.V.Sc. in Livestock Products Technology

I. **Course Title : Abattoir Practices and Meat Plant Operations**
II. **Course Code : LPT 601**
III. **Credit Hours : 2+1**
IV. **Why this course?**

Human Resource Development (Manager, Supervisor, Meat inspector and other Technocrats) for Slaughterhouses and Meat processing plants.

V. **Aim of the Course**

To impart knowledge about the handling of meat animals, layout and design of abattoir, sanitation and basics of slaughterhouse practices and meat plant operations.

VI. **Theory**

Unit I (12 Lectures)

Handling and transportation of meat animals including poultry - Pre-slaughter handling and care of food animals – Ante-mortem inspection - Humane slaughter - Principles and methods of stunning - Ritual methods of the slaughter of food animals and poultry - Machinery for slaughter and dressing of food animals - Post- mortem inspection - Handling, disposal and condemnation of unfit materials.

Unit II (11 Lectures)

Abattoir - layout, designing, organization and operation - Maintenance of meat and poultry processing plants - Record keeping - Legislations and regulations for establishment and operation of slaughterhouses and meat processing plants.

Unit III (11 Lectures)

Sanitation of slaughterhouse - Sanitary practices in meat plant and its benefits - Solid and liquid waste management of slaughterhouse - Different methods of effluent treatment and designs of effluent treatment plants - State and Central Pollution Control Board norms.

VII. **Practical (17 classes)**

Design and outlay of modern abattoir including poultry processing and effluent treatment plants for different capacities - Judging and grading of food animals - Procedure for the slaughter of food animals and poultry - Ante-mortem and post- mortem inspection - Recording of carcass data - carcass yield, meat bone ratio, etc.

- Measurement of effluent characteristics - pH, BOD, COD, suspended solids, etc.
- Visit slaughterhouse, poultry processing and effluent treatment plants - DPR for the establishment of an abattoir.

VIII. Teaching methods

- Classroom teaching, practical demonstration in Divisional laboratory/ slaughter unit.
- Visit municipal slaughterhouse and meat plants.
- Demonstration of charts, video films and models.

IX. Learning Outcome

Gaining knowledge of abattoir practices and operations to be carried out in meatplants.

X. Suggested Reading

- Collins DS and Huey RJ. 2015. *Gracey's Meat Hygiene*, 11th Ed. John Wiley and Sons Ltd., UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences* Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., UK.
- Sahoo J, Sharma DK and Chatli M. 2011. *Practical Handbook on Meat Science and Technology*, 1st ed., Daya Publishing House.
- Swatland HJ. 2004*. Meat Cuts and Muscle Foods*. Nottingham Univ. Press.
- Warriss P. 2010. *Meat Science: An Introductory Text*, 2nd ed. Oxford Press.

I. Course Title : Fresh Meat Technology

II. Course Code : LPT 602

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development for Meat processing Sector

V. Aim of the Course

To impart knowledge about the status of the meat industry, muscle structure and composition, carcass handling, grading and fabrication.

VI. Theory

Unit I (10 Lectures)

History, current development and prospects of meat and poultry industry in India Skeletal muscle development – pre- and post-natal- Structure and chemistry of muscle including poultry – Muscle Proteins - sarcoplasmic and myofibrillar proteins Stromal proteins – Types of muscle fibres - Post mortem changes – Rigor mortis - Conversion of Muscle to meat - Pre and post-slaughter factors affecting meat quality – Defects during the

conversion of muscle to meat – PSE/ DFD/ Cold Shortening – Off odour development.

Unit II (7 Lectures)

Composition and nutritive value of meat and poultry - Qualities of fresh meat – pH, WHC, colour, odour, juiciness, texture/ tenderness and firmness - Chilling, ageing and conditioning of meat - Electrical stimulation - Carcass evaluation, grading and fabrication- Tenderization of meat.

VII. Practical (17 Classes)

Evaluation/ estimation of physicochemical properties of fresh meat pH, colour, water holding capacity, ERV, shear force value, glycogen, R-value and myoglobin Proximate analysis of meat - Estimation of drip loss - Determination of sarcomere length, fibre diameter and myofibrillar fragmentation index - Fractionation of sarcoplasmic, myofibrillar and stromal proteins - Carcass evaluation and grading Meat cutting, retail and wholesale cuts.

VIII. Teaching methods

- Classroom teaching, practical demonstration and analysis in Divisional laboratory/ slaughter unit.
- Visit slaughterhouses, meat plants and retail units
- Use of Audio-visual Capsules.

IX. Learning Outcome

Acquiring knowledge on quality attributes of fresh meat, factors affecting these attributes, composition and nutritive value of meat.

X. Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed., Kend All/ Hunt Publishing Company, IOWA.
- Bender A. 1992. *Meat and Meat Products in Human Nutrition in Developing Countries*. FAO, Rome.
- Carlson CW, Greaser ML and Jones KW. 2001. *The Meat We Eat*, 14th ed. Interstate Publishers, INC.
- Jensen WK, Devine C and Dikeman M. 2004. Encyclopaedia of Meat Sciences Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Lawrie RA and Ledward DA. 2006. *Lawrie's Meat Science*, 7th ed. Woodhead Publishing Limited, Cambridge, England.
- Pearson AM. 1994. *Quality Attributes and their Measurement in Meat, Poultry and Fish Products*. Springer, New York.
- Swatland HJ. 2004. *Meat Cuts and Muscle Foods*. Nottingham University Press.

I. **Course Title : Processing and Preservation of Meat**

II. **Course Code : LPT 603**

III. **Credit Hours : 2+1**

IV. **Why this course?**

Human Resource Development for Meat and Poultry Processing Industry and Entrepreneurship development

V. **Aim of the Course**

To impart knowledge about processing and preservation of meat including poultry meat, fundamentals of sensory evaluation and techniques for sensory evaluation of meat products.

VI. **Theory**

Unit I (8 Lectures)

Basic principles of meat preservation – dehydration, chilling, freezing, freeze-drying, thermal processing, direct microbial inhibition, irradiation, use of chemicals and antimicrobials - Curing and smoking - Hurdle technology concept.

Unit II (17 Lectures)

Principles of Meat Processing - Meat and non-meat ingredients and their roles - Additives - Processing techniques - comminution, chopping, blending, marination, massaging, tumbling, etc. - Cooking methods including microwaving – Development of meat products including ham, bacon, tandoori and barbeque - Emulsion formation – factors affecting emulsion formation - Emulsion based meat products - sausages, nuggets and patties - Enrobed, restructured, fermented and intermediate moisture meat products – Ready-to-cook, ready-to-eat and shelf-stable meat products – Canned and retort meat products – Traditional and ethnic meat products - Functional meat products.

Unit III (9 Lectures)

Sensory evaluation – Sensory physiology, types, methods, quality attributes - Factors influencing sensory measurements - Types of sensory panels - Selection of sensory panellists- Sensory evaluation tests- Layout and designing of sensory evaluation laboratory.

VII. **Practicals (17 Classes)**

Estimation of tyrosine value, nitrite content, TBARS value, peroxide value - Preparation of Meat Products - Minced meat products - Emulsion based meat products – sausages, nuggets and patties - Ham and Bacon - Meat Pickles – Enrobed, restructured, fermented and shelf-stable meat products - Canned/ retorted Meat Products - Traditional and ethnic Meat Products - Kebabs - Sensory evaluation of meat products - Subjective and objective method of sensory evaluation - differential, descriptive,

training tests, etc. – Test practices and training in the sensory lab - Determination of emulsion stability - Cooking yield - Texture Profile Analysis.

VIII. **Teaching methods**

- Classroom teaching, practical performance in Divisional Pilot Processing Plant.
- Visit of Meat and Poultry Processing Unit.
- Demonstration videos

IX. **Learning Outcome**

Theoretical and practical understanding of meat preservation, processing and sensory evaluation of the meat products.

X. **Suggested Reading**

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Amerine MA, Pangborn RM and Roessler EB. 1965. *Principles of Sensory Evaluation of Food*. Academic Press, New York.
- Barbut S. 2005. Poultry Products Technology. CRC Press.
- Carlson CW, Greaser ML and Jones KW. 2001. *The Meat We Eat*, 14th ed. Interstate Publishers, INC.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., UK.
- Lawless HT and Heymann H. 2010. *Sensory Evaluation of Food - Principles and Practices*, 2nd ed, Springer-Verlag, New York Inc.
- Mountney GJ and Parkhurst CR. 2017. *Poultry Products Technology*, 3rd ed. Food Products Press, New York.
- Pearson AM and Gillett TA. 1996. *Processed Meats*, 3rd ed. Chapman and Hall, Inc, New York.
- Sharma BD, Wani S and Sharma N. 1997. *Sensory Evaluation Manual for Meat and Meat Products*. IVRI Publication.
- Toldrá F. 2010. *Handbook of Meat Processing*. Wiley-Blackwell.

I. **Course Title : Processing of Milk and Milk Products**

II. **Course Code : LPT 604**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Human Resource Development (Manager, Supervisor and other Technocrats) for Milk Processing Industry, Cooperatives, etc.

V. **Aim of the Course**

To impart knowledge about the organization of dairy plants, basic milk operations, cleaning and sanitization of milk processing plants,

milk products processing and applications of membrane technologies in dairy industries.

VI. **Theory**

Unit I (6 Lectures)

Basic concepts of dairy plant organization and operation - collection, chilling, transportation - Heat treatments of Milk - Cleaning and sanitization of Dairy plants - Composition, nutritional, physico-chemical and functional properties of milk - Standards for milk and milk products.

Unit II (7 Lectures)

Manufacture of milk products - Flavoured Milk - Drying of milk and milk products- Evaporated and condensed milk - Milk powders – Butter - Ice cream and other frozen desserts - Manufacture of different fermented milk products - Manufacture of cheddar, mozzarella, cottage and processed cheese - Manufacture of indigenous milk products – paneer, channa, khoa, ghee, dahi and shrikhand - Rheology of milk products - Dairy by-products.

Unit III (4 Lectures)

Membrane filtration technology- principles and concepts - Manufacturing and functional properties of casein - Caseinates- Co-precipitates - Whey protein concentrates (WPC) - Lactose- Dairy whiteners.

VII. **Practical (17 Classes)**

Platform tests - Determination of fat, SNF, TS, protein, lactose and ash contents of milk - Preparation of butter, ice cream, cheese – cheddar, mozzarella and cottage cheese, khoa, paneer, channa, ghee, dahi, yoghurt, casein, caseinate, co-precipitate, flavoured milk - Determination of degree of browning - Measurement of rheological properties of different milk products - Evaluation of sensory quality of milk and milk products - Visit dairy plants.

VIII. **Teaching methods**

- Classroom teaching and laboratory practical.
- Visit the milk processing plant.
- Use of Audio-visual Capsules

IX. **Learning Outcome**

Gaining knowledge of handling and processing of milk and milk products.

X. **Suggested Reading**

- Aneja RP, Mathur BN, Banerjee AK and Chandan RC. 2002. *Technology of Indian Milk Products*. Dairy India.
- Chandan RC, Kilara A and Shah NP. 2008. *Dairy Processing and Quality Assurance*, 1st ed. Willey–Blackwell.

- Davis JG. 2010. *Milk Testing: A Laboratory Control of Milk*. Agribios.
- MIF. 2005*. Analysis of Milk and its Products: A lab Manual,* 2nd ed. Milk Industries Foundation. Biotech Books, Delhi
- Singh S. 2014. *Dairy Technology,* Vol. 1 and 2. New India Publishing Agency.
- Spreer E. 1993. *Milk and Dairy Products*. Marcel Dekker.
- Varnam AH and Sutherland JP. 1994. *Milk and Milk Products Technology.* Chapman and Hall, UK.
- Walstra P, Wouters JTM and Geurts, TJ. 2006. *Dairy Science and Technology*, 2nd ed. Taylor and Francis Group.
- Web BH, Johnson AH and Alford JA. 1987*. Fundamental of Dairy Chemistry*, 3rd ed. Westport AVI Publ.

I. **Course Title : Packaging and Marketing of Livestock Products**

II. **Course Code : LPT 605**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Human Resource Development (Manager, Supervisor, Marketing Executives and other Technocrats) for Packaging Industry and Business Planning.

V. **Aim of the Course**

To impart knowledge about properties of different packaging material, techniques used in packaging of different livestock products, marketing channels and value chain of processed products.

VI. **Theory**

Unit I (10 Lectures)

Principles of packaging - objectives and functions - Product characteristics affecting packaging requirements - Packaging materials and their characteristics - Different packaging systems for fresh, cured, dehydrated, freeze-dried and shelf-stable products of milk, meat and chicken - Aseptic packaging of milk - UHT milk - Vacuum packaging – MAP and role of different gases - Retort pouch processing - Active and intelligent/ smart (biosensors) packaging - Edible and biodegradable packaging - Nanotechnology for food packaging - Recycling of packaging materials - Labelling requirements – Barcoding and its importance - Packaging standards and regulations – Economics of different packaging systems.

Unit II (7 Lectures)

Marketing of Livestock Products - Types of markets - Marketing

channels of live meat animals and Poultry - Existing systems - constraints and possible solutions

- Value Chain of meat, poultry and processed products - strategies and interventions for better profitability – Meat retailing and establishment of retail outlets for meat and poultry - FSSAI, APEDA, EIA, GOI/ WTO regulations for the domestic market, import and export of livestock products.

VII. Practical (17 Classes)

Different packaging materials and their properties - Determination of thickness, bursting strength, piercing strength, water vapour transmission rate, gas transmission rate, headspace gas analysis - Vacuum, shrink, MAP and retort packaging of meat and milk products - Visit milk and meat processing plants - Study of the value chain of livestock products including online marketing.

VIII. Teaching methods

- Classroom teaching, Practical demonstration in the laboratory.
- Visit market and packaging units.
- Demonstration using video films and models.

IX. Learning Outcome

Developing an understanding of packaging and marketing of livestock products.

X. Suggested Reading

- Aberle ED, Forrest JC, Gerrard DE and Mills EW. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences,* Vol. I, II and III, 1st ed., Elsevier Academic Press, UK.
- Robertson GC. 2012. *Food Packaging- Principles and Practices*, 3rd ed. CRC Press.
- *Selected Articles from Journals.*

I. Course Title : Microbiology and Quality Control of Livestock Products

II. Course Code : LPT 606

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development for Quality Control of Livestock Products

V. Aim of the Course

To develop an understanding about microbial spoilage of different livestock products, quality control and legal standards.

VI. Theory

Unit I (9 Lectures)

Microorganisms associated with spoilage of livestock products - Factors affecting microbial growth - Contamination of livestock products - Microbial spoilage of meat, poultry, eggs, milk and their products - Physical and chemical changes produced by microbes in milk, meat, eggs and their products - Meat and milk-borne infections and intoxications - Control of microbial growth in livestock products - Antimicrobial resistance (AMR).

Unit II (8 Lectures)

Introduction to Good Laboratory Practices (GLP), Good Hygienic practices (GHP) and Good Manufacturing Practices (GMP), Sanitary and Phytosanitary measures (SPS) and Food Safety System Certification (FSSC) - Quality Control – Quality Assurance - principles and practices - Quality Management Systems – Food Safety and Standards Act (FSSAI, 2006 Act) - Codex regulation for food products safety

- ISO 9001 - ISO 22000 - HACCP concepts - Risk-based quality assessment - Microbial quality control - FSSAI/ BIS standards for milk, meat and poultry, Chemical residues in livestock products and their effects on the health of the consumer.

VII Practical (17 Classes)

Basic requirements for setting up of quality control laboratory - Sampling methods for the microbiological examination of different processing plants, products and equipment - Development of HACCP plan for milk and meat processing plants - Microbial evaluation of market samples of milk, meat and egg – Total Viable Count, coliform, etc. - Pathogens of Public Health importance - *E. coli, Salmonella, Staphylococcus aureus, Campylobacter* - Rapid detection methods of food pathogens.

VIII. Teaching methods

- Classroom teaching with laboratory analysis.
- Sampling and survey of market, butchers shop, milk and meat processing plants.
- Visits to units having HACCP and ISO certification.

IX. Learning Outcome

Acquiring knowledge on microbiology, quality control and legal standards for different livestock products.

X. Suggested Reading

- Aberle ED, Forrest JC, Gerrard DE and Mills EW. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing

Company, Iowa.
- Bell C, Neaves P and Williams AP. 2005. *Food Microbiology and Laboratory Practices*, 1st ed. Blackwell Publishing.
- Collins DS and Huey RJ. 2015. *Gracey's Meat Hygiene*, 11th ed. John Wiley and Sons Ltd., UK.
- Frazier WC and Westhoff DC. 2013. *Food Microbiology*, 5th ed. McGraw Hill Publication.
- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Jay JM, Loessner MJ and Golden DA. 2006. *Modern Food Microbiology*, 7th ed. Springer.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences,* Vol. I, II and III, 1st ed., Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., UK.
- Pearson AM and Dutson TR. 1995. *Quality Attributes and their Measurement in Meat, Poultry and Fish Products*. Aspen Publishers, Inc, Maryland, USA.

I. **Course Title : Slaughterhouse By-products Technology**
II. **Course Code : LPT 607**
III. **Credit Hours : 1+1**
IV. **Why this course?**

Human Resource Development for better utilization of animal by-products and pollution control

V. **Aim of the Course**

To impart knowledge about the utilization and processing of animal by-products.

VI. **Theory**

Unit I (6 Lectures)

Status and scope of slaughterhouse by-products utilization - Trade practices - Planning, design and layout of by-products plant - Classification of by-products - edible and inedible - Rendering methods and products - Yield and characteristics of rendered fat and meat cum bone meal.

Unit II (6 Lectures)

Utilization of blood, horns and hooves, intestine, bones, feathers, bristles, glandular by-products and ruminal contents - Value-added by-products from slaughterhouse and poultry processing plants - Processing of animal by-products for pet foods - High-value low volume by-products – collagen sheets, scaffolds, bone morphogenic

proteins, biopeptides, biodiesel, etc.- Legislation and regulations related to animal by-products.

Unit III (5 Lectures)

Flaying - Classification and factors affecting the quality of hides and skin - Physical and chemical characteristics of hide and skin - Grading and processing of hide and skin for the manufacture of leather - Preparation and quality control of gelatine and glue.

VII. **Practical (17 Classes)**

Preparation of casing, neatsfoot oil, gelatin and glue - Demonstration of preparation of carcass meal, meat meal, bone meal, blood meal, feather meal, slime meal - Grading of casings - Collection and preservation of glandular by-products - Preparation of pet foods -Visit local by-products processing units - Quality evaluation of rendered animal fat.

VIII. **Teaching methods**

- Classroom teaching, practical demonstration of different by-products preparation in the Divisional laboratory/ slaughter unit
- Visit of municipal slaughterhouse and tanneries.
- Use of Audio-visual Capsules.

IX. **Learning Outcome**

Gaining knowledge on proper utilization of slaughterhouse by-products

X. **Suggested Reading**

- Aberle ED, Forrest JC, Gerrard DE and Mills EW. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences,* Vol. I, II and III, 1st ed., Elsevier Academic Press, UK.
- Mann I. 1962. *Animal By-products: Processing and Utilization*. FAO, Rome. Ockerman HW and Hansen CL. 1999. *Animal By-product Processing and Utilization*. CRC Press.

I. **Course Title : In-Plant Training**

II. **Course Code : LPT 608**

III. **Credit Hours : 0+2**

IV. **Why this course?**

Development of Entrepreneurial Skill and Human Resources for Meat and Milk Industry

V. **Aim of the Course**

To impart industrial exposure and develop entrepreneurial skill among postgraduate students.

VI. **Practical (*34 sessions/ Hours equivalent to 34 credit hours of practical*)**

LPT students shall undergo in-plant training in any one of the specialized area of Livestock Products Technology in an institute/ industry – private or public sector. After completion of the training, the student will submit a training report. The evaluation will be based on attendance, report submission and viva-voce examination.

VII. **Teaching methods**

- Deputation to slaughterhouse/ meat/ milk processing plants
- Use of Audio-visual Capsules.

VIII. **Learning Outcome**

Students after undergoing training will have a good understanding of the functioning of the industry and capable of starting their own enterprises.

IX. **Suggested Reading**

- Interaction with Industry Persons.
- *Selected articles from Journals.*

I. **Course Title : Egg and Egg Products Technology**

II. **Course Code : LPT 609**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Human Resource Development for Egg Processing Industry/ Plants

V. **Aim of the Course**

To impart knowledge about the status of egg production, composition, nutritive value, preservation, grading, processing packaging and marketing of eggs and egg products.

VI. **Theory**

Unit I (9 Lectures)

Status of egg production and processing in India - Structure, composition, nutritive value and functional properties of eggs - Grading, preservation, packaging and marketing of shell eggs - Quality evaluation of shell eggs and factors influencing egg quality - Defects and Spoilage of eggs.

Unit II (8 Lectures)

Layout and design of egg processing Unit - Principles and procedures involved in pasteurization, chilling, freezing, desugarization and drying of egg products - Quality standards of egg products - Packaging of egg products - Designer egg products.

VII. **Practical (17 Classes)**

Evaluation of physical, chemical, functional and microbial quality of egg and egg products - Preservation of eggs - Preparation of value-

added egg products - Visit egg-processing plant.

VIII. **Teaching methods**

- Classroom teaching, practical demonstration in Divisional laboratory.
- Visit egg processing plant.

IX. **Learning Outcome**

Gaining knowledge on composition, nutritive value, preservation and marketing of eggs. Quality maintenance and development of designer egg products.

X. Suggested Reading

- Romanoff AL and Romanoff AJ. 1949. *Avian Egg*. John Wiley and Sons.
- Stadelman WL and Cotterill OJ. 2002. *Egg Science and Technology*, 4th ed. CBS.
- *Selected articles from Journals.*

I. **Course Title : Market Milk Processing and Dairy Plant Practices**

II. **Course Code : LPT 610**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Human Resource Development (Manager, Supervisor and other Technocrats) for Milk Processing Industry and Dairy Plants.

V. **Aim of the course**

To impart knowledge about procurement of milk, assessment of milk quality, legislation for quality control, milk processing techniques, the layout of milk processing and dairy effluent plants and preparation of special milk.

VI. **Theory**

Unit I (5 Lectures)

Organization of procurement and pricing plans of raw milk - Operation of automatic milk collection stations - Reception of milk at Raw Milk Reception Dock (RMRD)

- Assessing raw milk quality - Sanitary handling of milk - Milk standards and legislations.

Unit II (6 Lectures)

Unit operations in milk processing plants - Clarification – Bactofugation - Different chilling methods - Standardization - Homogenization (theories, methods and effects)

- Heat treatments (thermization, boiling, pasteurization, sterilization (UHT and In-container) - Separation technologies (Microfiltration, Ultrafiltration, reverse osmosis, diafiltration, nanofiltration etc).

Unit III (2 Lectures)

Distribution methods for liquid milk - Consumer pricing - Traceability - Handling of unsold and returned milk- - Adulteration of milk and detection - Residues in milk and preventive steps

Unit IV (4 Lectures)

Fortified, special and functional market milk - A1 and A2 milk Design and layout of dairy plants of different capacities - Dairy by-products - Treatment of Dairy Effluents.

VII. Practical (17 Classes)

Platform tests - Principles of rapid milk analyzers including milko-tester and operation of automatic milk collection stations - Raw milk quality, somatic cell count, bacteriological count - Estimation of homogenization efficiency - Assessment of efficiency of pasteurization, sterilization and boiling- Detection of adulterants.

VIII. Teaching methods

- Classroom teaching and laboratory analysis.
- Visit milk processing plants.
- Acquaintance with the processing of market milk and other dairy plant practices.

X. Suggested Reading

- FAO. 2013. *Milk and Dairy Products in Human Nutrition*. FAO, Rome.
- Fuquay JW, Fox PF and McSweeney PLH. 2011*. Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Walstra P, Wouters JTM and Geurts, TJ. 2006. *Dairy Science and Technology*, 2nd ed., Taylor and Francis Group.

I. Course Title : Processing and Marketing of Wool

II. Course Code : LPT 611

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor and other Technocrats) for Wool Processing Industry

V. Aim of the Course

To impart knowledge about the growth and structure of wool and fibres and their use. Grading, processing, marketing and specifications of wool and speciality fibres.

VI. Theory

Unit I (10 Lectures)

Status and prospects of wool industry - Wool types and their uses - Growth and molecular structure of wool fibre - physical and

chemical properties of wool - Grading of wool, Characteristics of speciality hair fibres and their uses- factors influencing the quality of wool and speciality hair fibres - principles and steps involved in the processing of wool and speciality hair fibres, Impurities in wool and their removal, Defects in wool.

Unit II (7 Lectures)

Physical, chemical and mechanical testing of wool - by-products of wool industry - Trade and Marketing of wool, specification and regulation for quality control - Characteristics of natural and synthetic fibres

VII. Practical (17 Classes)

Physical, chemical and mechanical testing of wool and speciality hair fibres - Characterization of wool - grading of wool - Identification of natural and synthetic fibres - Visit the wool processing industry and acquaintance with various steps in the processing of wool and speciality hair fibres.

VIII. Teaching methods

- Classroom teaching and laboratory analysis.
- Visit wool processing units.

IX. Learning Outcome

Gaining knowledge on the quality and processing of wool.

X. Suggested Reading

- Bergen WV. 1963. *Wool Hand Book*, Vols. I and II. Interscience.
- Houck MM. 2009. *Identification of Textile Fibres*. Woodhead Publishing Limited, Cambridge, England.
- Johnson NAG and Russell IM. 2009. *Advances in Wool Technology*. Woodhead Publishing Limited, Cambridge, England.

I. Course Title : Biotechnology of Foods of Animal Origin

II. Course Code : LPT 612

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development for meat and milk processing Industry with understanding of the latest biological techniques

V. Aim of the Course

To impart knowledge about new biotechnological techniques and tools for improving livestock productivity, quality control and food value.

VI. Theory

Unit I (10 Lectures)

Role of Biotechnology in improving productivity and quality of Meat, Milk and their products - Application of biotechnological tools in food

preservation and packaging - Transgenic meat animal production - techniques - Genes influencing meat quality traits – Production of meat and milk with the desired composition - Application of enzymes in dairy and meat industry - Genetically modified enzymes - Biotechnologically produced food flavours and colours for animal products.

Unit II (7 Lectures)

Starter cultures in Meat and milk - Pre and probiotics, and their supplementation in animal origin foods - Biopreservation- Bacteriocin - Fermentation technology - Upstream and Downstream processing - Biosensors - Antimicrobial Peptides - Meat Species Identification- Molecular tools.

VII. Practical (17 Classes)

Introduction of basic biotechnological techniques such as western blotting, enzyme isolation and identification, DNA extraction, amplification, different types of PCR, Acquaintance with RT-PCR, Multiplex PCR, gene identification and characterization

- Biotechnological techniques for meat species identification and meat quality - Electrophoresis, Chromatography for fatty acids- Operation of Fermenters.

VIII. Teaching methods

- Classroom teaching.
- Use of Audio-visual capsules.

IX. Learning Outcome

Gaining knowledge on utilization of biotechnology as a tool to improve production, shelf life and nutritive value of livestock products.

X. Suggested Reading

- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing - Improving Quality*. Woodhead Publishing Ltd., UK.
- Kowale BN, Kulkarni VV and Keshava Rao V. 2008. *Methods in Meat Science*. Jaypee Brothers Medical Publishers, New Delhi.
- Sahoo J, Sharma DK and Chatli MK. 2011. *Practical Handbook on Meat Science and Technology*, Daya Publishing House, New Delhi.
- Toldra F. (Ed). 2008. *Meat Biotechnology*, Springer Science, New York
- Webb BH, Johnson AH and Alford JA. 2005 *Fundamentals of Dairy Chemistry*, 2nd ed. CBS Publishers and Distributors Pvt. Ltd.
- Selected articles from Journals.

I. **Course Title : Fish and Fish Products Technology**

II. **Course Code : LPT 613**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Human Resource Development (Manager, Supervisor and other Technocrats) for Fish Processing Industry

V. **Aim of the Course**

To impart knowledge about fish resources, structure and composition of fish muscles, preservation and processing of fish, marketing of fish products, deterioration of quality and legislations for quality control.

VI. **Theory**

Unit I (9 Lectures)

Fishery resources, marine and freshwater fishes- Transportation and hygienic handling of fish - Fish Muscle structure, composition and nutritive value - Processing of fish - gutting, filleting, beheading, peeling, deveining, etc. - Preservation - chilling, freezing, etc. - Principles and procedure of canning, curing, smoking, dehydration

- Surimi and other Fish based products.

Unit II (8 Lectures)

Quality control- identification of freshness of fish - Chemical and Microbial spoilage of fish, labelling and marketing of fish and fish products, utilization of fish processing waste. National and international regulations, standards, quality control and marketing of fish and fish products.

VII. **Practical (17 Classes)**

Visit fish processing plant - Grading of live fish for freshness - Filleting and other techniques for the processing of fish - Proximate Composition of Fish - Physico- chemical and Microbial evaluation of fish quality - Preparation of Value added fish products.

VIII. **Teaching methods**

- Classroom teaching.
- Practical demonstration in the laboratory.

IX. **Learning Outcome**

Acquiring knowledge on the structure of fish muscle, preservation, processing and quality control of fish and fish products.

X. **Suggested Reading**

- Pearson AM. 1994. *Quality Attributes and their Measurement in Meat, Poultry and Fish Products*. Springer, New York.
- Suzuki T. 1981. *Fish and Krill: Protein Processing Technology*. Applied Science Publ.
- *Selected articles from Journals.*

Course Contents
Ph.D. in Livestock Products Technology

I. **Course Title : Modern Abattoir Practices and Animal By-Products Technology**

II. **Course Code : LPT 701**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Human Resource Development (Manager, Supervisor and other Technocrats) for Slaughterhouses, Tanneries and other by-products industries.

V. **Aim of the Course**

To impart knowledge about advances in abattoir practices and animal by-products utilization.

VI. **Theory**

Unit I (5 Lectures)

Current scenario of slaughterhouses and processing plants in India - Establishment and operation of a modern abattoir - Basic machinery and tools of slaughterhouse

- Automation/ Robotics in meat and by-product processing – Latest developments in the evaluation of carcass quality – Chilling and freezing of carcass - Maintenance of cold storages.

Unit II (8 Lectures)

Latest machinery and tools used in by-products processing plant - New technologies for utilization of animal by-products as food, feed, pharmaceuticals and other miscellaneous products - Leather chemistry and processing technology - Latest Techniques in handling, preservation, tannery procedure, manufacture and testing of leather - Value addition in leather processing - Developments in gelatin, glue and natural casings production - Characterization, processing, yield and quality control of rendered fat and meat cum bone meal.

Unit III (4 Lectures)

Organization, layout and operation of dry and wet rendering plants. Latest trends in the disposal of slaughterhouse effluents and control of environmental pollution. Designs and function of effluent treatment plants.

VII. **Practical (17 Classes)**

Plan and outlay of various components of a modern abattoir. Designs of ETP. Estimation of TS (suspended and dissolved) BOD and COD from abattoir effluents. Ante-mortem inspection of food animals, methods of stunning, stunning instruments. Slaughter and dressing of food animals. Electrical stimulation of carcasses.

Post mortem inspection of carcasses of food animals - Visit municipal slaughterhouse, by-product processing plant, Effluent treatment plant and tanneries.

VIII. Teaching Methods

- Classroom teaching, practical demonstration in laboratory/ slaughter unit.
- Visit municipal slaughterhouse and tanneries.
- Demonstration through charts, video films and models.

IX. Learning Outcome

Understanding of latest techniques employed in abattoir practices and slaughterhouse by-products utilization.

X. Suggested Reading

- Biswas A and Kondaiah N. 2014. *Meat Science and Technology*, 1st ed. Jaya Publishing House.
- Collins DS and Huey RJ. 2015. *Gracey's Meat Hygiene*, 11th ed. John Wiley and Sons Ltd., UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., UK.
- Swatland HJ. 2004*. Meat Cuts and Muscle Foods*. Nottingham University Press.
- Warriss P. 2010. *Meat Science: An Introductory Text*, 2nd ed. Oxford Press.
- *Selected articles from Journals.*

I. Course Title : Advances in Meat Production and Fresh Meat Technology

II. Course Code : LPT 702

III. Credit Hours : 1+1

IV. Why this course?

Human Resource Development (Manager, Supervisor and other Technocrats) for Meat Industry

V. Aim of the Course

To impart knowledge about the latest trends in meat production, the ultrastructure of muscle fibres, strategies for improving meat production and traceability of meat products.

VI. Theory

Unit I (7 Lectures)

Current status of meat production trends in India - Government policies - economics and viability – Traceability in the meat industry –

Strategies for augmenting meat production - Salvaging male buffalo calf - Non-conventional meat resources.

Unit II (10 Lectures)

Pre- and Post-natal development of Muscle fibres - Genetic, nutritional and physiological aspects of muscle development - Ultrastructure of skeletal muscle - Modern tools for fibre typing of muscle - Chemical and biochemical aspects of rigor mortis and fresh meat quality – Odour, colour, water holding capacity - Texture profile - Artificial tenderization - Myofibrillar, sarcoplasmic and connective tissue proteins - Cytoskeletal proteins - Lipid profile - Meat in human nutrition - Meatand health issues.

VII. Practical (17 Classes)

Economics of establishing commercial meat animal production Unit - Extraction of sarcoplasmic and myofibrillar proteins and their fractionation - Estimation of Collagen content of Meat - Histochemistry of muscle tissues - Muscle fibre typing - Meat tenderization techniques.

VIII. Teaching methods

- Classroom teaching, practical demonstration in laboratory/ slaughter unit
- Visit municipal slaughterhouse and meat plants
- Use of Audio-visual capsules.

IX. Learning Outcome

Knowledge of latest trends in meat production and fresh meat technology.

X. Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science*, 5th ed. Kendall Hunt Publishing Company, Iowa.
- Carlson CW, Greaser ML and Jones KW. 2001. *The Meat We Eat*, 14th ed. Interstate Publishers, Inc.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Lawrie RA and Ledward DA. 2006. *Lawrie's Meat Science*, 7th ed. Woodhead Publishing Limited, Cambridge, England.
- Pearson AM and Dutson TR. 1997. *Advances in Meat Research*. *Healthy Production and Processing of Meat, Poultry and Fish Products,* Vol. 11. Springer.
- Swatland HJ. 2004. *Meat Cuts and Muscle Foods*. Nottingham Univ. Press.
- *Selected articles from Journals.*

I. **Course Title : Developments in Processed Meat Technology**

II. **Course Code : LPT 703**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Human Resource Development (Manager, Supervisor and other Technocrats) for Meat Processing Industry

V. **Aim of the Course**

To impart knowledge about the advances in the technology for processing of meat and development of value-added meat products.

VI. **Theory**

Unit I (5 Lectures)

Current trends in meat processing techniques - Functional properties of the tissue component in meat processing - Approaches for new product development - Latest equipment used for processing of meat products - Indigenous and heritage meat products - Curing and smoking - purpose, composition and methods of smoking - Liquid smoke - Processing of Ham, bacon, sausages, patties, meatloaves and tandoori chicken- Novel meat products - Non-thermal processing - Irradiation techniques - Canning/ retorting.

Unit II (8 Lectures)

Marination, massaging, tumbling and flaking techniques - Restructured/ reformed,intermediate moisture, fermented, enrobed, shelf-stable and dried meat products - Meat analogues and substitutes - Thermal processing of meat- Enzymatic and non- enzymatic browning reactions - Protein changes in processed meat products - Lipid changes - Protein and lipid interaction - Protein and carbohydrate interaction - Bioactive peptides.

Unit III (4 Lectures)

Functional and designer meat products - Role of omega-3 fatty acids in animal foods - Role of n-3 in PUFA enriched and CLA enriched meat and eggs - Packaging of meat and meat products - smart, active, intelligent packaging - Developments in sensory evaluation of meat products.

VII. **Practical (17 Classes)**

Evaluation of textural characteristics of meat products – Estimation of emulsifying capacity, emulsion stability- Estimation of Nitrosamines and PAHs - Preparation of emulsion-based, restructured, enrobed, cured and smoked, dried, fermented, intermediate moisture, ready to eat, and shelf-stable meat products-objective and subjective evaluation of meat products.

VIII. **Teaching methods**

- Classroom teaching, practical performance in Divisional Pilot Processing Plant.
- Visit Meat Processing Unit.
- Demonstration by videos.

IX. Learning Outcome

Acquaintance with the knowledge of the latest techniques used in meat processing and packaging and development of functional meat products.

X. Suggested Reading

- Aberle ED, Forest JC, Gerrard DE and Mills E. 2013. *Principles of Meat Science,* 5th ed. Kendall Hunt Publishing Company, Iowa.
- Barbut S. 2005. *Poultry Products Technology*. CRC Press.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., UK.
- Pearson AM and Gillett TA. 1996. *Processed Meats*, 3rd ed. Chapman and Hall, Inc, New York.
- Toldrá F. 2010. *Handbook of Meat Processing*. Wiley-Blackwell.
- *Selected articles from Journals.*

I. Course Title : Current Trends in Processing of Milk And Milk Products

II. Course Code : LPT 704

III. Credit Hours : 1+1

IV. Why this course?

Human resource development (Manager, Supervisor and other Technocrats) for the milk processing industry

V. Aim of the Course

To impart knowledge about current trends in the processing of milk and milk products and their effect on physico-chemical and nutritional quality of milk, the scope of mechanization in the production of indigenous milk products and advances in the utilization of dairy by-products.

VI. Theory

Unit I (8 Lectures)

Principles and practices of production of quality raw milk - Advances in methods of chilling of milk - Thermal processing of milk – Principles and methods - types of UHT processing plants - Advances in the packaging of milk and milk products

- Rheology of milk products - Preservatives, antioxidants, antibiotics and different toxic residues in milk - Advances in bacteriological and physico-chemical analysis of milk and milk product – Different legal and voluntary standards for milk and milk products - A1 and A2 milk and their significance.

Unit II (4 Lectures)

Bacteriological, physical, chemical and nutritional effects of processing on milk - New concepts in milk processing – radiation, microwave processing and conduction heating of milk – By-products from the dairy industry and their utilization.

Unit III (5 Lectures)

Innovative mechanization in the manufacture of Indigenous dairy products - Advances in the utilization of dairy by-products - preservation of milk products - Application of immobilized enzymes in dairy products – Latest trends in cleaning and sanitation of dairy plant

VII. Practical (17 Classes)

Quality evaluation of milk and milk products - Preparation of novel and indigenous milk products and their economics of production, quality and sensory evaluation - Use of Starter cultures - Maintenance of cultures - Demonstration of membrane processing technology - Preparation of DPR for Dairy plants of different capacities.

VIII. Teaching methods

- Classroom teaching and laboratory analysis.
- Visit the milk processing plant.
- Use of Audio-visual Capsules.

IX. Learning Outcome

Gaining knowledge of advances in the processing of milk and milk products.

X. Suggested Reading

- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia of Dairy Sciences*, 2nd ed. Elsevier Academic Press, UK.
- Herrington BL. 2000. *Milk and Milk Processing*. Green World Publishers.
- Walstra P, Wouters JTM and Geurts, TJ. 2006. *Dairy Science and Technology*, 2nd ed. Taylor and Francis Group.
- *Selected articles from Journals.*

I. Course Title : Biotechnological Techniques and Quality Control of Livestock Products

II. Course Code : LPT 705

III. **Credit Hours : 1+1**

IV. **Why this course?**

Human Resource Development (Manager, Supervisor and other Technocrats) for

V. **Aim of the Course**

To impart knowledge about advances in the application of biotechnological techniques for improving the production and quality of livestock products. To familiarize with the agencies responsible for maintaining the quality of livestock products, quality standards and legislations

VI. **Theory**

Unit I (10 Lectures)

Biotechnological tools for microbial testing of food - Industrial cell culture – Bioreactor types and design – Upstream and downstream processing - Bacterial food additives and supplements - Characteristics and application of microbial starters in milk and meat fermentation - Biotechnology in production of designer livestock products - Bio-production of flavours and colour and their application in dairy products - Enzyme applications in dairy technology. - Utilization of nanotechnology in livestock products - Biotechnology for food safety - Cultured meat - Biotechnology in meat species identification.

Unit II (7 Lectures)

Importance of quality control for livestock products - Concept and application of HACCP - BIS, FSSAI and AGMARK standards - GMP and total quality management in the processing of livestock products - ISO-9000, ISO-14000 and ISO-22000 - Codex regulations of food product safety.

VII. **Practical (17 Classes)**

Demonstration of the latest biotechnological techniques including DNA and protein- based techniques. Operation of bioreactors - Gene identification and characterization. Visit Milk/ Meat processing plants for an understanding of HACCP and other quality management systems.

VIII. **Teaching methods**

- Laboratory analysis.
- Visit of ISO and HACCP certified food processing plant.
- Use of Audio-visual Capsules.

IX. **Learning Outcome**

Gaining knowledge on the application of biotechnology for augmenting production and quality assurance.

X. **Suggested Reading**

- Fuquay JW, Fox PF and McSweeney PLH. 2011. *Encyclopaedia*

of Dairy Sciences, 2nd ed. Elsevier Academic Press, UK.
- Jensen WK, Devine C and Dikeman M. 2004. *Encyclopaedia of Meat Sciences*, Vol. I, II and III, 1st ed. Elsevier Academic Press, UK.
- Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., UK.
- *Selected articles from Journals.*

I. **Course Title : Ethnic and Organic Meat and Milk Products**

II. **Course Code : LPT 706**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Improving the production, processing and marketing of ethnic and organic meat and milk and their products.

V. **Aim of the Course**

To impart knowledge about the production of ethnic and organic meat and milk products.

VI. **Theory**

Unit I (9 Lectures)

Historical developments, present scenario and prospects of ethnic meat and milk products in various parts of India - Ethnic meat products - haleem, biryani, chettinad recipe, pork vindaloo, Kebab, Goan sausages, Kashmiri wazwan and meat products of North Eastern Region (NER) - Ethnic milk products – churpi, kalari, kunda, etc.

- Constraints in promoting ethnic meat products - Approaches for development and commercialization of ethnic meat products - Fermented and non-fermented ethnic milk and meat foods – Impact of Globalization and role of WTO in promoting ethnic meat and milk products from India.

Unit II (5 Lectures)

Entrepreneurship Development for Ethnic meat and milk Products – Formulation, composition, quality, safety and shelf life of ethnic meat and milk products of India

- Geographical indicators for recognition of ethnic meat and milk products.

Unit III (3 Lectures)

Organic meat and milk products - introduction, registration, certification, marketing and scope.

VII. **Practical (17 Classes)**

Preparation of ethnic meat products - haleem, biryani, chettinad recipe, pork vindaloo, Kebab, Goan sausages, Kashmiri wazwan and meat products of NER/ local region, Preparation of Ethnic milk

products – churpi, kalari, Kunda, etc. - Composition, physico-chemical and microbial quality of ethnic milk and meat products - Packaging and marketing of ethnic milk and meat products.

VIII. **Teaching methods**

- Classroom teaching, practical demonstration in the laboratory
- Through the study of reports published by Govt. agencies time to time

IX. **Learning Outcome**

To acquaint with the knowledge for the production of ethnic and organic meat and milk products.

X. **Suggested Reading**

- Books on Indian Food.
- *Selected articles from Journals*

I. **Course Title : Industrial and Entrepreneurial Training**

II. **Course Code : LPT 707**

III. **Credit Hours : 0+2**

IV. **Why this course?**

Human Resource Development for catering to livestock products and related industry.

V. **Aim of the Course**

To prepare students to venture into various start-ups for self-reliant enterprises.

VI. **Practical (34 Classes)**

Preparation of basic feasibility report including raw material availability, marketing potential, economic viability and regulatory requirements for different livestock products related industry. Entrepreneurial training in an industrial establishment related to livestock products (17 sessions/ Hours equivalent to 17 credit hours of practical).Preparation of Detailed project reports (DPR) for the establishment of livestock products enterprises, viz. slaughterhouses, milk and meat processing plants, effluent treatment and byproducts utilization plants, etc..

VII. **Teaching methods**

- Visiting processing units
- Web surfing

VIII. **Learning Outcome**

Students envisioned having adequate knowledge and skills for setting up livestock products enterprises.

IX. **Suggested Reading**

- *Selected articles from Journals.* Through Interaction with Industry personnel.

I. **Course Title : Current Trends in Disposal and Utilization of Waste From Meat and Dairy Industry**

II. **Course Code : LPT 708**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Human Resource Development (Manager, Supervisor, Meat inspector and other Technocrats) for better utilization of animal wastes and effluent treatments.

V. **Aim of the Course**

To impart knowledge about disposal and handling of wastes from the meat and dairy industry, Agencies involved and their norms for pollution control from meat and dairy industries.

VI. **Theory**

Unit I (8 Lectures)

Terminologies used in solid and liquid waste management systems - Public health significance - Classification, composition, functional elements and sources of solid waste from Meat and Dairy Processing plants and their management - Aerobic and anaerobic systems of liquid waste management.

Unit II (9 Lectures)

Waste handling, separation, storage, processing and utilization of Solid waste - Common solid waste disposal methods like rendering, composting, deep burial and incineration - Scope for zero waste management - Properties of dried sludge and its utilisation as manure - Economical aspects of waste treatment and disposal - Utilization of meat and dairy processing wastes - Application of nanotechnology in waste management - State and Central Pollution Control Board norms.

VII. **Practical (17 Classes)**

Visit Sewage and Effluent Treatment Plants - Estimation of pH, dissolved oxygen, TSS, BOD and COD - Estimation of micronutrients in treated effluents - Design and schematic layout of various solid and liquid waste treatment plants.

VIII. **Teaching methods**

- Classroom teaching
- Visit Sewage Treatment Plant

IX. **Learning Outcome**

Gaining knowledge on advances in the utilization of wastes from the meat and dairy industry.

X. **Suggested Reading**

- *Selected articles from Journals.* Through Interaction with personnel of Municipal Corporation and Pollution Control Board.

I. **Course Title : Advances in Egg and Egg Products Technology**

II. **Course Code : LPT 709**

III. **Credit Hours : 1+1**

IV. **Why this course?**

Human Resource Development for Egg Processing Industry and Egg Processing Plants

V. **Aim of the Course**

To impart knowledge about the status of egg production, composition, nutritive value, preservation, grading, processing packaging and marketing of eggs and egg products.

VI. **Theory**

Unit I (5 Lectures)

Advanced preservation techniques for egg and egg products - Maintenance of quality of eggs - Microbiology of egg - Spoilage of eggs and its prevention.

Unit II (8 Lectures)

Preparation of fast foods and role of egg in fast foods chains - Egg breaking and processing plants - lay-out and organization Preservation methods viz pasteurization, desugarization, freezing, dehydration, etc. – process and methods - Quality estimation of egg and egg products - Designer egg and egg products.

Unit III (4 Lectures)

Specifications, Standards and marketing of egg and egg products - Quality control of egg products.

VII. **Practical (17 Classes)**

Evaluation of physical, chemical and functional quality of egg and egg products - Detection of egg rots - Evaluation of microbiological quality of egg and egg products - Preservation techniques of eggs - Preparation of convenient, dehydrated and value- added egg products -Visit a modern egg processing plant

VIII. **Teaching methods**

- Classroom teaching, practical demonstration in the laboratory.
- Visit the egg processing plant.

IX. **Learning Outcome**

Gaining knowledge on composition, nutritive value, preservation and marketing of eggs. Quality maintenance and development of designer egg products.

X. **Suggested Reading**

- Romanoff AL and Romanoff AJ. 1949. *Avian Egg*. John Wiley and Sons.
- Stadelman WL and Cotterill OJ. 2002. *Egg Science and Technology*, 4th ed. CBS.

- *Selected articles from Journal.*

Syllabus for the Preliminary Comprehensive Examination for M.V.Sc. in Livestock Products Technology

Pre-slaughter handling and care of food animals – Ante-mortem inspection - Humane slaughter - Principles and methods of stunning - Ritual methods of the slaughter of food animals and poultry - Post-mortem inspection - Handling, disposal and condemnation of unfit materials.

Abattoir - layout, designing, organization and operation - Maintenance of meat and poultry processing plants. Sanitation of slaughterhouse - Sanitary practices in meat plant and its benefits -Solid and liquid waste management of slaughterhouse - Different methods of effluent treatment

Structure and chemistry of muscle including poultry – Muscle Proteins - sarcoplasmic and myofibrillar proteins, Stromal proteins – Types of muscle fibres - Post mortem changes – Rigor mortis - Conversion of Muscle to meat - Pre and post-slaughter factors affecting meat quality – Defects during the conversion of muscle to meat – PSE/ DFD/ Cold Shortening – Off odour development, Composition and nutritive value of meat and poultry - Qualities of fresh meat – pH, WHC, colour, odour, juiciness, texture/ tenderness and firmness - Chilling, ageing and conditioning of meat - Electrical stimulation - Carcass evaluation, grading and fabrication- Tenderization of meat.

Basic principles of meat preservation – dehydration, chilling, freezing, freeze-drying, thermal processing, direct microbial inhibition, irradiation, use of chemicals and antimicrobials - Curing and smoking - Hurdle technology concept.

Principles of Meat Processing - Meat and non-meat ingredients and their roles - Additives - Processing techniques - comminution, chopping, blending, marination, massaging, tumbling, etc. - Cooking methods including microwaving Emulsion formation – factors affecting emulsion formation - Emulsion based meat products - sausages, nuggets and patties - Enrobed, restructured, fermented and intermediate moisture meat products – Ready-to-cook, ready-to-eat and shelf-stable meat products – Canned products.

Sensory evaluation , methods, quality attributes – Factors influencing sensory measurements - Types of sensory panels - Selection of sensory panellists- Sensory evaluation tests

Basic concepts of dairy plant organization and operation - collection, Platform tests, chilling, transportation - Heat treatments of Milk - Cleaning and sanitization of Dairy plants - Composition, nutritional, physico-chemical and functional properties of milk - Standards for milk and milk products, Manufacture of milk products - Flavoured Milk - Drying of milk and milk products - Evaporated and condensed milk - Milk powders – Butter - Ice cream and other frozen desserts - Manufacture of different fermented milk products – Manufacture of cheddar, mozzarella, cottage and processed cheese, Manufacture of indigenous milk products – paneer, channa, khoa, ghee, dahi and shrikhand - Rheology of milk products - Dairy by-products.

Principles of packaging - objectives and functions - Product characteristics

affecting packaging requirements - Packaging materials and their characteristics – Different packaging systems for fresh, cured, dehydrated, freeze-dried and shelf-stable products of milk, meat and chicken - Aseptic packaging of milk - UHT milk - Vacuum packaging – MAP and role of different gases - Retort pouch processing - Active and intelligent/ smart (biosensors) packaging - Edible and biodegradable packaging, Marketing of Livestock Products - Types of markets - Marketing channels of live meat animals and Poultry - Existing systems - constraints and possible solutions -Meat retailing and establishment of retail outlets for meat and poultry - FSSAI, APEDA, EIA, GOI/ WTO regulations for the domestic market, import and export of livestock products.

Microorganisms associated with spoilage of livestock products - Factors affecting microbial growth - Contamination of livestock products - Microbial spoilage of meat, poultry, eggs, milk and their products - Physical and chemical changes produced by microbes in milk, meat, eggs and their products - Meat and milk-borne infections and intoxications, Quality Control – Quality Assurance - principles and practices - Quality Management Systems – Food Safety and Standards Act (FSSAI, 2006 Act) - Codex regulation for food products safety - ISO 9001 - ISO 22000 - HACCP concepts - Risk-based quality assessment - Microbial quality control - FSSAI/ BIS standards for milk, meat and poultry.

Planning, design and layout of by-products plant - Classification of by-products - edible and inedible - Rendering methods and products - Yield and characteristics of rendered fat and meat cum bone meal, Utilization of blood, horns and hooves, intestine, bones, feathers, bristles, glandular by-products and ruminal contents - Value-added by-products from slaughterhouse and poultry processing plants, Flaying - Classification and factors affecting the quality of hides and skin – Physical and chemical characteristics of hide and skin - Grading and processing of hide and skin for the manufacture of leather - Preparation and quality control of gelatine and glue.

Structure, composition, nutritive value and functional properties of eggs - Grading, preservation, packaging and marketing of shell eggs - Quality evaluation of shell eggs and factors influencing egg quality - Defects and Spoilage of eggs, Principles and procedures involved in pasteurization, chilling, freezing, desugarization and drying of egg products – Quality standards of egg products - Packaging of egg products

Operation of automatic milk collection stations - Reception of milk at Raw Milk Reception Dock (RMRD) - Assessing raw milk quality - Sanitary handling of milk - Milk standards and legislations, Unit operations in milk processing plants - Clarification – Bactofugation – Different chilling methods - Standardization - Homogenization (theories, methods and effects) - Heat treatments (thermization, boiling, pasteurization, sterilization (UHT and In-container) - Separation technologies (Microfiltration, Ultrafiltration, reverse osmosis, diafiltration, nanofiltration etc), Distribution methods for liquid milk - Consumer pricing - Traceability – Handling of unsold and returned milk- - Adulteration of milk and

detection - Residues in milk and preventive steps

Wool types and their uses - Growth and molecular structure of wool fibre - physical and chemical properties of wool - Grading of wool, Characteristics of speciality hair fibres and their uses- factors influencing the quality of wool and speciality hair fibres - principles and steps involved in the processing of wool and speciality hair fibres, Impurities in wool and their removal, Defects in wool, Physical, chemical and mechanical testing of wool

Fish Muscle structure, composition and nutritive value – Processing of fish - gutting, filleting, beheading, peeling, deveining, etc. - Preservation - chilling, freezing, etc. - Principles and procedure of canning, curing, smoking, dehydration - Surimi and other Fish based products, Quality control- identification of freshness of fish - Chemical and Microbial spoilage of fish.

Dairy Technology

DEPARTMENT OF DAIRY TECHNOLOGY
Semester-wise M. Tech. Courses

Course Code	Course Title	Credit Hours	Semester
DT-511*	ADVANCES IN DAIRY PROCESSING	3+1	I
DT-512	ADVANCES IN FOOD PROCESSING	3+1	I
DT-513*	RHEOLOGY OF DAIRY AND FOOD PRODUCTS	2+1	I
DT-514	BIOTECHNOLOGY FOR DAIRY APPLICATIONS	2+1	I
DT-515*	ADVANCES IN TRADITIONAL INDIAN DAIRY PRODUCTS	2+1	I
DT-516	NON-CONVENTIONAL PROCESSES FOR DAIRY AND FOOD INDUSTRY	2+1	I
DT-521*	MEMBRANE PROCESSING FOR DAIRY APPLICATIONS	2+1	II
DT-522*	ADVANCES IN DAIRY AND FOOD PACKAGING	2+1	II
DT-523	TECHNOLOGY OF FOOD EMULSIONS, FOAMS AND GELS	2+1	II
DT-524*	FUNCTIONAL FOODS AND NUTRACEUTICALS	3+1	II
DT-525	PRODUCTION AND APPLICATIONS OF DAIRY INGREDIENTS	2+1	II
DT-526	ADVANCES IN CHEESE TECHNOLOGY	2+1	II
DT-591	MASTER'S SEMINAR	1+0	I and II
DT-599	MASTER'S RESEARCH	0+30	I and II
***compulsory courses**			

DEPARTMENT OF DAIRY TECHNOLOGY
Semester-wise Ph.D. Courses

Course Code	Course Title	Credit Hours	Semester
DT 611*	ADVANCES IN LIPID TECHNOLOGY	3+0	I
DT 612*	ADVANCES IN PROTEIN TECHNOLOGY	3+0	I
DT 621*	PRODUCT MONITORING AND PROCESS CONTROL	3+0	II
DT 622*	R AND D MANAGEMENT IN DAIRY INDUSTRY	3+0	II
DT 623	ADVANCES IN CARBOHYDRATES TECHNOLOGY	3+0	I
DT 691	DOCTORAL SEMINAR-I	1+0	I and II
DT 692	DOCTORAL SEMINAR-II	1+0	I and II
DT 699	DOCTORAL RESEARCH	0+75	I and II
***compulsory courses**			

Course Contents
M. Tech. in Dairy Technology

I. **Course Title : Advances in Dairy Processing**
II. **Course Code : DT 511**
III. **Credit Hours : 3+1**
IV. **Why this course?**

The basic principles of dairy processing have been understood at undergraduate level. Any dairy plant has to be abreast with the latest developments taking place in the arena of dairy processing, dairy product preservation, quality assurance and public health safety, automation, mechanization, etc. Knowledge of such aspects will help in controlling milk solids losses, aid in process optimization and help in catering to quality dairy products to the consumers.

V. **Aim of the course**

To provide in-depth knowledge about the various unit operations and basic concepts in dairy processing

VI. **Theory**

Unit I

Use of bio-protective factors for preservation of raw milk: effects on physico-chemical, micro-bial and nutritional properties of milk and milk products; Present status of preservation of raw milk.

Unit II

Methods of determining lethality of thermal processing; UHT processed milk products, their properties and prospects, types of UHT plants, aseptic fillers, heat stability and deposit formation aspects, effect on milk quality; techno-economic considerations; Nutritional aspects of UHT treated milk vis-à-vis retort sterilized/ HTST treated milk.

Unit III

Principles and equipment for bactofugation and bactotherm processes; Partial homogenization and its application in dairy industry, Low pressure homogenization; Microfluidization of milk: Principle, equipment, effects and applications.

Unit IV

Concentration processes and their impact on quality of finished products; Dehydration: advances in drying of milk and milk products; Freeze dehydration: physico-chemical changes and in-dustrial developments; Glass Transition Temperature and its relevance to dried milks.

Unit V

Water activity; Sorption behaviour of foods, energy of binding water,

control of water activity of different milk products in relation to their chemical, microbiologi-cal and textural properties; Hurdle technology and its application in development of shelf-stable and intermediate-moisture foods; Use of carbonation in extending the shelf life of dairy products.

Unit VI

Current trends in cleaning and sanitization of dairy equipment; Automation, Ultrasonic techniques in cleaning; Bio-films; Bio-detergents, innovations in sanitizers - chemical, radiation; Mechanism of fouling and soil removal; Assessing the effectiveness of cleaning and sanitization of dairy equipment, Water conservation methods.

VII. Practical

- Measurement of thiocyanate in milk system
- LP system for extending the keeping quality of raw milk
- Determination of HCT-pH profile of milk
- Determination of water activity and sorption isotherms of milk products
- Determination of WPNI of milk powders
- Functional properties of milk powders
- Determination of HMF content in dried milks
- Freeze drying of milk and milk products
- Homogenization efficiency
- Cleaning and sanitization efficiency of dairy equipment
- Visit to a UHT Processing plant.

VIII. Teaching Methods/Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work and Group Discussion
- Visit to various dairy plants

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge to ensure delivery of safe and quality product from the dairy plant to the consumers
- To process the milk and dairy products in such a manner that losses of milk solids are minimal
- Be able to suggest to the dairy plant personnel, the latest type of tools that can be harnessed to produce quality products, without impairing the nutritive value of milk
- To suggest the dairy industry personnel regarding the formulation

of detergent and/or acid and sanitizers which would help in efficient cleaning and sanitization of dairy equipment?

x. Suggested Reading

- Barbosa-CA, GV, Fontana Jr, AJ, Schmidt SJ, and Labuza TP. (Eds.). 2008. *Water Activity in Foods: Fundamentals and Applications* (Vol. 13). John Wiley and Sons.
- Britz T and Robinson RK. (Eds.). 2008. *Advanced Dairy Science and Technology.* John Wiley and Sons.
- Chandan RC and Kilara A. 2015. Dairy-based Ingredients. In: *Dairy Processing and Quality Assurance.* (2nd Edn.). Wiley-Blackwell.
- Chandan RC, Kilara A and Shah NP. (Eds.). 2015. *Dairy Processing and quality Assurance*. 2nd Edn, Wiley-Blackwell, pp. 1-696.
- Dekker M. *Benefits and potential risks of the lacto-peroxide system of raw milk preservation*. www.fao.org/docrep/fao/009/a0729e/a0729e00.htm
- Figura L and Teixeira AA. 2007. *Food physics: Physical properties-measurement and applications.* Springer Science and Business Media.
- Goyal MR, Kumar A and Gupta AK. (Eds.). 2018. *Novel Dairy Processing Technologies: Techniques, Management, and Energy Conservation*. CRC Press.
- Heldman DR. 2011. *Food preservation process design.* Academic Press.
- Hotchkiss JH, Werner BG and Lee EY. 2006. Addition of carbon dioxide to dairy products to improve quality: a comprehensive review. *Comprehensive Reviews in Food Science and Food Safety*, **5**(4), 158-168.
- Koca N. (Ed.). 2018. *Technological Approaches for Novel Applications in Dairy Processing*. InTechOpen.
- Leistner L and Gould GW. 2002. The hurdle concept. In: *Hurdle Technolo*gies, pp. 17-28, Boston, MA: Springer.
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- Nicoli MC. 2016. *Shelf life assessment of food*. CRC Press.
- Rahman MS. 2015. Hurdle technology in food preservation. In *Minimally processed foods*, pp. 17-33. Springer, Cham.
- Subramaniam P and Wareing P. (Eds.). 2016. *The stability and shelf life of food*. Woodhead Publishing.
- TetraPak Dairy Processing Handbook. 2015.

www.dairypeocessinghandbook.com

- Thompkinson DK and Sabikhi L. 2012. *Quality milk production and processing technology*. New India Publishing Agency.

Websites

- GEA Dairy Processing Industry-https://gea.com/en/applications/dairy-processing/index.jsp
- IndiaDairy.com-https://indiaDairy.com
- Scherjon Dairy Equipment Holland: Dairy processing equipment-https://scherjon.eu/
- National Dairy Council-https:/nationaldairycouncil.org/
- Alfa Laval – Dairy Processing-https://alfalaval.in/industries/food-dairy-and-beverage/dairy- processing/

I. **Course Title : Advances in Food Processing**

II. **Course Code : DT 512**

III. **Credit Hours : 3+1**

IV. **Why this course?**

The basic principles of food processing, including dairy processing has been understood at undergraduate level. Any food plant has to be abreast with the latest developments taking place in the sphere of food processing, food product preservation, quality assurance and public health safety, automation, mechanization, etc. Information on composite foods may give an idea about foods formed using amalgamation of dairy foods with other food materials and ingredients. Knowledge of such aspects will help in developing value-added food products, cater to functional (health promoting) foods, adopting non-thermal processing methods to obtain food products having freshness and preserved nutrients and colour, etc.

To provide in-depth understanding of advances in theoretical and practical aspects of food processing keeping in mind the nutritive value of product and its perishability

VI. **Theory**

Unit I

Status of food processing industry in India and abroad; Prospects and constraints in development of Indian food industry.

Unit II

Development in Post-harvest management of Fruits and Vegetables (Controlled and Modified Atmospheric Storage, Designing aspects of CAS/MAS, Components of CAS/MAS), hypobaric storage, harvesting indices for fruits and vegetables.

Unit III

Newer methods of drying of foods (Super-heated steam drying,

Freeze drying, infra-red drying and microwave drying; Osmodrying process), Concepts of UHT and retort sterilization of food products, packaging materials for thermally processed foods.

Unit IV

Basic principles involved in fermentation, Technological aspects of pickled vegetables like sauerkraut, cucumbers, Technology of wine, beer and distilled alcoholic beverages, defects in alcoholic beverages.

Unit V

Advances in milling of rice (solvent extractive milling) and Turbo milling of wheat. Emerging concepts in cereal processing including gluten free products, Low calories bakery products, Technologies for breakfast cereals, Utilization and importance of dairy ingredients in bakery products.

Unit VI

Definition, classification and technologies of fabricated and formulated foods and their nutritional aspects. Imitation dairy products and dairy analogues; meat analogues. Principle of extrusion processing, design and working of extruder, classification, application in food and dairy processing. Food additives, including stabilizers, emulsifiers, Fortification of staples.

Unit VII

Antioxidants, preservatives, etc. for formulated foods.

Non-thermal processing technologies for food: Principles, Effect on food constituents and Salient application in food sector/industry.

Unit VIII

Enzymes in food processing; newer concepts in food processing including organic foods; Processing of organic raw material; Genetically modified foods; Space foods, Nutrigenomics, metabolomics and other Omics concepts in food processing.

VII. Practical

- Experiments on MAS of fruits and vegetables
- Application of microwave for blanching and drying of foods
- Osmoair drying of fruits and vegetables
- Retort processing of food products
- Application of milk ingredients in caramel, egg-less cake, mayonnaise
- Enzymatic extraction and clarification of fruit juices
- Preparation of soymilk and tofu, Manufacture of sauerkraut/ fermented vegetables
- Preparation of protein isolates
- Application of extrusion processing for breakfast cereal and meat analogue manufacture

- Application of hydrocolloids in stabilization of proteins in acidified beverages
- Manufacture of low calorie and gluten-free cereal products.

VIII. Teaching Methods/Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work and Group Discussion
- Visit to various food plants

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the latest post-harvest management of fresh produce with limited shelf life
- To have an idea about the processing methods that do not diminish the quality attributes of food being processed
- To know about the recent packaging methodologies that can enhance the shelf life of fresh as well as processed produce/food.
- To have any idea about the enzymes that can be used as processing aids.

X. Suggested Reading

- Corredig M. 2009. *Dairy Derived ingredients: Foods and Nutraceutical Uses*. Washington DC: CRC press.
- Eskin Michael NA and Shahidi F. 2013. *Biochemistry of Foods*. 3rd Edn, Elsevier Publication.
- Fellows PJ. 2000. *Food Processing Technology: Principles and Practices*. 2nd Edn, CRC Press, London: Woodhead Publishing Ltd.
- Fennema CR. 1975. *Principles of Food Science.* Part-II: Physical principles of Food preservation. New York: Marcel Dekker.
- Guy R. 2001. *Extrusion cooking: Technologies and Applications*. England: CRC-Woodhead Publishing Ltd.
- Honseney RC. 1986. *Cereal Science and Technology.* American Association of Cereal Chemists, Minnesota.
- Hui YH, Meunix-Goddick L, Hansen AS, Josephsen J, Nip W-K, Stanfield PS and Toldra F. 2004. *Handbook of Food and Beverage Fermentation*. New York: Marcel Decker.
- Hui YH, Nip WK, Rogers RW and Young DA. 2001. *Meat Science and Application.* New York: Marcel Decker.
- Muthukumarappan K and Knoerzer K. 2020. *Innovations in Food*

Processing Technologies: A comprehensive review, 1st ed., Elsevier.
- Penfield MP, and Campbell AM. 1990. *Experimental Food Science*. 3rd Edn. New York: Academic Press.
- Ramaswamy H and Marcotte M. 2006. *Food Processing: Principles and Applications*. USA: Taylor and Francis Group.
- Wrigley CW and Batey IL. 2010. *Cereal Grains: Assessing and Managing Quality.* Washington DC: CRC Press.
- Ministry of Food Processing Industry-https://india.gov.in/official-website-ministry-food- processing-industries-0
- Indian Food Industry, Food Processing Industry in India, Statistics-https://ibef.org › Industry
- *Food Processing – Make in India*-https://makeinindia.com/sector/food-processing
- *Welcome to APEDA*-https//*apeda.gov.in/*
- *Food safety and quality: Chemical risks and JECFA-FAO-https//fao.org/food/food-safety- quality/scientific-advice/jecfa/en/*
- HACCP and GHP: Standards in Food Industry: (EUFIC)-https://eufic.org/en/food-safety/ article/food-industry-standards-focus-on-haccp.

I. **Course Title: Rheology of Dairy and Food Products**

II. **Course Code : DT 513**

III. **Credit Hours : 2+1**

IV. **Why this course?**

The mouth feel of processed food product is one of the parameters for the acceptance of foods. The sensory textural quality of food is closely related to the rheology of that pertinent food product. Any technological treatment meted out to dairy/food product leads to change in its rheological characteristics. Such treatment can be specifically practiced to improve the textural quality of food product. Rheology can be used as a quality control tool to monitor the quality of food product being processed or manufactured.

V. **Aim of the course**

To explain the basics of food rheology, and to familiarize the students with rheological instruments and their use in relation to dairy and food products

VI. **Theory**

Unit I

Introduction to rheology of foods: Definition of texture, rheology and psychophysics – their structural basis; Physical considerations in study of foods; Salient definitions of stress tensor and different kinds of stresses.

Unit II

Rheological classification of Fluid Foods: Shear-rate dependence and time dependence of the flow-curve; Non-Newtonian fluids; Mechanisms and relevant models for non-Newtonian flow; Effect of temperature on rheology; Compositional factors affecting flow behaviour; Viscosity of food dispersions: dilute and semi- dilute systems, concentration effects.

Unit III

Viscometers; Types (Co-axial cylinders, Spindle or Impeller type, Cone-plate, Capillary, Falling sphere, Vibratory, Extrusion, and Orifice), comparative assessment, merits and limitations; Rheometer: principles and operational features.

Unit IV

Rheological characterization of semi-solid and solid foods; Mechanical models for viscoelastic foods (Maxwell, Kelvin, Burgers and generalized models) and their application; Dynamic measurement of viscoelasticity. Large Deformations and failure in foods: Definitions of fracture, rupture and other related phenomena; Texture Profile Analysis; Instrumental measurements: Empirical and fundamental methods; Rheometers and Texture Analyzers; Measurement of extensional viscosity; Acoustic measurements on crunchy foods.

Unit VI

Rheological and textural properties of selected dairy products; Measurement modes and techniques; Effect of processing and additives (stabilizers and emulsifiers) on food product rheology; Relationship between instrumental and sensory data; Microstructure of dairy products; Tribology and its applications.

VII. Practical

- Study of different types of viscometers.
- Flow behaviour of fluid dairy products.
- Thixotropy in ice-cream mix.
- Force-deformation study in selected dairy products using Texture Analyzer.
- Effect of test conditions on the texture profile parameters of dairy products.
- Stress relaxation studies in solid foods.
- Use of Cone Pen-etrometer and FIRA-NIRD extruder for measurement of buttertexture.
- Assessment of pasting profile of starch/flours using viscoanalysers.
- Oscillatory measurements using Rheometer.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Classify food products based on their rheological characteristics
- Understand the relationship between instrumental rheology and sensory perception of food
- To recommend use of textural analysis of dairy and food product for its quality control aspect
- To recommend specific type of instrument for textural analysis of specific type of food (fluid or solid)

IX. Suggested Reading

- Ahmed J, Ptaszek P and Basu S. (Eds.). 2016. *Advances in Food Rheology and its Applications.* Amsterdam: Woodhead Publishing.
- Barnes HA, Hutton JF and Walters K. 1989. *An introduction to rheology.* Elsevier Pub.
- Bourne M 2002. *Food texture and viscosity: Concept and Measurement*. London: Elsevier Pub.
- Irgens F. 2014. *Rheology and Non-Newtonian Fluids*. New York: Springer International Publishing.
- Malkin AY and Isayev AI. 2017. *Rheology: Concepts, methods, and applications*. Toronto: ChemTec Publishing.
- Mezger TG. 2006. *The Rheology Handbook: For Users of Rotational and Oscillatory Rheometers.* Hannover: Vincentz Network GmbH and Co KG.
- Mohsenin NN. 1970. Physical properties of plant and animal materials. Vol. 1. Structure, physical characteristics and mechanical properties. New York: Gordon and Breach Science Publishers.
- Norton IT, Spyropoulos F and Cox P. (Eds.). 2010. *Practical Food Rheology: An Interpretive Approach*. John Wiley and Sons. New York: Springer Science and Business Media.
- Sherman P. 1979. *Food texture and rheology*. London: Academic press.

Websites

- Texture in Food Production – Food Technology Corporation- https://www.foodtechcorp.com/texture-food-production
- Universal testing/Tensile testing machine: SCHIMADZU- https//shimadzu.com/an/test/universal/index.html
- Texture Analysis System and Software – Food Online- https://foodonline.com/doc/texture-analysis-system-and-software-0001

I. **Course Title : Biotechnology for Dairy Applications**

II. **Course Code : DT-514**

III. **Credit Hours : 2+1**

IV. **Why this course?**

Biotechnology is a tool for the value addition to dairy foods. Genetic techniques have been employed to manipulate bacteria that have significance to the dairy industry. Biotechnological means can be used to regulate the production of flavour enhancing metabolites and to develop starter cultures that are resistant to bacteriophage and bacteriocins. Genetic engineering will be able to deliver dairy foods that can be tolerated by lactose intolerant persons or for persons who are allergic to milk proteins too.

V. **Aim of the course**

To project the importance of biotechnology in dairy processing and imparts knowledge on all aspects of dairy process biotechnology in production and preservation of dairy products employing the principles of biotechnology.

VI. **Theory**

Unit I

Introduction to process biotechnology; Principles of recombinant DNA technique; Development and impact of biotechnology on dairy and food industry.

Unit II

Microbial rennet and recombinant chymosin - characteristics and application**s** in cheese making; exogenous free and microencapsulated enzymes. Immobilized enzymes - their application in continuous coagulation of milk in cheese making; Enzyme modified cheeses (EMC) - their utilization in various food formulations.

Unit III

Technological requirements of modified micro-organisms for applications in cheese, Probiotic and fermented milk products; physiologically active bio-peptides/nutraceuticals.

Unit IV

Protein hydrolysates - production, physico-chemical, therapeutic properties and application in food formulations; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages; Continuous lactose hydrolysis of whey.

Microbial polysaccharides - their properties and applications in foods; Production of alcoholic beverages; Bio-sweeteners - Types, properties and their applications in dairy and food industry.

Unit VI

Bio-preservatives - characteristics and their applications in enhancing the shelf life of dairy and food products.

VII. **Practical**

- Effect of exogenous enzymes on hydrolysis of protein and fat in culture containing milk sys-tems
- Factors affecting the coagulation of milk by microbial and vegetable rennets
- Manu-facture and evaluation of probiotic cheese and fermented milks
- Preparation of Enzyme Modified Cheese
- Determination of glycolysis, proteolysis and lipolysis in cheese and fermented milks
- Enzymatic process for manufacture of low lactose milk/whey products
- Preparation of casein hydrolysates
- Visit to a bio-processing unit.

VIII. **Learning outcome**

After undergoing this course, the students are expected to deliver the following:

- To have any idea about the enzymes that can be used as processing aids.
- Have knowledge on the latest biotechnological approaches to add value to the dairy product
- Ability to produce protein hydrolysates
- Application of biotechnology for bio-preservation of dairy foods

IX. **Suggested Reading**

- Aluko RE. (Ed.). 2012. *Functional Foods and Nutraceuticals*. Springer.
- Bhat R, Alias AK and Paliyath G. 2012. *Progress in Food Preservation*. John Wiley and Sons Ltd. (Print ISBN: 9780470655856. Online ISBN: 9781119962045) DOI: 10.1002/ 9781119962045.
- Coffey AG, Daly C and Fitzgerald G. 1994. The impact of biotechnology on the dairy industry. Biotechnology Advances, 12(4): 625-633. Elsevier Pub. doi.org/10.1016/0734-9750(94)90003-5

I. **Course Title : Advances in Traditional Indian Dairy Products**

II. **Course Code : DT 515**

III. **Credit Hours : 2+1**

IV. **Why this course?**

Traditional Indian dairy products (TIDP) especially the

sweetmeats have its own significance in Indian diet and have tremendous export potential. The application of strict hygiene in manufacture of such TIDPs is the need of the day and its technology up gradation (especially mechanization and automation) from research level to industry level needs to be harnessed. Even there is an urgent need to have knowledge about the 'Techno-economic aspects for establishing commercial units for traditional dairy products'. Enhancement in the shelf life of TIDPs has been still a challenging task in the dairy industry.

To project the present status, modernization and globalization of production of traditional Indian dairy products with a focus on process innovation, shelf life, quality and functionality enhancement.

VI. Theory

Unit I

Global prospects and export potential of traditional Indian dairy products.

Unit II

Differences in quality of traditional dairy products from cow, buffalo, goat, camel, and sheep milks; Process innovations in commercial production of heat-desiccated, coagulated and fermented traditional dairy products; Mechanized production of traditional milk based sweets; Automation for manufacture of ghee, *paneer*, *dahi*, *lassi*and traditional sweetmeats.

Unit III

Composite traditional milk products; Application of membrane technology and microwave processing for industrial production of traditional Indian dairy products.

Unit IV

Technologies for region specific traditional Indian dairy products and their value addition, their application as a vehicle for delivering functional ingredients; Manufacture of dietetic traditional dairy products.

Unit V

Techno-economic aspects for establishing commercial units for traditional products.

Unit VI

Convenience traditional dairy products; Food safety issues; Shelf life extension of food using newer techniques; Novel packaging and preservatives.

VII. Practical

- Production of reduced calorie, composite and functional

traditional Indian dairy products.

- Microwave heating of traditional Indigenous milk delicacies for shelf life extension.
- Membrane technology for improving the quality of traditional Indigenous products made from cow and buffalo milk.
- Preparation of feasibility report for establishing commercial units for traditional dairy products.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Have an idea about the global prosper and export potential of TIDPs.
- Be an entrepreneur in delivering mechanized production of certain TIDPs including automation, wherever feasible.
- Be able to recommend the methods to enhance the shelf life of perishable TIDPs and recommend the type of packaging technology to be used for safety and shelf life extension.

IX. Suggested Reading

- Aneja RP, Mathur BN, Chandan RC and Banerjee AK. 2002. *Technology of Indian dairy products.* A Dairy India Publication.
- Goyal MR, Kumar A and Gupta AK. 2018. *Novel Dairy Processing Technologies: Techniques, Management, and Energy Conservation*. CRC Press.
- Puniya AK. 2015. *Fermented Milk and Dairy Products;* CRC Press/Taylor and Francis (ISBN 9781466577978)
- Shrott C and O'Brien. 2003. *Handbook of Functional Dairy Products*. CRC Press
- *TetraPak Dairy Processing Handbook.* 2015. www.dairypeocessinghandbook.com.

Websites

- Indian Dairy Product Market–Indian Council of Food and Agriculture– https//icfa.org.in/assets/doc/reports/Indian_Dairy_Product_Market.pdf
- Mechanized production of Indian Dairy Products–AMEFT– https//download.ameft.com/MechanisedProduction.pdf
- Indian Dairy Industry–Aavin – https//aavinmilk.com/dairyprofile.html
- Present Status of Traditional Dairy Products–Technische–TIB– https://www.tib.eu/en/search/id/./Present-Status-of-Traditional-Dairy-Products/

I. **Course Title : Non-Conventional Processes for Dairy and Food Industry**

II. **Course Code : DT 516**

III. **Credit Hours : 2+1**

IV. **Why this course?**

Unravelling the truths based on the knowledge of 'science and technology' has paved the way for development of several non-conventional technologies. These when used judiciously can have advantage in minimizing the changes in the colour, nutritive value and textural quality of dairy and food products. Certain non-conventional processes may be used as adjunct to the conventional processing technology to reap the benefits from use of such synergistic effects.

V. **Aim of the course**

To develop an understanding of the basic principles underlying the novel/non- conventional food processing techniques, equipment required, features and actual and potential applications

VI. **Theory**

Unit I

Irradiation: sources and properties of ionizing radiation; Mechanism of interaction with microorganisms and food components; Chemi-cal effects; Industrial irradiation systems, benefits and limitations; UV pasteurization of milk; Safety aspects in radiation processing; National and international regulations in relation to radiation processing; Cold plasma processing.

Unit II

High frequency heating (Microwave and Radio frequency processing): Principles, merits and demerits; Design and working of processing units; Applications in dairy and food processing; Microwavable packaging; Safety aspects.

Unit III

Infra-red (IR) heating and Ohmic heating: Principle, equipment and applications.

Unit IV

Ultrasonic treatment of food: Mechanism of ultrasound induced cell damage,

generation of ultrasound, design of power ultrasonic system, types of ultrasonic reactors, application of power ultrasound in food processing, effects on food constituents, ultrasound in amalgamation with other food processing operations – thermo-sonication, manosonication, thermo-manosonication, advantages and future prospects.

Unit V

High hydrostatic pressure (HHP) processing: Principle of microbial inactivation, barotolerance of microorganisms, effect on food constituents; equipment; dairy and food applications; Merits and demerits of HHP.

Unit VI

Pulsed electric field processing; Description/ mechanism and factors affecting microbial inactivation; effects on food components; Present status and future scope for food applications.

Unit VII

Super-critical Fluid Extraction; Principle, instrumentation and applications.

VII. Practical

- Market survey of food products processed using non-conventional technologies
- Pasteurization and concentration of milk using ohmic heating
- Degassing of fluids using ultrasound
- Determination of power output and temperature profile of a microwave oven
- Effect of chemical composition on heating behaviour of milk and milk products
- Microwave pasteurization of milk
- Effect of shape and size of container on microwave heating
- Preparation of 'instant' products in a microwave oven
- Visit to a commercial food processing facility.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To recommend use of feasible non-conventional technology for processing and shelf life extension of food
- Application of non-conventional processing technology as adjunct processing for accomplishing hurdle technology for dairy and food products
- To visualize the difference in the physico-chemical properties and microbial changes in dairy/food product when adopting traditional vs. non-conventional technology

IX. Suggested Reading

- Chen D, Sharma SK and Mudhoo A. 2012. *Handbook on applications of ultrasound- sonochemistry for sustainability*. Boca Raton: Taylor and Francis Group, LLC, 273-739.
- Delgado A, Kulisiewicz L, Rauh C and Wiersche A. 2012. *Novel thermal and non-thermal technologies for fluid foods.* New York: Academic Press.

- Monika Willert-Porada. 2001. Advances in Microwave and Radio Frequency Processing. Report from the 8th International Conference on 'Microwave and high frequency heating' held in Bayreuth, Germany, 2001.
- Nanda V and Sharma S. 2017. *Novel food processing technologies.* New India Publishing Agency, New Delhi, India.
- Raso J and Heinz V. 2006. *Pulsed electric fields technology for the food industry fundamentals and applications*. Springer Science + Business Media, LLC, USA.

  JT. (Eds.). 2011. *Non-thermal processing technologies for food* (Vol. 45). John Wiley and Sons.

Websites

- Microwave-assisted green extraction technology for sustainable food processing-https:// intechopen.com/books/emerging-microwave-technologies-in-industrial-agricultural-medical- and-food-processing/microwave-assisted-green-extraction-technology-for-sustainable-food- processing
- Ultrasound in the food industry– https://hielscher.com/food_01.htm; Microwave assisted extraction (MAE)-https://slideshare.net/Nabiilah/microwave-assisted-extraction

I. Course Title : Membrane Processing for Dairy Applications

II. Course Code : DT 521

III. Credit Hours : 2+1

IV. Why this course?

Amongst non-thermal processes for dairy applications, membrane processing is one of the significant illustrations. Membrane processing has helped the dairy industry, not only to obtain dairy ingredients with high protein and low lactose content, but even to recover the important whey proteins from the by-product – whey. Salient application of use of membrane processed milk concentrate is in cheese making and in concentrated and dried milk manufacture.

V. Aim of the course

To elucidate the basics of membrane technology and its applications in dairy processing

VI. Theory

Unit I

Membrane techniques; Classification and characteristics of filtration pro-cesses; types of commercially available membranes; membrane hardware, design of membrane plants, modelling of ultrafiltration (UF) processes, mass transfer model, resistance model;

Membrane fouling-problems and mitigation strategies; Cleaning and sanitization of different types of membranes.

Unit II

Factors affecting permeate flux during ultrafiltration and reverse osmo-sis of milk and sweet/sour whey, energy requirements for membrane processing of milk and whey.

Unit III

Applications of ultrafiltration (UF), reverse osmosis, nanofiltration and microfiltration in the dairy industry: food and pharmaceutical grade lactose, low lactose milk powder, dairy whiteners, WPC, WPI, MPC, MPI, Native micellar casein powder, etc. Preparation, properties and uses of Milk Protein Concentrate (MPC) and Milk Protein Isolate (MPI); Manufacture of some cheeses and fermented milk products and impact of membrane processing on quality of such products. Use of membrane processing techniques for separating prophylactic biological from milk.

Unit IV

Demineralization: principles, processes, equipment and applications.

Functional properties of whey proteins (WPC and WPI), micellar casein and UF milk retentate and their modifications.

VII. Practical

- Factors affecting permeate flux during membrane processing (type of feed, temperature, transmembrane pressure, etc.)
- Effect of microfiltration of skim milk and whey on fat content and microbial count
- Preparation of WPC, WPI, MPC, native micellar casein, etc.
- Evaluating the functional properties of milk proteins.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To recommend use of membrane processed milk in manufacture of selected dairy products
- Application of specific membrane processes for milk/whey to prepare certain prophylactic biological
- To recommend the suitable cleaning and sanitization agents to take care of cleaning and sanitization of specific type of membrane used in membrane processing of milk.

IX. Suggested Reading

- Baker RW. (Ed.) 2012. *Membrane Technology and Applications*, 3rd Edn,Wiley Publishers.
- Cooper A.R. (Ed.) 2013. *Ultrafiltration Membranes and Applications* (Vol. 13). Springer Science and Business Media.

- Field RW, Bekassy-Molnar E, Lipnizki F and Vatai G. 2017. *Engineering Aspects of Membrane Separation and Application in Food Processing*. CRC Press.
- Fuquay JW, Fox PF and Mc Sweeney PL. 2011. *Encyclopedia of Dairy Sciences.* Academic Press.
- Hu K and Dickson J. (Eds.). 2015. *Membrane Processing for Dairy Ingredient Separation.* John Wiley and Sons.
- Mohanty K and Purkait M. 2011. *Membrane Technologies and Applications*. CRC Press, Taylor and Francis Group.
- Tamime AY. (Ed.). 2013. *Membrane processing: Dairy and beverage applications.* Wiley- Blackwell Publishers, pp. 1-370.

Websites

- Membrane technology in Dairy Industry – Slideshare- https://slideshare.net/./membrane- technology-in-dairy-industry
- Specialty and Dairy – Products – Toray Membrane- https://toraywater.com/products/ specialty/index.html
- Membrane filtration in the dairy industry GEA- https://gea.com/en/binaries/gea-membrane- filtration-brochure-for-dairy-industry_tcm11-17109.pdf

I. **Course Title : Advances in Dairy and Food Packaging**

II. **Course Code : DT 522**

III. **Credit Hours : 2+1**

IV. **Why this course?**

Packaging of food though carried out towards the end of product manufacture has a great role to play in conserving the processed food in its original state – including freshness of fresh food. Packaging plays a crucial role in acceptance of the food product by the consumer and the extensibility of the shelf life of the food being packaged, especially using advanced techniques such as MAP, active packaging, etc.

V. **Aim of the course**

To impart basic and advanced knowledge of dairy and food packaging

VI. **Theory**

Unit I

Trends in packaging industry; designing framework for packaging; Testing of packaging materials.

Unit II

Adhesives; Graphics; Coding (Barcode and Quick Response code), and labeling used in food packaging.

Unit III

Protective packaging of foods; Effect of light, oxygen and moisture on packaged food.

Unit IV

Packaging of dairy products, convenience foods, fresh produce and fruits and vegetable products, Packaging of fats and oils, spices, meat, poultry, fish and other sea foods.

Unit V

Modified atmosphere packaging, Shrink and stretch packaging; Self-heating and self-cooling cans.

Unit VI

Retort pouch technology, microwavable, biodegradable, and edible packages; Principles and applications of Active Packaging, Smart and Intelligent Packaging, Antimicrobial packaging.

Unit VII

Industrial packaging: unitizing, palletizing, containerizing, distribution systems for packaged foods.

Unit VIII

Safety aspects of packaging materials; sources of toxic materials and migration of toxins into food materials, packaging and flavour interaction.

VII. Practical

- Testing of packaging materials for qual-ity assurance: thickness, GSM, grease resistance, bursting strength, tearing resistance, WVTR, puncture resistance
- Estimation and prediction of shelf life of packaged foods
- Development of edible, biodegradable and antimicrobial films
- MAP of perishable foods
- Effect of edible coatings on respiration behaviour of fruits and vegetables
- Application of oxygen scavengers in packaged foods.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To recommend the type of package suitable for specific type of dairy or other food products
- To employ intelligent packaging techniques in food packaging to warn the public in case of impeding health hazard
- Recommending SOPs to the food industry personnel to avoid migration of toxic substances from the package into the food system

IX. Suggested Reading

- Coles R, McDowell D and Kirwan MJ. 2003. *Food Packaging Technology*. Oxford: Oxford Blackwell. Frank, A., Paine, H., and

Paine,Y. (1983). *A Handbook of Food Packaging*. Glasgow: Leonard Hill.
- Gordon LR. 2013. *Food Packaging: Principles and Practi*ce, 3rd Edn., Florida, USA: CRC Press, Taylor and Francis Group.
- Han JH. 2005. *Innovations in Food Packaging*. Elsevier Science and Technology Books.
- Parry RT. 1993. *Principles and Applications of Modified Atmosphere Packaging of Foods*. Dordrecht: Springer Science+Business Media.
- Piergiovanni L and Limbo S. 2015. Food Packaging Materials. In: *Chemistry of Foods*, Springer Publishers.
- Raija A. 2006. *Novel Food Packaging*. England: Woodland Publishing Co.
- Robertson GL. (Ed.). 2012. *Food Packaging: Principles and Practice*. 3rd Edn.,Florida, US: CRC Press.
- Robertson GL. 2010. *Food Packaging and Shelf Life: A Practical Guide*. Boca Raton: CRC Press.
- Yam KL. 2009. *The Wiley Encyclopedia of Packaging Technology*, 3rd Edn., USA: John Wiley and Sons, Inc.

Websites

- Indian Institute of Packaging-https//iip-in.com/
- The Regulation of Food Packaging-https://www.packaginglaw.com/special-focus/regulation- food-packaging
- Packaging Industry Servies-www.nsf.org/services/by-industry/food-safety-quality/packaging

I. **Course Title : Technology of Food Emulsions, Foams and Gels**

II. **Course Code : DT 523**

III. **Credit Hours : 2+1**

IV. **Why this course?**

In order to improve the viscosity or rheological characteristics of food systems, certain food additives such as stabilizers, emulsifier and even foaming agents play a significant role. The chances of probability of defect in certain food products can be circumvented through use of such food additives. Emulsifiers play a great role in maintaining emulsion of two or multiple phases in the food system till its consumption. Foaming agents are of significance in ice cream, whipping cream, meringue, certain baked goods, etc.

V. **Aim of the course**

To impart basic knowledge regarding food dispersion systems,

their formation, behaviour, and factors affecting their stability.

VI. Theory

Unit I

Food dispersions, their characteristics and factors affecting food dispersions.

Unit II

Food emulsions; Emulsifiers and their functions in foods; HLB concept for food

Unit III

Dairy based foams and their applications, structure of foams; Egg foams and uses; Foam formation and stability.

Unit IV

Theory of gel formation; Carbohydrate and protein based gels. Gelled milk products. Advances in food gels (organogel, hydrogel and nanogel).

Unit V

Structure of dairy based emulsions, foams and gels; blend of stabilizers and emulsifiers; Effect of stabilizers and/or emulsifiers on functional properties of dairy foods; Aerosols and propelling agents in foamed dairy products.

Unit VI

Techniques for evaluating the structure of food emulsions, foams and gels

VII. Practical

- Determination of emulsifying efficiency and emulsion stability
- Examination of foaming capacity and foam stability
- Gel formation and gel properties
- Preparation of hydrogels and organogels
- Preparation of single and double emulsions.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To be able to recommend specific type of food additive from amongst stabilizers and emulsifiers for stability of the food system
- Be able to recommend solution to the food processor to improve upon the textural quality of food products through use of food additives like stabilizers and/or emulsifiers
- To make the food processors understand how the type of emulsion in question in the food product has a bearing on the functional property of that specific food product

IX. Suggested Reading

- Rajah KK. (Ed.). 2014. Emulsifiers and stabilisers. Chapter

7.Young, N.W.G. *Fats in food technology.*UK: John Wiley and Sons Ltd. (ISBN: 9781405195423).

- Valdez B. (Ed.) 2012. Milani J and Maleki G. Hydrocolloids in food industry. Chapter in Book. *Food industrial processes – Methods and equipment*. InTech Europe, Rijeka, Croatia, pp. 1-418 (www.InTechopen.com)
- Whitehurst RJ. (Ed.). 2004. *Emulsifiers in food technology*. 1st Edn. Wiley-Blackwell Publisher, pp. 1-264. (ISBN-13 978-1405118026).

X. Websites

- Stabilizers – Specialty food ingredients – Federation of European Specialty Food Ingredients Industry- https://specialtyfoodingredients.eu/ingredients-and-benefits/group/stabilizers
- Emulsifier Solutions – Corbion- https://corbion.com/base/DownloadHelper/DownloadFile/ 8386

I. Course Title : Functional Foods and Nutraceuticals

II. Course Code : DT 524

III. Credit Hours : 3+1

IV. Why this course?

Ingestion of food possessing nutraceuticals can sustain and maintain human health – free from diseases. Today's consumers are aware about the health promoting foods and if the industry launches functional foods, there are takers for such foods. Several herbs and spices are known to contain components that have nutraceutical value. Ayurveda system is built on such naturally available materials. However, consumer does want to seek food that can sustain their health and nutritional requirement – not to rely on medicines. Fermented probiotic foods are the latest prominent functional foods.

V. Aim of the course

To impart knowledge about functional ingredients and nutraceuticals and their utilization in developing physiologically beneficial health foods, functional foods and speciality foods

VI. Theory

Unit I

Classes of functional foods and their status.

Unit II

Functional ingredients; Classification; Dietary and therapeutic significance.

Unit III

Food fortification; Significance and techniques of fortifying foods with functional ingredients.

Unit IV

Infant nutrition; Dietary formulations, special needs, additives; Geriatric Foods: Design considerations, ingredients, special needs; Sports foods: Significance, strategies and design considerations.

Unit V

Reduced calorie foods: Significance, strategies, additives (fat replacers, bulking agents, non-nutritive sweeteners).

Unit VI

Low sodium and low lactose foods: Nutritional and health significance.

Unit VII

Herbs; Classification; Therapeutic potential, applications; Phytochemicals; Classes; Physiological role; Applications; Bioactive ingredients from animal and marine sources.

Unit VIII

Probiotic, prebiotic and synbiotic foods: Concept and applications.

VII. Practical

- Determination of soluble and insoluble fibre
- Determination of antioxidant activity of functional ingredient/food
- Determination *of in vitro* bioavailability of nutrients
- b-galactosidase activity for low-lactose dairy products
- Prebiotic potential of selected plant/milk components
- Probiotic potential of selected microorganisms
- Preparation of functional foods

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Be able to identify food in which fortification with necessary nutrients are required
- Be able to evolve Geriatric foods and food for infants based on their requirement and physiological functions
- To make food available to the consumers amalgamated with functional ingredients such as herbs, phytochemicals, etc.

IX. Selected Reading

- Earle M, Earle R and Anderson A. (Eds.). 2001. Food product development.1st Edn., Woodhead Publishing, pp. 1-392 (eBook ISBN: 9781855736399).
- Francesco C. (Ed.). 2017. Advances in dairy products. John Wiley and Sons Ltd. pp. 1-448. Chapter 4.2 - Consumer insight in the process of new dairy products development(ISBN:

9781118906460).
- Kanekanian A. (Ed.). 2014. Milk and dairy products as functional foods. John Wiley and Sons, Ltd., UK: West Sussex, pp. 1-373.
- Leong TSH, Manickam S, Martin GJ, Li W and Ashokkumar M. 2018. Ultrasonic Production of Nano-emulsions for Bioactive Delivery in Drug and Food Applications. Springer.
- Saarela M. (Ed.). 2007. Functional dairy products (2007) Vol. 2, Series in Food Science, Technology and Nutrition, Woodhead Pub., pp. 521-539.
- Shortt C and O'Brien J. (Eds.). 2003. Handbook of functional dairy products – Functional foods and Nutraceuticals, 1st Edn. Boca Raton, FL: CRC Press, pp. 1-312.

Websites

- Foods for Specified Health Uses (FOSHU)- https://mhlw.go.jp/english/topics/foodsafety/fhc/ 02.html
- A New Definition for Functional Food by FFC- https//functionalfoodscenter.net/files/ 111174880.pdf
- Food-info.net: Functional Foods-https//food-info.net/uk/ff/intro.htm

I. **Course Title : Production and Applications of Dairy Ingredients**

II. **Course Code : DT 525**

III. **Credit Hours : 2+1**

IV. **Why this course?**

Milk is a source of several components, which may contribute to nutrients, nutraceuticals, flavour, colour, texture to the food products in which they may be incorporated. Nowadays, we have perfected technologies to separate the dairy components having specified function for use in dairy as well as food products. The by-products such as whey and buttermilk can be salvaged through separation of components, which are of significance to the dairy and food industries alike.

V. **Aim of the course**

The aim of this course is to give comprehensive information of various milk components used as ingredients in food processing with regard to their separation, properties and applications.

VI. **Theory**

Unit I

An overview of dairy ingredients for food processing; Composition, nutritive value and health attributes of dairy ingredients; Important quality indices; National and international regulatory standards.

Unit II

Principles of conventional and novel approaches for separation, concentration and fractionation of milk components(Ig, lf, b-Lg): centrifugal separation, concentration, drying, membrane processing, enzyme-assisted separation, supercritical fluid extraction, electric field assisted membrane technique, etc.

Unit III

Chemical, physical and functional characteristics of concentrated and dried dairy ingredients (SMP, WMP, lactose, whey powder, WPC, WPI, MPC, casein and caseinates, cream powder, butter powder, cheese powder, yogurt powder, buttermilk powder, etc.).Miscellaneous dairy ingredients, viz. dairy permeates, hydrolysates, coprecipitates andlactoferrin.

Unit V

Interactions of dairy ingredients with other food components and its effect on product quality.

Unit V

Applications of dairy ingredients in food industry: bakery and confectionery; Infant, adult and sports nutrition; Processed meat products; spreads; functional Foods; edible films and coatings.

VII. Practical

- Manufacture of whey powder, caseinates, whey protein/milk protein concentrates, lactose, sweet cream butter milk powder, cream powder, yogurt powder and cheese powder.
- Determination of functional and nutraceutical properties of dried dairy ingredients.
- Manufacture of enzyme-modified dairy ingredients
- Production of eggless cakes using WPC
- Production of processed meat products incorporating caseinates
- Visit to a dairy ingredients manufacturing industry.

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Be able to separate the various important components from milk/dairy byproduct having significance in dairy and food industries
- Be able to recommend the required type of specialized dairy ingredient for use in formulated and composite foods
- To be able to erect a dairy factory producing specialized dairy ingredients with immense value addition

IX. Suggested Reading

- Chandan RC and Kilara A. 2011. *Dairy Ingredients for Food Processing*. Iowa, USA: Blackwell Publishing Ltd.

- Corredig M. 2009. *Dairy Derived Ingredients: Food and Nutraceutical Uses*. Cambridge, UK: Woodhead Publishing Ltd.
- Fox PF. 1985. *Developments in Dairy Chemistry.* Vol.3.Lactose and minor constituents, New York: Elsevier Applied Science.
- Fox PF. 1989. *Developments in Dairy Chemistry.* Vol.4. Functional milk proteins, New York: Elsevier Applied Science.
- McSweeney PLH and Fox PF. 2013. *Advanced Dairy Chemistry.* Vol.1A: Proteins: Basic aspects. 4th Edn. Springer Publication.
- McSweeney PLH and O'Mahony JA. 2016. *Advanced Dairy Chemistry.* Vol.1B: Proteins: Applied Aspects. Springer Science + Business Media.

I. **Course Title : Advances in Cheese Technology**

II. **Course Code : DT 526**

III. **Credit Hours : 2+1**

IV. **Why this course?**

There is an array of cheese varieties; use of different starter cultures can lead to the development of specific cheese variety too. However, the technological principles involved in Cheddar cheese making are common to several varieties of cheeses with some modifications. Cheese is getting popularized in India, especially the Pizza cheese variety that is preferentially used as a topping on pizza pie. The functional properties of cheese dictate its end use functionality in food system. Basically, some cheese varieties can be produced by two methods – starter culture and direct acidification. Wheyless cheese making from ultra-filtrated milk concentrate is one unique possibility. There has been trend to produce cheeses having low-fat and low salt for the health conscious consumers.

V. **Aim of the course**

To impart advanced knowledge on milk coagulants, theory of milk coagulation, the technology, biochemistry and microbiology of cheese.

VI. **Theory**

Unit I

Rennet coagulation: Measurement of milk clotting activity and gelation properties, Catalytic mechanism and milk-clotting properties of rennet and rennet substitutes. Advances in renneting of milk; recombinant rennet.

Unit II

Advances in cheese starters; genetics of Lactic Acid Bacteria

(LAB); Polysaccharide (EPS) starters; Genetic engineering of LAB.

Unit IVExo Acid coagulated milk gels: formation, rheology, structural properties, etc.

Unit III

Biochemistry of cheese ripening: Metabolism of residual lactose and lactate, protein hydrolysis, lipid hydrolysis, amino acid catabolism; Development of cheese flavour, and body and texture; Cheese microstructure. Accelerated cheese ripening.

Unit V

Mold-ripened cheeses; Starter cultures, technology, ripening process (Blue, Roquefort, Camembert, etc.)

Low fat and low-sodium cheeses: challenges, strategies and advances; Membrane technology in cheese; Cheese as an ingredient in food systems.

Unit VII

Technology of non-bovine cheese: popular varieties, challenges, strategies; Technology of cheeses prepared by coagulation other than rennet and acid (Ricotta, Brown whey cheese, etc.); Advances in cheese packaging; Automation in cheese making; Cheese analogues.

VII. Practical

- Instrumental determination of rennet coagulation time
- Rheology of acid-coagulated milk gels
- Fermentation dynamics of common cheese starters
- Evaluation of cheese ripening behaviour
- Manufacture of mold ripened-, low sodium-, low fat-cheeses
- Manufacture of Goat and Ewemilk cheeses
- Manufacture of Ricotta cheese
- Microstructure of cheese

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Be able to manufacture various varieties of cheeses
- Try to employ various non-thermal pre-treatment to milk to obtain value added cheese
- Be able to develop low-calorie and low-salt cheeses
- Recommend the cheese makers for appropriate mechanization

IX. Suggested Readings

- Jana AH and Thakar PN. 1996. Recombined milk cheeses – A review. *Australian Journal of Dairy Technology*, **51**(1), 33-43.
- Jana AH and Tagalpallewar GP. 2017. Functional properties of Mozzarella cheese for its end use application – A Review.

Journal of Food Science and Technology, **54**(12), 3766- 3778.
- Johnson ME, Kapoor R, McMahon DJ, McCoy DR and Narasimmon RG. 2009. Reduction of sodium and fat levels in natural and processed cheeses: Scientific and technological aspects. *Comprehensive Reviews in Food Science and Food Safety*, **8**(3), 252-268.
- Lucey JA and Singh H. 1997. Formation and physical properties of acid milk gels: a review. *Food Research International*, **30**(7), 529-542.
- Mc Sweeney PLH. 2004. Biochemistry of cheese ripening. *International Journal of Dairy Technology*, **57**(2 3), 127-144.
- Mc Sweeney PLH, Fox PF, Cotter PD and Everett DW. (Eds.) 2017. *Cheese: Chemistry, physics and microbiolo*gy, 4th Edn, Vol. 1, Academic Press.

Websites

- Cheeses and related cheese products – Proposal to permit the use of ultra-filtered milk- https://federalregister.gov/documents/2005/10/19/05-20874/cheeses-and-related-cheese- products-proposal-to-permit-the-use-of-ultrafiltered-milk
- Go cheese to add new products in its portfolioBW Businessworld- http://businessworld.in/ article/GO-Cheese-To-Add-New-Products-In-Its-Portfolio/10-07-2018-154382
- American Cheese Society: Serving the Cheese Industry- https://cheesesociety.org/
- Cheese: Dairy Processing Handbook- https://dairyprocessinghandbook.com/chapter/cheese

Course Contents Ph.D. in Dairy Technology

I. **Course Title : Advances in Lipid Technology**
II. **Course Code : DT 611**
III. **Credit Hours : 3+0**
IV. **Why this course?**

Fats have multifarious effect on human beings. These are source of saturated fats, unsaturated fats, sterols (including cholesterol), phospholipids, etc. The essential fatty acids have a significant role in human health. There are however, some relations between certain type of fats (i.e. cholesterol, certain saturated fats and trans-fats) and cardiovascular disease in humans. There are several technological means to modify fat such as inter-esterification, fractionation of fat, hydrogenation, bleaching, refining, etc. Repeated frying of fat can lead to formation of toxic substances, unfit for consumption. Consumers have started accepting the modified fats for health reasons.

V. **Aim of the course**

To study the physico-chemical and nutritional characteristics of fats and oils, their processing and application in food products.

VI. **Theory**

Unit I

Current trends in the fats and oil industry in India and abroad: Sources and classification of commercial edible fats and oils from animal, vegetable and marine origin; Non-conventional fats/oils for edible purpose – rice bran oil, microbial lipids, etc.

Unit II

Structural aspects of fats and oils in relation to their processing, properties and utilization; Polymorphism and polytypism, crystallization kinetics.

Unit III

PUFA, MUFA, CLA, Medium Chain Triglycerides (MCTs), Omega fatty acids, Trans- fatty acids: Nutritional and technological interventions; Phytosterols and their significance.

Unit IV

Advances in extraction and refining of oils and fats; Application of membrane techniques in oil refining.

Unit V

Physical, chemical and enzymatic modification approaches to tailor-made fats. Cholesterol reducing treatments; structured lipids; Fat replacers; Isolation of emulsifiers. Applications of fats and oils: Margarine and low-fat table spreads; Bakery and confectionery fats; Coatings; Shortenings; Salad dressings;

Technology of cooking oils, salad oils and oil based dressings.

Unit VI

Frying process and systems; Changes in fats and oils during frying; Snack foods - Processing sys-tems; Modified fats and oils for use in bakery and confectionery products, shortenings and spreads; Cocoa butter substitutes.

VII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Able to recommend the type of fat suitable for given application (i.e. for frying).
- Prepare modified fats with reduced cholesterol, reduced long chain saturated fats, etc.
- Make the food processor understand the principle of polymorphic transformation of fat for texture development in fatty food system.
- Can modify the fat to suit physiological needs of the people.

VIII. Suggested Reading

- Garti, N.andSato, K. (Eds.). 2001.Hartel, R.W., and Kaylegian, K.E. Chapter 11. Advances in milk fat fractionation – Technology and applications. In: *Crystallization processes in fats and lipid systems*, 1st Edn,Boca Raton: Taylor and Francis Group (eBook ISBN 9781482270884).
- Hartel, R. W., and Kaylegian, K. E. 2001. Advances in milk fat fractionation – Technology and applications. In: *Crystallization Processes in Fats and Lipid Systems*. Garti, N., and Sato, K. (Eds.), Chapter 11, Taylor and Francis Group.
- Rajah, K.K. (Ed.). 2014. *Fats in food technology.* John Wiley and Sons Ltd., UK**(ISBN:** 9781405195423)
- Tamime, A.Y. (Ed.). 2009. *Dairy fats and related products*. Oxford, UK: Blackwell Publishing Ltd., pp. 1-315.

Websites

- **AOCS Lipid Library-**http://lipidlibrary.aocs.org/human-nutrition/trans-fat-replacements- in-foods-(pg2)
- **Fats and Cholesterol - USDA**-https://nal.usda.gov/fnic/fats-and-cholesterol
- **Fats and Fatty Acids in Human Nutrition**-http://fao.org/3/a-i1953e.pdf
- **Dietary Guidelines Advisory Committee** - http://www.usda.gov/cnpp/Pubs/DG2000/ Full%20Report.pdf

I. **Course Code : DT 612**

II. **Course Title : Advances in Protein Technology**

III. **Credit Hours : 3+0**

IV. **Why this course?**

Protein is an essential major nutrient in the diets. Essential amino acids play an important role. Cheaper sources of protein are being constantly unearthed possibly from several sources, viz. plants, animals, microbes and mushrooms. Protein malnutrition, especially in children is being tackled today. Use of membrane processing (especially ultrafiltration) and food texturization technologies has led to the development of newer type of high protein food ingredients and products. The state of protein – un-denatured and denatured can play a role in functionality of resultant food as well as in digestion of the nutrient. Protein hydrolysates have their own application even in pharmaceuticals.

V. **Aim of the course**

To study the characteristics of food proteins and to familiarize the students with their nutritional role, implications in processing and their interactions in food systems

VI. **Theory**

Unit I

Characteristics, functional properties and applications of proteins from plant, animal, microbial and non-conventional sources.

Unit II

Denaturation of proteins: effect of processing parameters on denaturation; effect of denatur-ation on the physico-chemical and biological properties of proteins in food systems.

Unit III

Structure-functional relationship of food proteins; Protein interactions with food constituents and their significance: protein-protein interactions. Protein--lipid interactions, protein-polysaccharide interactions, protein-ion interactions.

Unit IV

Nutritional aspects of dietary proteins: Protein nutrition and digestion; protein quality evaluation methods; effect of processing on nu-tritive value of proteins.

Unit V

Food protein concentrates and isolates: types, production, characterization and applications Protein hydrolysates: production and processing; de-bittering; bioactive peptides: classification, production and properties.

Unit VI

Texturization of proteins; Selection of ingredients and processes; Microstructure of texturized foods, Protein based fat substitutes; Protein engineering; Protein genetic polymorphism.

VII Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Tackle the problem of protein malnutrition.
- Adopt some recent technological means to produce high protein food ingredients such as WPC, WPI, MPC, Micellar casein powder, etc.
- Modify the native protein (i.e. protein hydrolysate) to have specific applications in composite food products

IX. Suggested Reading

- Boland M, Singh H and Thompson A. (Eds.). 2014. *Milk proteins: From expression to food*. Academic Press.
- Consultation FE. 2011. Dietary protein quality evaluation in human nutrition. *FAO Food Nutrition Papers*, 92, 1-66.
- Damodaran S. 1997. *Food proteins and their applications*. CRC Press.
- Fox Patrick F and McSweeney PLH. (Eds.) 2013. *Advanced Dairy Chemistry: Volume 1: Proteins, Parts A&B*, New York: SpringerScience+Business Media.
- Hayes M. 2018. *Food Proteins and Bioactive Peptides: New and Novel Sources*, Characterisation Strategies and Applications. *Foods*, **7**(3):E38. (doi: 10.3390/foods7030038).
- Hettiarachchy NS, Sato K, Marshall MR and Kannan A. (Eds.). 2012. *Food proteins and peptides: Chemistry, functionality, interactions and commercialization*. CRC Press.
- Maskan M and Altan A. 2016. *Advances in Food Extrusion Technology*. CRC press.
- Phillips GO and Williams PA. (Eds.). 2011. *Handbook of Food Proteins*. Elsevier Pub.
- Sims S. (Ed.). 2019. Protein Hydrolysates: Uses, Properties and Health Effects. Nova Publishers.
- Yada RY. (Ed.). 2017. *Proteins in Food Processing*. Woodhead Publishing.

Websites

- Protein energy malnutrition-FAO- http://fao.org/DOCREP/W0073e/w0073e05.htm
- Dietary Protein EU Science Hub European Commission- https://ec.europa.eu/jrc/en/health- knowledge-gateway/promotion-

prevention/nutrition/protein

- High and Low Biological Value Protein Foods: (EUFIC)- https://www.eufic.org/en/whats-in- food/article/the-basics-proteins

I. **Course Title : Product Monitoring and Process Control**

II. **Course Code : DT 621**

III. **Credit Hours : 3+0**

IV. **Why this course?**

Whatever food products are processed at the food plant needs to be monitored for product quality and safety. Recent developments in advanced control techniques have opened up novel possibilities for food process control. Food processes have been particularly difficult to automate and control owing to non-uniformity and variability in raw-materials, and lack of sensors for real-time monitoring of key process variables and quality attributes. Model-based control, distributed control systems together with field communication protocols, and other computer-aided advanced control strategies have proven themselves in selected food processing applications. The benefits of advanced control techniques include reduced costs, increased quality and improved food safety.

V. **Aim of the course**

To develop the understanding of the concept of monitoring and optimization of food quality/characteristics and familiarize the students with the techniques involved.

VI. **Theory**

Unit I

The concept of Product-Process Monitoring in dairy and food industries; Definition of 'quality', optimization paradigm, quality-prediction model based on quality kinetics and process state equations, simulation modelling; Process/Product Optimization: optimization procedures – search methods, Response surface, differentiation and programming methods; neural networks, optimization software.

Unit II

Process Control: objectives, control loop, loop elements and their functions; Modes of process control; Control techniques; Control equipment.

Unit III

Real-time instrumentation: sensors, their classification based on proximity, working principle, examples of applications in process control; Requirements of on-line sensors; Biosensors – construction, types, working principles, applications, merits and limitations; Time-temperature indicators – partial-history and full-

history indicators; Commercial devices; Applications and limitations; E-Nose and E-Tongue

– Simulation of natural organs, components and their functions, applications.

Unit IV

Flavour analysis: flavour bioassays – Gas Chromatography-Olfactometry techniques; Isolation, separation and detection/identification of flavour compounds – GC-MS, LC-MS, NMR, FTIR; Analysis of chiral compounds.

Unit V

Formation of flavour compounds in milk and milk products during heat processing (including UHT processing, caramelization and extrusion cooking), fermentation and ripening (cultured products and cheese flavour, with special reference to bitterness) and storage (Maillard browning); Aroma losses/retention during the drying process (in rela-tion to milk powder, cheese powder and dry cultured products); Industrial processes for extraction of desirable and undesirable volatile components from fresh and/or stored products by supercritical fluid (SCF) technique.

Unit VI

Monitoring of food structure: Application of analytical techniques (Differential Thermal Analysis, Differential Scanning Calorimetry, X-ray crystallography, circular dichroismspectroscopy, dynamic light scattering, laser diffraction, image analysis and Nuclear Magnetic Resonance) to monitor the effect of processing and storage on structure of foods.

Unit VII

Emerging spectroscopic techniques in assessment of foods: Raman Spectroscopy and Electron Spin Spectroscopy – working principles and applications; Monitoring of irradiated foods, detection of lipid auto-oxidation, etc.; Microwave and NIR absorption/reflection methods for Compositional analyses; Automated milk analysers; Proximate principles in cheese and milk powder.

Unit VIII

Colour Characterization: colour and appearance (gloss and translucence) monitoring through visual colorimeter, tri-stimulus colorimeters and reflectance spectrophotometer, CIE, Hunter-Lab, Munsel and other systems of three-dimensional expression of colour; Colour-based sorting of foods; Computer vision – principles, applications and benefits.

VII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Prepare a protocol for specific food industry in which all critical processes are to be monitored
- Avoid chances of occurrence of structure defect in food product through monitoring of the food structure using latest methodologies (i.e. DSC, NMR, etc.)
- Improve and stabilize the color of the food system through color characterization methods
- Elucidate the development of flavor for flavor rich foods (i.e. cheese, Enzyme modified cheese, fermented dairy products, etc.)

VIII. Suggested Reading

- Acree TE and Teranishi R. 1993. *Flavour Science: Sensible Principles and Techniques*. Washington: Amer. Chem. Soc.
- Bartlett PN, Elliott JM and Gardner JW. 1997. Electronic noses and their application in the food industry. *Food Technology*, **51**(12), 44-48.
- Kress-Rogers E and Brimelow CJB. (Eds.). 2001. *Instrumentation and Sensors for the Food Industry*. CRC Press, Woodhead Pub. Ltd.
- Nollet LML. (Ed.) 2020. *Mass Spectrometry Imaging in Food Analysis*, CRC Press.
- Pomeranz Y. (Ed.). 2013. *Food analysis: Theory and Practice*. Springer Science and Business Media.
- Schaertel BJ and Firstenberg-Eden R. 1988. Biosensors in the food industry: present and future. *Journal of Food Protection*, **51**(10), 811-820.

IX. Websites

- Quality Management Tools-Including TQM, Six Sigma, Cost of Quality and EFQM- https://cgma.org/resources/tools/essential-tools/quality-management-tools.html
- Process Control Solutions: Berthhold Technologies- https://berthold.com/en/pc/ home?gclid=EAIaIQobChMIl-uQ4—K4gIVQyUrCh0P_gqvEAMYASAAEgJfcPD_BwE
- Laboratory Quality Management System – World Health Organization-https://who.int/ihr/ publications/lqms_en.pdf
- Real Time Process Monitoring in Food and Beverage Manufacturing-https:// manufacturing.net/article/2016/02/real-time-process-monitoring-food-and-beverage- manufacturing

I. Course Title : R&D Management in Dairy Industry

II. Course Code : DT 622

III. Credit Hours : 3+0

IV. Why this course?

Several dairy industries have separate R and D cell to carry out

product innovation or to bring in more returns to the organization. Managing the R&D in a planned manner helps to deliver the goods to reap its benefit. Once patenting procedure is known, those research findings of extreme utility in dairy industry can be filed for patenting. The researches that have far reaching impact value should be taken for transfer of technologies within the limited time frame.

V. Aim of the course

To provide in-depth knowledge to students about selection and management of research projects and in patenting and transfer of technology processes.

VI. Theory

Unit I

Global scenario of R&D efforts in dairy processing; Determinants of Consumer Preferences; Competitive positioning and value chain configuration in global market.

Unit II

Management of human resources in dairy Industry: Structure and design of Research and Development organization; Analysis of organization behaviour – Transactional analysis; Personnel management – Typology analysis, individual and the organization, team building, human behaviour at work, motivation.

Unit III

Skill requirements of an R and D manager; New product development: strategies, models and life cycle analysis.Food innovation dynamics; innovation opportunities; innovations in traditional and functional foods; consumer driven food innovation; implementation of latest technology and assessment.

Unit IV

Management of R&D functions: Criterion for selection of R&D projects; Technology development process, Techniques for monitoring R and D functions.

Unit V

Patenting Laws; Indian Patenting Act/International Protocols for technology transfer; Transfer of technology from Lab to Plant, ISO 9001, ISO 14001, ISO 22000, ISO 50001, OHSAS; Laboratory Quality Management System- ISO 17025, Retailer Standards - BRC Food and BRC/IoP Standards, International Food Standard (IFS), SQF 1000 and SQF 2000, Global GAP and India GAP., Six-Sigma concept.

Unit VI

Project proposal writing for research funding, Development of

feasibility and technical report for dairy plant establishment, Report writing of projects and its evaluation

VII. **Learning outcome**

After undergoing this course, the students are expected to deliver the following:

- Identify whether the researches carried out are suitable for patenting
- Help in selecting proper R and D projects for the benefit of the industry as well as for the consumers
- Can write Project proposals to bring in Research funding from external agencies for mutual benefit

VIII. **Suggested Reading**

- Basu CR. 2017. *Business Organization and Management*. Tata-McGraw Hill Publication.
- Early R, Early M and Anderson A. 2009. *Food Product Development*. Woodhead Publishing Ltd.
- Robbins SP, Judhe, TA and Vorha N. 2013. *Organization Behaviour.* 15th Edn, Pearson Education Publishing Inc.
- Tetra Pak Dairy Processing Handbook. 2015. www.dairyprocessinghandbook.com.

Websites

- World Intellectual Property Organization-https//wipo.int
- IPR and Patents CEN CENELEC-https://cencenelec.eu/ipr/Pages/default.aspx
- ISO-International Standardization for Organization-https://iso.org/home.html
- ISO-45001 Occupational Health and Safety-https://iso.org/iso-45001-occupational-health-and-safety.html

I. **Course Title : Advances in Carbohydrate Technology**

II. **Course Code : DT 623**

III. **Credit Hours : 3+0**

IV. **Why this course?**

Besides proteins and fats, carbohydratesareother important nutrients. The flavour,

colour and structure of food product also depend on the type and amount of carbohydrates present and their reactivity with other constituents during processing. Modified starches have been the recent addition to the list of stabilizers available for the food industry. Lactose – the carbohydrate of milk origin has a special role to play in dairy and food industry. Modifications of carbohydrates such as inversion, enzymic hydrolysis, maillard reaction can lead to value-addition in some food products.

V. Aim of the course

To study the physico-chemical and nutritional characteristics of carbohydrates, and their applications in food processing and health

VI. Theory

Unit I

Introduction to Carbohydrates: Classification, Sources of carbohydrates, Structure of major groups, Non-conventional sources of carbohydrates.

Unit II

Characterization and functional properties of Carbohydrates; Various classes of sweeteners; Production technologies for Corn Syrup Solids (CSS), High fructose corn syrup (HFCS); Maltodextrins; Phenomenon of retrogradation of starch and interventions in foods and methods to control it.

Unit III

Milk Carbohydrates: Manufacturing technologies and their functional, nutritional and technological properties; Lactose hydrolysed dairy products.

Unit IV

Nutritional and therapeutic aspects of carbohydrates: Role in dental caries, obesity, cardiovascular diseases (CVD), colon health, diabetes; resistant starches, Prebiotics, Non-digestible carbohydrates (NDC) and their health benefits.

Unit V

Modified starches: Technologies for starch modification; Properties, applications, safety and toxicity. Carbohydrate based edible packaging films.

Unit VI

Hydrocolloids: Classification, structures, functional properties, and applications.

Unit VII

Cyclodextrins; Carbohydrates as fat replacers/fat substitutes; microencapsulating agents; Techniques for production of protein-polysaccharide conjugates and their applications.

VII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Unravel the unconventional sources of carbohydrate for human nutrition
- To produce dairy foods free of allergenicity i.e. lactose-free for lactose intolerant persons
- Able to ameliorate defects in food product through knowledge about interaction of carbohydrates with other constituents in food

during processing and/or storage

- To recommend reducing calorie in food (formulate dietetic food) through use ofcarbohydrate source to mimic properties of fat

VIII. Suggested Reading

- Eliasson AC. 2006. *Carbohydrates in Food*, 2nd Edn, CRC Press, Taylor and Francis group.
- Biliaderis CG and Izydorczyk MS. 2007. *Functional Food Carbohydrates.* CRC Press, Taylor and Francis group.
- Mc Sweeney PLH and Fox PF. 2009. *Advanced Dairy Chemistry*. Volume 3, Lactose, water, salts and minor constituents. USA: Springer Science and Business Media.
- Paques M and Lindner C. (Eds.). 2019. Lactose: Evolutionary Role, Health Effects, and Applications. Academic press.
- Steve W Cui. 2005. *Food Carbohydrates: Chemistry, Physical Properties and Applications.* CRC Press, Taylor and Francis group.

Websites

- Effect of Food Processing on Dietary Carbohydrates- http://fao.org/3/W8079E/w8079e0j.htm
- Carbohydrates: Uses, health benefits, and risks – Medical News Today-https:// www.medicalnewstoday.com/articles/161547.php

Potential Areas for Research

1. Active, intelligent and biodegradable packaging
2. Application of non-thermal processes for value-added dairy products
3. Bioactives from plant/plant bio-waste for human nutrition
4. By-products from agri-food industry: Recovery, utilization and revalorization
5. Composite dairy foods
6. Dairy based analogues
7. Dairy derived ingredients and their applications
8. Green technologies for dairy and food products
9. Health foods for conferring physiological benefits
10. Innovations in fermented dairy and food products
11. Nanotechnology in dairy and food applications
12. Non-bovine milk and milk products
13. Novel extruded food based on dairy and cereal/legume based solids.
14. Novel products utilizing membrane processed dairy solids.
15. Sensory characterization, technology standardization, value addition and shelflife extension of traditional Indian dairy products

16. Target delivery of nutraceuticals/active functional ingredients through dairy matrices
17. Technology of novel and exotic cheeses
18. Utilization of dairy by-products

List of Journals

1. *Australian Journal of Dairy Technology*
2. *British Food Journal*
3. *Cereal Chemistry*
4. *Cereal Foods World*
5. *Comprehensive Reviews in Food Science and Food Safety*
6. *Critical Reviews in Food Science and Nutrition*
7. *CyTA - Journal of Food (Ciencia Y TecnologiaAlimentaria)*
8. *Dairy Science and Technology (formerly Le Lait)*
9. *Drying Technology: An International Journal*
10. *Emirates Journal of Food and Agriculture*
11. *European Food Research and Technology*
12. *European Journal of Nutrition and Food Safety*
13. *Food and Bioprocess Technology*
14. *Food and Bioproducts Processing*
15. *Food and Function*
16. *Food Bioscience*
17. *Food Hydrocolloids*
18. *Food Quality and Preference*
19. *Food Research International*
20. *Food Reviews International*
21. *Indian Journal of Dairy Science*
22. *Innovative Food Science and Emerging Technologies*
23. *International Dairy Journal*
24. *International Journal of Dairy Technology*
25. *International Journal of Fermented Foods*
26. *International Journal of Food Properties*
27. *International Journal of Food Science and Technology*
28. *Irish Journal of Agricultural and Food Research*
29. *Journal of Dairy Research*
30. *Journal of Dairy Science*
31. *Journal of Food Measurement and Characterization*
32. *Journal of Food Processing and Preservation*
33. *Journal of Food Science and Technology*
34. *LWT - Food Science and Technology*

Syllabus for the Preliminary Comprehensive Examination for M.Tech. in Dairy Technology

Bio-preservation of raw milk, application of Bactofugation, Bactotherm process, Microfluidization, UHT, retort processing and partial homogenization processes with respect to milk and milk products processing and their, on sensory, physico-chemical and microbiological quality of milk. Aseptic packaging system of UHT milk, heat stability and deposit formation aspects. Nutritional aspects of milk. Water activity and hurdle technology for food preservation. Current trends in cleaning and sanitization of dairy equipment using bio-detergents; innovations in sanitizers.

Rheology of foods, classification of fluid foods based on rheological, Shear-rate dependence and time dependence of the flow-curve; Non-Newtonian fluids; Mechanisms and relevant models for non-Newtonian flow; Effect of temperature on rheology; Compositional factors affecting flow behaviour; Viscosity of food dispersions: dilute and semi- dilute systems, concentration effects. Rheometer: principles and operational features. Effect of processing and additives (stabilizers and emulsifiers) on food product rheology; Relationship between instrumental and sensory data; Microstructure of dairy products; Tribology and its applications.

Traditional Indian dairy products (TIDP) from cow, buffalo, goat, camel, and sheep milks and their quality differences; Process innovations in commercial production of heat-desiccated, coagulated and fermented traditional dairy products; Mechanization; application of membrane technology and microwave processing for TIDP processing. Composite and Convenience traditional dairy products.

Packaging of dairy and food products; testing of packaging materials. Adhesives; Graphics; Coding (Barcode and Quick Response code), and labeling used in food packaging. Shrink and stretch packaging; Self-heating and self-cooling cans. Retort pouch technology, microwavable, biodegradable, and edible packages; Safety aspects of packaging materials.

Functional foods;. Functional ingredients; their dietary and therapeutic significance. Food fortification; Infant nutrition; Geriatric Foods: Sports foods: Reduced calorie foods: Low sodium and low lactose foods: Herbs in dairy products; Bioactive ingredients from animal and marine sources. Probiotic, prebiotic and synbiotic foods:

Composition, nutritive value and health attributes of dairy ingredients; production techniques, application of milk components(Ig, lf, b-Lg); Chemical, physical and functional characteristics of concentrated and dried dairy ingredients (SMP, WMP, lactose, whey powder, WPC, WPI, MPC, casein and caseinates, cream powder, butter powder, cheese powder, yogurt powder, buttermilk powder, etc.). Applications of dairy ingredients in food industry.

Dairy Engineering

DEPARTMENT OF DAIRY ENGINEERING
Semester-wise M. Tech. Courses

Course Code	Course Title	Credit Hours	Semester
DE-511*	DAIRY AND FOOD ENGINEERING-I	3+0	II
DE-512	ANALYTICAL HEAT AND MASS TRANSFER	2+1	I
DE-513	TRANSPORT PHENOMENA	3+0	II
DE-514*	ADVANCES IN REFRIGERATION ENGINEERING	2+1	I
DE-515*	DESIGN OF DAIRY AND FOOD PROCESS EQUIPMENT	3+0	II
DE-516*	ENGINEERING PROPERTIES OF DAIRY AND FOOD PRODUCTS	2+1	II
DE-517	MECHANIZATION IN MANUFACTURE OF INDIGENOUS DAIRY PRODUCTS	3+0	I
DE-521*	DAIRY AND FOOD ENGINEERING-II	3+0	I
DE-522	BIO-THERMAL PROCESS ENGINEERING	3+0	II
DE-523*	INDUSTRIAL INSTRUMENTATION AND PROCESS CONTROL	2+1	I
DE-524	INDUSTRIAL AUTOMATION AND ROBOTICS	2+1	I
DE-525	UNIT OPERATIONS	2+1	II
DE-526*	ENVIRONMENTAL ENGINEERING	2+0	I
DE-527	ENERGY MANAGEMENT AND AUDITING IN DAIRY AND FOOD PLANTS	2+1	I
DE-591	MASTERS' SEMINAR	1+0	I and II
DE-599	MASTERS' RESEARCH	0+30	I and II
***compulsory courses**			

DEPARTMENT OF DAIRY ENGINEERING
Semester-wise Ph.D. Courses

Course Code	Course Title	Credit Hours	Semester
DE 611*	ADVANCES IN DAIRY PROCESS ENGINEERING	3+1	II
DE 612*	ADVANCES IN HEAT TRANSFER	3+0	II
DE 613	PHYSICOCHEMICAL PROCESSES	3+0	I
DE 621*	COMPUTATIONAL METHODS AND SIMULATION IN DAIRY AND FOOD ENGINEERING	2+1	I
DE 622*	PACKAGE PERMEABILITY AND SHELF-LIFE MODELLING	3+0	I
DE 624	SPECIAL PROBLEMS	0+2	II
DE 691	DOCTORAL SEMINAR I	1+0	I and II
DE 692	DOCTORAL SEMINAR II	1+0	I and II
DE 699	DOCTORAL RESEARCH	0+75	I and II
***compulsory courses**			

Course Contents
M.Tech. in Dairy Engineering

I. **Course Title : Dairy and Food Engineering-I**
II. **Course Code : DE 511**
III. **Credit Hours : 3+0**
IV. **Why this course?**

The development in mechanization and automation of the dairy and food processing are dependent on deeper knowledge of rheological, thermal and physical properties of the dairy and food products. Energy conservation and preservation of food quality during processing using emerging and non-thermal processes are the need of the hour. Therefore, this course is designed to provide the students a deeper understanding of the role of rheology and other food properties in the design, handling and operation of various processing equipment. Also, newer and emerging technologies are introduced to reduce the impact of processing on food quality.

V. **Aim of the course**

- To familiarize with the study of rheological properties of food and their measurements.
- To introduce the developments in thermal and non-thermal processing of foods

VI. **Theory**

Unit I

Viscoelastic characterisation of materials, stress-strain behaviour, creep, stress relaxation, solving problems on creep and stress relaxation of foods, non-Newtonian fluids; Viscometry-capillary and rotational viscometers, derivation on principle of operation of capillary and rotational viscometers, fitting of flow models; Rheometers: types and applications, temperature sweep, amplitude sweep and frequency sweep; identification of LV region.

Unit II

Freezing: IQF, Cryogenic freezing- process and equipment details, freezing curves, freezing time calculations, design of freezing equipment, freeze drying, freeze concentration.

Unit III

Design of single and multi-effect evaporators, design of TVR and MVR, design and selection of evaporator pumps, calculation of wetting rate, concept of condenser free design of evaporator, design of condenser (barometric and surface), flash vessel, preheater design for bacterial destruction, DSI, vacuum pump, concept of fanless cooling tower, aroma recovery unit.

Unit IV

Design of spray drier and its components, design of three stage drier, selection of fans, roots blower, selection of nozzle, HPP cum homogeniser used for automation,

CIP, cleanable bag filter, concept of cyclone free spray drier operation, use of computer software in design of evaporators and spray driers.

Unit V

Novel processing methods and equipment: high pressure processing, ohmic heating, ultraviolet light, pulsed electric field, pulsed light field, micro and nano- encapsulation, microwave heating, cold plasma, ultrasound processing and low dose e-beams.

Unit VI

Ultra-high temperature processing (UHT): concept, process, system; Design: plate and tubular type, their merits and demerits and selection; heat balances and concept of differential temperature; steam cleaning systems. Analysis of sterilization performance and validation, determination of residence time distribution.Pouch forming, can and carton filling systems for UHT. Cleaning and sterilization of UHT processing plants

VII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Case Analysis and case studies
- Guest Lectures
- Industry Visit

VIII. Learning outcome

The students will be more confident in design and operation of dairy and food process equipment. They will also be familiar with non-thermal processes and emerging processing methods in the manufacture of dairy and food products.

IX. Suggested Reading

- Burton H. 2012. *Ultra-High-Temperature Processing of Milk and Milk Products*. Springer Science.ISBN-13: 978-1461359012.
- Chauhan OP. 2019. *Non-thermal Processing of Foods*. 1st Edition, CRC Press. ISBN-13: 978-1138035843.
- Das SK and Das M. 2019. *Fundamentals and Operations in Food Process Engineering*. 1st Edition, CRC Press. ISBN-13: 978-1466560901.
- Gunasekaran S and Mehmet MAK. 2002. *Cheese Rheology*

and Texture. 1st Edition, Taylor and Francis. ISBN-13: 978-1138198425.
- Heldman RD, Daryl BL and Sabliov C. 2019. *Handbook of Food Engineering*. 3rd Edition, CRC Press. ISBN-13: 978-1466563124.
- Kessler HG. 1981. *Food Engineering and Dairy Technology*. Verlag A. Kessler.
- Bourne M. 2002. *Food Texture and Viscosity: Concept and Measurement* 2nd Edition, Academic Press. ISBN-13: 978-0121190620.
- McCabe WL, Smith JC and Harriott P. 2017. *Unit Operations of Chemical Engineering.* 7th Edition, McGraw Hill Education. ISBN-13: 978-8184959635.
- Mohsenin NN. 1970. *Physical Properties of Plant and Animal Materials*. 1st Edition, Routledge. ISBN-13: 978-0677023007.
- Singh RP and Heldman DR. 2013. *Introduction of Food Engineering*. 5th Edition, Bio-Green Elsevier. ISBN-13: 978-9351073499.
- Toledo RT, Singh RK and Kong F. 2000. *Fundamentals of Food Process Engineering*. 2nd Edition, CBS. ISBN-13: 978-8123915517.

I. **Course Title : Analytical Heat and Mass Transfer**
II. **Course Code : DE 512**
III. **Credit Hours : 2+1**
IV. **Why this course?**

Heat and mass transfer are the basic transport processes occurring in all the unit operations. These are complex processes because these occur mostly simultaneously and under unsteady state conditions with continuous changes in product characteristics. These also affect the efficiency and productivity of food processing lines. Deeper analytical solutions to heat and mass transfer operations are therefore needed. This course is aimed to provide solutions to such complex heat and mass transport processes, which will help in the design of efficient process equipment.

V. **Aim of the course**

- To introduce two dimensional and unsteady state of heat transfer.
- To introduce the forced convective heat transfer and relationships with dimensionless numbers.

- To learn appropriate design and analytical tools to investigate heat and mass transport phenomena
- To apply various computational techniques to obtain numerical solutions of these phenomena

VI. Theory

Unit I

One-dimensional steady state heat conduction through fins (Extended surfaces): actual and approximate solution. Efficiency, effectiveness and design of profile area of fins.

Unit II

Two-dimensional steady state heat conduction: analytical and numerical solution.

Unit III

Unsteady state heat conduction: Concept of Biot number, Lumped parameter analysis, transient heat flow in semi-infinite solids, use of Heisler charts.

Unit IV

Forced convection heat transfer in flow over a flat surface: hydrodynamic and thermal boundary layer, continuity equation, momentum equation and energy equation, heat transfer coefficient/ Nusselt number in laminar and turbulent region of boundary layer. Stanton number; Colburn analogy; empirical co-relations.

Unit V

Forced convection heat transfer in flow through tubes: Nusselt number in the entrance region and fully developed laminar and turbulent region.

Unit VI

Condensation and boiling heat transfer: Film wise condensation on vertical surface; Nusselt equation, regimes of boiling, boiling heat transfer.

Unit VII

Performance analysis of parallel flow and counter flow heat exchangers. LMTD and effectiveness NTU approach. Application of computational software for process heat transfer applications.

Unit VIII

Mass transfer - Fick's law of diffusion, diffusion of gases and liquids through solids, equimolar diffusion, isothermal evaporation of water into air, mass transfer coefficients. Governing equation for mass transfer; boundary conditions. Various
non-dimensional numbers and their analogy to heat transfer.
Examples of simultaneous heat and mass transfer

VII. Practical Topics

- Steady state heat conduction through fins
- Two-dimensional steady state heat conduction
- Solving problems in unsteady state heat conduction and use of Heisler charts
- Experiments on forced convection heat transfer
- Experiments on drop and film-wise condensation
- Determination of heat transfer coefficient
- Solving problems in condensation and boiling heat transfer
- Solving problems on mass transfer in diffusion and evaporation
- Experiments in parallel flow/ counter flow heat exchanger test rig
- Determination of mass transfer coefficient
- Design of engineering systems involving thermofluid phenomena.

VIII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Solving problems
- Familiarising with relevant software

IX. Learning outcome

Students have better understanding of heat and mass transfer processes and the skills to obtain solutions to such complex problems. They will develop competence in the design of process equipment using the analytical solutions of heat and mass transfer.

X. Suggested Reading

- Cengel YA. 2020. *Heat and Mass Transfer*. Tata McGraw Hill Education, New Delhi, 6th Edition, ISBN: 978-9390185283.
- Domkundar S and Arora SC. 2007. *A Course in Heat and Mass Transfer*. Dhanpat Rai and Co., Ltd. ISBN-13: 978-8177000290.
- Holman JP and Bhattacharyya S. 2017. *Heat Transfer*. 10th Edition, McGraw Hill. ISBM- 13: 978-0071069670.
- Majumdar P. 2017. *Computational Methods for Heat and Mass Transfer*. T&F India. ISBN- 13: 978-1138044869.
- Muralidhar and Sundararajan. 2009. *Computational Heat and Mass Transfer*. Narosa.
- Nag P K. 2011. *Heat and Mass Transfer*. 3rd Edition, McGraw Hill Education. ISBN-13: 978- 0070702530.
- Rajput RK. 2018. *A Textbook of Heat and Mass Transfer SI Units*. S. Chand Publishing. ISBN-13: 978-9352533848.

I. **Course Title : Transport Phenomena**

II. **Course Code : DE 513**

III. **Credit Hours : 3+0**

IV. **Why this course?**

An understanding of uniform approach to mass, energy and momentum transfer is necessary in modelling and predicting the above phenomena in food processing operations. This course provides engineering students advance methods to solve problems involving transports of momentum, energy and mass in biological, mechanical and chemical systems using a unified approach. Emphasis is given on developing the mathematical models to describe the flow phenomena.

V. **Aim of the course**

- To introduce the transport phenomena of mass, energy and momentum.
- To study the transport phenomena with the help of dimensional analysis.

VI. **Theory**

Unit I

Introduction to vector analysis, dot product and cross product and its physical significance, Stress tensor, total and partial derivatives, total acceleration, Eulerian and Lagragian frames of reference, Reynolds transport theorem, Different three-dimensional co-ordinate systems (Cartesian and Polar).

Unit II

Introduction to transport phenomena - transport processes and similarities in momentum, energy and mass transfer; Application of transport phenomena in CFD, practical examples in food engineering. Classification of flows and flow visualization; vorticity and potential and stream function, Potential flow, Cauchy Reimann equations.

Unit III

Steady-state equations - Momentum transport equations for Newtonian and non- Newtonianfluids, continuity equation in different co-ordinates; Derivation for Cartesian, cylindrical and spherical coordinate system.

Unit IV

Equations of motion - Navier-Stokes equations and their application in viscous fluid flow between parallel plates and through pipes.

Unit V

Turbulent transport mechanism - Mathematical analysis; Eddy

viscosity and eddy diffusivity; Velocity, temperature and concentration distribution; time smoothing equations. Inter-phase transport in isothermal system -friction factors for various geometries.

Unit VI

Dimensional analysis- Buckingham Pi-theorem and matrix method, application to transport phenomena, analysis among mass, heat and momentum transfer, Reynolds' and Chilton –Colburn analogy.

Unit VII

Non-dimensional numbers in transport phenomena- definition, mathematical relation and physical significance; Boundary layer concept - Theoretical and exact solutions for heat, mass and momentum transfer. Governing equations, Blassius solution and Von-Karmen integral equation

VII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Solving problems
- Familiarising with relevant software
- Industry Visit

VIII. Learning outcome

Student will obtain the knowledge and analytical skills to modelling and predicting the action of mass, energy and momentum transfer. They will be able to solve, using rigorous mathematics, fundamental and elucidating problems involving momentum, energy, and mass transport phenomena and apply this knowledge in design and operation of processing equipment.

IX. Suggested Reading

- Bird RB, Stewart WE and Lightfoot EN. 2006. *Transport Phenomena*. 2nd Edition. Wiley. ISBN-13: 978-8126508082.
- Deen WM. 2013. *Analysis of Transport Phenomenon.* Oxford University Press. ISBN-13: 978- 0198098584.
- Foust AS, Wenzel LA, Clump CW, Maus L and Andersen LB. 2015. *Principles of Unit Operations*. 2nd Edition, Wiley.ISBN-13: 978-8126518296.
- Geankoplis CJ, Herse AA and Lepek DH. 2018. *Transport Processes and Separation Process Principles*. 4th Edition. Pearson Education India Prentice-Hall Private Ltd.ISBN-13: 978- 9332549432.
- McCabe WL, Smith JC and Harriott P. 2017. Unit Operations of

Chemical Engineering. 7th Edition, McGraw Hill Education.ISBN-13: 978-8184959635.
- Raj B. 2012. *Introduction to Transport Phenomena: Momentum, Heat and Mass*. Prentice Hall India Learning Private Limited.ISBN-13: 978-8120345188.
- Yanniotis, S. 2008. *Solving Problems in Food Engineering*. 2008th Edition. Springer. ISBN-13: 978-0387735139.

I. **Course Title : Advances in Refrigeration Engineering**
II. **Course Code : DE 514**
III. **Credit Hours : 2+1**
IV. **Why this course?**

Refrigeration engineering is an essential technology to preserve the food products. It is an integral part of dairy industry as milk and milk products have very short shelf life. This course is intended to impart knowledge on design aspects of refrigeration and air conditioning systems, system analysis and load calculations.

Troubleshooting techniques are schematics and 3D sketches.

V. **Aim of the course explained with the use of wiring diagrams,**

- To study the various components and the parameters that affect the performance of vapour compression refrigeration
- To study the vapour absorption refrigeration systems
- To study heat pumps and their applications in dairy industry
- To study design and maintenance of cold stores.
- To study controls of refrigeration systems

VI. **Theory**

Unit I

Vapour compression refrigeration system: major components and their different types; Theoretical vapour compression cycle, theoretical COP; Effect of operating parameters on COP; actual vapour compression cycle; Multi-pressure commercial refrigeration systems.

Unit II

Vapour absorption refrigeration system; Ammonia-water system, lithium bromide - water system, vapour absorption refrigeration cycle and its representation on enthalpy-concentration diagram; Absorption system calculations.

Unit III

Heat Pumps: different heat pump circuits; analysis of heat pump cycle; Use of heat pumps in dairy plant for energy conservation.

Unit IV

Non-conventional refrigeration systems; Steam jet refrigeration, thermoelectric refrigeration, vortex tube, cooling by adiabatic demagnetization.

Unit V

Design elements of refrigeration equipment: compressor, condenser, evaporator, cooling tower, spray pond, etc. Balancing of different components. Design of brazed PHE for condensers

Unit VI

Design of cold storage and air-conditioning systems: types of cooling loads and their calculation, design of cold storage for food products, construction of cold storage, equipment selection, insulating materials, vapour barriers, ice bank tank. Concept of Ice silos, centralised distribution of ammonia through pump, PUF panel design.

Unit VII

Control and maintenance of a commercial refrigeration plant: Pressure regulating valves, Thermostatic valves, LP/ HP cut-outs, high to low side bypass valve, condenser water regulating valve, capacity control devices, pump down control, defrosting methods, liquid charging**,** advanced intelligent control systems; General preventive maintenance of refrigeration plant.

VII. **Practical**

- To find and compare the theoretical and actual COP of a small refrigeration unit on Refrigeration Tutor.
- Study and design of refrigeration components of a bulk milk chiller.
- Visit to a commercial refrigeration plant for cold storage/ ice bank unit and calculation of its theoretical COP by making cycle on P-h chart.
- Calculation of theoretical work and comparing it with actual work for some specified cooling job in a commercial plant.
- Study of various control and safety devices in a commercial refrigeration plant.
- Design problems on cold storage for different food/ dairy products.
- Use of computer software specific to cold store AC design
- Study the working of heat pump system.
- Study and design of refrigeration components of a walk-in-cooler
- Evaluate actual performance of a heat pump on heat pump tutor.
- Study of compressors used in vapour compression refrigeration system.
- Study of condensers and expansion devices used in vapour

compression refrigeration system

- Study of cooling towers used in vapour compression refrigeration system.
- Industry visit

VIII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Case Analysis and case studies
- Guest Lectures
- Industry Visit

IX. Learning outcome

The students will be familiar with newer technologies like heat pumps, improved VAR systems and cold store prefabricated designs. Students will also be familiar with improved application of energy efficiencies and automation in refrigeration systems. They can apply this knowledge to perform cooling load calculations and service and troubleshoot commercial refrigeration systems.

X. Suggested Reading

- Arora CP. 2017. *Refrigeration and Air-Conditioning*. 3rd Edition, McGraw Hill Education. ISBN-13: 978-9351340164.
- Arora SC and Domkundwar S. 2018. *A Course in Refrigeration and Air- Conditioning*. Dhanpat Rai and Sons.
- *ASHRAE Handbook*. 2018. American Society of Heating and Refrigeration. ISBN-13: 978-1939200983.
- Hundy GF, Trott AR and Welch T. 2008. *Refrigeration and Air-Conditioning*. 4th Edition. Butterworth Heinemann. ISBN-13:9780750685191.
- Dincer I. 2017. *Refrigeration Systems and Applications*. 3rd Edition, Wiley. ISBN-13: 978-1119230755.
- Khurmi RS. 2006. *Textbook of Refrigeration and Air-conditioning*. S. Chand. ISBN- 13:9788121927819.
- New-Comer JL. 1981. *Refrigeration and Air-Conditioning*. Venus Trading Co.
- Wang S. 2000. *Handbook of Air Conditioning and Refrigeration*. 2nd Edition, McGraw Hill Education. ISBN-13:9780070681675.
- Whitman WC, Johnson WM, John A and Silberstein E. 2016. *Refrigeration and Air Conditioning Technology*. 8th Edition, Delmar Publications. ISBN-13: 978-0357001059.

I. **Course Title : Design of Food and Dairy Processing Equipment**

II. **Course Code : DE 515**

III. **Credit Hours : 2+1**

IV. **Why this course?**

The knowledge of various design codes and steps are needed to understand the design and fabrication of dairy and food processing equipment. These are also essential to design new equipment as well as prevent equipment failure. The challenges are to develop machines/gadgets that are responsive to the customer with high quality and low cost. This course is aimed to provide the students with working knowledge of design principles as applied in food and dairy processing operations. In this course, the students will learn how to design major equipment common to most unit operations using relevant CAD/CAM software.

V. **Aim of the course**

To study design and various codes for pressure vessels, heat exchangers and reactors

VI. **Theory**

Unit I

Design of vessels: codes and regulations, Design for pressure and temperature, loading; allowable stress, minimum thickness after forming, design for internal and external pressure, cylindrical and spherical shells, formed heads, reinforcement openings; fabrication requirements, inspection, tests and non-destructive examination, pressure tests, design and stress evaluation**,** design problem.

Unit II

Design of storage vessels/ tanks, horizontal and vertical tanks, design of insulated and un-insulated tanks, nozzles and mountings, Design problems.

Unit III

Design of high-pressure vessels: constructional features, material for high pressure, multi shell construction, solid walled vessel.

Unit IV

Supports for vessel: bracket support or Lug support, web (gusset plates), skirt support, skirt design, skirt bearing plate, saddle support, Design problems.

Unit V

Heat exchangers: shell and tube heat exchangers, construction codes, general design considerations, U- tube heat exchangers, double pipe exchanger, scraped surface exchanger, spiral tube

exchangers, joints; welded tube joints, baffles and tube bundles, tube sheet, double tube sheet construction; plate type heat exchanger; air cooled heat exchangers; Computer software for design of heat exchanger, Design problems.

Unit VI

Design of reactor vessel: material of construction, agitation, classification, heating systems, design consideration, tank coils, design of agitation system components, baffles, power requirement for agitation, Hygienic engineering design.

Unit VII

Fundamentals of CAD/ CAM for design of dairy and food processing equipment.

VII. Practical

- Design of storage tanks and silos
- Design of supports for silos and tanks
- Design of high pressure vessels
- Design of plate heat exchanger
- Design of scraped surface heat exchanger
- Design of air cooled heat exchangers
- Computation of power requirement of agitators
- Exercises on use of CAD/CAM software for design of heat exchangers
- Use of computational software for design of heat exchangers

VIII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Case Analysis and case studies
- Guest Lectures
- Industry Visit

IX. Learning outcome

The students will understand the impact of various constraints on product design and process planning. The knowledge and understanding of design codes and procedures would help to understand, operate the processing equipment as well as design new equipment that are efficient and safe to operate. The students can analyse structures using computer software and expedite the design process of various equipment used in the dairy and food industry.

X. Suggested Reading

- Evans FL. 2016. *Equipment Design Handbook for Refineries and Chemical Plants*. Gulf Publishing, Houston, Texas. ISBN-13: 978-0872012660.

- Farrall AW. 2018. *Engineering for Dairy and Food Products*. 3rd Edition, MedTech. ISBN-13: 978-9386800718.
- Kessler HG. 1981. *Food Engineering and Dairy Technology*. Verlag A. Kessler.
- Mahajani VV and Umarji SB. 2016. *Joshi's Process Equipment Design*. 5th Edition, Laxmi Publications. ISBN-13: 978-9351380191.
- Saravacos GD and Kostaropoulos AE. 2012. *Handbook of Food Processing Equipment*. Springer. ISBN-13: 978-1461352129.

I. **Course Title : Engineering Properties of Dairy and Food Products**

II. **Course Code : DE 516**

III. **Credit Hours : 2+1**

IV. **Why this course?**

The successful and efficient design and operation of process equipment depend on the information and knowledge of engineering properties of dairy and food products. This course is to acquaint the students with different techniques of measurement of engineering properties of biological materials and their importance in the design of food processing equipment. The student will be taught to design and conduct experiments for measuring different properties of biological materials, as well as to analyze and interpret data. Also, the students will acquire knowledge on the application of physical properties to design a system, component, or engineering process to meet desired needs.

V. **Aim of the course**

- To familiarize with the engineering properties of food products and their measurement.
- To study the application of the properties in design of food process equipment.

VI. **Theory**

Unit I

Geometrical Properties; Shape, size, volume, density, porosity, surface areas, friction, rolling resistance, angle of repose, specific surface area, mean diameter, sphericity, particle size analysis, Hausner's ratio, Carr's index.

Unit II

Aerodynamic, Hydrodynamic and Frictional Properties; Drag coefficient, terminal velocity, Relation between drag coefficient and Reynolds number, terminal velocity from time distance relation.

Pressure drop through packed beds.

Unit III

Thermal properties; Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow, enthalpy, surface heat transfer coefficient freezing point. Measurement of thermal properties and prediction techniques.

Unit IV

Electrical conductivity, capacitance, inductance, Dielectric properties, viz. dielectric and microwave, dielectric constant, Dielectric loss factor, loss tangent, energy absorption, heating; Optical properties, colorimetry, transmittance and reflectance.

Unit V

Non-destructive quality evaluation techniques; Measurement techniques and instruments for food quality determination, destructive and non-destructive quality evaluation, UV-VIS NIR spectroscopy, X-ray, CT, NMR, machine vision system. FTIR, DSC, machine vision system, particle size determination by laser diffraction, e-nose, biosensors, etc.

Unit VI

Application of engineering properties in equipment design, processing and handling of dairy and food products.

VII. Practical

- Determination of geometric mean diameter, sphericity and surface area
- Determination of angle of repose and coefficient of internal friction
- Determination of bulk density, tapped density, true density, porosity, Hausner's ratio and Carr's index
- Particle size distribution analysis
- Determination of aerodynamic properties such as terminal velocity, lift and drag force for grains and particulates.
- Use of empirical equations for determination of thermal properties
- Determination of thermal conductivity, thermal resistivity and specific heat of food materials
- Estimation of surface heat transfer coefficient
- Measurement of electrical conductivity and dielectric properties
- Colour measurement and determination of CIELAB colour parameters
- Study of machine vision system

VIII. Teaching Methods

- Lecture
- Assignment Writing

- Student presentation
- Solving problems
- Familiarising with relevant software

IX. Learning outcome

The student will be familiar with engineering properties of food products and methods to determine these properties. They will be able to apply the fundamentals of engineering sciences to characterize the physical and rheological properties of biological materials. The students can apply the physical, aerodynamic and rheological data in the design of agricultural and food processing machines and processing systems and to various unit operations in the food industry.

X. Suggested Reading

- Arana I. 2016. *Physical Properties of Foods: Novel Measurement Techniques and Applications*. 1st Edition, CRC Press. ISBN-13: 978-1138627130.
- Gunasekaran S. 2000. *Non-destructive Food Evaluation: Techniques to Analyze Properties and Quality*. 1st Edition, CRC Press. ISBN-13: 978-0824704537.
- Heldman DR and Singh PR. 2012. *Food Process Engineering*. 2nd Edition, Springer Science and Business Media. ISBN-13: 978-0870553806
- Mohsenin NN. 1970. *Physical Properties of Plant and Animal Materials*. 1st Edition, Routledge. ISBN-13: 978-0677023007.
- Mohsenin NN. 2020. *Thermal Properties of Food and Agricultural Materials*. Gordon and Breach Science Publishers (CRC Press). ISBN: 0677054505.
- Rahman MS. 2016. *Food Properties Handbook.* 2nd Edition, CRC press. ISBN-13: 978-1138627598.

I. Course Title : Mechanization in Manufacturing of Indigenous Dairy Products

II. Course Code : DE 517

III. Credit Hours : 3+0

IV. Why this course?

The focus of the industry today is now on hygienic, mechanized and mass production of indigenous dairy products. This trend is due to the greater urbanization and higher disposable income and life style change. This course is going to cover all these aspects.

V. Aim of the course

- To design equipment suitable for manufacture of indigenous dairy products.

- To adopt, modify SSHE for continuous manufacture of indigenous dairy products.
- To upscale these equipment for a large scale, hygienic and safe production ofindigenous dairy products

VI. Theory

Unit I

Present status of mechanization in manufacture of indigenous dairy products.

Unit II

Preliminary design calculations and material selection, design considerations like force alignment and vibration. Analysis of stresses and strains in rectangular and
polar coordinates; Cauchy's formula, principal stresses and principal strains. Failure modes and effects analysis. Manufacturing system types and principles, manufacturing models- physical and mathematical models, realistic model buildingand design of prototypes.

Unit III

Design of liquid-filled SSHE for preheating applications; Design of equipment for batch and continuous mechanized manufacture of khoa, khoa-based sweets, chhana and chhana-based sweets; Conical process vat, single SSHE, triple SSHE, etc. Equipment for manufacture of batch and continuous manufacture of fermented dairy products, paneer, butter and ghee. Sizing and optimization. Cooling systems for viscous products. Machining standards for stainless steel.

Unit IV

Instrumentation and automation in manufacturing of indigenous dairy products. Automatic filling machines. Changes in engineering properties of milk during manufacture of indigenous dairy products.

Unit V

Design, layout and preparation of project report for establishing unit for the manufacture of indigenous dairy products. Scaling up of prototypes to commercial capacity.

VII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Familiarising with relevant software
- Industry visit

VIII. Learning outcome

The student familiarizes with equipment manufacture suitable for

the typical indigenous dairy products. Also the ability to adopt heat exchanger design suitable to manufacture these products in large scale, continuous manufacture under hygienic condition

IX. Suggested Reading

- Aneja RP, Mathur BN, Chandan RC and Banerjee AK. 2002. *Technology of Indian Milk Products*. Dairy India Publications, New Delhi. ISBN-13: 978-8190160308.
- Askin RG. and Standridge CR. 1993. *Modeling and Analysis of Manufacturing System.* John Wiley and Sons. ISBN-13: 978-0471514183.
- Gupta V. 2018. *Dairy India*. 7th Edition. Dairy India Year Book.ISBN-13: 978-8190160339.
- Haik Y, Sivaloganathan S and Shahin MT. 2009. *Engineering Design Process*. 3rd Edition, Cengage Learning.ISBN-13: 978-8131510599.
- Kessler HG. 1981. *Food Engineering and Dairy Technology*. Verlag A. Kessler.
- Kutz M. 2019. *Handbook of Farm, Dairy and Food Machinery Engineering.* 3rd Edition, Academic Press Inc. ISBN-13: 978-0128148037.
- Pahl G, Beitz W, Feldhusen J and Grote KH. 2014. *Engineering Design- A Systematic Approach*. 3rd Edition, Springer. ISBN-13: 978-1447160250.
- Sukumar De. 2001. Outlines of Dairy Technology, 1st Edition, Oxford University Press. ISBN-13: 978-0195611946.

I. Course Title : Dairy and Food Engineering-II

II. Course Code : DE 521

III. Credit Hours : 3+0

IV. Why this course?

Shelf life of a food is governed by internal and external factors and the type of packaging used. Thus, water activity, package permeability and temperature determine the shelf life of a food. This course is aimed to acquaint the students to integrate these factors to evaluate, model and validate the shelf life of a food product. Also newer methods of non-thermal preservation process like membrane technology and also some of the efficient thermal processes like microwave heating to be better understood and applied.

V. Aim of the course

- To study role of water activity in food preservation.
- To study different packaging material, their properties and effect

on shelf life offood products
- To study membrane processing and microwave heating of food products

VI. Theory

Unit I

Water activity and states: a thermodynamic quantity, water sorption isotherms, hysteresis, theories of sorption hysteresis, water activity measurement methods, water binding, control of water activity and moisture; Relationship between water activity and glass transition. Diffusion and sorption kinetics of water in foods

Unit II

Different types of packaging materials, their key properties and applications, Plastic packaging, different types of polymers used in food packaging and their barrier properties. Recent innovations in packaging, identification and testing of packaging materials

Unit III

Permeability and shelf-life: theoretical considerations, permeability to gases and vapours, measurement methods, permeability of multiplayer materials, permeability in relation to packaging requirements of food products. Development of shelf-life models based on moisture gain, lipid oxidation and light.

Unit IV

Calculation of shelf life and requirements for packaging, deteriorative reactions accelerated testing, relationship between transport properties of the package and shelf life of packaged products, simulation of product package- environment interaction, shelf life simulation for moisture, oxygen and light sensitive products.

Unit V

Theory of ultra-filtration, reverse osmosis and electrodialysis, selection and types of membrane and properties, concentration polarization, mathematical description of flow through membrane, application and use in dairy industry. Design calculation and selection of various membrane systems.

Unit VI

Microwave energy absorption, physical parameters in microwave heating processes, heat transfer phenomena, equipment and application in dairy food industry. Types of waveguides, electromagnetic resonators and microwave tubes.

VII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation

- Solving problems
- Familiarising with relevant software
- Industry visit

VIII. **Learning outcome**

Students can design and select packaging material to achieve desired shelf life of a wide variety of food and dairy products. An understanding of application of newer technologies such as Membrane processing, and Microwave heating is also achieved.

IX. **Suggested Reading**

- Barbosa-Cánovas GV, Fontana AJ, Schmidt SJ and Labuza TP. 2020. *Water Activity in Foods. Fundamentals and Applications*. 2nd Edition, Blackwell Publishing. ISBN-13: 978-0813824086.
- Brennan JG. 2012. *Food Processing Handbook.* 2nd Edition, Wiley-VCH. ISBN-13: 978- 3527307197.
- Cheryan M. 2016. *Ultrafiltration and Microfiltration Handbook.* Technomic Publishing. ISBN-13: 978-1498771139.
- Collin RE. 2007. *Foundations for Microwave Engineering*. 2nd Edition. Wiley. ISBN-13: 978- 8126515288.
- Karel M and Lund DB. 2003. *Physical Principles of Food Preservation*. 2nd Edition, CRC Press.ISBN-13: 978-0824740634.
- Robertson GL. 2016. *Food Packaging-Principles and Practice*. CRC Press, 3rd Edition, ISBN- 13: 9781138628052.
- Varzakas T and Tzia C. 2015. *Handbook of Food Processing*. 1st Edition, CRC Press. ISBN-13: 978-1466582309.

I. **Course Title : Bio-Thermal Process Engineering**

II. **Course Code : DE 522**

III. **Credit Hours : 3+0**

IV. **Why this course?**

The trend towards longer shelf life milk products is necessitating a closer look at the reaction kinetics and the areas of thermo-bacteriology and fermenters for controlled reaction studies. Also, the field of bioprocessing is developing very rapidly and needs skilled engineers with the background to design, build, control, and operate bioreactors and fermenters. This course provides students with advanced concepts and prepares them to meet the challenges of the new and emerging area of bioprocessing in the food industry.

V. **Aim of the course**

- To study biochemical reaction kinetics, reaction vessel design

and operation.

- To study thermal effects on the UHT processed food products.

VI. Theory

Unit I

Introduction to biochemical engineering: biochemical kinetics, kinetics of substrate utilization, enzyme reaction, growth of microorganisms, fermenters, pasteurization and sterilization and thermal destruction.

Unit II

Design and analysis of fermentation vessels: residence time distribution, reactors in food processing, reactor types, analysis of reactor systems.

Unit III

Mixing in reactors: mixing equipment, power consumption, gas-liquid mixing, liquid- liquid dispersion, solids suspension and solid-liquid mass transfer. Scale-up of mixers and alternative mixing devices.

Unit IV

UHT systems and recent advances: factors affecting spoilage of food, Aseptic packaging systems and conditions.

Unit V

Thermo-bacteriology: Survivor curve, thermal death curve, Arrhenius curve, techniques for determination of heat resistance of microorganisms, analysis of thermal resistance data, processing in containers, process time, lethality, design of batch and continuous sterilisation cycles in vat.

VII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Solving problems
- Familiarising with relevant software

VIII. Learning outcome

Student will be familiar with biochemical reaction kinetics and the design of equipment to study the same. The student will also understand the mixing equipment and their dynamic and scale up relationships. A better understanding of UHT processes in perspective of reactions will be achieved.

IX. Suggested Reading

- Bailey JE and Ollis DF. 2017. *Biochemical Engineering Fundamentals.* 2nd Edition, McGraw Hill Education.ISBN-13: 978-0070701236.
- Blanch HW and Clark DS. 2007. *Biochemical Engineering*. T&F India. ISBN-13: 979-0824700996.
- Das H. 2008. *Food Processing Operations Analysis.* Asian

Books. ISBN-13: 978-8186299784.
- Das SK and Das M. 2019. *Fundamentals and Operations in Food Process Engineering*. 1st Edition, CRC Press.ISBN-13: 978-1466560901.
- McNeil B and Harvey LM. 1990. *Fermentation: A Practical Approach*. IRL Press. ISBN-13: 978-0199630455.
- Pauline MD. 2013. *Bioprocess Engineering Principles.* Elsevier Science, 2nd Edition, ISBN-13: 978-9381269831.
- Stumbo. 1965. *Thermobacteriology in Food Processing.* 2nd Edition, Academic Press. ISBN- 13: 978-0126753523.

I. **Course Title : Industrial Instrumentation and Process Control**
II. **Course Code : DE 523**
III. **Credit Hours : 2+1**
IV. **Why this course?**

With the advancements in electronics, automation has become the trend in dairy industry. Automation enables better control of the process operations resulting in improved efficiency. Therefore, understanding of computer control of instrumentation and automation is essential in the rapidly developing field of Automation in Dairy and Food Industry.

V. **Aim of the course**
- To study microprocessor based instruments used in industries.
- To study various control systems for process control.
- To study computer based control systems.

VI. **Theory**

Unit I

Introduction; Instrumentation systems and its classification, measuring instruments, characteristics of instruments, intelligent versus dumb instruments, Microprocessor based instrumentation, Function of measurement systems, its elements and applications. Industrial instrumentation, Structure of industrial instrumentation in real time applications

Unit II

Control Systems; Feedback principles. Mechanical, hydraulic and pneumatic system components. Characteristics of liquid system, gas system, thermal system. Mathematical model of liquid process, gas process, flow process, thermal process, mixing process, Chemical reaction, D.C. and A.C. Servomotors, D.C. and A.C. Tachogenerators, Potentiometers and optical encoders, Synchro and stepper motors, Modelling and objectives of modelling for batch and continuous processes, Self- regulation.

Pneumatic valves

Unit III

Process Control and Controllers; Principles of automatic process control, Process characteristics, control system parameters, Process control loop, Elements of process control, process variables, Process facility considerations, controller modes, lag time, error signals, and correction signals, Actuators and Control valves; on-off, P, PI, P-I- D, cascade, feed forward, and ratio controllers, Fuzzy controllers. Data loggers and data acquisition, Introduction to computer based control systems, PLC, DCS, SCADA, HMI, etc.

Unit IV

Modern Transducers and Display Devices; Silicon micro transducers, optical transducer principles, types, characteristics of fibres and fibre optic transducers, Introduction to smart transducers and their applications, displays and their classification - Storage CRTs, Flat CRTs, LEDs, LCD display, Gas discharge plasma displays, Incandescent display, Electrophoretic image displays (EPID), Liquid vapour display (LVD). Introduction to computer based control; Computer based controller, data logging, supervisory control, flow chart, control system networks, basic structure and operation of programmable logic controllers (PLCs).

VII. Practical

- Study and analysis of electric switches, networks, electromechanical relays, MCB, SCR etc.
- Study of CRO and digital display devices.
- Study of automation techniques to control temperature by using PID controller.
- Study and application of digital timer to control timing of various processes, working of controllers in constant temperature water baths
- Make ladder diagrams and flow sheet diagrams for control logics in PLC.
- Study programme of a PLC and computer interface of a PLC.
- Study the characteristics of resistance transducer potentiometer and calibration of ammeter, voltmeter using DC potentiometer.
- Characteristics of LDR, photo diode, and phototransistor:
  - Variable illumination.
  - Linear displacement.
- Study of storage oscilloscope and transient response of RLC circuit.
- Study the characteristics of one solid state sensor/ fibre optic

sensor
- Design and test a signal conditioning circuit for the transducers.
- Visit to a microprocessor controlled dairy plant

VIII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Solving problems
- Industry visit

IX. Learning outcome

Students will get an insight on advanced data acquisition, processing and monitoring systems that provide dynamic responses of various systems. The student will learn about various systems and levels of automation involved in operation and control of dairy plant and the link up of computer software to it.

X. Suggested Reading

- Barney GC. 2018. *Intelligent instrumentation: Microprocessor Applications in Measurement and Control*. Prentice Hall International. ISBN-13:978-0134689432.
- Bhargava NN, Kulshreshtha DC and Guptta S. (Eds.). 2017. *Basic Electronics and Linear Circuits*. 2nd edn, McGraw Hill Publication.
- Harriot P. 2012. *Process Control*, Tata McGraw Hill Publishing Co Ltd., New Delhi. ISBN: 9780070993426.
- Johnson CD. 2015. *Process Control Instrumentation Technology*, 8th Edition, Pearson Education India. ISBN-13: 978-9332549456.
- Kalsi HS. 2019. *Electronic Instrumentation and Measurements*, 4th Edition, McGraw-Hill Education. ISBN-13: 978-9353162511.
- Sawhney AK. 2015. *A Course in Electronic Measurements and Instrumentation*, Dhanpat Rai and Co. ISBN-13: 978-8177001006.
- Stephanopoulos G. 2008. *Chemical Process Control: An Introduction to Theory and Practice*, Prentice Hall India, ISBN-13: 978-8120306653.

I. Course Title : Industrial Automation and Robotics

II. Course Code : DE 524

III. Credit Hours : 3+0

IV. Why this course?

The understanding of the Microprocessor controls, SCADA and Robotics and their application in material handling, process control and supervision is essential in large food industry. This

course is going to cover all these aspects.

V. **Aim of the course**

- To study automation, role in material handling and manufacturing systems.
- To study computer based industrial automation, SCADA, etc.
- To study elements of Robotics.

VI. **Theory**

Unit I

Introduction; Automation in Production System, principles and strategies of automation, basic elements of an automated system, advanced automation functions, levels of automation. Flow lines and transfer mechanisms, fundamentals of transfer lines.

Unit II

Material handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods.

Unit III

Automated manufacturing systems; Components, classification and overview of manufacturing systems, Manufacturing cells, GT and Cellular manufacturing, FMS, FMS and its planning and implementation. Quality control systems: Traditional and modern quality control methods, SPC tools, inspection principles and practices, inspection technologies.

Unit IV

Control technologies in automation; Industrial control systems. Manufacturing industries, continuous versus discrete control, computer process and its forms.

Unit V

Computer based industrial control; Introduction and automatic process control building blocks of automation systems; LAN, Analog and Digital I/O modules, SCADA systems and RTU. Distributed control system: Functional requirements, configurations and some popular distributed control systems. Industrial control applications in dairy and food processing industry. Microcontroller units (MCU); Arduino, Raspberry Pi sensors compatible with MCUs: temperature-RH, ultrasound and infrared sensors.

Unit VI

Basic principles of robotics, configurations, control. Application of machine vision systems, Image processing and analysis. Typical pick and place, loading and unloading, packaging and palletizing applications.

VII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Solving problems
- Familiarising with relevant software

VIII. Learning outcome

Student will have knowledge of application of Robotics in the operations of the food processing industry. Also acquire knowledge of microcontroller applications and the components of automation in using them.

IX. Suggested Reading

- Cichocki A, Ansari HA, Rusinkiewicz M and Woelk D. 2012. *Workflow and Process Automation: Concepts and Technology* (Vol. 432). Springer Science and Business Media. ISBN-13: 978-1461375999.
- Groover MP. 2016. *Automation, Production Systems and Computer-Integrated Manufacturing*. 4th Edition, Prentice Hall Press. ISBN-13: 978-9332572492.
- Helfrick AD and Cooper WD. 2015. *Modern Electronic Instrumentation and Measurement Techniques*. Pearson Education India.
- Hollender M. 2012. *Collaborative Process Automation Systems*. ISA.
- Kant K. 2010. *Computer-based Industrial Control*. 2nd Edition, PHI Learning Pvt. Ltd. ISBN-13: 978-8120339880.
- Moore CA. 2012. *Automation in the Food Industry*. Springer Science and Business Media. ISBN-13: 978-1461565109

I. Course Title : Unit Operations

II. Course Code : DE 525

III. Credit Hours : 2+1

IV. Why this course?

Many of processing steps are categorized and studied under independent operations called Unit Operations. It is important to study these individually, so that in the larger context, these can be seamlessly integrated into the industrial operations. Treatment of the process in terms of individual unit operations allows process engineers to move away from product specific operation to one which is general. In order to manufacture a product of desired quality with the maximum yield, each unit operation must be designed correctly. Mathematical treatment of the process can lead to prediction of

conditions that give the highest efficiency. This course is specifically designed for students of food processing disciplines, so that these can be exposed to various unit operations that would enable them to improve the design and operation of food processing plants.

V. Aim of the course

- To study various unit operations in food processing.
- To study crystallization and distillation in food processing.
- To study extrusion, extraction, expelling in food processing.

VI. Theory

Unit I

Grading, cleaning, washing, sorting, shelling, dehusking, decortication, milling,polishing, pearling, drying (evaporative, osmotic and freeze drying), mixing, clarification, coagulation, mechanical separation, sedimentation.

Unit II

Handling of food products; Mechanics of bulk solids, selection of bulk handling equipment, operation and construction of conveyors and elevators, viz. belt conveyors, screw/auger conveyors, bucket elevators and drag/chain conveyors. Estimation of energy requirement, damage to products during mechanical handling. Operation and maintenance of conveying equipment.

Unit III

Mechanical cleaning and sizing of food products – size reduction, size characteristics, particle geometry, energy for size reduction of granular materials and dry powders, size- reduction equipment, performance characteristics of size reducers. Different milling methods, cryogenic grinding.

Unit IV

Crystallization; Material and energy balance in crystallizers, Principles of crystal growth, super saturation and nuclei formation, operation of batch and continuous crystallizers.

Unit V

Distillation; Flash-off distillation, binary mixtures, differential distillation, steam distillation.

Unit VI

Flow through porous media, adsorption, pressing, expelling, extraction, palletizing,and extrusion.

VII. Practical

- Performance evaluation of cleaning and sorting equipment- destoners, spiral separators, graders, etc.
- Performance evaluation of size reduction equipment- disc grinders, hammer mill,ball mill, etc.

- Calculation of energy for size reduction through Kick's, Bond's and Rittinger's laws.
- Determination of particle size distribution of powders by ASTM sieve analysis
- Application of rotary and vacuum evaporator for concentration of liquid foods
- Use of distillation for solvent extraction of oleoresins and essential oils
- Performance evaluation of conveying equipment- screw conveyors, belt conveyors, bucket elevators, etc.

VIII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Solving problems
- Industry visit

IX. Learning outcome

Student will have good understanding of the unit operations like size reduction, crystallization, distillation, material handling and the energies involved in these operations. This course serves to integrate the fundamental concepts learned with various industrial operations of manufacturing of food products. Also the knowledge gained in the treatment of one process can be used to a completely new process.

X. Suggested Reading

- Berk Z. 2018. *Food Process Engineering and Technology*. 3rd Edition, Academic Press. ISBN- 13: 978-0123736604.
- Earle RL. 2013. *Unit Operations in Food Processing.* 2nd Edition, Pergamon press, ISBN- 13: 978-1483293103.
- Fellows P. 2016. *Food Processing Technology: Principles and Practice*.4th Edition, Woodhead Publishing, ISBN-13: 978-0081019078.
- Foust AS, Wenzel LA, Clump CW, Clump CW and Andersen LB. 2008. *Principles of Unit Operations*. 2nd Edition, John Wiley and Sons. ISBN-13: 978-8126518296.
- Geankoplis CJ, Hersel AA and Lepek DH. 2018. *Transport Processes and Separation Process Principles*. 5th Edition Pearson. ISBN-13: 978-0134181028.
- Ibarz and Barbosa-Carnovas GV. 2003. *Unit Operations in Food Engineering*. 1st Edition, CRC Press. ISBN-13: 978-6610546282.

- McCabe WL, Smith JC and Harriott P. 2017. *Unit Operations of Chemical Engineering*. 7th Edition, McGraw Hill Education. ISBN-13: 978- 8184959635.
- Sahay KM and Singh KK. 2004. *Unit Operations of Agricultural Processing*. 2nd Edition, Vikas Publishing House Pvt. Ltd. ISBN-13: 978-8125911425
- Singh RP and Heldman DR. 2013. *Introduction to Food Engineering*. 5th Edition, Academic press. ISBN-13: 978-0123985309.

I. **Course Title : Environmental Engineering**

II. **Course Code : DE 526**

III. **Credit Hours : 2+0**

IV. **Why this course?**

There is a continuous change in the environmental norms and regulatory standards of the country and all industries including dairy and food industry have to follow them. This requires up gradation of techniques for treatment of wastewater and solid waste from the industries. Hence, it is important to have good understanding of the latest methods of treatment of the dairy industry effluents and their safe, economic and legal disposal.

V. **Aim of the course**

- To study waste water characteristics, measurement and its treatment methods.
- To study air pollution and methods to control it.

VI. **Theory**

Unit I

Waste water sources, characteristics, standards for disposal of dairy waste water.

Unit II

Physical, chemical and biological characteristics of waste water, measurement of organic content in waste water

Unit III

Physical unit operations in waste water treatment: screening, racks, mixing, flocculation, sedimentation, floatation, elutriation, vacuum filtration and incineration.

Unit IV

Chemical unit operations in waste water treatment: reaction kinetics, chemical precipitation, aeration and gas transfer process, rate of gas transfer, adsorption and disinfection.

Unit V

Biological unit operations- aerobic and anaerobic cycles, kinetics of

biological growth, application of kinetics to treatment systems, aerobic waste treatment, anaerobic waste treatment

Unit VI

Air conditioning systems: clean – room air conditioning; important pollutants of air; properties of particulate matter and air pollution control methods. Dairy plant fire hazards.

VII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Solving problems
- Industry visit

VIII. Learning outcome

Student will be able to learn the advances in physical, chemical and biological operations of dairy waste treatment and effluent disposal. This will enable them to identify and implement scientific and technological solutions to various environmental problems. Also, they will learn about control methods to provide clean and conditioned air for enclosures in dairy plant operations.

IX. Suggested Reading

- Davis M and Cornwell D. 2017. *Introduction to Environmental Engineering*. 5th Edition, McGraw Hill Education ISBN-13: 978-9339204037.
- Hussain A and Ahmed S. 2018. *Advanced Treatment Techniques for Industrial Wastewater (Advances in Environmental Engineering and Green Technologies*).1st Edition, IGI Global. ISBN-13: 978-1522557548.
- Karia GL. 2013. *Wastewater Treatment: Concepts and Design Approach*. 2nd Edition, Prentice Hall India Learning Private Limited.ISBN-13: 978-8120347359.
- Kuehn T, Ramsey J and Threlkeld J. 1998. *Thermal Environmental Engineering*. 3rd Edition, Prentice Hall of India. ISBN-13: 978-0139172205.
- Metcalf and Eddy, Tchobanoglous G, Burton F and H David Stensel. 2017. *Wastewater Engineering*: *Treatment Disposal Reuse*. Tata McGraw Hill. ISBN-13: 978-0070495395.
- Peavy HS, Rowe DR and Tchobanoglous G. 2017. *Environmental Engineering*. McGraw Hill Education. 1st Edition, ISBN-13: 978-9351340263.
- Rao MN. 2020. *Waste Water Treatment* 3rd Revised Edition. Oxford and IBH Publishing. ISBN-13: 978-8120417120.
- Syed R. Qasim and Guang Zhu. 2018. *Wastewater Treatment and*

Reuse Theory and Design Examples. 1st Edition, Volume 2: Post-Treatment, Reuse, and Disposal. CRC Press. ISBN- 13: 978-1138300941.

I. **Course Title : Energy Management and Auditing in Dairy and Food Plants**

II. **Course Code : DE 527**

III. **Credit Hours : 3+0**

IV. **Why this course?**

The energy cost is increasing as fossil fuels are being depleted. Lot of energy is used for heating and refrigeration purpose in the dairy industry. Therefore, there is a need for understanding and implementing various methods of 'Energy Conservation and Management' in the dairy industry. This is important in view of reducing environmental pollution too.

V. **Aim of the course**

- To study methods of identifying various Energy Conservation opportunities in dairy and food plants.
- To study various methods involved in Energy Management in dairy and food plants
- To study methods and steps involved in Energy Auditing in dairy and food plants.

VI. **Theory**

Unit I

Energy audit; its need and types. Bench marking of energy costs. Matching energy use to requirement. Optimizing the input energy requirements. Fuel and energy substitution. Energy Balance and computation of efficiency of energy.

Unit II

High efficiency boilers, improved combustion techniques, energy conservation in steam distribution systems, upkeep and maintenance of steam fittings.

Unit III

Electrical load management; Demand management, Energy saving controllers, Power factor and its improvement. Transformer; Energy saving in transformers.

Unit IV

Electric motor; Selection and application, energy efficient motors. Variable speed drives and Variable Frequency drives. Industrial lighting

Unit V

Energy conservation in Refrigeration and Cold storages, cooling towers, pumps and pumping systems, fans, blowers, air

compressors, Maintenance and upkeep of vacuum and compressed air pipelines.

Unit VI

Processing equipment; Improving efficiency and energy conservation opportunities in kettles, PHEs, Evaporators and Driers. Hot air generator, thermic fluid heater, steam radiator, waste heat recovery and thermal energy storage in food processing facilities, condensate recovery and reuse.

VII. Practical

- Bench marking for various dairy plant operations
- Computation of energy conservation in boilers and steam distribution
- Computation of energy demand management of a dairy plant
- Computation of energy savings in induction motors and transformers
- Exercise on variable frequency drive applications
- Computation of cooling load and energy savings in refrigeration plant and cold stores
- Computation of energy savings in air compressor and compressed air distribution
- Computation of energy savings in counter-current plate heat exchangers and HTST pasteurizer
- Computation of energy saving in multiple effect evaporators and modern dryers
- Energy audit of a dairy plant

VIII. Teaching Methods

- Lecture
- Assignment Writing
- Student presentation
- Solving problems
- Industry visit

IX. Learning outcome

Student will gain knowledge of different types of Energy Auditing, Energy Conservation and substitution with Renewable Energy. Important aspects of Electrical load management and selection and up gradation of equipment to higher energy efficiency to save energy will be covered.

X. Suggested Reading

- Abbi YP and Jain S. 2009. *Handbook on Energy Audit and Environment Management*, The Energy and Resources Institute (TERI), New Delhi. ISBN-13: 978-8179930922.
- *Bureau of Energy Efficiency*, 4th floor, Sewa Bhavan, R.K. Puram, New Delhi. Guide Books No. 1 to 4. for National Certification

Examination for Energy Managers and Energy Auditors. Pub. 2015.

- Klemes J, Smith R and Kim JK. 2008. *Handbook of Water and Energy Management in Food Processing* (Woodhead Publishing series in Food Science, Technology and Nutrition). 1st Edition, Woodhead Publishing, CRC Press. ISBN-13: 978-1420077957.
- *Practical Guide to Energy Conservation in Dairy Industry*. 2011. Petroleum Conservation Research Association, Sanrakshan Bhawan, 10 Bhikaiji Cama Place, New Delhi. Pub. ISBN 978-81-908167-1-7
- Roosa SA, Doty S and Turner WC. 2018. *Energy Management Handbook*. 9th Edition, River Publishers. ISBN-13:978-1138666979.

Course Contents Ph.D. in Dairy Engineering

I. **Course Title : Advances in Dairy Process Engineering**
II. **Course Code : DE 611**
III. **Credit Hours : 3+1**
IV. **Why this course?**

To provide the latest methodologies of simulation and modelling for designing of process equipment, problem solving in operation and maintenance of evaporators, driers and mixing equipment. This course is going to cover all these aspects.

V. **Aim of the course**

To impart knowledge on design and analysis of selected dairy equipment.

VI. **Theory**

Unit I

Evaporator designs and selection, piping and instrumentation diagrams of evaporator systems, heat and mass balance in single effect system, vapour recompression and impact on efficiency, layout and design calculations of multiple effect evaporator, estimation of residence time in film evaporators, fouling of evaporators and cleaning, entrainment separators.

Unit II

Drying; Design data, performance and selection and design of dryers: tray dryer, drum dryer, freeze dryer, fluidized bed dryer. Design of powder recovery systems; Automation in spray dryers, management of explosions and fire hazards in spray dryers.

Unit III

Mixing of materials; Factors in mixing, types of mixers, operation, mixing gas, liquid and solid; heat transfer in mixers, power requirement, transmission, scale-up of models.

Unit IV

Material handling; System and devices, design and applications of screw, belt, flight, apron conveyors, bucket elevators; power requirements, feeding and discharge mechanisms.

Unit V

Mathematical modelling in food processing operations; Process modelling and optimisation approaches, framework and challenges, transport phenomena models for food process simulation for optimal design and operation. Stochastic finite element analysis of thermal food processes. Neural networks approach to modelling food processing operations.

VII. **Practical**

- Problems on design of evaporators- effect of temperature and

pressure on heat
transfer and efficiency

- Effect of boiling point rise and enthalpy of concentration on heat transfer in evaporators
- Study of vacuum pan
- Reading Piping-Instrumentation diagrams of evaporator systems
- Analysis of drying rate curves of different types of dryers
- Design of tray, drum and fluidized bed dryers
- Design of agitators for liquid systems
- Analysis of heat transfer in agitated vessels
- Effectiveness of mixing of liquids, dispersions and emulsions
- Design of belt, bucket and screw conveyors

VIII. Learning outcome

Students will acquire thorough understanding of recent advances in the design and operation of Evaporators, driers, Mixers and material handling equipment, using Modelling and optimization techniques.

IX. Suggested Reading

- Ahmed J and Shafi-ur-Rahman M. 2012. Handbook of Food Process Design. Wiley-Blackwell Publishing Ltd. ISBN-13: 978-1444330113.
- Chaudhary C, Rai D and Kumar D. (Eds.). 2018. *Advances in Food Processing Techniques.* Kalyani Publishers.
- Chen XD and Mujumdar AS. 2008. Drying Technologies in Food Processing, Blackwell Publishing Ltd. ISBN-13: 978-8126549788.
- Das H. 2008. Food Processing Operation and Analysis. Asian Books. ISBN-13: 978-8186299784.
- Geankoplis CJ, Hersel AA and Lepek DH. 2018. Transport Processes and Separation Process Principles, 5th Edition, Pearson. ISBN-13: 978-0134181028.
- Saravacos GD and Kostaropoulos AE. 2016. Handbook of Food Processing Equipment, 2nd Edition, Springer International. ISBN-13: 978-3319250182.
- Valentas KJ, Rotstein E and Paul Singh R. 1997. Handbook of Food Engineering Practice. CRC Press. ISBN-13: 978-0849386947.
- Zeki Berk. 2018. Food Process Engineering and Technology, 3rd Edition, Academic Press. ISBN: 9780128120187.

I. **Course Title : Advances in Heat Transfer**

II. **Course Code : DE 612**

III. **Credit Hours : 3+0**

IV. **Why this course?**

To enable the students to solve problems on heat transfer under steady and unsteady state conditions in 1, 2 and 3 dimensional geometries and turbulent flow conditions. This course is going to cover all these aspects.

V. **Aim of the course**

To develop analytical and numerical approaches for heat transfer operation

VI. **Theory**

Unit I

Steady state one - dimensional problems, Bessel functions, composite structures, Principal of superposition, Heterogeneous solids, Power series solutions, Properties of Bessel functions, Extended surfaces, Approximate solutions for extended surfaces. Steady state two- and three- dimensional problems, Separation of Variables; Orthogonal functions; Boundary value problems; Characteristic value problems; Orthogonality of characteristics functions; Fourier series. Separation of variables; Steady two-dimensional Cartesian geometry, selection of coordinates, steady two- dimensional spherical geometry, Legendre polynomials, Steady three-dimensional geometry.

Unit III

Unsteady problems - Separation of Variables, Orthogonal functions, Distributed systems having stepwise disturbances, Use of one-dimensional chart, Time - dependent boundary conditions, Duhamel's superposition integral, Laplace transforms.

Unit IV

Heat transfer in turbulent flow: turbulent flow, boundary layer, Prandtl analogy, temperature distribution in turbulent flow, empirical and practical correlation for convection heat transfer, heat transfer in packed beds. Use of computational software for modelling heat and moisture transfer in various unit operations.

VII. **Learning outcome**

The students will learn problem solving skills on heat transfer under steady and unsteady state conditions encountered in unit operations such as frying, baking, cooling, freezing, evaporation, drying, etc.

VIII. **Suggested Reading**

- Arora SC, Domkundwar S and Domkundwar AV. 2007. *A Course*

in Heat and Mass Transfer. Dhanpat Rai and Co. (P) Ltd. ISBN-13: 978-8177000290.

- Bergman TL, Lavine AS, Incropera FP and DeWitt DP. 2016. *Fundamentals of Heat and Mass Transfer*. 8th Edition, Wiley Publishers. ISBN-13: 978-1119337683.
- Cengel YA and Ghajar AJ. 2017. *Heat and Mass Transfer*. 5th Edition, Tata McGraw-Hill Education Pvt. Limited. ISBN-13: 978-9339223199.
- Geankopolis CJ, Hersel AA and Lepek DH. 2018. *Transport Processes and Separation Process Principles*. 5th Edition, Prentice-Hall Private Ltd. ISBN-13: 978-0134181028.
- Holman JP. 2017. *Heat Transfer*. 10th Edition, McGraw-Hill Higher Education Publishers. ISBN-13: 978-0071069670.
- Kreith F and Manglik RM. 2017. *Principles of Heat Transfer*. 8th Edition, Cengage Learning Publishers. ISBN-13: 9781305387102.
- Kumar DS. 2013. *Basics of Heat and Mass Transfer*. S K Kataria and Son Publishers. ISBN-13: 978-9350140604.

I. **Course Title : Physicochemical Processes**

II. **Course Code : DE 613**

III. **Credit Hours : 3+0**

IV. **Why this course?**

Physicochemical processes are like cog in the wheels of various unit operations. These help in deeper understanding of the various chemical unit operations and mass separation processes in the industry. This course will impart advance knowledge of mass transfer in various chemical engineering processes, which form the backbone of dairy and food engineering operations.

V. Aim of the course

- To develop understanding of advanced physical and chemical processes, their unit operations and design.

VI. **Theory**

Unit I

Types of separation processes; Adsorption process; Relationship between surface tension and adsorption, adsorption equilibrium and adsorption isotherm; Commercial adsorbents; Sorption kinetics in continuous flow reactors, factors influencing adsorption; Design of fixed adsorption columns and breakthrough adsorption curve.

Unit II

Membrane processing-computation of osmotic pressure of various solutions; Mathematical description of mass transport through

reverse osmosis membrane; Water and solute diffusion, mechanisms of membrane transport, membrane transport models; Factors affecting membrane performance: membrane properties, concentration polarization; Types of flow: difference between gas and liquid permeation processes; Extraction: Liquid-solid extraction, single and multi-stage extraction, liquid-liquid extraction, supercritical fluid extraction, classification and properties of supercritical fluids, design and applications.

Unit III

Electrodialysis: Minimum energy requirements, selective ion transport, power requirement of electrodialysis, design of an electrodialysis systems; Ion-exchange process: exchange resins, kinetics of exchange and resin capacity, equilibrium relations in ion exchange, ion-selectivity: Design of fixed bed ion exchange columns.

Unit IV

Aeration and gas transfer, gas transfer processes, rates of gas transfer, power requirement of aerations systems, film transfer, theories of gas transfer, liquid- phase transport involving chemical reactions.

VII. Learning outcome

The students will learn mass transfer in various physical and chemical processes which will help them to better understand dairy and food processing unit operations.

VIII. Suggested Reading

- Das H. 2008. *Food Processing Operation and Analysis*. Asian Books. ISBN-13: 978-8186299784.
- Don Green and Southard MZ. 2018. *Perry's Chemical Engineers' Handbook*, 9th Edition, McGraw-Hill Education. ISBN-13: 978-0071834087.
- Geankoplis CJ, Hersel AA and Lepek DH. 2018. *Transport Processes and Separation Process Principles*, 5th Edition, Pearson. ISBN-13: 978-0134181028.
- Martinez JL. 2007. *Supercritical Fluid Extraction of Nutraceuticals and Bioactive Compounds*, 1st Edition.CRC Press. ISBN -13: 978-0849370892.
- McCabe W, Smith J and Harriot P. 2017. *Unit Operations of Chemical Engineering*, 7th Edition, McGraw Hill Education, ISBN-13: 978-9339213237.
- Rao MA, Rizvi SSH. and Datta AK. 2014. *Engineering Properties of Foods*, 4th Edition, CRC Press, ISBN-13: 978-1466556423.
- Ruthven D M. 1984. *Principles of Adsorption and Adsorption*

Processes. John Wiley and Sons.
- Sinnot RK and Towler G. 2019. *Coulson and Richardson's Chemical Engineering: Chemical Engineering Design*. (Coulson and Richardson's Chemical Engineering). Elsevier. ISBN- 13: 978-9351073932.

I. Course Title : Computational Methods and Simulation in Dairy and Food Engineering

II. Course Code : DE 621

III. Credit Hours : 2+1

IV. Why this course?

With the advent of powerful computers and software, there is a paradigm shift in the computation and simulation methods used to solve complex and advanced problems in the field of dairy and food engineering. This is a mathematical course for engineers and scientists designed to solve various engineering and natural problems. It deals with the approximate solution formations of various mathematical models. This course is aimed to impart knowledge on the recent developments in Computational and Simulation techniques, with practical applications in the field of Dairy and Food Engineering.

V. Aim of the course

To develop competence in developing statistical/theoretical models.

VI. Theory

Unit I

Taylor's series expansion in development of numerical differentiation; numerical differentiation procedures, forward difference, backward difference, central difference.

Unit II

Numerical integration trapezoidal rule, Simpson's rule, improper integrals, Gauss- Legrendre Quadretuse method, numerical methods to solve ordinary differential equations.

Unit III

Euler method, improved Euler method, Runge-Kutta method, Adam's P-C method, initial value problems, numerical solution of partial differential equation: explicit method, implicit method.

Unit IV

Simulation concept, simulation methods and their limitations, statistical and theoretical models.

Unit V

Problem formulation and development of models; solution and validation of models; data collection; processing and analysis; basic

modeling problems on unit operations involved in dairy and food processing.

VII. Practical

- Solution to Taylor's series approximation
- Exercises on numerical differentiation – central difference, forward difference and backward difference
- Numerical integration by Simpson's rule, trapezoidal rule, Gauss-Legrendre approximation
- Exercises on Euler's method approximation
- Exercises on Runge-Kutta method
- Numerical solution to partial differential equations
- Problem solving on unit operations in dairy and food processing
- Application of computational software for solving numerical integration, differentiation and boundary layer problems
- Concepts of simulation and validation

VIII. Learning outcome

The skills and knowledge taught in this course are fundamentally useful to students who do simulations and research in computational engineering. The students will be trained on solving complex and advanced problems in the field of dairy and food engineering using computational and simulation approaches in software such as MATLAB, CFD, COMSOL Multiphysics, etc.

IX. Suggested Reading

- Balagurusamy E. 2017. *Numerical Methods*. McGraw Hill Education. ISBN-13: 978- 0074633113.
- Bober W. 2013. *Introduction to Numerical and Analytical Methods with MATLAB for Engineers and Scientists*. CRC Press. ISBN-13: 978-1466576025.
- Franks and Roger GE. 1972. *Modeling and Simulation in Chemical Engineering*. Wiley- Interscience.
- Gerald CF and Wheatley PO. 2007. *Applied Numerical Analysis*. 7th Edition. Addison Wesley. ISBN-13: 978-8131717400.
- Hamming RW. 1987. *Numerical Methods for Scientists and Engineers*. Dover Publications Inc. ISBN-13: 978-0486652412.
- Jain MK, Iyengar SR, Kanchi MB and Jain. 1993. *Computational Methods for Partial Differential Equations*, New Age Publishers. ISBN-13: 9788122404296.
- Kandaswamy P, Thilagavathy K and Gunavathi K. 2006. *Numerical Methods*. S. Chand and Company. ISBN-13: 978-8121914383.
- Kiusalaas J. 2015. *Numerical Methods in Engineering with MATLAB*. 3rd Edition, Cambridge University Press.

- Kobayashi H. 1978. *Modeling and Analysis: An Introduction to System Performance Evaluation Methodology*. Addison-Wesley Publishing. ISBN-13: 978-0201144574.
- Fausett LV. 2009. *Applied Numerical Analysis Using MATLAB*. 2nd Edition. Pearson Education India. ISBN-13: 978-8131728536.
- Sastry SS. 2015. *Introductory Methods of Numerical Analysis-Theory and Applications*. 9th Edition, Cengage learning, New Delhi.

X. Software

1. MATLAB version 9.6
2. CONSOL multi-physics version 5.4
3. CFD software like ANSYS, Fluidyn

I. Course Title : Package Permeability and Shelf-Life Modelling

II. Course Code : DE 622

III. Credit Hours : 3+0

IV. Why this course?

Traditional dairy products have very short shelf life due to poor packaging. Their shelf life can be improved by designing appropriate tailor made packaging. This course will impart the required knowledge on deteriorative reactions, their kinetics that affect the shelf life of the food and the design/ selection of appropriate flexible packaging materials for dairy products. Also, integration of water activity, deteriorative reactions and package permeability will be covered to predict the shelf life of foods.

V. Aim of the course

To impart knowledge on design of specific packaging for indigenous dairy products and to determine their shelf life.

VI. Theory

Unit I

Thermodynamics of water activity; Composition based water activity prediction models; determination of sorption isotherms; Moisture sorption types and hysteresis: Theory and Everett's classification of hysteresis, models for prediction of sorption isotherms; Composition based moisture sorption isotherm models.

Unit II

Temperature and moisture control in foods; Moisture management systems; Importance of temperature control and temperature management; Adiabatic saturation of air and its applications.

Unit III

Protective packaging of foods: Cushioning and G-factor, Use of moisture vapours permeability rates in design for a definite shelf-life; Design problems; Rates of deteriorative reactions and factors influencing them, prediction and simulation of shelf-life of foods; Validation of predictive shelf-life models.

Unit IV

Iterative procedures for moisture sensitive products, oxygen sensitive products; error analysis, water vapour permeability and oxygen barrier properties of composite packaging materials and fabricated package systems.

Unit V

Nanocomposites from biopolymers: production, mechanical properties and applications; Influence of nanocomposites and clays on barrier properties of packaging materials.

VII. Learning outcome

The students will acquire knowledge on design of packaging for indigenous dairy products and understand the intricacies among deteriorative reaction kinetics and package permeability affecting the shelf life of food. Also the students will learn about testing, prediction and validation of shelf life of dairy products in various packaging environment.

VIII. Suggested Reading

- Advani S. 2007. *Processing and Properties of Nanocomposites*. World Scientific. ISBN-13: 978-9812703903.
- Barbosa-Canovas G, Fontana AJ, Schmidt SJ and Labuza TP. 2007. *Water Activity in Foods- Fundamentals and Applications*. Blackwell Publishing.ISBN-13: 978-0-813-82408-6.
- Brennan JG. 2011. *Food Processing Handbook*. 2nd Edition, Wiley-VCH Verlag GmbH and Co. KGaA, Wienheim. Germany.ISBN-13:9783527324682.
- Karel M and Lund DB. 2003. *Physical Principles of Food Preservation*. 2nd Edition, CRC Press. ISBN-13: 978-0824740634.
- Fennema OR. 1976. *Principles of Food Science*. Part I and II. Marcel Dekker Inc. ISBN-13: 9780824763503.
- Robertson GL. 2015. *Food Packaging- Principles and Practice*. CRC Press. ISBN-13: 9781439862421.
- Simatos D and Multon JL. 2011. *Properties of Water in Foods in Relation to Quality and Stability*. Dordrecht: Martinus Nijhoff. ISBN-13**:** 9789401087568.

Suggested Broad Topics of Research

- Application of high pressure processing in indigenous dairy

products
- Pulsed electric field and pulsed light treatment of milk and indigenous dairy products
- Studies on irradiation of dairy products
- Application of thermo and manosonification during manufacture of dairy products
- Micro- and nanoencapsulation of active food ingredients
- Energy and exergy performance evaluation of evaporators and dryers.
- Performance evaluation of agitated tanks and solids blenders
- Performance evaluation of conveyor systems
- Design modifications and upgradation of process equipment for better performance
- Hygienic design solutions
- Design of evaporators and dryers
- Freezing of dairy products
- Simultaneous momentum, heat and mass transfer analysis of thermal processing of dairy products
- Application of computational methods for heat and mass transfer analysis and simulation of dairy process equipment
- Development of computer software for the performance analysis and design of heat exchange equipment.
- Biosensors, E-nose, machine vision and non-destructive analysis and evaluation of dairy products
- Application of MATLAB in design of biothermal processes and equipment
- Recovery of heat energy and reuse for improvement of efficiency in dairy plant
- Studies on use of heat pumps in dairy plant for energy conservation
- Water activity characterization of milk products
- Shelf life simulation and modelling of moisture and oxygen sensitive products
- Design of fermenters and aeration systems
- Design of improvised wastewater treatment techniques
- Model-based fault-detection for process engineering instrumentation
- Instrumentation for measurement of engineering properties of dairy and food materials
- Controlled atmosphere storage for enhancing the shelf-life of foods
- Non-thermal processing of dairy products
- Development of simulation models for various unit operations in

dairy and food processing.

- Engineering and rheological properties of food materials and characterization of food powders
- Extrusion technologies and sub-baric frying of dairy products
- Supercritical extraction of bioactive compounds
- Small scale milk processing equipment and farm level cooling and chilling systems
- Novel, edible and biodegradable packaging for dairy products
- Enhancement of thermal performance of dairy equipment by nanocoatings

List of Journals

- *Journal of Food Engineering*
- *Drying Technology*
- *Journal of Food Process Engineering*
- *Journal of Food Processing and Preservation*
- *International Dairy Journal*
- *LWT – Food Science and Technology*
- *Trends in Food Science and Technology*
- *Agricultural Engineering International*
- *Journal of Food Science and Technology*
- *Indian Journal of Dairy Science*
- *Indian Journal of Agricultural Engineering*
- *Food Research International*
- *European Food Research and Technology*
- *International Journal of Food Science and Technology*
- *Applied Thermal Engineering*
- *Heat and Mass Transfer*
- *International Heat and Mass Transfer*
- *Journal of Food Measurement and Characterization*
- *Industrial Crops and Products*
- *Industrial and Engineering Chemistry Research*
- *Powder Technology*
- *Advanced Powder Technology*
- *Journal of Encapsulation*
- *Biosystems Engineering*
- *International Journal of Dairy Technology*
- *Journal of Dairy Science*
- *Computers and Electronics in Agriculture*

Viscoelastic characterization of materials, stress-strain behaviour, creep, stress relaxation, solving problems on creep and stress relaxation of foods, non-Newtonian fluids; Viscometry-capillary and rotational viscometers, derivation on principle of operation of capillary and rotational viscometers, fitting of flow models; Rheometers: types and applications, temperature sweep, amplitude sweep and frequency sweep; identification of LV region. Freezing: IQF, Cryogenic freezing- process and equipment details, freezing curves, freezing time calculations, design of freezing equipment, freeze drying, freeze concentration. Design of single and multi-effect evaporators, design of TVR and MVR, design and selection of evaporator pumps, calculation of wetting rate, concept of condenser free design of evaporator, design of condenser (barometric and surface), flash vessel, preheater design for bacterial destruction, DSI, vacuum pump, concept of fan less cooling tower, aroma recovery unit. Design of spray drier and its components, design of three stage drier, selection of fans, roots blower, selection of nozzle, HPP cum homogenizer used for automation CIP, cleanable bag filter, concept of cyclone free spray drier operation, use of computer software in design of evaporators and spray driers. Viscoelastic characterization of materials, stress-strain behaviour, creep, stress relaxation, solving problems on creep and stress relaxation of foods, non-Newtonian fluids; Viscometry-capillary and rotational viscometers, derivation on principle of operation of capillary and rotational viscometers, fitting of flow models; Rheometers: types and applications, temperature sweep, amplitude sweep and frequency sweep; identification of LV region. Freezing: IQF, Cryogenic freezing-process and equipment details, freezing curves, freezing time calculations, design of freezing equipment, freeze drying, freeze concentration. Design of single and multi-effect evaporators, design of TVR and MVR, design and selection of evaporator pumps, calculation of wetting rate, concept of condenser free design of evaporator, design of condenser (barometric and surface), flash vessel, preheater design for bacterial destruction, DSI, vacuum pump, concept of fanless cooling tower, aroma recovery unit. Design of spray drier and its components, design of three stage drier, selection of fans, roots blower, selection of nozzle, HPP cum homogeniser used for automation CIP, cleanable bag filter, concept of cyclone free spray drier operation, use of computer software in design of evaporators and spray driers.

Novel processing methods and equipment: high pressure processing, ohmic heating, ultraviolet light, pulsed electric field, pulsed light field, micro and nano-encapsulation, microwave heating, cold plasma, ultrasound processing and low dose e-beams. Ultra-high temperature processing (UHT): concept, process, system; Design: plate and tubular type, their merits and demerits and selection; heat balances and concept of differential temperature; steam cleaning systems. Analysis of sterilization performance and validation, determination of residence

time distribution. Pouch forming, can and carton filling systems for UHT. Cleaning and sterilization of UHT processing plants.

Vapour compression refrigeration system: major components and their different types; Theoretical vapour compression cycle, theoretical COP; Effect of operating parameters on COP; actual vapour compression cycle; Multi-pressure commercial refrigeration systems. Vapour absorption refrigeration system; Ammonia-water system, lithium bromide - water system, vapour absorption refrigeration cycle and its representation on enthalpy-concentration diagram; Absorption system calculations. Heat Pumps: different heat pump circuits; analysis of heat pump cycle; Use of heat pumps in dairy plant for energy conservation. Design elements of refrigeration equipment: compressor, condenser, evaporator, cooling tower, spray pond, etc. Balancing of different components.Design of cold storage and air-conditioning systems: types of cooling loads and their calculation, design of cold storage for food products, construction of cold storage, equipment selection, insulating materials, vapour barriers, ice bank tank. Concept of Ice silos. Control and maintenance of a commercial refrigeration plant: Pressure regulating valves, Thermostatic valves, LP/ HP cut-outs, high to low side bypass valve, condenser water regulating valve, capacity control devices, pump down control, defrosting methods, liquid charging, advanced intelligent control systems; General preventive maintenance of refrigeration plant.

Design of vessels: codes and regulations, Design for pressure and temperature, loading; allowable stress, minimum thickness after forming, design for internal and external pressure, cylindrical and spherical shells, formed heads, reinforcement openings; fabrication requirements, inspection, tests and non-destructive examination, pressure tests, design and stress evaluation, design problem. Design of storage vessels/ tanks, horizontal and vertical tanks, design of insulated and un-insulated tanks, nozzles and mountings, Design problems. Design of high-pressure vessels: constructional features, material for high pressure, multi shell construction, solid walled vessel. Supports for vessel: bracket support or Lug support, web (gusset plates), skirt support, skirt design, skirt bearing plate, saddle support, Design problems. Heat exchangers: shell and tube heat exchangers, construction codes, general design considerations, U-tube heat exchangers, double pipe exchanger, scraped surface exchanger, spiral tube exchangers, joints; welded tube joints, baffles and tube bundles, tube sheet, double tube sheet construction; plate type heat exchanger; air cooled heat exchangers; Computer software for design of heat exchanger, Design problems. Design of reactor vessel: material of construction, agitation, classification, heating systems, design consideration, tank coils, design of agitation system components, baffles, power requirement for agitation, Hygienic engineering design. Fundamentals of CAD/ CAM for design of dairy and food processing equipment.

Geometrical Properties; Shape, size, volume, density, porosity, surface areas,

friction, rolling resistance, angle of repose, specific surface area, mean diameter, sphericity, particle size analysis, Hausner's ratio, Carr's index. Aerodynamic, Hydrodynamic and Frictional Properties; Drag coefficient, terminal velocity, Relation between drag coefficient and Reynolds number, terminal velocity from time distance relation. Pressure drop through packed beds. Thermal properties; Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow, enthalpy, surface heat transfer coefficient freezing point. Measurement of thermal properties and prediction techniques. Electrical conductivity, capacitance, inductance, Dielectric properties, viz. dielectric and microwave, dielectric constant, Dielectric loss factor, loss tangent, energy absorption, heating; Optical properties, colorimetry, transmittance and reflectance. Non-destructive quality evaluation techniques; Measurement techniques and instruments for food quality determination, destructive and non-destructive quality evaluation, UV-VIS NIR spectroscopy, X-ray, CT, NMR, machine vision system. FTIR, DSC, machine vision system, particle size determination by laser diffraction, e-nose, biosensors, etc. Application of engineering properties in equipment design, processing and handling of dairy and food products.

Water activity and states: a thermodynamic quantity, water sorption isotherms, hysteresis, theories of sorption hysteresis, water activity measurement methods, water binding, control of water activity and moisture; Relationship between water activity and glass transition. Diffusion and sorption kinetics of water in foods. Different types of packaging materials, their key properties and applications, Plastic packaging, different types of polymers used in food packaging and their barrier properties. Recent innovations in packaging, identification and testing of packaging materials. Permeability and shelf-life: theoretical considerations, permeability to gases and vapours, measurement methods, permeability of multiplayer materials, permeability in relation to packaging requirements of food products. Development of shelf-life models based on moisture gain, lipid oxidation and light. Calculation of shelf life and requirements for packaging, deteriorative reactions accelerated testing, relationship between transport properties of the package and shelf life of packaged products, simulation of product package- environment interaction, shelf life simulation for moisture, oxygen and light sensitive products. Theory of ultra-filtration, reverse osmosis and electrodialysis, selection and types of membrane and properties, concentration polarization, mathematical description of flow through membrane, application and use in dairy industry. Design calculation and selection of various membrane systems. Microwave energy absorption, physical parameters in microwave heating processes, heat transfer phenomena, equipment and application in dairy food industry. Types of waveguides, electromagnetic resonators and microwave tubes.

Introduction; Instrumentation systems and its classification, measuring instruments, characteristics of instruments, intelligent versus dumb instruments,

Microprocessor based instrumentation, Function of measurement systems, its elements and applications. Industrial instrumentation, Structure of industrial instrumentation in real time applications. Control Systems; Feedback principles. Mechanical, hydraulic and pneumatic system components. Characteristics of liquid system, gas system, thermal system. Mathematical model of liquid process, gas process, flow process, thermal process, mixing process, Chemical reaction, D.C. and A.C. Servomotors, D.C. and A.C. Tachogenerators, Potentiometers and optical encoders, Synchro and stepper motors, Modelling and objectives of modelling for batch and continuous processes, Selfregulation. Pneumatic valves. Process Control and Controllers; Principles of automatic process control, Process characteristics, control system parameters, Process control loop, Elements of process control, process variables, Process facility considerations, controller modes, lag time, error signals, and correction signals, Actuators and Control valves; on-off, P, PI, P-ID, cascade, feed forward, and ratio controllers, Fuzzy controllers. Data loggers and data acquisition, Introduction to computer based control systems, PLC, DCS, SCADA, HMI, etc. Modern Transducers and Display Devices; Silicon micro transducers, optical transducer principles, types, characteristics of fibres and fibre optic transducers, Introduction to smart transducers and their applications, displays and their classification - Storage CRTs, Flat CRTs, LEDs, LCD display, Gas discharge plasma displays, Incandescent display, Electrophoretic image displays (EPID), Liquid vapour display (LVD). Introduction to computer based control; Computer based controller, data logging, supervisory control, flow chart, control system networks, basic structure and operation of programmable logic controllers (PLCs).

Waste water sources, characteristics, standards for disposal of dairy waste water. Physical, chemical and biological characteristics of waste water, measurement of organic content in waste water. Physical unit operations in waste water treatment: screening, racks, mixing, flocculation, sedimentation, floatation, elutriation, vacuum filtration and incineration. Chemical unit operations in waste water treatment: reaction kinetics, chemical precipitation, aeration and gas transfer process, rate of gas transfer, adsorption and disinfection. Biological unit operations- aerobic and anaerobic cycles, kinetics of biological growth, application of kinetics to treatment systems, aerobic waste treatment, anaerobic waste treatment. Air conditioning systems: clean – room air conditioning; important pollutants of air; properties of particulate matter and air pollution control methods. Dairy plant fire hazards.

Dairy Chemistry

DEPARTMENT OF DAIRY CHEMISTRY
Semester-wise M.Tech. Courses

Course Code	Course Title	Credit Hours	Semester
DC 511	PHYSICO-CHEMICAL ASPECTS OF MILK CONSTITUENTS	2+1	I
DC 512*	MILK CARBOHYDRATES, MINERALS AND WATER SOLUBLE VITAMINS	2+1	I
DC 513*	CHEMISTRY OF MILK LIPIDS	2+1	I
DC 514*	CHEMISTRY OF FOOD CONSTITUENTS	2+1	I
DC 521*	CHEMISTRY OF MILK PROTEINS	3+1	II
DC 522*	CHEMISTRY OF PROCESSED DAIRY FOODS	3+1	II
DC 523	CHEMICAL QUALITY ASSURANCE AND MANAGEMENT TOOLS	2+1	II
DC 524*	RESEARCH TECHNIQUES	1+2	II
DC591	MASTER'S SEMINAR	1+0	I and II
DC 599	MASTER'S RESEARCH	0+30	I and II
***compulsory courses**			

DEPARTMENT OF DAIRY CHEMISTRY
Semester-wise Ph.D. Courses

Course Code	Course Title	Credit Hours	Semester
DC 611*	ADVANCES IN CHEMISTRY OF MILK PROTEINS	3+0	I
DC 612*	ADVANCES IN CHEMISTRY OF MILK LIPIDS	3+0	I
DC 621*	ADVANCES IN CHEMISTRY OF DAIRY PROCESSING	3+0	II
DC 622*	ADVANCES IN ANALYTICAL TECHNIQUES IN DAIRY CHEMISTRY	3+0	II
DC 691	DOCTORAL SEMINAR-I	1+0	I and II
DC692	DOCTORAL SEMINAR-II	1+0	I and II
DC 699	DOCTORAL RESEARCH	0+75	I and II
***compulsory courses**			

Course Contents
M.Tech. in Dairy Chemistry

I. **Course Title : Physico-Chemical Aspects of Milk Constituents**

II. **Course Code : DC 511**

III. **Credit Hours : 2+1**

IV. **Why this course?**

This course will help the students while working in dairy industry/research institutes for better understanding of behaviour of milk constituents with respect to their chemical reactions and physical state. This course is going to cover all these aspects.

V. **Aim of the course**

To impart knowledge on the physico-chemical aspects of milk and milk products with special reference to their processing and quality assurance.

The course is organized as follows:

No.	Blocks	Units
1.	Reaction Kinetics	I Chemical and Enzymatic reactions II Electrochemistry
2.	Surface and colloidal Chemistry	III Surface Chemistry IV Foams and Emulsions V Micelles and Gelation

VI. **Theory**

Block 1: Reaction Kinetics

Unit I: Chemical and Enzymatic reactions

Basics of chemical reaction kinetics, Order and molecularity of a reaction. Kinetics of denaturation of whey proteins and Maillard browning. Kinetics of enzymatic reactions; the role of enzymes as biological catalysts; factors affecting the rate of enzyme reaction: concentration of substrate, concentration of enzyme, concentration of reaction products, pH, temperature, time, activators and inhibitors. Thermal inactivation of enzymes present in milk. Concept of activation energy

Unit II: Electrochemistry

Electrolytic dissociation: activity, ionic strength and dissociation constants of acids and bases; effect of ionic strength on dissociation constants. Buffer, buffer capacity and buffer index of milk and milk products. Redox reactions and photo-oxidation of milk.

Block 2: Surface and colloidal Chemistry

Unit III: Surface Chemistry

Adsorption at solid – vapour interphase; Monolayer and multilayer adsorption; capillary condensation; adsorption isotherms; Hysteresis. Sorption of water on milk constituents and milk products and its relation to stability of dairy products.

Unit IV: Foams and Emulsions

Colloidal and surface phenomena in milk; adsorption at solid-liquid and liquid- liquid interphases; Gibb's equations. Interfacial tension, surface tension, surface active agents, general aspects of foaming, churning and whipping of cream; emulsion and emulsion stability; coalescence and dispersion; an introduction to the concept of Nano emulsion and Nano micelles.

Unit V: Micelles and Gelation

Micelles: definition, critical micelle concentration, formation and stability; Colloidal stability of casein micelles in milk, zeta potential, size distribution of casein micelles and fat globules. Gels and their formation, structure and stability; acid and rennet gels.

VII. Practical

- Determination of the order of hydrolysis of an ester and measurement of activation energy.
- Measurement of the order of hydrolysis of a carbohydrate and measurement of activation energy.
- Assessment of the progress curve obtained during the hydrolysis of p-nitrophenyl phosphate by milk alkaline phosphatase.
- Analysis of effect of substrate concentration on hydrolysis of p-nitrophenyl phosphate by milk alkaline phosphatase.
- Study of effect of enzyme concentration on hydrolysis of p-nitrophenyl phosphate by milk alkaline phosphatase.
- Michaelis constant determination for the digestion of casein by trypsin.
- Measurement of pH and buffering capacity of different types of milk.
- Preparation of a buffer of a given molarity/ionic strength and pH and determination of pH of the buffer.
- Stability analysis of an oil-in-water emulsion stabilised by milk proteins
- Foaming capacity and foam stability of caseins/whey proteins.
- Study of the gel formation and gel stability of milk proteins.
- Drawing of an adsorption isotherm of water on casein.
- Measurement of thermal inactivation of enzymes (Alkaline phosphatase, Lactoperoxidase).

VIII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work
- Guest Lectures

IX. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Apply basics of reaction kinetics in understanding different phenomenon in milk during processing and storage.
- Role of different constituents of milk in formation and stability of emulsions, foams and gel

X. Suggested Reading

- Ancheyta J. 2017. *Chemical Reaction Kinetics: Concepts, Methods and Case Studies*. John Wiley and Sons.
- Dickinson E. 1995. *Food Macromolecules and Colloids*, RSC Special Publication.
- Dickinson E. 2005. *Food Colloids: Interactions, Microstructure and Processing*, RSC advancing chemical series.
- Fox PF, Uniacke-Lowe T, McSweeney PLH and O'Mahony JA. 2015. *Dairy Chemistry and Biochemistry*. Springer International Publishing-Switzerland.
- McClements DJ. 2016. *Food Emulsions: Principles, Practices and Techniques*, 3rd Edn, CRC press Taylor and Fracis group.
- Puri BR, Sharma LR, Pathania MS. 2016. *Principles of Physical Chemistry,* 47th Edition Vishal Publishing Co.
- Rockland LB and Beuchat LR. 1987. *Water Activity: Theory and Applications to Food*, Marcel Dekker Inc, NY.
- Walstra P and Jenness R. 1984. *Dairy Chemistry and Physics*. John Wiley and Sons.

I. Course Title : Milk Carbohydrates, Minerals and Water Soluble Vitamins

II. Course Code : DC-512

III. Credit Hours : 2+1

IV. Why this course?

This coursewill givean overview of carbohydrates, minerals and vitamins present in milk. This knowledge will help the students to understand the various physicochemical reactions occur during processing and storage of dairy foods.

V. Aim of the course

To impart basic knowledge on aspects of milk carbohydrates,

minerals and water soluble vitamins and to project the importance of these milk constituents on the quality of milk and milk products as well as in human health.

The course is organized as follows:

No.	Blocks	Units
1.	Lactose	I. Chemistry of lactose
		II. Physical properties of lactose
		III. Chemical properties of lactose
2.	Mineral	IV. Minerals in milk
		V. Physical equilibrium amongst milk salts
		VI. Effect of Processing on Minerals
3.	Vitamins	VII. Water soluble vitamins:

VI. Theory

Block 1: Lactose

Unit I: Chemistry of lactose

Lactose: occurrence, isomers, molecular structure, levels in milk of different species.

Unit II: Physical properties of lactose

Physical properties of lactose: crystalline habits, hydrates, lactose glass, specific rotation, equilibrium of different isomers in solution, solubility, density, sweetness.

Unit III: Chemical properties of lactose

Chemical properties of lactose: hydrolysis; Pyrolysis; Oxidation; Reduction; Degradation with strong bases; Derivatives; Dehydration and Fragmentation; Browning reaction; Oligosaccharides in milk-health significance.

Block 2: Mineral

Unit IV: Mineral in Milk

Minerals: major and minor minerals; Factors affecting variation in salt composition of milk; Distribution and importance of trace elements in milk.

Unit V: Physical equilibrium amongst milk salts

Physical equilibrium amongst milk salts; Effect of various treatments on salt equilibrium; Partitioning of salts and factors affecting them.

Unit VI: Effect of Processing on Minerals

Salt balance and its importance in the processing of milk; Protein-

mineral interactions.

Block 3: Vitamins

Unit VII: Water soluble vitamins

Water soluble vitamins: molecular structure, levels in milk and milk products; factors affecting their levels; Biological significance; Ascorbic acid structure; Relation with redox potential (Eh) of milk and milk products.

VII. Practical

- Estimation of lactose in milk by volumetric method
- Estimation of lactose in milk by gravimetric method
- Estimation of lactose in milk by polarimetric method
- Estimation of lactose in milk by colorimetric methods
- Determination of sodium and potassium by (flame photometry)
- Determination of calcium and magnesium by EDTA method
- Determination of phosphorus by colorimetric method (Fiske and Subba Rao)
- Estimation of citric acid by colorimetric methods
- Determination of iron by colorimetric methods
- Estimation of vitamin C in milk by volumetric method
- Determination of HMF content in heated milk

VIII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work
- Guest Lectures

IX. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Appreciate the significance of milk as a source of carbohydrates, minerals and water soluble vitamins.
- Understand the importance of these constituents in chemical, physical, technological, nutritional and physiological properties of milk.

- Fox PF, Uniacke-Lowe T, McSweeney PLH and O'Mahony JA. 2015. *Dairy Chemistry and Biochemistry*. Springer International Publishing-Switzerland.
- Jennes RG. 1995. *Handbook of Milk Composition*. Academic Press.
- McSweeney PLH and Fox PF. 2009. *Advanced Dairy Chemistry Volume 3: Lactose, Water, Salts and Minor Constituents.* Springer-Verlag New York.

- Paques M and Lindner C. (Eds.). 2019. Lactose: Evolutionary Role, Health Effects, and Applications. Academic press.
- Walstra P and Jenness R. 1984. *Dairy Chemistry and Physics*. John and Wiley.
- Watson RR, Collier RJ and Preedy VR. (Eds.). 2017. Nutrients in dairy and their implications for health and disease. Academic Press.
- Young W. Park and George F.W. Haenlein. 2013. *Milk and Dairy Products in Human Nutrition*. John Wiley and Sons, UK.
- Zadow JG. 1992. *Whey and Lactose Processing*. Elsevier Science Publishers Ltd- Springer Netherlands.

I. **Course Title : Chemistry of Milk Lipids**
II. **Course Code : DC 513**
III. **Credit Hours : 2+1**
IV. **Why this course?**

The course will provide in-depth coverage of milk lipids. It makes the students capable to understand various chemical reactions occur during processing and storage of milk and milk products. This course is going to cover all these aspects.

V. **Aim of the course**

To impart the basic knowledge on different aspects of milk lipids and to project the importance of milk lipids in the quality of dairy products as well as in human health.

The course is organized as follows:

No.	Blocks	Units
1.	Milk Lipids	I. Classification of milk lipids
		II. Properties of milk lipids
		III. Unsaponifiable matter
2.	Chemical properties of milk lipids	IV. Chemical Reaction of milk fat
		V. Oxidation of milk fat

VI. **Theory**

Block 1: Milk Lipids

Unit I: Classification of milk lipids

Milk lipids: General classification, neutral and polar lipids (phospholipids) in milk, gross composition of milk lipids in different species, physico-chemical properties of milk lipids; role of major milk lipids in milk and milk products and biological significance of milk lipids; Composition of milk fat globule membrane.

Unit II: Properties of milk lipids

Fatty acid profile of milk lipids; factors affecting the profile of fatty acids; Different properties of fatty acids

Unit III: Unsaponifiable matter

Unsaponifiable matter and its importance; Composition of unsaponifiable matter; Chemistry, levels and physiological functions of sterols; Fat soluble vitamins and carotenoids in milk.

Block 2: Chemical properties of milk lipids

Unit IV: Chemical Reaction of milk fat

Chemical properties of milk lipids: hydrolysis by alkali, water and enzymes; hydrogenation, halogenation, transesterification, inter-esterification and fractionation.

Unit V: Oxidation of milk fat

Autoxidation: Definition, theories, induction period, secondary products of autoxidation, factors affecting, prevention and measurement; various methods for evaluating primary and secondary oxidation products; Antioxidants: Definition, types, reaction mechanism and estimation. Thermal oxidation of fat

VII. Practical

- Determination of melting point/slip point and B.R reading of milk fat.
- Determination of conjugated dienes, peroxide value and anisidine value of milkfat.
- Analysis of milk fat for its thiobarbituricacid-(TBA) value.
- Estimation of carbonyl value of milk fat
- Determination of unsaponifiable matter in milk fat.
- Total cholesterol estimation in milk fat.
- Determination of vitamin A and D in milk fat
- Estimation of total phospholipids and free fatty acids in milk fat.
- Preparation of fatty acid methyl esters and their analysis by GLC.
- Quantitative determination of butylatedhydroxylanisole (BHA) in milk fat.

VIII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work
- Guest Lectures

IX. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the basic aspects of milk lipids in terms of quality

of dairy products and human health
- Understand the different reactions taking place during processing and storage of milk fat

X. Suggested Reading

- Akoh CC and Min DB. 1997. *Food Lipids: Chemistry, Nutrition and Biotechnology*. Marcel Dekker.
- Fox PF and McSweeney PLH. 2006. *Advanced Dairy Chemistry Volume 2: Lipids*. Springer- US.
- Fox PF, Uniacke-Lowe T, McSweeney PLH and O'Mahony JA. 2015. *Dairy Chemistry and Biochemistry*. Springer International Publishing-Switzerland.
- Mathur MP, Datta Roy D and Dinakar P. 1999. *Text Book of Dairy Chemistry*. ICAR.
- Truong T, Lopez C, Bhandari B and Prakash S. 2020. *Dairy Fat Products and Functionality*.
- Walstra P and Jenness R. 1984. *Dairy Chemistry and Physics*. John Wiley and Sons.
- Wong NP, Jenness R, Keeney M and Elmer HM. 1988 *Fundamentals of Dairy Chemistry*. Van Nostrand Reinhold Co.

I. Course Title : Chemistry of Food Constituents

II. Course Code : DC 514

III. Credit Hours : 2+1

IV. Why this course?

This course will help the students to get more insight into chemistry of food constituents such as water, carbohydrates, protein, lipids, phytochemicals and food additives. This course will also enrichthe knowledge of students for working in food industry/research institutes for better understanding of processed food products development.

V. Aim of the course

To impart knowledge on different chemical aspects of food components The course is organized as follows:

No.	Blocks	Units
1.	Major Constituents of Foods	I. Water
		II. Carbohydrates
		III. Proteins
		IV. Food Lipids
2.	Minor constituent of foods	V. Phyotchemicals
		VI. Food Additives

VI. Theory

Block 1: Major Constituents of FoodsUnit I: Water

Water: Forms of water in foods; water- solute interactions, and food stability in relation to water activity; solute mobility; property of ice crystals; role of ice in the stability of food at sub-freezing temperatures.

Unit II: Carbohydrates

Carbohydrates: Starch; Types, swelling behaviour, gelatinization and their role in bread making; modification of starches for industrial applications, physico-chemical changes taking place during malting. Oligosaccharides: Structural units of commercially available oligosaccharide, their properties and preparation methods, Hydrocolloids, their properties and utilization in different food preparations; mutual interactions among hydrocolloids and interactions with proteins.

Unit III: Proteins

Proteins: Classification, distribution and physico-chemical properties of food proteins from various sources; structure-function relationship and their modifications; denaturation of food proteins. Application of enzymes in food Industry; Immobilized enzymes, Browning reactions in foods: enzymatic browning and non-enzymatic browning (caramelization and maillard reaction).

Unit IV: Food Lipids

Food Lipids: Physico-chemical properties of food lipids and their modifications; Composition of various types of edible oils/fats with special reference to their quality; auto-oxidation of food lipids.

Block 2: Minor constituent of foods

Unit V: Phyotchemicals

Phytochemicals: Chemistry of polyphenols, phenolic acid, flavonoids, phytosterols, phytostanol.

Unit VI: Food Additives

Food Additives: Sweeteners, anticaking agents, antioxidants, humectants, preservatives, neutralizers, stabilizers, emulsifiers, texture modifiers, flavours and colours etc.

VII. Practical

- Estimation of fat content in cereal products by Soxhlet method.
- Determination of total nitrogen in cereal products.
- Determination of gluten content in wheat flour.
- Analysis of starch in flour by polarimetric method.
- Estimation of crude fibre in food product.
- Determination of polyphenol content in tea and coffee.
- Determination of antioxidant activity in various foods using

DPPH/FRAP methods

- Detection of adulteration of mustard oil with argemone oil.
- Detection of artificial colours in various spices.
- Determination of level of artificial sweeteners (saccharin and aspartame)
- Visit to a food plant.

VIII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work
- Guest Lectures

IX. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Forms of water in food and its role in stability of food during storage at low temperature
- Types of carbohydrates, proteins, lipids in various types of foods, changes in such constituents during processing, interaction of carbohydrates and proteins, application of enzymes in food industry including immobilization of enzymes
- Types of phytochemicals in foods and role of additives to impart various functions in foods.

X. Suggested Reading

- Belitz HD, Grosch W and Schieberle P. 2004. *Food Chemistry*. 3rd Ed. Springer.
- Connie M. Weave. 2017. *The Food Chemistry Laboratory: A Manual for Experimental Foods,* Dietetics, and Food Scientists, Second Edition CRC Press.
- Damodaran S, Parkin KL and Feenema OR. 2008. *Fennema's Food Chemistry*. 4th Ed. CRC Press.
- Dwidvedi A. 2016. *Enzyme Immobilization: Advances in Industry, Agriculture, Medicine, and the Environment*. 1st edition. Springer.
- Fennema OR. 1985. *Food Chemistry*. Marcer Dekker.
- Peter CK and Bhavbhuti M. 2015. *Handbook of Food Chemistry.* Springer-Verlag Berlin Heidelberg.
- Srinivas D and Alan Praf. 1997. *Food Proteins and their Applications*. Marcel Dekker.
- Velisek J, Koplik R and Cejpek K. 2020. *The Chemistry of Food.* John Wiley and Sons.

I. **Course Title : Chemistry of Milk Proteins**

II. **Course Code : DC 521**

III. **Credit Hours : 3+1**

IV. **Why this course?**

This course will help the students of dairying to get more insight into chemistry of milk proteins and in understanding the various physicochemical reactions occur during milk processing. This course is going to cover all these aspects.

V. **Aim of the course**

To impart knowledge on different aspects of milk proteins The course is organized as follows:

No.	Blocks	Units
1.	Milk proteins	I. Basic concept of milk proteins
		II. Major milk proteins
		III. Whey proteins
		IV. Minor milk proteins
2.	Properties of milk proteins	V. Denaturation of proteins
		VI. Enzymes

VI. **Theory**

Block 1: Milk proteins

Unit I: Basic concept of milk proteins

Milk proteins of different species and their variability. Distribution and fractionation of different nitrogen fractions of milk proteins; nomenclature of milk proteins; genetic polymorphism and biological significance of milk proteins.

Unit II: Major milk proteins

Major milk proteins: caseins (acid and micellar), methods of isolation; Fractionation of casein and heterogeneity; Physico-chemical properties; amino acid composition; Casein micelle models; Primary structure of different caseins; Modification of casein: Physical, chemical (glycosylation, phosphorylation) and enzymatic.

Unit III: Whey proteins

Alpha-lactalbumin and beta-lactoglobulin, bovine serum albumin: distribution and methods of isolation and their physico-chemical properties.

Unit IV: Minor milk proteins

Minor milk proteins: Proteose-peptone, immunoglobulins, lactoferrin, and fat globule membrane proteins.

Block 2: Properties of milk proteins

Unit V: Denaturation of proteins

Denaturation of milk proteins, various factors affecting denaturation; Casein-whey protein interactions.

Unit VI: Enzymes

Indigenous milk enzymes: Properties and their significance with particular reference to lipases, proteases, phosphatases, catalase, peroxidase, xanthine oxidase, lysozyme, lactoperoxidase and galactosyltransferase

VII. Practical

- Estimation of different nitrogen fractions of milk by Kjeldahl method.
- Preparation of acid and rennet casein; urea fractionation of acid casein; isolation of alpha-lactalbumin and beta-lactoglobulin by ammonium sulphate precipitation.
- Milk protein estimation by Folin method.
- Polyacrylamide gel electrophoresis of milk proteins.
- Assay of indigenous milk enzyme activity like protease, lipase, alkaline phosphatase and lactoperoxidase.
- Estimation of hexoses and sialic acid in casein.
- Measurement of degree of hydrolysis of milk proteins.
- Measurement of denaturation of whey proteins.

VIII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work
- Guest Lectures

IX. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the basic aspects of milk proteins in terms of major and minor milk proteins
- Understand the effect of different processing of milk on interaction of milk proteins

X. Suggested Reading

- Boland M and Singh H. (Eds.). 2019. Milk proteins: from expression to food. Academic Press.
- Fox PF, Uniacke-Lowe T, McSweeney PLH and O'Mahony JA. 2015. *Dairy Chemistry and Biochemistry*. Springer International Publishing-Switzerland.
- Mathur M, Datta Roy D and Dinakar P. 1999. *Text Book of Dairy Chemistry*. ICAR.

- McSweeney PLH, O'Mahony and James A. 2013. *Advanced Dairy Chemistry Volume 1A: Proteins: Applied Aspects*. Springer-Verlag, New York.
- McSweeney PLH, O'Mahony and James A. 2016. *Advanced Dairy Chemistry Volume 1B: Proteins: Applied Aspects*. Springer-Verlag, New York.
- Robert G Jensen 1991. *Handbook of Milk Composition*. Academic Press.
- Wong NP, Jenness R, Keeney M and Elmer HM. 1988 *Fundamental of Dairy Chemistry*. 3rd Ed. Van Nostrand Reinhold Co.

I. **Course Title : Chemistry of Processed Dairy Foods**
II. **Course Code : DC 522**
III. **Credit Hours : 3+1**
IV. **Why this course?**

To gain insights in the underlying chemical changes during processing of milk for preparation of concentrated, dried, fermented and fat rich dairy products and frozen desserts. This course is going to cover all these aspects.

V. **Aim of the course**

To understand the physico-chemical changes and effects of various milk constituents of milk products during manufacture and storage of processed dairy foods.

The course is organized as follows:

No.	Blocks	Units
1.	Concentrated and Dried milks	I. Process induced changes in concentrated and dried milks II. Human milk and infant food III. Heat induced changes in milk
2.	Chemistry of Dairy Products	IV. Cheese and other fermented dairy products V. Cream, butter and ghee VI. Ice cream and frozen desserts

VI. **Theory**

Block 1: Concentrated and Dried milks

Unit I: Process induced changes in concentrated and dried milks

Process induced changes in milk constituents during preparation and storage of concentrated and dried milks.

Unit II: Human milk and infant food

Role of biologically active components in human milk; Standards,

composition and properties of infant milk and infant food formulations

Unit III: Heat induced changes in milk

Heat induced changes in milk leading to coagulation; Heat stability of concentrated milk as affected by different process variables, Milk constituents and additives; Age gelation: Mechanism and control.

Block 2: Chemistry of Dairy Products

Unit IV: Cheese and other fermented dairy products

Biochemical changes during ripening of different varieties of cheese; Lactic acid fermentation in cheese and other fermented dairy products; chemical defects in cheese.

Unit V: Cream, butter and ghee

Storage stability of cream, butter and ghee. Physico-chemical properties of ghee; Ghee flavour, texture (grains) and colour in ghee.

Unit VI: Ice cream and frozen desserts

Role of different ingredients during processing and storage of ice cream/ frozen desserts; Concept of antifreeze protein/ice structuring protein in ice cream

VII. Practical

- Determination of lactose and sucrose in condensed milk and ice-cream.
- Determination of weight per litre of ice-cream.
- Determination of heat stability of milk and concentrated milks.
- Determination of WPNI of skim milk powder.
- Determination of fat in cream and butter by Mojonnier method.
- Determination of salt in butter.
- Determination of diacetyl and acetyl methyl carbinol in butter/ cultured products.
- Determination of RM, Polenske value, iodine value, saponification value of ghee.
- Determination of soluble proteins, salt and free fatty acids in cheese.
- Determination of rennet clotting time of milk.

VIII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work
- Guest Lectures

IX. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the basic aspects of dairy chemistry in terms of processing of different dairy products
- Understand the different reactions taking place during storage of dairy products

X. Suggested Reading

- Fox PF, Uniacke-Lowe T, McSweeney PLH and O'Mahony JA. 2015. *Dairy Chemistry and Biochemistry*. Springer International Publishing-Switzerland.
- Koca N. (Ed.). 2018. *Technological Approaches for Novel Applications in Dairy Processing*. BoD–Books on Demand.
- Mathur MP, Roy DD and Dinakar P. 1999. *Textbook of Dairy Chemistry*. ICAR.
- Official methods of AOAC. 11th and 15th Eds.
- Walstra P and Jenness R. 1984. *Dairy Chemistry and Physics*. John Wiley and Sons.
- Wong NP, Jeness R, Keeney M and Elmer HM. 1988. *Fundamentals of Dairy Chemistry*. Van Nostrand Reinhold Co.

I. Course Title : Chemical Quality Assurance and Management Tools

II. Course Code : DC 523

III. Credit Hours : 2+1

IV. Why this Course?

The course will provide in depth knowledge in preparing the reagents, testing methodologies and quality tools to understand the concept of 'Quality Assurance' in dairy industries. This course is going to cover all these aspects.

V. Aim of the course

To project the importance of chemical quality assurance and safety in relation to dairy industry and impart basic knowledge on all aspects of chemical quality and safety assurance

The course is organized as follows:

No.	Blocks	Units
1.	Quality Management Tools and Quality Assurance Organizations	I. Quality Tools and Management System II. International and National organisations
2.	Analytical Methods	III. Assessment of Quality of milk and milk products IV. Contaminants and Food Traceability

VI. **Theory**

Block1: Quality Management Tools and Quality Assurance Organizations Unit I: Quality Tools and Management System

Concept of quality assurance and quality control in relation to dairy industry; Quality management systems - good manufacturing practices (GMP); HACCP certification; ISO 9001, ISO 22000, FSSC, total quality management (TQM); Lean and Six sigma, Five –S, Kaizen, Kanban and other quality tools; Good laboratory practices (GLP), laboratory accreditation

Unit II: International and National Organisations

Role of international organisations such as ISO, IDF, CAC, AOAC, WTO and national organisations like BIS, FSSAI, AgMark and APEDA in dairy industry, Quality Council of India (QCI), Export Inspection Council (EIC); Guidelines for setting up quality control laboratory and chemical safety aspects; sampling of milk and milk product; Food labeling guidelines.

Block 2: Analytical Methods

Unit III: Assessment of Quality of milk and milk products

Detergents, sanitizers and disinfectants; Calibration of milk testing glassware; Preparation of standard reagents; Detection of adulterants in milk and milk products; Quality of packaging material for dairy products; Instrumentation in analysis of milk and milk products.

Unit IV: Contaminants and Food Traceability

Agro-chemicals/veterinary drug residues; occurrence of pesticide residues, antibiotic residues, heavy metals etc. in dairy products and their testing methods, Laboratory auditing, Food traceability systems, Food recall and withdrawal

VII. **Practical**

- Preparation of standard solutions

- Testing of available chlorine content in hypochlorites/ bleaching powder
- Determination of purity of common salt to be used for butter and cheese making
- Detection of common adulterants in milk and foreign fat/ oil in ghee
- Checking the accuracy of calibration of hydrometers/ lactometers, butyrometers, milk pipette and thermometer
- Qualitative colour tests to distinguish between azo dyes and natural dyes in butter
- Maintenance of records as per NABL and ISO criteria.
- Visit to a food analytical laboratory.

VIII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work
- Guest Lectures

IX. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the requirements and policy relating to implementation of various quality management tools.
- Apply the food safety standards to specific situations

X. Suggested Reading

- Hoorfar J. 2012. *Case Studies in Food Safety and Authenticity*. 1st Ed. Woodhead Publishing
- IDF. 1993. *Quality Assurance* (*QA*) *and Good Lab. Practices* (*GLP*) *in Dairy Laboratories*. Special Issue No. 9302.
- IDF. 1997. *Monograph on Residues and Contaminants in Milk and Milk Products.* Special Issue No. 9701.
- Konieczka P and Namiesnik J. 2018. *Quality Assurance and Quality Control in The Analytical Chemical Laboratory: A Practical Approach*. CRC Press.
- Ralph Early. 1995. *Guide to Quality Management System for Food Industry*. Blackie.
- Schrenk D and Cartus A. 2017. *Chemical Contaminants and Residues in Food.* 2nd Ed. Woodhead Publishing.
- Young W. Park and George FW. Haenlein 2013. *Milk and Dairy Products in Human Nutrition*. John Wiley and Sons, UK.

I. **Course Title : Research Techniques**

II. **Course Code : DC 524**

III. **Credit Hours : 1+2**

IV. **Why The Course?**

This course concentrates on instrumental methods of analysis. The course will beof importance to all the students, who rely on the use of instrumental analysis in their field of research while conducting research as part of their postgraduate studies.

V. **Aim of the course**

To impart the advanced knowledge on the use of analytical techniques in Dairy Chemistry

The course is organized as follows:

No.	Blocks	Units
1.	Separation and Purification of Biomolecules	I. Electrophoresis II. Chromatography III. Membrane processing and centrifugation
2.	Laboratory Analytical Techniques	IV. Instrumental Techniques V. ELISA and lateral flow assay

VI. **Theory**

VII. **Block1: Separation and Purification of Biomolecules Unit I: Electrophoresis**

Electrophoresis: principles and types, isoelectric focussing

Unit II: Chromatography

Chromatographic techniques: Principles and types (Paper and Column Chromatography, TLC, GLC, HPLC, gel-permeation, ion-exchange, affinity).

Unit III: Membrane processing and centrifugation

Separation of bio-molecules using membranes; Centrifugation: principle, types and applications.

Block 2: Laboratory Analytical Techniques

Unit IV: Instrumental Techniques

Spectrophotometry: UV, visible, IR and flame photometry; Potentiometry: principles, ion-selective electrodes; buffers. Measurement of size and zeta potential of colloidal solution or emulsion using dynamic light scattering/ particle size analyser

Unit V: ELISA and lateral flow assay

Immuno based analytical techniques such as ELISA and Lateral

flow assay.

VIII. Practical

- Paper chromatography, TLC separation of amino acids.
- Gel-filtration of biomolecules.
- Preparation of a buffer and measurement of its pH electrometrically and using indicators.
- SDS gel electrophoresis and molecular weight determination.
- Plotting of UV-visible absorption spectra of a standard analyte.
- Demonstration of Beer's law using standard protein.
- Estimation of minerals using AAS.
- Separation of milk proteins using ion-exchange chromatography and affinity chromatography.
- Detection of analytes using ELISA and lateral flow assay.
- Separation of biomolecules using HPLC.
- Preparation of methyl esters of fatty acids of milk fat and analysis by GLC.
- Separation of fat/casein using centrifugation.

IX. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Provides a sound foundation to the theory and application of modern analytical techniques.
- Impart the concept of good laboratory practice and protocol, and hands-on experience of modern analytical instrumentation.

X. Suggested Reading

- Christian GD, Dasgupta PS and Schug K. 2014. *Analytical Chemistry*, 7th Edition Wiley Global Education.
- Clark JM and Switzer RL. 1977. *Experimental Biochemistry*. WH Freeman and Co.
- Cooper TG. 1977. *The Tools of Biochemistry*. John Wiley and Sons.
- Frank A Settle. 1997. *Handbook of Instrumental Techniques for Analytical Chemistry*. Prentice Hall.
- Leo ML and Toldra NF. *Handbook of Dairy Foods Analysis*. 1st Ed. CRC Press.
- Nielsen S Suzanne 1994. *Introduction to the Chemical Analysis of Foods*.Jones and Barlett Publ.
- Sawhaney SK and Singh R. 1985. *An Introduction to Practical Biochemistry*. Narosa Publ.
- Stock R and Rice F. 1974. *Chromatographic Methods*. Chapman and Hall.

- Su W. 2018. *Trends in Food Authentication*: Wen-Hao Su; Ioannis S. Arvanitoyanni; Da- Wen, Sun. In Modern Techniques for Food Authentication (Second Edition).
- Wilson K and Walker J. 2000. *Practical Biochemistry: Principles and Techniques*. Cambridge Univ. Press.

Course Contents Ph.D. in Dairy Chemistry

I. **Course Title : Advances in Chemistryof Milk Proteins**
II. **Course Code : DC-611**
III. **Credit Hours : 3+0**
IV. **Why this course?**

To gain insights in the underlying structure-function aspects of milk proteins, biological role of bioactive milk proteins, properties of bioactive peptides and allergy aspects of milk proteins.

V. **Aim of the course**

To understand the advances in area of functionality of milk proteins The course is organized as follows:

No.	Blocks	Units
1.	Biosynthesis and Structure Function relationship of milk Proteins	I. Biosynthesis of milk proteins II. Structure of milk protein with respect to function III. Modification of milk proteins with respect to function
2.	Biological role of milk proteins	IV. Antimicrobial protein in milk V. Significance of bioactive peptides VI. Nutritive and therapeutic aspects of milk proteins

VI. **Theory**

Block 1: Biosynthesis and structure Function relationship of milk Proteins Unit I: Biosynthesis of milk proteins

Biosynthesis of milk proteins, milk fat globule membrane (MFGM) proteins.

Unit II: Structure of milk protein with respect to function

Primary structure of casein, structural properties of casein and whey proteins and their structure-functional relationship

Unit III: Modification of milk proteins with respect to function

Physical, chemical and enzymatic modification of milk proteins and their functional characteristics

Block 2: Biological roles of milk proteins

Unit IV: Antimicrobial protein in milk

Mechanism of action and biological role of specific and non-specific antimicrobial factors in milk- immunoglobulins, lactoferrin,

lactoperoxidase and lysozyme

Unit V: Significance of bioactive peptides

Milk protein derived bioactive peptides – their properties; significance and application; bitter peptides in cheese; growth factors in milk.

Unit VI: Nutritive and therapeutic aspects of milk proteins

Nutritive and therapeutic aspects of milk proteins and peptides; Milk protein allergy: mechanism and method of their reduction in dairy products

Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work
- Guest Lectures

VII. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the basic mechanism on functionality of major milk proteins and bioactive milk proteins
- Understand the aspects on biosynthesis of milk proteins, bioactive peptides and nutritive properties of milk proteins

VIII. Suggested Reading

- Damodaran S and Paraf A. 1997. *Food Proteins and their Applications*. Marcel Dekker.
- Gigli I. (Ed.). 2016. *Milk Proteins: From Structure to Biological Properties and Health Aspects*. BoD–Books on Demand.
- Hettiarachchy NS, Sato K, Maurice R, Marshall MR and Kannan A. 2016. *Bioactive Food Proteins and Peptides: Applications in Human Health*. CRC Press.
- Deeth HC and Bansal N. 2018. *Whey Proteins from Milk to Medicine*. 1st Edition, Academic Press
- McSweeney PLH, O'Mahony and James A. 2013. *Advanced Dairy Chemistry Volume 1A: Proteins: Applied Aspects*. Springer-Verlag, New York.
- McSweeney PLH, O'Mahony and James A. 2016. *Advanced Dairy Chemistry Volume 1B: Proteins: Applied Aspects.* Springer-Verlag, New York.
- Popay AI and Prosser CG.1997. *Biotech in Agric*. Series No. 18, CABI.
- Visser Hans. 1992. *Protein - Interactions*. VCS.
- Welch RAS, Burns DJW and Davis SR. 1997. *Milk Composition,*

Production and Biotechnology. CABI.

I. **Course Title : Advances in Chemistry of Milk Lipids**

II. **Course Code : DC-612**

III. **Credit Hours : 3+0**

IV. **Why this course?**

This is an advanced course for in-depth understanding of milk fat including recent research work in the area of milk fat. This course is going to cover all these aspects.

V. **Aim of the course**

To impart the students with the in-depth understanding of various facets of milk fat including synthesis, changes during processing, various constituents of milk fat including minor components. The course also gives the opportunity to learn the recent research work being done in the area of milk fat. The course is organized as follows:

No.	Blocks	Units
1.	Composition and Structure and physical	I. Origin, composition, structure chemistry of milk fat globule membrane II. Lipolytic enzymes in milk of different species III. Fatty acids and other components in milk fat
2.	Stability and Health Significance due to oxidization	IV. Deterioration of milk fat and heating V. Significance of milk fat in human health

VI. **Theory**

Block 1: Composition and Structure

Unit I: Origin, composition, structure and physical chemistry of milk fat globule membrane

Origin, composition, structure and physical chemistry of milk fat globule membrane; Comparative aspects of milk lipids from different species such as human, bovine, buffalo, sheep, goat, and camel. Changes in milk fat globule membrane during processing and its effect on digestion.

Unit II: Lipolytic enzymes in milk of different species

Lipolytic enzymes in milk of different species including human; Bile salt stimulated lipase and esterases, induced and spontaneous lipolysis in milk. Assay for lipase activity; Biosynthesis of fatty acids, glycerol, neutral lipids, phospholipids, sphingolipids and cholesterol.

Unit III: Fatty acids and other components in milk fat

Essential fatty acids, prostaglandins and flavour compounds. Conjugated linoleic acids – different isomers, factors affecting their levels in dairy products and their significance.

Unit IV: Deterioration of milk fat due to oxidization and heating

Chemistry of oxygen in relation to autoxidation of milk fat including effect of milk components and environmental factors; Types of oxidations; Thermal oxidation; Chemical and biological properties of heated and oxidized fats.

Unit V: Significance of milk fat in human health

Significance of milk lipids in human health. Role of milk lipids in consumer acceptance of dairy products. Polymorphism and milk fat crystallization

VII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work
- Guest Lectures

VIII. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Have in-depth understanding of milk fat including its origin in mammary gland
- Lipolytic enzyme in milk of various species including lipolysis
- Types of minor milk components and their structure
- Deterioration of milk fat due to oxidation
- Significance of milk fat in human health.

IX. Suggested Reading

- Fox PF. 1995. *Advanced Dairy Chemistry.* Vol. II. *Lipids.* 2nd Ed. Chapman and Hall.
- Fox PF and McSweeney PLH. 2006. *Advanced Dairy Chemistry Volume 2: Lipids*. Springer-US.
- Fox PF, Uniacke-Lowe T, McSweeney PLH and O'Mahony JA. 2015. *Dairy Chemistry and Biochemistry*. 2nd Edition. Springer.
- Jensen RG. 2018. The lipids of human milk. CRC Press.
- Nollet LML and Toldra F. 2009. *Handbook of Dairy Foods*

Analysis. CRC Press. Taylor and Francis Group.
- Truong T, Palmer M, Bansal N and Bhandari B. 2016. *Effect of Milk Fat Globule Size on the Physical Functionality of Dairy Products*. Springer International Publishing.
- Truong T, Lopez C, Bhandari B and Prakash S. 2020. *Dairy Fat Products and Functionality*.
- Walstra P and Jenness R. 1984. *Dairy Chemistry and Physics*. John Wiley and Sons.
- Wong NP, Jenness R, Keeney M and Elmer HM. 1988. *Fundamental of Dairy Chemistry*. 3rd Ed. Van Nostrand Reinhold Co.

I. Course Title : Advances in Chemistry of Dairy Processing

II. Course Code : DC 621

III. Credit Hours : 3+0

IV. Why this course?

This course covers the physicochemical changes during processing of milk and chemistry of different additives and ingredients with respect to their effect on functional properties of dairy foods. This course is going to cover all these aspects.

V. Aim of the course

To highlight the impact of processing parameters on the milk constituents with special reference to chemical changes involved and also to impart the basic knowledge on the chemistry and significance of bio active compounds and additives

The course is organized as follows:

No.	Blocks	Units
1.	Physicochemical changes during processing	I. Heat induced changes and interactions II. Physical changes in the fat globules after homogenisation III. Specific and non-specific enzymatic coagulation of milk IV. High Pressure Processing of milk
2.	Food additives/ ingredients	V. Encapsulation of bioactive compounds VI. Micronutrients, Stability of sweeteners and Milk fat replacers

VI. **Theory**

Block 1: Physicochemical changes during processing **Unit I: Heat induced changes and interactions**

Heat induced changes and interactions between protein, lipids, carbohydrates and minerals during processing of milk. Effect of heat on the proteins of concentrated milk systems. Inactivation of indigenous milk enzymes during processing.

Unit II: Physical changes in the fat globules after homogenisation

Physical changes in the fat globules in unhomogenized and homogenized milk; cold agglutination – its mechanisms and role.

Unit III: Specific and non-specific enzymatic coagulation of milk

Specific and non-specific enzymatic coagulation of milk.

Unit IV: High Pressure Processing of milk

Physico-chemical and structural changes occurring in milk constituents during high pressure processing of milk.

Block 2: Food additives/ ingredients

Unit V: Encapsulation of bioactive compounds

Chemistry involved in encapsulation of bioactive compounds and factors affecting their stability during processing.

Unit VI: Micronutrients, Stability of sweeteners and Milk fat replacers

Chemistry involved in the fortification of milk with vitamins, minerals and nutraceuticals. Stability of high intensity sweeteners during processing of milk and milk products. Milk fat replacers.

VII. **Teaching Methods/ Activities**

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review
- Student presentation
- Group Work
- Guest Lectures

VIII. **Learning outcome**

After successful completion of this course, the students are expected to be able to:

- Understand the effect of processing on milk constituents
- Analyse the stability of different additives including micronutrients added to milk as affected by different processing treatments

IX. **Suggested Reading**

- Shortt C and Brien JO. 2004. *Handbook of Functional Dairy Products*. CRC Press.

- Deeth HC and Lewis MJ. 2017. *High Temperature Processing of Milk and Milk Products*. Wiley-Blackwell.
- Fox PF and McSweeney PLH. 1998. *Dairy Chemistry and Biochemistry*. Blackie Academic Professional, Chapman and Hall.
- IDF. 1995. Special issue. *Heat Induced Changes in Milk*. Intern. Dairy Fed.,Brussels.
- Koca, N. (Ed.). 2018. Technological Approaches for Novel Applications in Dairy Processing. BoD–Books on Demand.
- Leo ML Nollet. 2004. *Intense Sweeteners. Handbook of Food Analysis*. 2nd Ed. Marcel Dekker
- Minj, J., Sudhakaran, A. and Kumari, A. 2020. Dairy Processing: Advanced Research to Applications. Springer Singapore.
- Walstra P, Walstra P, Wouters JTM and Geurts TJ. 2005. *Dairy Science and Technology*. CRC Press

I. **Course Title : Advances in Analytical Techniques in Dairy Chemistry**

II. **Course Code : DC 622**

III. **Credit Hours : 3+0**

IV. **Why this course?**

To gain insights in the underlying principle of newer instrumental techniques and their application in the dairy science research. This course is going to cover all these aspects.

V. **Aim of the course**

To highlight the application of advance analytical techniques used for analysis of milk and milk products

The course is organized as follows:

No.	Blocks	Units
1.	Electrophoresis and Chromatographic techniques	I. Isoelectric focusing, 2-D gel electrophoresis, Immuno assays II. High performance liquid chromatography III. Mass spectroscopy
2.	Protein structure determination Spectroscopy	IV. Protein sequencing and V. X-ray crystallography VI. Circular dichroism spectroscopy VII. Atomic spectroscopy VIII. Infrared, Fluorescence

VI. Theory

Block 1: Electrophoresis and Chromatographic techniques

Unit I: Isoelectric focusing, 2-D gel electrophoresis, Immuno assays

Electrophoresis: Isoelectric focusing and 2-D polyacrylamide gel electrophoresis; Capillary zone electrophoresis, Enzyme linked immune-sorbentassay, blotting techniques

Unit II: High performance liquid chromatography

High performance liquid chromatography; Theory, instrumentation and application in analysis of dairy foods

Unit III: Mass spectroscopy

Mass spectroscopy: Principle, instrumentation and application in milk proteins/ milk fat analysis

Block 2: Protein structure determination and Spectroscopy

Unit IV: Protein sequencing

Protein sequencing; Chemical reactions involved in analysis of primary structure of proteins.

Unit V: X-ray crystallography

Circular dichroism spectroscopy; Theory and application for determination of secondary structure of proteins.

Unit VI: Circular Dichroism Spectroscopy

X-ray crystallography; Theory and application for determination of tertiary structure of milk proteins.

Unit VII: Atomic spectroscopy

AAS (Atomic Absorption Spectroscopy, Atomic Emission Spectroscopy, ICPS (Inductively coupled plasma spectroscopy); Principle and application in analysis of milk and milk products.

Unit VIII: Infrared, Fluorescence

Infrared Spectroscopy, Fluorescence Spectroscopy: principle and application.

Unit IX: Differential scanning calorimetry, NMR and FTIR

Differential scanning calorimetry: principle and application for milk fat and protein analysis.

NMR (Nuclear Magnetic Resonance), FTIR (Fourier Transform Infrared). Principle, application for quality analysis of milk and milk products.

VII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Publication Review

- Student presentation
- Group Work
- Guest Lectures

VIII. Learning outcome

After successful completion of this course, the students are expected to be able to:

- Understand the basic principle on advance analytical techniques for quality assessment of milk and milk products
- Understand the aspects on structure determination of milk proteins

IX. Suggested Reading

- Blundell TL and Johnson LN. 1976. *Protein Crystallography*. Academic Press.
- Calter P. 2004. *Methods in Molecular Biology*. Vol. 244 2nd Ed. *Protein Purification Protocols*. Humana Press.
- FL Creighton T. 1998. *Protein Structure*. 2nd Ed. Portland Press.
- Nielsen SS. 1994. *Introduction to Chemical Analysis of Foods*. Part IV.Jones and Bertlett Publ.
- Leo ML and Toldra NF. *Handbook of Dairy Foods Analysis*. 1st Ed. CRC Press.
- Wilson K and Walker J. 2000. *Practical Biochemistry: Principles and Techniques*. Cambridge University Press.
- Christian GD, Dasgupta PS, Schug K. 2014. Analytical Chemistry, 7th Edition Wiley Global Education.
- Nollet, L. M. (Ed.). 2020. *Mass Spectrometry Imaging in Food Analysis*. CRC Press.
- Nordén, B., Rodger, A., and Dafforn, T. 2019. *Linear Dichroism and Circular Dichroism: A Textbook on Polarized-Light Spectroscopy*. Royal Society of Chemistry.
- Singh, D. B., and Tripathi, T. 2020. *Frontiers in Protein Structure, Function, and Dynamics*.

Suggested Broad Topics for Master's and Doctoral Research

1. Profiling of milk from indigenous breeds of cattle, buffalo, goat and other minor species for their composition, physico-chemical properties and health benefits.
2. Encapsulation of bioactive compounds using milk and food grade constituents for their use in functional foods.
3. Physico-chemical changes in milk and milk products on fortification with micronutrients and nutraceuticals.
4. Flavour profiling of indigenous dairy products.
5. Shelf life enhancement of dairy products using natural and

synthetic additives.

6. Development and evaluation of new generation methods for detection of adulterants and contaminants in milk and milk products based on biotechnological and nanotechnological approaches.
7. Development and validation of methods for detection of emerging contaminants and adulterants.
8. Validation of existing methods for quantification of different claimed constituents in various dairy products.
9. Stability of newer additives in milk and milk products and development of methods for their quantification.
10. Migration from food contact materials into food products.
11. Development of methods for detection of mixed milk and ghee-species and breeds.
12. Physico-chemical changes in milk proteins and lipids during processing and storage of dairy products.
13. Isolation and purification of growth factors and bioactive peptides from colostrum, milk and whey.
14. Enzymatic modification of milk proteins and incorporation of biopeptides into food system.
15. Incorporation of whey/whey constituents in milk and milk products for enhancement of biofunctional properties.
16. Evaluation of microstructure of dairy products.

List of Journals

1. *Indian Journal of Dairy Science*
2. *International Dairy Journal*
3. *International Journal of Dairy Technology*
4. *Journal of Dairy Research*
5. *Journal of Dairy Science*
6. *Comprehensive Reviews in Food Science and Food Safety*
7. *Critical Reviews in Food Science and Nutrition*
8. *Food Additives and Contaminants: Part A and Part B*
9. *Food Analytical Methods*
10. *Food Hydrocolloids*
11. *Food Chemistry*
12. *Food Research International*
13. *Food Reviews International*
14. *Food Science and Technology - Lebensmittel-Wissenschaft and Tech*
15. *Food Science and Technology International*
16. *Food Science and Technology Research*
17. *Food and Chemical Toxicology*
18. *Indian Journal of Dairy Science*

19. *International Journal of Food Properties*
20. *International Journal of Food Science and Technology*
21. *IDF Bulletins*
22. *Journal of Agricultural and Food Chemistry*
23. *Journal of Food Biochemistry (Journal of Food Lipids)*
24. *Journal of Food Composition and Analysis*
25. *Journal of Food Processing and Preservation*
26. *Journal of Food Quality*
27. *Journal of Food Safety*
28. *Journal of Food Science*
29. *Journal of Food Science and Technology*
30. *Journal of Functional Foods*
31. *Journal of the Science of Food and Agriculture*

Emulsions, Colloids & Gels: Emulsion and emulsion stability; coalescence and dispersion; an introduction to the concept of Nano emulsion and Nano micelles. Micelles: definition, critical micelle concentration, formation and stability; Colloidal stability of casein micelles in milk, zeta potential, size distribution of casein micelles and fat globules. Gels and their formation, structure and stability; acid and rennet gels.

Lactose: occurrence, isomers, molecular structure, levels in milk of different species. Physical properties of lactose: crystalline habits, hydrates, lactose glass, specific rotation, equilibrium of different isomers in solution, solubility, density, sweetness. Chemical properties of lactose: hydrolysis; Pyrolysis; Oxidation; Reduction; Degradation with strong bases; Derivatives; Dehydration and Fragmentation; Browning reaction; Oligosaccharides in milk-health significance.

Minerals: major and minor minerals; Factors affecting variation in salt composition of milk; Distribution and importance of trace elements in milk. Physical equilibrium amongst milk salts; Effect of various treatments on salt equilibrium; Partitioning of salts and factors affecting them. Effect of Processing on Minerals Salt balance and its importance in the processing of milk; Protein-mineral interactions.

Physico-chemical properties of milk lipids; role of major milk lipids in milk and milk products and biological significance of milk lipids; Composition of milk fat globule membrane. Fatty acid profile of milk lipids; factors affecting the profile of fatty acids; Unsaponifiable matter composition and its importance Chemical properties of milk lipids: hydrolysis by alkali, water and enzymes; hydrogenation, halogenation, transesterification, inter-esterification and fractionation. Autoxidation: Definition, theories, induction period, secondary products of autoxidation, factors affecting, prevention and measurement; various methods for evaluating primary and secondary oxidation products; Antioxidants: Definition, types, reaction mechanism and estimation.

Major constituents of foods – water, carbohydrates, proteins and lipids. Phytochemicals and food additives.

Major milk proteins: caseins (acid and micellar), methods of isolation; Fractionation of casein and heterogeneity; Physico-chemical properties; amino acid composition; Casein micelle models; Primary structure of different caseins; Modification of casein: Physical, chemical (glycosylation, phosphorylation) and enzymatic. Alpha-lactalbumin and beta-lactoglobulin, bovine serum albumin: distribution and methods of isolation and their physico-chemical properties. Minor milk proteins. Denaturation of milk proteins, various factors affecting denaturation; Casein-whey protein interactions. Indigenous milk enzymes: Properties and their significance.

Standards, composition and properties of infant milk and infant food formulations; Process induced changes in milk constituents during preparation and storage of

concentrated and dried milks; Biochemical changes during ripening of different varieties of cheese; Role of different ingredients during processing and storage of ice cream/ frozen desserts; Storage stability and physic-chemical properties of ghee.

Concept of quality assurance and quality control in relation to dairy industry; Quality management systems - good manufacturing practices (GMP); HACCP certification; ISO 9001, ISO 22000, FSSC, total quality management (TQM). Laboratory accreditation. Guidelines for setting up quality control laboratory and chemical safety aspects. ; Detection of adulterants in milk and milk products; Instrumentation in analysis of milk and milk products.

Electrophoresis: principles and types, isoelectric focusing. Chromatographic techniques: Principles and types (Paper and Column Chromatography, TLC, GLC, HPLC, gel-permeation, ion-exchange, affinity). Membrane processing and centrifugation: principle, types and applications. Instrumental Techniques Spectrophotometry: UV, visible, IR and flame photometry; Potentiometry: principles, ion-selective electrodes; buffers. Immuno based analytical techniques such as ELISA and Lateral flow assay.

Dairy Microbiology

DEPARTMENT OF DAIRY MICROBIOLOGY
Semester-wise M. Tech. Courses

Course Code	Course Title	Credit Hours	Semester
DM 511*	MICROBIAL PHYSIOLOGY	2+1	I
DM 512*	MICROBIOLOGY OF PROCESSED DAIRY FOODS	3+1	I
DM 513	MICROBIAL MORPHOLOGY AND TAXONOMY	2+1	I
DM 514	MICROBIOLOGY OF FLUID MILK AND DAIRY PRODUCTS	2+1	I
DM 515*	MICROBIAL GENETICS	2+1	I
DM 516	ENVIRONMENTAL MICROBIOLOGY	2+1	I
DM 517	BIOTECHNOLOGY IN DAIRY INDUSTRY	2+1	I
DM 521*	DAIRY STARTER CULTURES	2+1	II
DM 522*	MICROBIAL SAFETY AND QUALITY	2+2	II
DM 523	MICROBIOLOGY OF CHEESE AND FERMENTED DAIRY FOODS	2+1	II
DM 524	PROBIOTICS AND PREBIOTICS	2+1	II
DM 525*	RESEARCH TECHNIQUES	2+1	II
DM 526	MICROBIAL FERMENTATION TECHNOLOGY	2+1	II
DM 591	CREDIT SEMINAR	1+0	I and II
DM 599	MASTER'S RESEARCH	0+30	I and II
***compulsory courses**			

DEPARTMENT OF DAIRY MICROBIOLOGY
Semester-wise Ph.D. Courses

Course Code	Course Title	Credit Hours	Semester
DM 611*	ADVANCES IN MICROBIAL PHYSIOLOGY	3+0	I
DM 612*	ADVANCES IN MICROBIAL GENETICS	3+0	I
DM 621*	ADVANCES IN DAIRY AND FOOD MICROBIOLOGY	3+0	II
DM 622	ADVANCES IN FOOD SAFETY OF DAIRY PRODUCTS	3+0	II
DM 623*	ADVANCES IN PROBIOTICS AND FUNCTIONAL FOODS	3+0	II
DM 691	CREDIT SEMINAR-I	1+0	I and II
DM 692	CREDIT SEMINAR-II	1+0	I and II
DM 699	DOCTORAL RESEARCH	0+75	I and II
***compulsory courses**			

Course Contents M.Tech. in Dairy Microbiology

I. **Course Title : Microbial Physiology**
II. **Course Code : DM 511**
III. **Credit Hours : 2+1**
IV. **Why this course?**

Microbial physiology is the study of how microbial cell structures, growth and metabolism function in living organisms. It covers the study of nutritional transport system of bacteria, electron transport chain in prokaryotes and nutritional requirements of bacteria for their growth.

V. **Aim of the course**

To familiarize the student with various aspects of growth and energy generating activities of bacteria for the betterment of human life.

VI. **Theory**

Unit I

Bacterial growth: Growth phases and kinetics; synchronous, continuous, and associative growth; factors affecting bacterial growth; growth measurement; sporulation.

Unit II

Effect of environment on the growth of bacteria: Temperature, air, osmotic pressure, pH, hydrostatic pressure, surface tension, metals, electromagnetic and other waves, sonics, various chemicals, their application in dairy industry; mechanism of action of antimicrobials.

Unit III

Bacterial nutrition; Nutrient media; Nutritional groups of bacteria; Role of growth factors; Active and passive transport.

Unit IV

Energy metabolism: Electron transport chain, fermentation, respiration and photosynthesis.

VII. **Practical**

- Measurement of bacterial growth by direct methods (cell number, SPC, DMC) and indirect methods (turbidometric methods, MPN, cell mass).
- Preparation of growth curve; determination of generation time.
- Determination of cell activity; Carbohydrate fermentation; Acid production/pH alteration; Starch, lipid, casein and gelatin hydrolysis.
- Effect of different factors, viz. physical (temperature, pH, osmotic pressure, surface tension), chemical (dyes, antibiotics, phenol) and nutritional (amino acid supplements, vitamin supplements,

protein hydrolysates, casamino acids) on bacterial growth.

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the effect of environmental factors on microbial growth of bacteria
- To have an idea about nutritional transport system of bacteria
- To know about the electron transport chain in prokaryotes.
- To have any idea about the nutritional requirements of bacteria during their growth using various growth measurement techniques.

X. Suggested Reading

- Dean Watson. 2017. *Microbial Physiology*.
- Seaman GR and Mary JD. 2012. *Experiments in Microbial Physiology and Biochemistry*. Literary Licensing, LLC, USA.
- Willey J, Sherwood L and Woolverton CJ. 2017. *Prescott's Microbiology*, 10th Edition.
- Madigan MT, Martinko JM and Parker J. 2020. *Brock Biology of Microorganisms*. 16th edition, Prentice Hall, London, UK.
- Moat AG, Foster JW and Spector MP. 2002. *Microbial Physiology*. 4th Ed. Wiley-Liss.
- Poole RK. 2006. *Advances in Microbial Physiology*. Apple Academic Press (CRC Press), USA
- Rose AH. 2009. *Chemical Microbiology: An Introduction to Microbial Physiology*. Plenum Pub. Corp.
- Tortora GJ, Funke BR and Case CL. 2020. *Microbiology: An Introduction*, 13th Edn, Pearson, Harlow, UK.

I. Course Title : Microbiology of Processed Dairy Foods

II. Course Code : DM 512

III. Credit Hours : Credit: 3+1

IV. Why this course?

Different types of processing are done in dairy and foods industry for improving the quality and shelf life of the products. Each

processing step affects microbial quality. Students should have idea about such changes. Course will also coverbio- preservation system of processed dairy foods, antimicrobial or bioactive packaging systems and GMO and their regulatory systems.

V. Aim of the course

To understand the microbiology of processed foods, types of processing and their effect on microbiological quality, significance of different food microorganisms, their control and other related aspects.

VI. Theory

Unit I

Introduction to microbes in foods, history and development of food microbiology, microorganisms important in foods, microbial ecology of processed foods and food ecosystem, factors influencing microbial growth in foods; Intrinsic factors and extrinsic factors.

Unit II

High temperature food preservation, factors affecting heat resistance in microorganisms, thermal destruction of microorganisms, low temperature food preservation, food preservation by irradiation, food preservation by drying and fermentation, modern processing techniques-ohmic heating, high pressure processing, infra-red heating, cold plasma, pulsed electric field, ultra sound etc., bio preservation of foods - concepts: metabolites of lactic acid bacteria; Bacteriocins, Antifungal substances etc., protective cultures and other antimicrobials (herbs, spices and other natural antimicrobial compounds), Nanoscience in food preservation; microencapsulation.

Unit III

Microbial stress response in the food environment; Stress adaptation, sublethal stress and injury, antibiotic resistance in food bacteria, predictive modelling for food spoilage, industrial strategies for ensuring safe foods, HACCP; GMP, GHP

Unit IV

Antimicrobial packaging; concepts and development, modified atmosphere packaging (MAP), intermediate moisture foods (IMF), and hurdle technology in processed foods.

Unit V

New prospects and problems in processed dairy foods. Genetically modified foods

VII. Practical

- D and Z-value calculation of common food pathogens.
- Production of antimicrobial substances-bacteriocins.
- Production of antifungal substances.

- Application of bacteriocins for bio preservation of foods.
- Application of hurdle concepts for enhanced shelf stability of processed foods.
- Induction of bacterial cell injury and recovery of injured cells.
- Antibiotic resistance of food pathogens.
- Shelf life enhancement using antimicrobial packaging.

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the latest technologies for processing of foods, biopreservation system of processed dairy foods
- To have an idea about the processing methods that do not diminish the quality attributes of food being processed
- To know about the recent antimicrobial or bioactive packaging systems that can enhance the shelf life of fresh as well as processed produce/food.
- To have any idea about the GMO and their regulatory systems.

X. Suggested Reading

- Ozer B and Evrendilek GA. 2014. *Dairy Microbiology and Biochemistry: Recent Developments*. CRC Press.
- Silva ND, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MDSD and Gomes RAR. 2012. *Microbiological Examination Methods of Food and Water: A Laboratory Manual*. CRC Press, USA.
- Erkmen O and Bozoglu TF. 2016. *Food Microbiology: Principles into Practice*, 2 Volume Set. Wiley Publishing.
- Papademas P. 2014. *Dairy Microbiology: A Practical Approach*. CRC Press.
- Prajapati JB and Behare PV. 2018. *Textbook of Dairy Microbiology.* Directorate of Knowledge Management in Agriculture, ICAR, ISBN: 978-81-7164-182-6.
- Ray RC and Didier M. 2014. *Microorganisms and Fermentation of Traditional Foods*. CRC Press, USA.
- Ray B. 2003. *Fundamental Food Microbiology*. CRC Press.
- Hutkins RW. 2019. *Microbiology and Technology of Fermented*

Foods, 2nd Ed, Wiley Blackwell, New Jersey, USA.

I. **Course Title : Microbial Morphology and Taxonomy**
II. **Course Code : DM 513**
III. **Credit Hours : 3+1**
IV. **Why this course?**

Morphology is the study of the form of bacteria. This covers morphological features such as shape, size, cell structure, motility (ability to move in a liquid), and spore and capsule formation, different staining methods and micrometry etc.

V. **Aim of the course**

To educate the students about the morphological features and taxonomy of the various microorganisms, viz. bacteria, fungi and viruses

VI. **Theory**

Unit I

Evolution of life on earth, history and diversity of microorganisms

Unit II

Principles of classification and taxonomy of Eubacteria (Bacteria and Archaea); Major characteristics used in taxonomy; Cultural, Morphological, Biochemical; Physiological, Genetic and Molecular; Numerical Taxonomy (Taxometrics) and Chemotaxonomy. Assessing Microbial Phylogeny: Chronometers; Phylogenetic trees, r-RNA, DNA and proteins as indicators of phylogeny.

Unit III

Cell ultra-structure (prokaryotes and eukaryotes); Cell wall- structure, chemical composition, synthesis and inhibition; cell membrane, cytoplasmic inclusions, cytoskeleton, cell appendages- capsule, flagella, pili; sporulation - structure of endospore, composition and function of spore constituents, induction and germination.

Unit IV

Fungi: Distribution, importance and recent classification, study of yeasts and moulds in dairy foods

Unit V

History, development and scope of virology; classification and nomenclature, characteristics of viruses (acellular organization and viral genome), viral reproduction, brief account of viroids and prions

VII. **Practical**

- Staining: Simple staining; differential staining - Gram's staining, spore staining, acid fast staining; special staining - cell wall staining, flagella staining, nucleoids staining, capsule staining, inclusion/storage bodies staining

- Preparation of bacterial protoplasts and spheroplasts
- Measuring dimensions of microorganisms (bacteria) using micrometry
- Morphology of fungi: yeast and moulds
- Application of computer software in bacterial identification

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the Principles of classification and taxonomy of Eubacteria
- To have knowledge on the advanced techniques help in classification of organisms
- To know about the ultrastructure of microorganisms.
- To acquire the knowledge on different staining methods and micrometry.

X. Suggested Reading

- Cowan MK. 2012. *Microbiology: A Systems Approach*, 3rd Edition. The McGraw Hill Companies, New York, USA.
- Holt JG, Krieg NR, Sneath PHA, Staley JT and Williams ST. 1997. *Bergey's Manual of Determinative Bacteriology* (9th edition). Williams and Wilkins, Baltimore, Maryland, USA.
- Krejer van-Rij NJW. 1998, *The Yeasts: A Taxonomic Study*, 4th edn, Elsevier Science Publishers, Amsterdam, The Netherlands.
- Madigan MT, Martinko JM and Parker J. 2020. *Brock Biology of Microorganisms*. 16th edition, Prentice Hall, London, U.K.
- Prescott LM, Harley JP and Klein DA. 2002, *Microbiology*, 5th edn, McGraw Hill, New York, USA.
- Tolaro KP. 2011. *Foundations in Microbiology*, 8th Edn. The McGraw Hill Companies, New York, USA.
- Tortora GJ, Funke BR and Case CL. 2020. *Microbiology: An Introduction*, 13th Edn, Pearson, Harlow, UK.

I. **Course Title : Microbiology of Fluid Milk and Dairy Products**

II. **Course Code : DM-514**

III. **Credit Hours : 2+1**

IV. **Why this course?**

Milk is a complex biological fluid secreted in the mammary glands of mammals. It contains all the nutrients which help the organisms to grow well. For the safe processing and production of milk and milk products, student should have good knowledge of various handling and processing practices on market milk. Novel technologies must be applied in milk and milk product processing for the inactivation of food borne microorganisms or toxins produced by the organisms during transportation or storage or raw milk.

V. **Aim of the course**

To familiarize the students with microbes in milk and milk products, microbiological aspects of processing, microbiology of milk products and safety aspects

VI. **Theory**

Unit I

Common microbes in milk and their significance, Microflora of mastitis milk and its importance in dairy industry, Sources of microbial contamination of raw milk and their relative importance in influencing quality of milk during production, collection, transportation and storage; Clean milk production and natural antimicrobial systems in raw milk, Microbial changes in raw milk during long storage, Microbiological grading of raw milk.

Unit II

Microbiological aspects of processing techniques like bactofugation, thermization, pasteurization, sterilization, boiling, UHT, non-thermal processes (pulsedelectric field) and membrane filtration of milk; Role of psychrotrophic, mesophillic, thermophilic and thermoduric bacteria in spoilage of processed milks, their sources and prevention; Heat induced damage in bacteria and role of resuscitation in recovery of injured microbial cells. Microbiological standards (BIS/ FSSAI) of heat- treated fluid milks

Unit III

Microbiological quality of dairy products; fat rich (cream and butter), frozen (ice cream), concentrated (evaporated and condensed milk), dried milks (roller and spray dried), infant dairy foods and legal standards; Sources of contamination and factors affecting microbial quality of these products during processing, storage and distribution; Microbiological defects associated with these products and their control.

Unit IV

Microbiological quality of traditional dairy products in India; heat desiccated (khoa, burfi, peda, kheer, etc.), acid coagulated (paneer, chhana, rasogolla, etc.), fermented (dahi, lassi, srikhand, etc.) and frozen (kulfi); Sources of microbial contaminants and their role in spoilage; Importance of personnel and environmental hygiene on quality of traditional milk products; Microbiological standards for indigenous dairy foods.

Unit V

Food poisoning- Food intoxications, Food infections and Toxi-infections, pathogens associated with fluid milks, dairy products and their public health significance; Sources of pathogens and their prevention; Importance of biofilms, their role in transmission of pathogens in dairy products and preventive strategies.

VII. Practical

- Grading of raw milk based on SPC, coliforms and dye reduction tests.
- Effect of different storage temperatures on microbiological quality of fluid milk.
- Tests for mastitic milk and brucellosis.
- Microbiological quality evaluation of cream and butter for coliforms, yeasts and moulds, lipolytic and proteolytic bacteria.
- Detection of *Cronobacter sakazakii* in infant dairy foods.
- Microbial evaluation of burfiand pedafor SPC, *S. aureus*, yeast and mould counts.
- Detection of *Bacillus cereus, Salmonella,Shigella* and coagulase positive staphylococci in milk powder.
- Evaluation of ice cream for coliforms and *Escherichia coli*.
- Microbiological quality of paneer.
- Enumeration of aerobic and anaerobic spores in condensed, sterilized and dried milks.
- Line testing for determining the source of contamination of dairy products.
- Detection of toxins (staphylococcal, aflatoxins/mycotoxins) in dairy foods

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the novel technologies applied in milk and milk product processing for the inactivation of food borne microorganisms.
- To have an idea about the latest standards formulated by FSSAI on milk and milk products (Microbiological Standards).
- To know about the different toxins produced by microorganisms in milk and milk products.
- To have knowledge on Microbiological quality of traditional dairy products in India.

X. Suggested Reading

- Eozer B. 2014. *Dairy Microbiology and Biochemistry: Recent Developments*. CRC Press, USA.
- Law BA. 2012. *Microbiology and Biochemistry of Cheese and Fermented Milks*. Springer Publisher.
- Quin M. 1989. *Applied Microbiology in the Dairy Industry*. Hobsons Publishing PLC.
- Osei G. 2017. *Handbook of Dairy Microbiology*. AGri-Horti Press.
- Poltronieri P (Editor). 2017. *Microbiology in Dairy Processing: Challenges and Opportunities* John Wiley and Sons Inc.
- Prajapati JB and Behare PV. 2018. *Textbook of Dairy Microbiology*: Directorate of Knowledge Management in Agriculture, ICAR, ISBN: 978-81-7164-182-6.
- Fernandes R (Editor). 2009. *Microbiology Handbook: Dairy Products*. RSC Publishing.

I. Course Title : Microbial Genetics

II. Course Code : DM 515

III. Credit Hours : Credit: 2+1

IV. Why this course?

Microbial genetics is a subject area within microbiology and *genetic* engineering. *Microbial genetics* provides powerful tools for deciphering the regulation, as well as the functional and pathway organization, of cellular processes.

V. Aim of the course

To understand the fundamentals of structure, functions and synthesis of macromolecules and their genetic manipulation.

VI. Theory

Unit I

Macromolecules: DNA, RNA and their structure, types, organization, function and properties of macromolecules, DNA replication.

Unit II

Regulation and Gene Expression: Gene Expression and its regulation in Prokaryotes- Transcription, Genetic Code, Translation, Negative and Positive regulation in gene expression, Operon Models - Lac, Trp.

Unit III

Mutations: Mutations - Spontaneous and Induced, Type of mutations, Mutagenic agents – physical and chemical, Damage and repair system operating in Prokaryotes.

Unit IV

Plasmids and gene transfer systems: Plasmids and their properties, transposable elements, bacterial recombination, transformation, transduction and conjugation.

Unit V

Recombinant DNA technology, Fundamental aspects of genetic engineering/ recombinant DNA technology, restriction enzymes, plasmid vectors (cloning as well as expression vectors), PCR and real time PCR.

VII. Practical

- Isolation and quantitative estimation of chromosomal DNA from *E. coli* and *Lactobacillus* by mini prep method.
- Isolation of plasmid DNA from *E. coli* by miniprep method.
- Calcium chloride induced transformation of *E. coli* hosts with plasmids.
- Digestion of plasmid DNA with restriction enzymes and ligation into plasmid vector for transformation
- PCR based detection of microorganisms
- Demo of real time PCR machine

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the macrostructure of DNA and RNA

- To have an idea about the genetic expression and regulation in Prokaryotic system
- To know about the recent advancements in genetic engineering/recombinant DNA technology.
- To have exposure on different types of PCR and their applications.

X. Suggested Reading

- Bansal MP. 2012. *Molecular Biology and Biotechnology: Basic Experimental Protocols*. Teri Press - New Delhi.
- Hofmann A and Clokie S. (Eds.). 2018. *Wilson and Walker's principles and techniques of biochemistry and molecular biology*. Cambridge University Press.
- Watson JD, Tania AB, Stephen PB, Alexander G, Michael L and Richard L. 2017. *Molecular Biology of the Gene*.
- Russell J. Peter. 2014. *IGenetics: a molecular approach*. Pearson.
- Synder L and Champness W. 2003. *Molecular Genetics of Bacteria*. ASM Publ.
- Uldis N Streips and Ronald E Yasbin (Eds.). 2004. *Modern Microbial Genetics*. John Wiley and Sons.
- Watson JD. 2003. *Molecular Biology of Genes*. W.A. Benjamin.

I. Course Title : Environmental Microbiology

II. Course Code : DM 516

III. Credit Hours : 2+1

IV. Why this course?

Environmental microbiology is the study of the composition and physiology of microbial communities in the environment. This includes: structure and activities of microbial communities, processing of waste water using microbes, microbial interactions with bioecosytem, environmentally transmitted microbial pathogens, various bio-geochemical cycles etc.

V. Aim of the course

To understand the fundamentals of environmental microbiology for overall effects of microorganisms in combating the pollution in the environment.

VI. Theory

Unit I

Environmental microbiology; Aero-microbiology; Airborne pathogens, toxins, aerosols, nature and control of bio-aerosols, aquatic environments and microbial habitats; Soil as a microbial environment; Microbes in extreme environments.

Unit II

Bio-geochemical cycles; Carbon cycles (fixation, energy flow and respiration), nitrogen cycle (fixation, ammonia assimilation, nitrification and nitrate reduction) sulphur cycle (assimilatory sulphate reduction, sulphur mineralization, oxidation and reduction), iron cycle; microbial influenced metal corrosion, acid mine drainage, metal recovery and desulfurization.

Unit III

Environmentally transmitted microbial pathogens (*Salmonella*, *E. coli*, *Campylobacter, Yersinia* etc.) and viruses (enteric and respiratory); indicator microorganisms (concept, total and faecal coliforms, faecal streptococci, bacteriophage etc.); Biofouling and biofilms; microorganisms as indicators of environment pollution; microbial toxicants and bio-organic pollutants.

Unit IV

Waste water treatment: physical - screening, racks, mixing, flocculation, sedimentation, floatation, elutriation, vacuum filtration and incineration; biological unit operations-aerobic and anaerobic cycles; kinetics of biological growth, application of kinetics to treatment systems, aerobic waste treatment, anaerobic waste treatment; waste water utilization for value addition, disposal and reuse of Waste water after treatment, solid wastes management; environment laws.

VII. Practical

- Determination of composite microflora (i.e. total bacteria, coliforms, yeasts and moulds etc.) of soil, water, air.
- Determination of BOD in dairy and food industrial wastes.
- Determination of composite microflora of waste water samples.
- Detection of residual antibiotics/pesticides in waste water samples.
- Isolation of bacteria capable of degrading organic and microbial pollutants from waste water samples.
- Isolation and characterization of bio-indicators from environmental samples.
- Utilization of waste water for production of ethanol, microbial and biomass.
- Visit to a sewage and sludge treatment plant.

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work

- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the environmental bioecosytem (aero-microbiology).
- To have an idea about the processing of waste water using microbes
- To know about the various bio-geochemical cycles
- To have idea on environmentally transmitted microbial pathogens.

X. Suggested Reading

- Hurst CJ, Crawford RL, Garland JL, Lipson DA and Mills AL. 2007. *Manual of Environmental Microbiology*. 3rd Ed. ASM Press.
- Madsen, Eugene L. 2016. *Environmental microbiology: from genomes to biogeochemistry*.
- Maier RM, Pepper IL and Gerba CP. 2000. *Environmental Microbiology*. Elsevier.
- Maier RM, Pepper IL and Gerba CP. 2009. *Environmental Microbiology*. Elsevier Academic press, USA.
- Mitchell R and Gu JD. 2010. *Environmental Microbiology*. Wiley Blackwell.
- Varnam AH and Evans MG. 2000. *Environmental Microbiology*. Manson Publishing Ltd.

I. Course Title : Biotechnology in Dairy Industry

II. Course Code : DM 517

III. Credit Hours : 2+1

IV. Why this course?

Biotechnology is a tool for value addition to dairy foods. Genetic techniques have been employed to manipulate bacteria that have significance to the dairy industry. Biotechnological means can be used to regulate the production of flavour enhancing metabolites and to develop starter cultures that are resistant to bacteriophage and bacteriocins. Genetic engineering will be able to enhance the technological functions of Lactic acid bacteria for industrial applications using genetic approaches.

V. Aim of the course

To impart knowledge in the application of biotechnology in dairy/ food Industries

VI. Theory

Unit I

History and development of biotechnology; Status of biotechnology industries in India to meet the demands of dairy and food Industries.

Unit II

Genetic improvement of lactic starters to enhance their technological functions for industrial applications, e.g. acid, flavour, EPS, probiotic functions; Metabolic engineering of lactic acid bacteria; Production of recombinant dairy/ food enzymes/ proteins, e.g. chymosin, lactoferrin, lysozyme, lipases, proteases, immunoglobulins etc. Detection of GMOs and GM foods and their safety from public health point of view.

Unit III

Dairy based functional foods/ health foods and nutraceuticals. Value addition in dairy products through fortification/supplementation with bioactive components and probiotic cultures, Nutrigenomics.

Unit IV

Application of molecular tools, biosensors, etc. for detection of foodborne pathogens and spoilage microorganisms.

Unit V

Molecular tools for studying biodiversity; Regulatory standards, value added products for GMOs and GM foods.

VII. Practical

- Plasmid isolation from *E. coli*.
- Agarose gel electrophoresis.
- Transformation of *E. coli* with plasmid (Amp^r).
- Growth of starter cultures on MRS for “lac” marker.
- Induction of “lac”mutation using UV rays or ethidium bromide
- PCR assays for identification of LAB and foodborne pathogen detection
- Production of enzymes:protease/ â galactosidase
- Preparation of value added dairy products: fruit and probiotic based dahi/yoghurt/ lassi.

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student’s Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver

the following:

- To have knowledge on the nutrigenomics.
- To have knowledge on how to enhance the technological functions of Lactic acid bacteria for industrial applications using genetic approaches.
- To know about the advanced molecular tools for the detection of pathogens.
- To have knowledge on Biosensor and its application on dairy industry

X. Suggested Reading

- Pometto A, Shetty K, Paliyath G and Levin RE. 2005. *Food Biotechnology*. CRC Press, USA.
- Ratledge C and Kristiansen B. 2001. *Basic Biotechnology*. Cambridge University Press, USA.
- Bagchi D, Lau FC and Ghosh DK. 2010. *Biotechnology in Functional Foods and Nutraceuticals*. CRC Press, USA.
- Rai RV. 2015. *Advances in Food Biotechnology*. John Wiley and Sons Ltd.

I. Course Title : Dairy Starter Cultures

II. Course Code : DM 521

III. Credit Hours : 2+1

IV. Why this course?

Starter cultures are those microorganisms that are used in the production of cultured dairy products such as dahi, yogurt, cheese etc. A starter culture can provide particular characteristics in a more controlled and predictable fermentation. This study covers isolation and characterization of Lactic acid bacteria, methods for selection and preservation, preparation of DVS cultures, control of starter slowness and control of phage in dairy industry.

V. Aim of the course

To familiarize the students with the starter organisms, their metabolism and

genetics; different types of starters, propagation, preservation and applications of starters

VI. Theory

Unit I

Taxonomy and characteristics of starter cultures: Taxonomy and natural habitat of starter cultures, Desirable properties of starter cultures with respect to various fermented milk products, Characteristics of starter organisms, bacteria (*Lactococcus, Leuconostoc, Streptococcus, Pediococcus*, *Lactobacillus*, *Bifdobacterium, Enterococcus, Propionibacterium, Brevibacterium*),

yeasts and moulds.

Unit II

Carbohydrate, citrate and protein metabolism; Lactose, galactose and glucose metabolism-transport of sugars across the cell boundaries, homolactic and heterolactic fermentations, other pathways of sugar metabolism, formation of flavouring agents from citrate fermentation, proteolytic systems and protein metabolism in lactic acid bacteria: Genetics of starter bacteria: Plasmids and plasmid instability; Industrially significant genes; Genetic modification of lactic acid bacteria, transposons and insertion sequences. Genetics of flavor formation in starter bacteria; Major enzymes and pathways involved.

Unit III

Classification of starters: Single, mixed and multiple strain, mesophilic and thermophilic starter cultures; propagation and preservation of starter cultures; factors affecting propagation of starter, functional starters producing exopolysaccharides, vitamins and antimicrobial compounds, commercial starter preparations: concentrated and super concentrated starters; Production systems for bulk cultures: Lewis, Jones and Tetra-pack systems; growth media: nutritional requirements of lactic acid bacteria, growth media formulations; PIM/PRM, pH control during culturing- external and internal pH control systems; preservation of bulk starter cultures- frozen and freeze dried, spray dried cultures; direct vat starter cultures.

Unit IV

Growth inhibition of lactic acid bacteria by antibiotics, bacteriocins, bacteriophages, cleaning and sanitizing agents and naturally occurring antimicrobial systems in raw milk; sources, types and characteristics of phages associated with starters, morphology and taxonomy, phage host interaction, prevention and control of phages during starter handling and fermented milk products manufacturing, mechanisms of phage resistance in lactic acid bacteria, inhibitory substances produced by lactic acid bacteria.

VII. Practical

- Morphological examination of dairy starter cultures.
- Isolation of lactic acid bacteria from fermented milk products.
- Examination of purity and activity of starter cultures.
- Effect of physical and chemical factors on starter cultures.
- Evaluation of homo and hetero fermentation by starter cultures.
- Production of bulk starter culture.
- Preservation of starter cultures by liquid, freeze drying and other methods.

- Preparation and quality evaluation of concentrated starters.
- Inhibition of starters by antibiotic residues and other inhibitors.
- Production of bacteriocins by lactic acid bacteria.
- Production of exopolysaccharides by lactic acid bacteria.
- Detection of bacteriophages in cheese whey.

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the isolation and characterization of Lactic acid bacteria
- To have an idea about biochemical pathways of Lactic acid bacteria for carbohydrate metabolisms
- To know about the freeze drying and preparation of DVS cultures.
- To have idea about causes of slowness of starter and control of phage.

X. Suggested Reading

- Speranza B, Bevilacqua A, Corbo MR and Sinigaglia M. 2017. *Starter Cultures in Food Production*. Wiley Black Well, John Wiley and Sons, Ltd, UK.
- Marth EH and Steele JL. 2001. *Applied Dairy Microbiology*. Marcel Dekker Inn. New York.
- Prajapati JB and Behare PV. 2018. *Textbook of Dairy Microbiology: Microbiology of Starter Culture* 147-183. Directorate of Knowledge Management in Agriculture, ICAR, ISBN: 978-81-7164-182-6.
- Puniya AK. 2015. *Fermented Milk and Dairy Products*; CRC Press/ Taylor and Francis (ISBN 9781466577978).
- Hutkins RW. 2019. *Microbiology and Technology of Fermented Foods*, 2nd Ed, Wiley Blackwell, New Jersey, USA.
- Gabriel V, Ouwehand A, Salminen S and Wright AV. 2019. *Lactic acid bacteria: microbiological and functional aspects*. CRC Press.
- Wood BJ and Warner PJ. (Eds.). 2003. *Genetics of Lactic Acid Bacteria*. Springer Verlag.

I. **Course Title : Microbial Safety and Quality**

II. **Course Code : DM 522**

III. **Credit Hours : 2+1**

IV. **Why this course?**

Food Quality and Standards Service is committed to the enhancement of *food safety and quality* along the *food* chain to prevent diseases and trade disruptions. This course covers principles of safety in a food microbiological laboratory, conventional and rapid methods for detection of hygiene indicators or pathogens, antibiotic resistance in bacteria etc.

V. **Aim of the course**

To impart knowledge pertaining to quality and safety functions in dairy processing unit and measure to control quality and safety of dairy products.

VI. **Theory**

Unit I

Principles of quality and safety functions in dairy processing unit: Introduction to ISO standards– ISO: 9000:2000; ISO: 9004:2000; ISO: 9001:2000: Brief concept and principles of QMS and standard requirements for certification HACCP, Hazard Analysis and Risk-Based Preventive Controls (HARPC), SAFE, GMP, SSOP, FSMS, personnel hygiene and food handling in dairy industry.

Principles of safety in a food microbiological laboratory-Bio-safety concept, Biosafety level-1-4 containment design and layout; Standard microbiological practices for safe handling in food laboratory, safety equipment, facility design.

Unit II

General principles for establishment of microbiological criteria Definition, purpose and components of microbiological criteria; mandatory and advisory criteria. Sampling methods - two and three class sampling plan as per International council for microbiological standards for foods (ICMSF). Establishment of microbiological standards, guidelines and specifications for different dairy foods as recommended by ICMSF, CODEX, FSSAI

Unit III

Conventional and rapid methods for detection of hygiene indicators; definition, selection criteria of indicator organisms as an index of food quality. Conventional detection methods for indicator organisms – Standard plate count (SPC), coliforms, *E. coli*, yeast and mould Counts (YMC), spore counts; enterobacteriaceae count; Faecal streptococci count; Dye reduction tests. Rapid techniques like D-count, petrifilm, ATP bioluminance including

commercial kits for monitoring hygiene indicators

Unit IV

Conventional and rapid methods for detection of safety indicators; definition, selection criteria of indicator Organisms as an index of food safety; Conventional detection methods for detection of pathogenic organisms as per ISO protocol specified by FSSAI – *Staphylococcus aureus*; *Bacillus cereus*; Pathogenic *E.coli*; *Salmonella*; *Shigella*; *Listeria monocytogenes*; *Enterobacter sakazakii*; Sulphite reducing clostridia (SRC), *Campylobacter jejuni*; Rapid techniques like–VIDAS, SPR, RT-PCR including commercial kits, for monitoring safety indicators.

Unit V

Bio-sensors and micro-techniques for rapid monitoring of contaminants; definition, history, basic characteristics of bio-sensors; classification based on bio- recognition molecule - Microbial, spore, Aptamer, DNA, immune and enzyme etc. Biosensors based on Transducers - electrochemical, optical, mechanical and calorimetric etc. Bio-sensors for rapid detection of hygiene indicators, pathogenic bacteria, antibiotics, pesticides, heavy metal, aflatoxin M1 in milk.

VII. Practical

- Demonstration of safety principles in a food microbiological laboratory.
- Aseptic technique for ensuring safety of personnel, product and environment.
- Conventional and rapid methods for hygienic assessment of milk for SPC, coliforms,
  E. coli, YMC, Spore counts, Enterobacteriaceae count, faecal streptococci count, Dye reduction tests
- Conventional ISO methods for enumeration of safety indicators in dairy foods for
  S. aureus; *B. cereus*; *E.coli*; *Salmonella*; *Shigella*; *L. monocytogenes*; *E. sakazakii*; SRC; *Campylobacter jejuni* as per FSSAI standards.
- Rapid tests for detection of antibiotics, aflatoxin M1 and pesticides in milk.
- Determination of antibiotic resistance in bacteria using phenotypic methods.
- Shelf life studies of dairy products; effect of storage condition and packaging material on microflora of dairy foods.
- Determination of efficacy of detergents and sanitizers using capacity and suspension tests.

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on principles of safety in a food microbiological laboratory
- To have an idea about the principles for establishment of microbiological criteria
- To know about the conventional and rapid methods for detection of hygiene indicators/pathogens
- To have knowledge on antibiotic resistance in bacteria.

X. Suggested Reading

- M. Brown and M Stringer. 2012. *Microbiological: Risk Assessment in Food Processing*. Woodhead Publishing 1st Edition
- Patel P. (Ed.). (2012). *Rapid Analysis Techniques in Food Microbiology*. Springer Science and Business Media.
- Borough LM. 2004. *Food Microbiology Laboratory*, CRC Press, USA
- Nordenfelt, Pontus, Collin, Mattias. 2017. *Bacterial Pathogenesis* (1st edition) Springer.
- Arvanitoyannis IS. 2012. HACCP and ISO 22000: *Application to Foods of Animal Origin* (Institute of Food Science and Technology Series). Wiley Blackwell
- Osiemo O. 2012. *Food Safety Standards in International Trade: The Case of the EU and the COMESA*. Routledge Publisher.
- Bhunia AK. 2016. *Sensors for Food Safety and Quality*. eBook

I. Course Title : Microbiology of Cheese and Fermented Dairy Foods

II. Course Code : DM 523

III. Credit Hours : 2+1

IV. Why this course?

There are several types of cheeses in the world; use of different starter culture can lead to development of specific cheese variety too. However, the technological principles involved in Cheddar cheese making are common to several varieties of cheeses, with some modifications. Cheese is getting popularized in India,

especially the Pizza cheese variety that is preferentially used as a topping on pizza pie. The functional properties of cheese depend on the starter cultures used and ripening of cheeses. Specific cheese has its own typical flavour and aroma depending on type of starter cultures used for particular ripening conditions.

V. Aim of the course

To impart knowledge on basic and applied aspects of cheese and fermented dairyfoods

VI. Theory

Unit I

Evolution and classification of cheeses and fermented Dairy foods; Introduction, classification and types of cheeses and fermented dairy foods. Market share and recent market trends

Unit II

Microbiology of cheese, Cheese starter cultures involved in the manufacture, their types, roles, Current classification and metabolic pathways. Rennet, rennet substitutes; Microbial and recombinant rennet used in cheese preparation. Bacteriophages of cheese starters. Microbes associated with spoilage, defects, causative organisms and preventive measures. Health aspects of cheese.

Unit III

Microbiology of cheese ripening. Microbiological changes, Factors Influencing Growth of Microorganisms, Flavour development, Role of starter flora and supplementary flora in cheese ripening. Accelerated cheese ripening through biotechnological approaches, Cheese with high linoleic acid content, Enzyme-modified cheese, GMO. Microbiological and biochemical aspects of major cheese varieties - Cheddar, Swiss- Type Cheeses - Emmental, Very hard cheese - Parmesan, Dutch cheese varieties - Edam, Gouda, Pasta Filata/Pizza Cheese - Mozzarella, Unripened cheese - Cottage, Internal mould ripened cheese - Roquefort, Surface mould ripened cheese - Camembert, Bacterial surface ripened cheese- Limburger; Microbiology of processed cheese.

Unit IV

Microbiology of Fermented dairy foods; Dahi, lassi, yoghurt, Kefir, Koumiss, functional fermented dairy based beverages, fermented whey drinks, and dairy based fermented cereal foods, fortified fermented dairy foods - Microbes associated with spoilage and preventive measures. Safety and standards of fermented foods.

Unit V

Functional cheeses, Cheese as matrix for probiotic delivery.

Health aspects of cheese and fermented foods: nutritional value,

and therapeutic benefits.

VII. Practical

- Preparation and evaluation of ethnic fermented dairy products
- Preparation of cheese with mesophilic dairy starter cultures and different microbial rennets.
- Preparation of functional/probiotic cheese
- Microbial analysis of cheeses
- Identification and characterization of specific starter cultures from different varieties of cheeses (*Leuconostoc* for Dutch type cheese, *Propioni bacterium* for Swiss type cheese).
- Determination of ß-galactosidase activity of microorganisms
- Accelerated cheese ripening using different interventions

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group work
- Routine practical as per the schedule
- Visit to the relevant industry or laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Be able to manufacture various varieties of cheeses using cheese specific starter cultures
- To have knowledge on Bacteriophages of cheese starters
- Be able to develop different fermented milk products, particularly traditional fermented milk products
- To develop the probiotic cheese using probiotic cultures

X. Suggested Reading

- Speranza B, Bevilacqua A, Corbo MR and Sinigagli M. 2017. *Starter Cultures in Food Production.* Wiley Black Well, John Wiley and Sons, Ltd, UK.
- FatihYildiz. 2009 *Development and Manufacture of Yogurt and Other Functional Dairy Products*, CRC Press, USA.
- El-Mansi EMT, Bryce CFA, Arnold L. Demain and Allman AR. (Edited). 2012. *Fermentation Microbiology and Biotechnology*, Third Edition CRC.
- McSweeney P, Fox P, Cotter P and Everett D. (Eds.) 2017. *Cheese -Chemistry, Physics and Microbiology*, 4th Edn. Academic Press.
- Puniya AK. 2015. *Fermented Milk and Dairy Products*; CRC Press/ Taylor and Francis (ISBN 9781466577978).

- Hutkins RW. 2019. *Microbiology and Technology of Fermented Foods*, 2nd Ed, Wiley Blackwell, New Jersey, USA.
- Wood BJ and Warner PJ. (Eds.). 2003. *Genetics of Lactic Acid Bacteria*. Springer Verlag.

I. **Course Title : Probiotics and Prebiotics**

II. **Course Code : DM 524**

III. **Credit Hours : 2+1**

IV. **Why this course?**

Probiotics are live microorganisms intended to provide health benefits when consumed, generally by improving or restoring the gut flora. This study covers Gut microbiota and its role in human health, mechanism of action of probiotics/prebiotics, safety and regulations on probiotics or probiotic food products.

V. **Aim of the course**

To understand the concept of probiotics and prebiotics in relation to food formulations and health effects.

VI. **Theory**

Unit I

Probiotics, Prebiotics and Synbiotics: Concepts, definitions and history. Gut microbiota and its role in human health and disease

Unit II

Identification of probiotic strains isolated from different niches by polyphasic approach using phenotypic, biochemical and genotypic tools/techniques. Characterization and selection of candidate probiotic strains on the basis of FAO/ WHO or ICMR/DBT guidelines.

Unit III

Mechanism of action of probiotics: Colonization in the gut; Adhesion to intestinal mucosal surface – role of surface proteins; Antimicrobial/antagonistic activity of probiotics, Pathogen exclusion; Immuno-modulatory action; Impact on gut homeostasis; Host microbe interaction and their cross talk; Role of biomarkers for probiotic functionality.

Unit IV

Mechanism of action of prebiotics and synbiotics: Selective stimulation of beneficial bacteria in the gut microbiota; Effect on gastric emptying and intestinal transit rate; Production of short chain fatty acids (SCFA); Effect of SCFA on host metabolism and immunomodulation; Anti-adhesive prebiotics. Synbiotics and their action through improved viability of probiotic microorganisms and provision of specific health benefits

Unit V

Dairy based foods as carrier of probiotics: Dairy based products as delivery vehicles – Stability towards manufacturing conditions, enhancing stability through encapsulation or drying strategies for lyophilized formulations etc., co-culture compatibility with starters, minimum effective dose, and large-scale production of probiotic biomass through fermentation for application in foods and as drugs/supplements.

Unit VI

Designer probiotics: Genetically modified probiotics as oral vaccines, enhanced adhesion properties and health promoting functions.

Unit VII

Safety, human trials and regulatory guidelines: *In vitro* and *in vivo* safety assessment of probiotics; designing human trials; regulatory guidelines - US, Canada, Europe and India.

VII. Practical

- Isolation of probiotic organisms from human milk and faecal samples.
- Tentative identification by microscopic examination, catalase and biochemical tests.
- Identification of isolates by genus and species-specific PCR.
- Evaluation of bacterial isolates for probiotic properties.
- Acid tolerance; Bile tolerance; Hydrophobicity; Antimicrobial activity.
- Specific utilization of prebiotics by probiotic bacteria.
- Survival of probiotic culture in fermented dairy products.
- Microencapsulation of probiotic bacteria.

VIII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Have knowledge on the Gut microbiota and its role in human health
- To have knowledge on identification, characterization and selection of probiotic strains using phenotypic, biochemical and

genotypic tools/techniques

- To know about the different mechanism of action of probiotics/prebiotics establishing through in vitro and in vivo studies.
- To have any idea about the safety and regulations on probiotics or probiotic food products.

X. Suggested Reading

- Sungsoo C and Finocchiaro ET. 2010. *Handbook of prebiotics and probiotics ingredients: health benefits and food applications*. Boca Raton: Taylor and Francis.
- Ipek G, Vijay JK and Mohamed A. 2006. *Probiotics in Food Safety and Human Health*.
- Huffnagle GB. 2008. *The Probiotics Revolution: The Definitive Guide to Safe, NaturalHealth Solutions Using Probiotic and Prebiotic Foods and Supplements*. Bantam,USA.
- Venema K. 2015. *Probiotics and Prebiotics: Current Research and Future Trends*.
- Min-TzeLiong. 2011. *Probiotics: Biology, Genetics and Health Aspects*. Springer.
- Prajapati JB and Behare PV. 2018. *Textbook of Dairy Microbiology:* Directorate of Knowledge Management in Agriculture, ICAR, ISBN: 978-81-7164-182-6.
- Di Gioia, Diana. -Biavati, Bruno. 2018. *Probiotics and Prebiotics in Animal Health and Food Safety*
- Wallace RK and Wallace S. 2017. *Gut Crisis: How Diet, Probiotics, and Friendly Bacteria Help You Lose Weight and Heal Your Body and Mind*. Dharma Publication, Fairfield, USA.

I. Course Title : Research Techniques

II. Course Code : DM-525

III. Credit Hours : 2+1

IV. Why this course?

Research techniques are required to study the tools and techniques that are used in quantitative and qualitative methods. This study covers microscopic analysis of different types of bacteria, activities of enzyme using spectrophotometric based assays, identification and characterization of microorganisms by PCR etc.

V. Aim of the course

To impart knowledge and skills related to microbiological analytical systems in microbiology and related sciences.

VI. Theory

Unit I

Microscopy: Principles, design and application of bright field, dark

field, phase contrast, fluorescence, atomic force, confocal laser and electron microscopes.

Unit II

Cell fractionation: Physical and chemical methods of microbial cell lysis: Ultrasonication, glass bead lysis, micro-fluidization, enzymatic and solvent induced techniques.

Unit III

Molecular separation: Ultrafiltration, crystallography, isoelectric focusing, chromatography, SDS-PAGE, micro and ultracentrifugation.

Unit IV

Assay methods: Spectrophotometric methods, ELISA, protein and enzyme assays, microbiological assay, and microbial receptor assay.

Unit V

Studying nutritional and therapeutic attributes of microorganisms and fermented dairy foods - Use of cell culture and small animal models.

VII. Practical

- Familiarization with the construction and design of a compound microscope; use of light microscope accessories; microscopic analysis of different types of bacteria by bright field, dark field, phase contrast and fluorescence microscopes
- Disruption of bacterial cells by ultra-sonification
- Demonstration of chromatographic techniques and SDS-PAGE
- Demonstration of aerobic and anaerobic culturing techniques
- Demonstration of use of animal models in toxicity studies
- Identification and characterization of microorganisms by PCR

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Be able to do the microscopic analysis of different types of bacteria
- To measure the activities of enzyme using spectrophotometric based assays

– To know about the identification and characterization of microorganisms by PCR

X. Suggested Reading

- Murphy DB. 2001. *Fundamentals of Light Microscopy and Electronic Imaging*, Wiley-Liss, Inc., USA.
- Harisha S. 2010. *Biotechnology Procedures and Experiments Handbook*. Infinity science press LLC, Hingham, MA 02043, USA.
- Hofmann A and Clokie S. (Eds.). 2018. *Wilson and Walker's principles and techniques of biochemistry and molecular biology*. Cambridge University Press.
- Spencer JFT & Ragout AL, Nollet LML and Toldra F. 2013. *Food analysis* HPLC, Third edition, CRC press, Taylor and Francis group, Florida, USA.
- Nollet LML and Toldra F. 2013. *Food analysis* HPLC, Third edition, CRC press, Taylor and Francis group, Florida, USA.
- Nasser Hajibagheri MA.1999. *Electron Microscopy Methods and Protocols, Methods in Molecular Biology Series*, # 117.Humana Press Inc., Totowa, New Jersey, USA.
- Singer S. 2001. *Experiments in Applied Microbiology*, Academic Press, New York, USA.

I. Course Title : Microbial Fermentation Technology

II. Course Code : DM-526

III. Credit Hours : 2+1

IV. Why this course?

Fermentation technology is the use of organisms to produce food, pharmaceuticals and alcoholic beverages on a large scale industrial basis. The basic principle involved in the industrial fermentation technology is that organisms are grown under suitable conditions, by providing raw materials meeting all the necessary requirements such as carbon, nitrogen, salts, trace elements and vitamins in a suitably designed bioreactor.

V. Aim of the course

To disseminate recent information on basic and applied aspects of fermentation technology and its industrial application to the students.

VI. Theory

Unit I

Fermentation for enhancing shelf life of foods, types of fermentation - submerged/solid state and semi-solid.

Unit II

Microbial growth, metabolism, death, membrane transport,

fermentation kinetics and fermentation modelling, batch, fed batch, continuous culture systems.

Unit III

Bioreactor design, measurement and control in fermentation.

Different types of fermenters, scaling up of fermentation, sterilization, agitation; pH, Eh, temperature measurement and control, downstream processing and product recovery, immobilization in fermentation

Unit IV

Biosensors in fermentation applications

Biosensors, basic principles; application in detection of sugars, alcohol, amino acids

Unit V

Industrial production of microbial cell biomass, organic acids, enzymes, antibiotics, micro-nutrients, amino acids, vitamins, ethanol, SCP and alcoholic beverages

VII. Practical

- Bacterial growth in batch culture.
- Different methods of microbial cultivation.
- Fermenter operation and measurement.
- Production of antimicrobial substances/ bacteriocins
- Production of microbial enzymes
- Production of baker yeast, SCP/microbial biomass.
- Production of alcohol, lactic acid.
- Production of alcoholic beverages and whey beverage

VIII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Routine Practical as per the schedule
- Visit to the relevant industry or Laboratory

IX. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the Bioreactor design, measurement and control infermentation
- Be able to produce the microbial cell biomass, organic acids, enzymes, antibioticsetc. using fermenter
- To have an idea about the construction, design and application of biosensor
- Be able to produce alcoholic and whey beverages.

x. Suggested Reading

- Kulandaivelu S and Janarthanan S. 2012. *Practical Manual on Fermentation Technology*. I K International Publishing House Pvt. Ltd.
- PF Stanbury Dr Whitaker. 2008. *Principles of Fermentation Technology*, Elsevier; 2editions.
- Okafor N, Okeke BC. 2017. *Modern Industrial Microbiology and Biotechnology* (Text Book), Second Edition published by CRC press, USA.
- ArindamKuila and Vinay Sharma. 2019. *Principles and Applications of Fermentation Technology* John Wiley and Sons.
- Hutkins RW. 2019. *Microbiology and Technology of Fermented Foods*, 2nd Ed, Wiley Blackwell, New Jersey, USA.
- Gabriel V, Ouwehand A, Salminen S and Wright AV. 2019. *Lactic acid Bacteria: Microbiological and Functional Aspects*. CRC Press.

Course Contents Ph.D. in Dairy Microbiology

I. **Course Title : Advances in Microbial Physiology**
II. **Course Code : DM 611**
III. **Credit Hours : 3+0**
IV. **Why this course?**

Microbial physiology deals with metabolism and energy provision; reproduction and death; and regulation of vital activity on the intracellular level and on the level of microbe-microbial interactions and interactions of microorganisms with plants, animals, and man. This study covers growth kinetics of microorganisms, genetical changes during endospore formation, interactions of bacterial communities and diversity in natural eco-systems

V. **Aim of the course**

To understand the advances in microbial physiology and diversity for its interface with all other branches of microbiology.

VI. **Theory**

Unit I

Microbial growth and stress response; Mathematics and kinetics of bacterial growth, Continuous culture system (chemostat and turbidostat), Diauxic and synchronous growth, Unrestricted versus nutrient-limited growth; Advances in growth measurement, counting viable but non-culturable microbes, Growth in natural environments and limitations. Osmotic stress and osmoregulation, high and low osmolality, osmotic control of gene expression, Aerobic to anaerobic transitions, oxidative stress, regulation of the oxidative stress response,pH stress and acid tolerance,Thermal stress and heat shock response, Nutrient stress and starvation stress response, starvation protecting proteins.

Unit II

Peptidoglycans of bacterial cell walls; peptidoglycan hydrolases and synthesis; teichoic and lipo-teichoic acids, Outer membranes of Gram-negative bacteria; lipo- polysaccharide biosynthesis; Outer membranes of Gram-negative bacteria, Bacterial flagella; Chemotaxis; Swarming motility; motility in spirochetes, Endospore formation in bacillus; molecular design of a spore; Stages, physiological changes and genetic aspects of sporulation; Sporulating genes; initiation, transition, forespore development and final stages of sporulation; spore cortex and coat synthesis; Biochemical changes during sporulation, heat resistance in spores; Activation, germination, and outgrowth of bacterial endospores.

Unit III

Energy generation and transport of metabolites: Substrate-level and oxidative phosphorylation; Measurement of proton motive force; Electron transport systems; Anaerobic respiration; Conversion of proton motive force to energy; Structure of F1F0 and the ATP operon; Energy yield; Generating ATP in alkalophiles; Energetics of chemolithotrophs; Metabolite transport; Facilitated diffusion; Mechanosensitive channels; ATP-binding cassette transporter family; Chemiosmotic-driven transport; Establishing ion gradients; New insight into Respiration and fermentation mechanism in Lactic Acid bacteria, specific transport systems; ATP-linked ion motive pumps, the histidine permease, iron, phosphotransferase system. Sugar transport in Lactic Acid bacteria.

Unit IV

Metabolic Pathways: Alternate pathways of carbohydrate metabolism; Fructose bisphosphatealdolase pathway; Alternate pathways of glucose utilization; Entner- doudoroff or ketogluconate pathway; phosphoketolase pathway; oxidative pentose phosphate cycle; Gluconeogenesis, regulation, glycogen synthesis, tricarboxylic acid cycle, glyoxylate cycle. Utilization of sugars other than glucose, lactose, galactose; maltose, mannitol, fucose and rhamnose, melibiose, raffinose, stachyose; Cellulose degradation; metabolism of starch and glycogen.

Unit V

Microbial (bacterial, archaeal, fungal and viral) diversity, Bacterial communities and diversity in natural eco-systems with special reference to Lactic Acid bacteria. Extremophiles: hyperthermophiles, extreme acidophiles, psychrophiles, barophiles halophiles, alkaliphiles, oligotrophs, radiation-resistant microorganisms, extremophiles habitats and microorganisms, Biochemistry and physiology of adaptation, biotechnology of extremophiles.

VII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/ Writing)
- Student's Book/ Journal Articles
- Student presentation
- Group Work
- Visit to the relevant industry or Laboratory

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the growth kinetics of microorganisms
- To have an idea about the genetical changes during endospore formation
- To know about the energy generation using electron transport chains
- To have idea on interaction of bacterial communities and diversity in natural eco-systems.

IX. Suggested Reading

- Cowan MK. 2012. *Microbiology: A Systems Approach*, 3rd Edn. The McGraw Hill Companies, New York, USA.
- Madigan MT, Martinko JM and Parker J. 2012. *Brock Biology of Microorganisms*, 13th Edn. Prentice Hall, London, UK. Edition, Prentice Hall, London, UK.
- Moat AG, Foster JW and Spector MP. 2004. *Microbial Physiology*. 4th Ed. John Wiley and Sons, USA.
- Ogunseitan O. 2005. *Microbial Diversity: Form and Function in Prokaryotes* Blackwell Publishing, Malden, USA.
- Poole RK. (Ed.). 2020. *Advances in microbial physiology*. Academic Press.
- Xie *et al*. 2011. *Bacterial Flagellum as a Propeller and as a Rudder for Efficient Chemotaxis*. PNAS108 (6): 2246-51.

I. Course Title : Advances in Microbial Genetics

II. Course Code : DM 612

III. Credit Hours : 3+0

IV. Why this course?

Microbial genetics is the study of inheritance in microorganisms, including bacteria and fungi. This study covers the advancement of genetic expression and regulation in Prokaryotic system, genetic engineering/recombinant DNA technology, mutations, gene editing using advanced tools, etc. The course will also highlight applications of genetic tools.

V. Aim of the course

To familiarize the students with basic concepts of Microbial Genetics and impart them knowledge in advancements of Microbial Genetics and Genetic Engineering

VI. Theory

Unit I

Nucleic Acids: Structure of DNA – A, B and Z and triplex DNA, Function of DNA, RNA, DNA Replication models, Protein-Nucleic acid Interactions and helix-turn- helix (HTH) motif, Genetic Code.

Unit II

Mutations – Spontaneous and Induced mutations, Types of mutations; Mutagenic agents (Physical and Chemical), Molecular basis of Mutagenesis, DNA Damage and Repair – Molecular Mechanisms, Photoreactivation, Excision repair, mismatch repair, post replication repair and SOS repair. Site Directed Mutagenesis, Directed evolution, Targeted Genome Editing and CRISPR/Cas9.

Unit III

Prokaryotic Transcription; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Transcriptional regulation-positive and negative; Operon models, - Lac, Gal and Trp. Translation: Translation machinery, translation process, Initiation, elongation, termination, factors of Protein Synthesis, peptide bond formation and translocation, Regulation of prokaryotic translation.

Unit IV

Plasmid - Structure and replication, types of plasmids, moveable genetic elements: Transposons, IS and Tn elements, molecular mechanism of transposition, Recombination in bacteria, homologous and non-homologous, 'illegitimate' recombination, and site-specific recombination; Transformation and competence factors, Transduction and Conjugation, structure of F plasmids, Hfr, Recombination methods as a tool for Gene mapping.

Unit V

Genetic Engineering/ rDNA–Restriction Enzymes – Types, Mode of action and application as a tool for gene manipulation, Vectors – Cloning and expression vectors, Construction of genomic and cDNA library, construction of full length cDNA, Microarray, Gene Silencing, Gene knock out.

Unit VI

Intracellular Signaling in microorganisms, cell-cell communication (quorum sensing), Signal transduction mechanism or pathways

Unit VII

Pyrosequencing, Illumina, Ion torrent, Nanopore sequencing technologies for whole genome and metagenome sequencing.

VII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Visit to the relevant industry or Laboratory

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the biological significance of DNA and RNA
- To have an idea about the genetic expression and regulation in Prokaryotic system
- To know about the recent advancements in genetic engineering/recombinant DNA technology.
- To have exposure on gene editing using advanced tools.

IX. Suggested Reading

- Dyson MR and Durocher Y. 2007. *Expression Systems*. Scion Publ.
- Hartl D, Jones L and Elizabeth W. 2000. *Genetic Analysis of Genes and Genomes*. Jones Bartkett Publ.
- Watson JD, Tania AB, Stephen PB, Alexander G, Michael L and Richard L. 2017. *Molecular Biology of the Gene*. Pearson.
- Keuzer H and Massey A. 2001. *Recombinant DNA and Biotechnology*. 2nd Ed. ASM Press.
- Russell Peter J. 2014. *IGenetics: a molecular approach*. Pearson
- Streips UN and Yasbin RE. 2002. *Modern Microbial Genetics*. 2nd Ed. John Wiley and Sons.
- Synder L and Champness W. 2003. *Molecular Genetics of Bacteria*. 2nd Ed. ASM Publ.

I. Course Title : Advances in Dairy and Food Microbiology

II. Course Code : DM 621

III. Credit Hours : 3+0

IV. Why this course?

Functional foods have potentially positive effects on health beyond basic nutrition and promote optimal health and help to reduce the risk of life style diseases. This course covers biochemical pathways of Lactic acid bacteria for carbohydrate metabolisms or protein metabolisms, bacteriocins and their application as biopreservatives, encapsulation of microorganisms and enzymes for the delivery to the target site etc.

V. Aim of the course

To study and understand the current trends and recent concepts related to microbiology of dairy and other foods products.

VI. Theory

Unit I

Lactic acid bacteria in food fermentations, Important metabolic

pathways of microorganisms, Current status of metabolism of starters cultures; Antibiotic resistance in lactic acid bacteria, Current trends in lactic starter for industrial applications and functional foods, Special additional cultures, Biofilm and their remedies, Future aspects in research and development of LAB.

Unit II

Current concepts in starter technology, Novel starter preservation techniques, DVS, Improving starter cultures for food fermentation by genetic manipulation/metabolic engineering, Development/formulation of new products based on dairy by-products, Bioactive metabolites and biogenic amines, Designer milk, Modern concepts in cheese ripening, Nutraceuticals and functional foods, Genetically modified foods/ products, Safety aspects of genetic engineered foods.

Unit III

Bacteriocins of lactic acid bacteria, Structure, function, transport and mode of action, Application of bacteriocins in food bio preservation, Non-bacteriocin antimicrobial compounds- reuterin, antifungal compounds, milk and food derived bioactive peptides and other antimicrobial compounds, Protective cultures, Antimicrobial packaging system, active packaging.

Unit IV

Newly emerging pathogens, Concepts in food toxicology, Food borne toxins, Rapid methods for detection in food borne pathogens, Current concepts in food quality and safety management, Control of food borne pathogens, Pasteurization, dehydration, freezing, fermentation, irradiation and chemical additives, microwave processing, microfiltration, bactofugation, Hurdle technology, modified atmosphere packaging and storage, novel technology in control of food based pathogens, Use of non-thermal technologies (ultra-high voltage electric fields, thermosonication hydrostatic pressure technology, cold plasma etc.) alternate-thermal technologies (ohmic heating, dielectric heating, infrared and induction heating etc.), Biological technologies (antibacterial enzymes, proteins and peptides) in food processing.

Unit V

Encapsulation as a means for delivery of bacteria and functional ingredients- microencapsulation and nanoencapsulation, nanotechnology, Immobilization of cell and enzymes and their use in dairy and food industry.

VII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)

- Student's Book/Journal Articles
- Student presentation
- Group Work
- Visit to the relevant industry or Laboratory

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- Have knowledge on the functional dairy foods
- To have an idea about biochemical pathways of Lactic acid bacteria for carbohydrate metabolisms or protein metabolisms
- To know about the Bacteriocins and their application as biopreservatives.
- To have any idea about the encapsulation of microorganisms and enzymes for the delivery to the target site.

IX. Suggested Reading

- Ozer B and Evrendilek GA. 2014. *Dairy Microbiology and Biochemistry: Recent Developments*. CRC Press
- Bagchi D, Lau FC and Ghosh DK. 2010. *Biotechnology in Functional Foods and Nutraceuticals* (1st Edition, 2010) CRC Press, USA.
- Kwak HS. 2015. *Nano- and Microencapsulation for Foods*. Wiley Publishing
- Erkmen O and Bozoglu TF. 2016. *Food Microbiology: Principles into Practice*, 2 Volume Set. Wiley Publishing.
- Suvendu Bhattacharya. 2014. *Conventional and Advanced Food Processing Technologies*. Wiley Publishing.

I. Course Title : Advances in Food Safety of Dairy Products

II. Course Code : DM 622

III. Credit Hours : 3+0

IV. Why this course?

Food safety is used as a scientific discipline describing handling, preparation, and storage of food in ways that prevent food-borne illness. This study covers principles of safety in advanced food microbiological laboratory, general mechanism of microbial pathogenesis, emerging food borne pathogens, antimicrobial resistance in bacteria etc.

V. Aim of the course

To develop knowledge, understanding and application of foodborne pathogens at an advanced level to ensure safety of dairy products.

VI. Theory

Unit I

Milk borne diseases, public health concern and epidemiology

Trends in food borne disease and implication; Methods of diseases transmission; Changing patterns in epidemiology of milk borne diseases; Impact of agricultural and modern food manufacturing practices in transmission of food borne diseases. Public health concern associated with milk and milk products; type of microbial spoilage, defects and control measures.

Unit II

General mechanism of microbial pathogenesis: Food borne infection by colonization and adhesion factors like Pilli or fimbriae, adhesion proteins, Food borne infection by biofilm formation; invasion and intracellular residence factors; Food borne infection by phagocytosis, invasion mediated induced phagocytosis; Food borne infection by iron acquisition; motility and chemotaxis; Food borne infection by invasion of immune system; Intoxication; Toxi-infection. Structure and function of exotoxins and endotoxin; Genetic regulation and secretary system for virulence factors.

Unit III

Growth, survival characteristics, virulence and infectivity of dairy pathogens; Growth and survival characteristics of *E. coli, Enterobacter sakazaki*, Salmonella, Shigella, *Yersinia enterocolitica,* Streptococcus sp., *L. monocytogenes*, *Mycobacterium avium* subsp. *paratuberculosis*, *Brucella* sp*., Campylobacter jejuni*, *Staph.aureus*, *B. cereus, Clostridium perfringens*, toxigenic fungi and viruses in milk and milk products, their pathology of illness, mode of transmission, incidence of illness, virulence and infectivity.

Unit IV

Microbiological risk assessment of dairy foods: Risk analysis principle and concept; Hazard identification and characterization; Exposer assessment;Risk characterization in dairy products; Risk assessment models (dose response/ exposer assessment models);Risk factors affecting microbial safety of raw and processed dairy foods; Risk profiling of pathogens in milk and milk products; Risk management issues and control strategies for dairy products.

Unit V

Antimicrobial resistance in dairy animals and public health concern: Global and national perspective of AMR in dairy sector; WHO priority list/ guidelines on AMR bacteria; National action plan on AMR. Surveillance/ Incidence of AMR bacteria in dairy food chain and public health concern Mechanisms of resistance development in AMR bacteria; Conventional and rapid diagnostics for detection of AMR bacteria in dairy foods.

VII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/ Writing)
- Student's Book/ Journal Articles
- Student presentation
- Group Work
- Visit to the relevant industry or Laboratory

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on principles of safety in advanced food microbiological laboratory
- To have an idea about the general mechanism of microbial pathogenesis
- To know about the emerging food borne pathogens
- To have knowledge on antimicrobial resistance in bacteria

IX. Suggested Reading

Schwarz S, Cavaco LM, Shen J and Aarestrup FM. 2018. *Antimicrobial Resistance in Bacteria from Livestock and Companion Animals* ASM Press.

- Haas CN, Rose JB and Gerba CP. *Quantitative Microbial Risk Assessment*. John Wiley and Sons.
- Kudva IT and Nicholson T. 2016. *Virulence Mechanisms of Bacterial Pathogens*. ASM Press.
- McVey DS, Kennedy M and Chengappa MM. 2013. *Veterinary Microbiology* John Wiley and Sons.
- Yoe C. 2016. *Principles of Risk Analysis: Decision Making Under Uncertainty*. Publisher - Technology and Engineering.
- Bhunia AK. 2019. *Foodborne Microbial Pathogens: Mechanisms and pathogenesis*. Springer-Verlag New York.

I. Course Title : Advances in Probiotics and Functional Foods

II. Course Code : DM 623

III. Credit Hours : 3+0

IV. Why this course?

Probiotics are live microbial food supplements that provide several health benefits, as they help in maintaining excellent stability and composition of the intestinal microbiota and boost the resistance against infection by pathogens. The requirement for probiotic functional foods is rapidly and progressively because of increased awareness of the public regarding the impact of food on health. This study covers prebiotics, synbiotics and postbiotics, functional food ingredients and their role in human health and nutrition, different

mechanism of action of probiotics establishing through in vitro and in vivo studies, scientific assessment of probiotics/functional foods, next generation probiotics etc.

V. Aim of the course

To familiarize the student with the advancements in probiotics and functional foods

VI. Theory

Unit I

Probiotics: Characteristics of probiotics for selection, Stability during storage and passage to gastrointestinal tract.

Unit II

Probiotic mode of action and disease control: Homeostasis of disturbed commensal microbial flora in the gut, pathogen exclusion, production of antimicrobial substances, modulation of immune system, alteration of intestinal bacterial metabolite action, alteration of microecology of healthy humans and patients.

Unit III

Prebiotics, synbiotics and postbiotics: Concept and definitions, criteria, types and sources of prebiotics, prebiotics and gut microbiota.

Unit IV

Functional foods; Nutraceuticals, medical/health foods, functional foods ingredients and their role in human health and nutrition.

Unit V

Dairy based functional foods: Dahi, lassi, yoghurt, kefir, cheese, koumiss, functional fermented dairy beverages, and dairy based cereal foods, fortified fermented dairy foods.

Unit VI

Cereals, soya, plant based and other functional foods; Miso, Kimchi, Sauerkraut, Sake, Ogi, Gundruk, Natto, Doenjang, Tempeh, Douchi, Cheonggukjang, and Soy milk based fermented foods:(yoghurt, dahi, beverages and cheese), fermented meat products.

Unit VII

Microbial production of Bioactive compounds: Bacteriocins, Bioactive peptides, Conjugated Linoleic Acids, gamma-Aminobutyric acid, Vitamins (Folate, Riboflavin, Vitamin B12), Low calorie sugars (Xylitol, Sorbitol, Mannitol, Trehalose), Micronutrients (Selenium, Zinc).

Unit VIII

Health benefits of probiotics/functional foods: Gastrointestinal disorders, metabolic syndrome including cardiovascular diseases, diabetes and obesity, Brain health, Immunological disorders, cancer, health and wellbeing in Ageing, alcoholic and non-alcoholic liver

disease, Reproductive and Hormonal disorders, mental health.

Unit IX

Scientific Assessment of probiotics/functional foods: Role of Biomarkers, Application of Proteomics, Metabolomics, Nutrigenetics and Nutrigenomics in establishing scientific evidence of functional foods for imparting health benefits.

Unit X

Regulations and Future prospects of probiotics and functional foods: Legal status of probiotics, safety and regulatory aspects and Future prospects.

Unit XI

Next generation probiotics (Designer probiotics): Robust probiotic strains with stress survival systems, enhanced adhesion ability and surface markers etc. and for mucosal delivery of vaccines.

VII. Teaching Methods/ Activities

- Lectures
- Assignment (Reading/Writing)
- Student's Book/Journal Articles
- Student presentation
- Group Work
- Visit to the relevant industry or Laboratory

VIII. Learning outcome

After undergoing this course, the students are expected to deliver the following:

- To have knowledge on the Prebiotics, synbiotics and postbiotics
- To have knowledge on functional food ingredients and their role in human health and nutrition
- To know about the different mechanism of action of probiotics establishing through *in vitro* and *in vivo* studies.
- To have any idea about the Scientific Assessment of probiotics/functional foods.

IX. Suggested Reading

- Huffnagle GB. 2008. *The Probiotics Revolution: The Definitive Guide to Safe*, Natural Health Solutions Using Probiotic and Prebiotic Foods and Supplements. Bantam, USA.
- Robert Keith Wallace (Author) and Samantha Wallace. 2017. *Gut Crisis: How Diet*, *Probiotics, and Friendly Bacteria Help You Lose Weight and Heal Your Body and Mind*. Dharma Publication, Fairfield, USA.
- Hae-Soo Kwak. 2015. *Nano- and Microencapsulation for Foods*. Wiley Publishing
- Edward R. (Ted) Farnworth. 2008. *Handbook of Fermented*

Functional Foods. CRC Press
- Prajapati JB and Behare PV. 2018. *Textbook of Dairy Microbiology*. Directorate of Knowledge Management in Agriculture, ICAR, ISBN: 978-81-7164-182-6.
- Puniya AK. 2015. *Fermented Milk and Dairy Products*; CRC Press/ Taylor and Francis (ISBN 9781466577978)
- Frias J, Villaluenga CM and Peñas E. (Ed.). 2016. *Fermented Foods in Health and Disease Prevention*. Elsevier Inc.
- Sungsoo C, and Finocchiaro ET. 2010. *Handbook of prebiotics and probiotics ingredients: health benefits and food applications*. Boca Raton: Taylor and Francis.
- Owen Judith A and Janis Kuby. 2013. *Kuby immunology*. New York: W.H. Freeman.
- Tamang Jyoti Prakash. 2020. *Ethnic fermented foods and beverages of India: science history and culture*. Singapore: Springer.

Suggested Broad Topics for Master's and Doctoral Research

- Application of predictive microbiology:Modeling microbial responses in foods
- A process approach to quality management system
- Air micro-flora as spoilage and infectious agents in dairy industry
- Alternative methods of microbial quantification
- Animal studies of functional attributes of dairy organisms
- Anti-microbial packaging and MAP of foods
- Bioactive peptides and Nutraceuticals
- Biodegradation of pollutants and packaging of food materials in the environment
- Biodiversity of Indian probiotic cultures/ LAB
- Biofilms in dairy industry
- Bioprospecting of dairy foods for identification, characterization and classification of prevailing microbiota
- Bioremediation of food industry wastes and metabolic engineering
- Biosensor Based assays for the detection of pathogens
- Cloning and Expression of prokaryotic and Eukaryotic genes in *E. coli* and yeast systems
- Defined strain cultures for indigenous fermented milks
- Detection and enumeration of conventional and emerging pathogenic organisms and other contaminants in dairy foods
- Detection and enumeration of indicator organisms in dairy foods
- Detection of phages in dairy and food environment
- Development of direct-fed microbial for ruminants
- Development of indicators and biosensors from microbial

metabolites
- Development of synbiotic products
- Effect of different nutrients on the growth and production of microorganisms
- Effect of natural environment on microbial growth and production
- Studies on bacterial growth kinetics in batch and continuous culture systems
- Emerging Foodborne pathogens
- Enhancing shelf life of foods through microbial fermentation
- Enrichment of poor-quality roughages by solid-state fermentation
- Evaluation lactic acid bacteria for production of functional biomolecules
- Fermentation Studies for cultivation of lactic acid bacteria
- Food toxins- bioremediation
- Formulation of novel pharmaceuticals and neutraceuticals
- Genetic improvement of starter cultures
- Genetic manipulation of lactic starter cultures
- Genetic modification of dairy cultures by rDNA technology
- Genetic modification of food through the use of food grade vectors
- Genetic modification of LAB
- Genomics and Proteomics of lactic acid bacteria
- Genotypic heterogeneity and diversity of microorganisms in fermented dairy foods
- Harnessing the potential of microbial growth in environmental depollution
- Improving functionality of probiotics through metabolic engineering
- Industrial production of metabolites such as recombinant proteins/enzyme in a bioreactor and downstream processing
- Manipulation of rumen microbial ecosystem
- Metabolic engineering of LAB
- Microbial stress metabolism and ecosystem
- Microorganisms as indicators of environment pollution
- Molecular diagnostics for detection and identification of food pathogens and dairy micro- organisms
- Molecular diagnostics in dairy/food industry
- Molecular techniques for detection of foodborne pathogens and their toxins
- Metagenomic analysis of gut microbiome
- Newly emerging pathogens- rapid method of identification
- Novel bacteriocins of LAB
- Novel bacteriocins of lactic acid bacteria

- Nutrient transport systems through cell-membrane of yeast and bacteria
- Nutritional and therapeutic value of probiotic products
- PCR based identification of dairy cultures and probiotic cultures
- PCR based identification of pathogens
- Phage resistance in lactic acid bacteria
- Plasmid borne genes, chromosomal integration and technological properties of LAB
- Preservation of leguminous/ non-leguminous fodder crops by ensiling
- Principles of bio-safety in establishment of pathogen testing laboratory in food industry
- Principles of food safety control programme on HACCP, standard sanitary operating procedures (SSOP) and GMP for dairy industry
- Probiotics: characterization, product formulations, novel probiotics, validation of health claims through animal and clinical trials
- Production of microbial biomass as single cell protein
- Rapid method for detection and identification of food pathogens
- Rapid methods for detection and identification of pathogens in milk and milk products.
- Recombinant proteins/ enzymes for application in food/ dairy industry
- Recombinant proteins/enzymes for application in dairy industry
- Regulation of metabolism for lactic acid and flavour production
- Resistance of Foodborne pathogens to emerging food processing technologies.
- Role of extremophiles in microbial ecology and industry
- Screening of prebiotics
- Stress induced injury: mechanism and application in hurdle technology
- Biofilms formation in milk handling and dairy processing environment
- Mode of action of antibacterial substances on cellular organelles
- Plasmid linked properties of dairy cultures
- Probiotic organisms by growing them under anaerobic conditions and their identification by PCR method
- Study of production of functional biomolecules by lactic acid bacteria
- Ultra-structure of spore forming and non-spore forming dairy/food microorganisms with the help of electron microscopy

- Transformation of gene of interest in the bacterial hosts
- Trends in food borne diseases and implications; method of diseases transmission; principles of safety in a food microbiological laboratory
- Understanding probiotic functionality at molecular level and role as potential probiotic markers
- Use of microorganisms in conversion of food wastes in preparation of newer foods
- Whole genome shuffling/ DNA/ Family shuffling

List of Journals

- *Advances in Applied Microbiology*
- *Advances in Bioscience and Biotechnology*
- *Advances in Genetics*
- *Advances in Microbial Physiology*
- *Annals of Microbiology*
- *Annual Review of Microbiology*
- *Antonie van Leeuwenhoek*
- *Applied and Environmental Microbiology*
- *Applied Biochemistry and Microbiology*
- *Applied Microbiology and Biotechnology*
- *Archives of Animal Nutrition*
- *Archives of Microbiology*
- *Bioscience, Biotechnology and Biochemistry*
- *BMC Microbiology*
- *BMC Molecular Biology*
- *Brazilian Journal of Microbiology*
- *British Food Journal*
- *British Journal of Nutrition*
- *Canadian Journal of Microbiology*
- *Cellular Microbiology*
- *Clinical Microbiology*
- *Comparative Immunology Microbiology and Infectious Diseases*
- *Comprehensive Reviews in Food Science and Food Safety*
- *Critical Reviews in Environmental Science and Technology*
- *Critical Reviews in Food Science and Nutrition*
- *Critical Reviews in Microbiology*
- *Current Genetics*
- *Current Microbiology*
- *Current Opinion in Biotechnology*
- *Current Science*
- *Current Topics in Microbiology and Immunology*
- *Dairy Science and Technology (Le Lait)*
- *Environmental Microbiology*

- *Enzyme and Microbial Technology*
- *Eukaryotic Cell*
- *European Food Research and Technology*
- *European Journal of Clinical Microbiology and Infectious Diseases*
- *FEMS Microbiology Ecology*
- *FEMS Microbiology Letters*
- *FEMS Microbiology Reviews*
- *Food Analytical Methods*
- *Food and Function*
- *Food Bioscience*
- *Food Biotechnology*
- *Food Control*
- *Food Microbiology*
- *Food Microbiology and Food Safety*
- *Food Quality and Preference*
- *Food Research International*
- *Food Reviews International*
- *Food Science and Technology - Lebensmittel-Wissenschaft and Tech*
- *Food Science and Biotechnology*
- *Food Science and Technology International*
- *Food Technology and Biotechnology*
- *Foodborne Pathogens and Disease*
- *Frontiers in Cellular and Infection Microbiology*
- *Frontiers in Microbiology*
- *Frontiers in Molecular Biosciences*
- *Fungal Genetics and Biology*
- *Future Microbiology*
- *Gene*
- *Indian Journal of Animal Sciences*
- *Indian Journal of Dairy Science*
- *Indian Journal of Medical Microbiology*
- *Indian Journal of Microbiology*
- *Indian Journal of Veterinary Science*
- *Innovative Food Science and Emerging Technologies*
- *International Dairy Journal*
- *International Journal of Dairy Technology*
- *International Journal of Fermented Foods*
- *International Journal of Food Microbiology*
- *International Journal of Food Properties*
- *International Journal of Food Science and Nutrition*
- *International Journal of Food Science and Technology*

- *International Journal of General and Molecular Microbiology*
- *International Journal of Probiotics and Prebiotics*
- *Journal of Agricultural and Food Chemistry*
- *Journal of Animal and Feed Sciences*
- *Journal of Animal Science*
- *Journal of Applied Animal Research*
- *Journal of Applied Microbiology*
- *Journal of Bacteriology*
- *Journal of Basic Microbiology*
- *Journal of Biological Chemistry*
- *Journal of Biotechnology*
- *Journal of Dairy Research*
- *Journal of Dairy Science*
- *Journal of Food and Drug Analysis*
- *Journal of Food Biochemistry*
- *Journal of Food Composition and Analysis*
- *Journal of Food Processing and Preservation*
- *Journal of Food Protection*
- *Letters in Applied Microbiology*
- *Journal of Food Quality*
- *Journal of Food safety*
- *Journal of Food Science*
- *Journal of Food Science and Technology*
- *Journal of Functional Foods*
- *Journal of General and Applied Microbiology*
- *Journal of Industrial Microbiology and Biotechnology*
- *Journal of Industrial Microbiology and Biotechnology*
- *Journal of Medicinal Food*
- *Journal of Microbial Food Safety Standards*
- *Journal of Microbiology*
- *Journal of Microbiology and Biotechnology*
- *Journal of Microscopy*
- *Journal of Molecular Microbiology and Biotechnology*
- *Journal of Rapid Methods and Automation in Microbiology*
- *Journal of The Science of Food and Agriculture*
- *Journal of Virology*
- *Methods in Microbiology*
- *Microbial Ecology in Health and Disease*
- *Microbial Pathogenesis*
- *Microbiological Research*
- *Microbiology*
- *Microbiology and Molecular Biology Reviews*
- *Microbiology: Bacteriology, Mycology, Parasitology and Virology*

- *Molecular Biology*
- *Molecular Genetics, Microbiology, virology*
- *Nature*
- *Nature Biotechnology*
- *Nature Reviews Microbiology*
- *Plasmid*
- *PNAS*
- Probiotics and Antimicrobial Proteins
- Process Biochemistry
- Quality Assurance and Safety of Crops and Foods
- Research in Microbiology
- Science
- Science of the Total Environment
- Systematic and Applied Microbiology
- The Lancet
- Trends in Food Science and Technology
- Trends in Microbiology
- Veterinary Microbiology
- Veterinary Research
- World Journal of Dairy and Food Sciences
- World Journal of Microbiology and Biotechnolog

Syllabus for the Preliminary Comprehensive Examination for M.Tech. in Dairy Microbiology

Microbial Morphology and Physiology: Bacterial growth, Growth phases and kinetics; synchronous, continuous, and associative growth; factors affecting bacterial growth; growth measurement. Cell structure (prokaryotes) Cell wall; cell membrane, cytoplasmic inclusions, cytoskeleton, cell appendages- capsule, flagella, pili; sporulation - structure of endospore, composition and function of spore constituents, induction and germination. Bacterial nutrition; Nutrient media; Nutritional groups of bacteria; Role of growth factors; Active and passive transport. Electron transport chain, fermentation, respiration.

Food Microbiology: Factors influencing microbial growth in foods: Intrinsic factors and extrinsic factors. Food preservation by high temperature, low temperature, irradiation, drying and fermentation. Modern processing techniques-ohmic heating, high pressure processing, infra-red heating, cold plasma, pulsed electric field, ultra sound.

Bio preservation of foods - concepts: metabolites of lactic acid bacteria; Bacteriocins, Antifungal substances etc., protective cultures. Stress adaptation, sublethal stress and injury, antibiotic resistance in food bacteria. Heat induced damage in bacteria and role of resuscitation in recovery of injured microbial cells. Antimicrobial packaging; modified atmosphere packaging (MAP), intermediate moisture foods (IMF), and hurdle technology in processed foods. Food poisoning-Food intoxications, Food infections and Toxi-infections. Biofilms: development and significance in dairy industry.

Microbiology of Fluid Milk: Microflora of mastitis milk and its importance in dairy industry, Sources of microbial contamination of raw milk; clean milk production and natural antimicrobial systems in raw milk, Microbial changes in raw milk during long storage. Microbiological aspects of processing techniques like bactofugation, thermization, pasteurization, sterilization, boiling, UHT. Role of psychrotrophic, mesophillic, thermophilic and thermoduric bacteria in spoilage of processed milks, their sources and prevention; Microbiological standards (FSSAI) of heat treated fluid milks.

Microbiological Quality of Dairy Products: fat rich (cream and butter), frozen (ice cream), concentrated (evaporated and condensed milk), dried milks (roller and spray dried), infant dairy foods and legal standards; Sources of contamination and factors affecting microbial quality of these products during processing, storage and distribution; Microbiological defects associated with these products and their control. Microbiological standards (FSSAI) of heat desiccated (khoa, burfi, peda, kheer, etc.), acid coagulated (paneer, chhana, rasogolla, etc.), fermented (dahi, lassi, srikhand, etc.) and frozen (kulfi).

Microbial Genetics: Macromolecules: DNA, RNA and their structure, types, organization, function and properties of macromolecules. Regulation and Gene Expression: Gene Expression and its regulation in Prokaryotes- Transcription, Genetic Code, Translation, Negative and Positive regulation in gene expression,

Operon Models - Lac, Trp. Mutations: Mutations - Spontaneous and Induced, Type of mutations, Mutagenic agents – physical and chemical, Damage and repair system operating in Prokaryotes. PCR and real time PCR.

Dairy Starters: Classification of starters: Single, mixed and multiple strains, mesophilic and thermophilic starter cultures; propagation and preservation of starter cultures; factors affecting propagation of starter, commercial starter preparations: concentrated and super concentrated starters; Production systems for bulk cultures: Lewis, Jones and Tetra-pack systems. Growth media: nutritional requirements of lactic acid bacteria, growth media formulations; PIM/PRM, pH control during culturing- external and internal pH control systems. Preservation of starter cultures.

Factors affecting growth of starter culture. Bacteriophage host interaction, prevention and control of phages during starter handling and fermented milk products manufacturing, mechanisms of phage resistance in lactic acid bacteria. Inhibitory substances produced by lactic acid bacteria.Carbohydrate, citrate and protein transportation and metabolism in dairy starters.

Microbial Quality Assurance: Brief concept and principles of QMS and standard requirements for certification. HACCP. Principles of safety in a food microbiological laboratory-Bio-safety concept, Biosafety level-1-4 containment design and layout. Definition, purpose and components of microbiological criteria; mandatory and advisory criteria. Sampling methods - two and three class sampling plan as per International council for microbiological standards for foods (ICMSF).

Microbiology of Cheese: Cheese starter cultures involved in the manufacture, their types, roles, Current classification and metabolic pathways. Rennet, rennet substitutes; Microbial and recombinant rennet used in cheese preparation. Bacteriophages of cheese starters. Microbes associated with spoilage, defects, causative organisms and preventive measures. Microbiology of cheese ripening, Flavour development, Role of starter flora and supplementary flora in cheese ripening. Accelerated cheese ripening.

Microbiology of Fermented and Functional Dairy Foods; Dahi, lassi, yoghurt, Kefir, Koumiss - Microbes associated. Safety and standards of fermented foods. Probiotics, Prebiotics and Synbiotics: Concepts, definitions and history. Characterization and selection of candidate probiotic strains on the basis of FAO/WHO or ICMR/DBT guidelines. Mechanism of action of probiotics; Colonization in the gut; Adhesion to intestinal mucosal surface; Antimicrobial/antagonistic activity of probiotics, Pathogen exclusion; Immuno-modulatory action; Impact on gut homeostasis. Safety, human trials and regulatory guidelines: *In vitro* and *in vivo* safety assessment of probiotics; designing human trials; regulatory guidelines

Microbial Techniques: Microscopy; Principles, design and application of bright field, dark field, phase contrast, fluorescence, and electron microscopes. Microbial growth, metabolism, death, membrane transport, batch, fed batch, continuous culture systems. Bioreactor design and different types of fermenters.