1. Degree Offered: M.V.Sc. & Ph.D.

A. Title of degree: M.V.Sc. Veterinary Biotechnology
Duration: 2 years
Eligibility Criteria: B.V.Sc & A.H. with ICAR entrance
Intake Capacity: 01
Opportunities: Industries, Diagnostics, Academics, Research

B. Title of degree: Ph.D. Veterinary Biotechnology
Duration: 3 years (fresh candidates) and 4 years (In-service candidates)
Eligibility Criteria: M.V.Sc (Animal/Veterinary Biotechnology)
ICAR/MAFSU entrance
Intake Capacity: 01

C. Opportunities: Industries, Diagnostics, Academics, Research

2. Academic Regulations: MAFSU Academic Regulations 2022 – Post Graduate (P.G. & Ph.D.) Degree Program

3. Admissions:
List of Admitted Students – First Year to Final Year (Veterinary Year wise / Fishery and Dairy Semester wise):

Sr. No.	Degree	Name of Student	Enrl. No.	Email Address	Name of Advisor
1.	M.V.Sc.	Ms. Shruti S. Barbuddhe	V/18/030	barbuddhess06@gmail.com	Dr. S. A. Ingle
2.	Ph.D.	Dr. Sujit M. Kolangath	V/23/438	sujitkolangath@mafsu.in	Dr. S. A. Ingle

- **List of M.V.Sc. Courses:**

Sr. No	**Course No.**	**Title**	**Credits**	**Core/ Optional**
SEMESTER I				
1.	BTY 601	Basic and Applied Biotechnology *	2+0	**Core**
2.	BTY 602	Fundamentals of Cell Biology *	2+0	**Core**
3.	BTY 604	Animal Cell Culture–Principles and Applications	2+1	**Optional**
4.	BTY 606	Immunology Applied to Biotechnology	2+1	**Optional**
		Total	**4 + 0 = 4**	
SEMESTER II				
1.	BTY 603	Molecular Biology and Genetic Engineering	2+0	**Optional**
2.	BTY 605	Molecular Diagnostics	2+1	**Optional**
3.	BTY 607	Introduction to Bioinformatics	2+1	**Optional**

4.	BTY 608	Animal Genomics *	2+1	**Core**
5.	BTY 610	Reproductive Biotechnology *	2+1	**Core**
		Total	**4 + 2 = 6**	
SEMESTER III				
1.	BTY 609	Techniques in Molecular Biology and Genetic Engineering*	0+2	**Core**
2.	BTY 611	Master's Seminar-I	1+0	**Core**
3.	BTY 612	Master's Research	0+10	**Core**
4.	PGS 601	Technical Writing and Communication Skills	0+1	**Core**
5.	PGS 602	Agricultural Research, Research Ethics and Rural Development Programmes	1+0	**Core**
6.	PGS 603	Basic Concepts in Laboratory Techniques	0+1	**Core**
7.	PGS 604	Intellectual Property and its Management in Agriculture	1+0	**Core**
8.	PGS 605	Library and Information Services	0+1	**Core**
		Total	**18**	
SEMESTER IV				
1.	BTY 612	Master's Research	0+20	**Core**
		Total	**20**	

- **List of Ph.D. Courses:**

In-Service

Sr. No.	Course No.	Title	Credits	Core/ Optional
SEMESTER I				
1.	BTY 701	Genetic Engineering*	1+2	**Core**
2.	BTY 709	Advances in Animal Cell Culture*	2+1	**Core**
		Total	**3+3=6**	
SEMESTER II				
3.	RPE 700	Research and Publication Ethics	1+1	**Core**
4.	BTY 702	Functional Genomics and Proteomics	3+0	**Optional**
5.	BTY 703	Advances in Cell and Molecular Biology	2+0	**Optional**
6.	BTY 704	Diagnostic Platform	1+1	**Optional**
7.	BTY 706	Trends in Vaccinology	2+1	**Optional**
8.	BTY 707	Advances in Bioinformatics	1+1	**Optional**
		Total	1+0=1	
SEMESTER III				
9.	BTY 712	Doctorate Seminar-I	1+0	**Core**
10.	BTY 713	Doctorate Seminar-II	1+0	**Core**
11.	BTY 705	Gene Manipulation and Genome Editing	2+0	**Optional**
12.	BTY 708	Advances in Reproductive Biotechnology	2+1	**Optional**
13.	BTY 710	Industrial Biotechnology	2+1	**Optional**
14.	BTY 711	Rumen and Feed Biotechnology	2+1	**Optional**

		Total	2+0=2	
SEMESTER IV				
15.	BTY 714	Doctorate Research	0+15	**Core**
		Total	**15**	
SEMESTER V				
16.	BTY 714	Doctorate Research	0+15	**Core**
		Total	**15**	
SEMESTER VI				
17.	BTY 714	Doctorate Research	0+15	**Core**
		Total	**15**	
SEMESTER VII				
18.	BTY 714	Doctorate Research	0+15	**Core**
		Total	**15**	
SEMESTER VIII				
19.	BTY 714	Doctorate Research	0+15	**Core**
		Total	**15**	

Regular

Sr. No.	**Course No.**	**Title**	**Credits**	**Core/ Optional**
SEMESTER I				
1.	BTY 701	Genetic Engineering*	1+2	**Core**
2.	BTY 702	Functional Genomics and Proteomics	3+0	**Optional**
3.	BTY 703	Advances in Cell and Molecular Biology	2+0	**Optional**
4.	BTY 704	Diagnostic Platform	1+1	**Optional**
5.	BTY 711	Rumen and Feed Biotechnology	2+1	**Optional**
6.	BTY 706	Trends in Vaccinology	2+1	**Optional**
		Total	**1+2=3**	
SEMESTER II				
7.	RPE 700	Research and Publication Ethics*	1+1	**Core**
8.	BTY 707	Advances in Bioinformatics	1+1	**Optional**
9.	BTY 708	Advances in Reproductive Biotechnology	2+1	**Optional**
10.	BTY 709	Advances in Animal Cell Culture*	2+1	**Core**
11.	BTY710	Industrial Biotechnology	2+1	**Optional**
		Total	**2+3=5**	
SEMESTER III				
12.	BTY 705	Gene Manipulation and Genome Editing	2+0	**Optional**
13.	BTY 712	Doctorate Seminar-I*	1+0	**Core**
14.	BTY 713	Doctorate Seminar-II	1+0	**Core**
15.	BTY 714	Doctorate Research	0+15	**Core**
		Total	**4+15=19**	
SEMESTER IV				
16.	BTY 714	Doctorate Research	0+20	**Core**

		Total	**20**	
SEMESTER V				
17.	BTY 714	Doctorate Research	0+20	**Core**
		Total	**20**	
SEMESTER VI				
18.	BTY 714	Doctorate Research	0+20	**Core**
		Total	**20**	

4. Lecture Schedule – UG, PG, PhD - Theory / Practical Schedule – Approved by BoS – Subject-wise

M.V.Sc. (Veterinary Biotechnology)

1. Course No.: BTY-601 Title: Basic & Applied Biotechnology (2+0)

Lecture No.	Topic
UNIT I	
1	History and scope of Biotechnology
2 – 3	Application of Biotechnology in agriculture and Veterinary Sciences, diagnostics and therapeutics, pharmaceutical industry, Food Industry and Chemical Industry, environmental sciences
4	Plant tissue culture and its applications
5	Biofermentation
UNIT II	
6 - 7	Fermentation technology, aerobic and anaerobic fermentation
8	Different types of fermentation
9	Basic design and construction of fermenter
10	Upstream processing- Media sterilization, inoculum preparation
11	Downstream processing
12 – 13	Microbes and enzymes of industrial importance, Microbial growth kinetics and products.
UNIT III	
14	Immobilized enzymes and cells
15	Immobilization process
16 - 17	Vaccines and their immune response
18 - 19	Types of vaccines - Conventional and new- generation vaccines
20 - 22	Subunit vaccine, recombinant vaccines
23 - 24	Vectored vaccines and DNA vaccine and their immune response
25 – 28	Edible vaccine, DIVA strategy and reverse vaccinology
UNIT IV	
29 – 30	Biodiversity, genetic diversity, molecular taxonomy, species and population biodiversity
31 – 33	Quantifying biodiversity, maintenance of ecological diversity

34 - 36	Conservation of biodiversity and conservation of animal genetic resources

2. Course No.: BTY-602 Title: Fundamentals of Cell Biology (2+0)

Lecture No.	Topic
	UNIT I
1 - 2	Origin and evolution of cells from molecules to first cell from prokaryotes to eukaryotes from single to multicellular organisms
3	Chemical components of a cell Catalysis and use of energy by cells
4 - 7	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
8	Structure of cell: Plasma membrane, Cytoskeleton
9 - 10	Structure of cell: Nucleus, Chromosome Chromosomal DNA packaging and its implications
11	Structure of cell: Endoplasmic reticulum, Ribosome Mitochondria
12	Structure of cell: Mitochondrial organization, Golgi complex Peroxisome, Lysosome
	UNIT II
13	Cell Membrane transport: Transport of small molecules, Macromolecules and particles
14	Cell Membrane transport: Exocytosis and endocytosis Nuclear transport
15	Cell Membrane transport: Protein synthesis and sorting into Endoplasmic reticulum Golgi complex
16 - 17	Cell Membrane transport, Protein synthesis and sorting into Peroxisomes, Lysosomes, Lipid synthesis and sorting
18 - 19	Cell Membrane transport, Electron transport chain Chemiosmotic coupling
20	Transport of metabolites across the inner mitochondrial membrane
	UNIT III
21	Mechanism of muscle contraction, cell crawling functions of keratin and neurofilaments
22	Cell Membrane transport: organelle transport, separation of mitotic chromosome
23 - 24	Cell signaling: Modes of cell-cell signaling, Steroid hormones and the steroid receptor super family

25	Cell signaling: Neurotransmitters, Peptide Hormones and Growth Factors
26	Cell signaling: G Protein-Coupled Receptors, Receptor Protein-Tyrosine Kinases
27	Cell signaling: Cytokine Receptors Non-Receptor Protein-Tyrosine Kinases
28	Cell signaling: The cAMP Pathway Second Messengers and Protein Phosphorylation
29	Cell signaling: Cyclic GMP Phospholipids and Ca2+
UNIT IV	
30 - 31	Cell signaling: Ras, Raf, and the MAP Kinase Pathway The JAK/ STAT Pathway, Integrins and Signal Transduction
32 – 33	Cell signaling: Regulation of the Actin Cytoskeleton Hedgehog and Wingless Notch Signaling
34 - 35	Cell signaling: Cell signal network, Feedback and crosstalk Networks of cellular signal transduction
36	Cell cycle, Regulators of cell cycle Events of M phase

3. Course No.: BTY 603 Title: Molecular Biology and Genetic Engineering (2+0)

Lecture No.	**Topics**
UNIT I	
1	History and scope of molecular biology – Discovery of DNA and evidence for DNA as the genetic material
2 - 3	Structure of DNA, RNA and proteins – Organization of prokaryotic and eukaryotic genome
4	Gene transfer in microorganisms like conjugation, transformation, transduction and protoplastic fusion
5 - 7	DNA replication - genetic code - transcription, RNA processing and alternative splicing
8 - 9	Translation in prokaryotes and eukaryotes - Regulation of gene expression
UNIT II	
10 - 11	Enzymes used in molecular biology and recombinant DNA research
12 - 13	Cloning vectors – plasmids, phages, phagemids, cosmids, BAC, YAC
14 - 15	Expression vector – bacterial, viral, baculo and yeast vectors, shuttle vectors
16 - 17	Polymerase chain reaction and different types of PCR
18 - 19	Probes – Synthesis and types, Nucleic acid hybridization and blotting
20	Construction of gene libraries and cDNA library - Gene mapping and DNA structure analysis
UNIT III	

21 -24	Cloning in bacteria, yeast, plant and animal cells – identification of gene of interest and synthesis of double stranded DNA and complementary DNA
25 - 27	Restriction enzyme digestion – ligation - methods for transfer of cloned DNA - identification and enrichment of recombinant clones
28 - 29	Expression of recombinant DNA in prokaryotic and eukaryotic vectors - strategies for purification of expressed protein
UNIT IV	
30 - 31	Molecular mechanism of mutation – DNA repair - site directed DNA alterations and gene manipulations
32 - 33	Gene editing techniques and Methods of DNA sequencing
34	Genetics of tumorigenic region of agrobacteria
35	Applications of genetic engineering in veterinary sciences
36	Ethics, legal issues and safety aspects of genetic manipulation

4. Course No.: BTY 604 Title: Animal Cell Culture - Principles and Application (2+1)

Theory

Lecture No.	Topics
UNIT I	
1 - 2	Introduction, History of cell culture development
3 - 4	Methods of sterilization
5 - 7	Tissue culture techniques- primary culture using various methods
8 - 10	Continuous cell lines- anchorage-dependent and independent cell lines
11 - 12	Organ culture
13	Cell bank and role of cell bank.
UNIT II	
14 - 17	Different types of cell culture media, Serum, growth supplements, balanced salt solution, Serum free media
18 - 19	Enzymes used in cell culture, Factors that affecting the growth of cells
UNIT III	
20	Cell culture contaminants
21	Cryopreservation of primary culture and cell line
22 - 23	Cell cloning
24 - 26	Types of cell culture bioreactor
27 - 29	Cell counting and cytotoxic assays
UNIT IV	
30 - 31	Applications of animal cell culture
32 - 33	Hybridoma technology and monoclonal antibody production,

34	Applications of monoclonal antibodies in diagnostic and cancer research
35 - 36	Isolation and culturing of adult and embryonic stem cells and therapeutic applications of adult stem cells

Practical

Practical No.	Topics
1	Packaging and sterilization of glass and plastic ware for cell culture
2 - 3	Preparation of reagents and media for cell culture
4	Primary chicken embryo fibroblast
5	Primary sheep/ goat kidney culture
6 - 8	Cultivation of continuous cell lines
9	Quantification of cells by trypan blue exclusion dye
10 - 11	Isolation of lymphocytes and cultivation
12	Study of effect of toxic chemicals on cultured mammalian cells
13 - 14	Study of cytopathic effect of virus on mammalian cells
15 - 16	Cryopreservation of primary cultures and cell lines
17 - 18	Isolation and culture of stem cells from bone marrow

5. Course No.: BTY 605 Title: Molecular Diagnostics (2+1)

Theory

Lecture No.	Topics
UNIT I	
1 - 2	Introduction, importance and historical perspective of development of molecular diagnostic technology
3 - 4	Development and optimization of nucleic acid detection assays: OIE guidelines
5 - 7	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	
8 - 9	Types and application of different molecular diagnostic assays
10 - 11	Restriction endonuclease analysis for identification of pathogens
12 - 13	Principle of development of pathogen specific DNA probes Blotting techniques e.g. Southern and Northern hybridization
UNIT III	
14 - 15	Nucleic Acid Sequence Based Amplification (NASBA)-Prospects and Applications

16 - 20	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 Applications PCR principle, cyclic and thermal parameters in PCR, Real time PCR, Variations in PCR, application of PCR for diagnosis of infectious diseases of animals and poultry
21 - 22	Real-time PCR and its application in diagnosis
UNIT IV	
23	Advancements in diagnostic technology platforms
24	DNA array technology
25 - 26	Nano - diagnostics
27 - 28	Biosensors
29	Mass spectrometry in disease diagnosis
30 - 31	Molecular cloning
32 - 33	Bead based assays
34 - 35	DNA sequencing including Next generation sequencing
36	Lateral-flow devices and its applications in diagnosis

Practical

Practical No.	Topics
1	Preparation of buffers and reagents
2 - 3	Extraction of nucleic acids and qualitative and quantitative analysis of Nucleic acid
4	Agarose gel electrophoresis of Nucleic acids.
5 - 6	Amplification of pathogen-specific gene using PCR.
7 - 10	Different types of PCR including RT-PCR, nested PCR, etc
11 - 12	Real-time PCR
13 - 14	PCR - RFLP
15 - 16	DNA fingerprinting for identification of genetic diseases
17 - 18	Sanger sequencing using capillary electrophoresis

6. Course No.: BTY 606 Title: Immunology Applied to Biotechnology (2+1)

Theory

Lecture No.	Topics
	UNIT 1
1	Introduction to principles of immunology, immune system and immune response
2 - 4	Major histocompatibility complex: its structure, functions and gene organization
5 - 6	MHC and its association with disease and resistance
7	Immunity against infectious agents of animals
8 - 9	Immunological tolerance
10	Autoimmunity: mechanism and control
11 - 12	Techniques used in biotechnology
	UNIT II
13 - 14	Immunoglobulins and its type: Isotype, Allotype and Idiotype
15 - 16	Antibody production and purification
17	Application of antibodies in purification
18 - 19	Immunoblotting: principle and applications
20 - 21	Expression of immunoglobulin genes in plants and production of Antibodies
22 - 23	Cytokines: classification, structure, functions
24	Industrial production of cytokines and interferon
	UNIT III
25	Application of antibodies in chemiluminescence and florescence assay for identification of recombinant genes
26	Antibody based nucleic acid probes and their applications
27 -28	Immunoinformatics: concept and application
29	Transgenic animals and cellular chimeras
30	Immunodiagnostic tests: agar gel precipitation, agglutination reaction-based assays
31	Various types of Immunoassays, immunofiltration tests, flow cytometry in disease diagnosis
	UNIT IV
32	Chimeric and humanized monoclonal antibodies
33	Recombinant antibodies: production and application
34 - 35	Modern uses of antibody: biosensors, catalysis, in vivo imaging, microarrays, proteomics
36	Cancer immunity and its immunotherapy

Practical

Practical No.	Topics
1 - 2	Agar gel immunodiffusion test; latex agglutination
3	Immunofiltration assay
4	Flow cytometry
5	Immunoelectrophoresis
6 - 7	Fluorescent antibody test
8 - 9	Enzyme immunoassays including various types of ELISA
10	Immunoblotting
11	Affinity chromatography
12	Lymphocyte proliferation assay
13 - 14	Cultivation of normal lymphocytes and myeloma cell line
15 - 16	Somatic cell hybridization and production of Hybridoma
17	Screening of hybrids for production of monoclonal antibodies
18	Bioinformatics tools for immunological research

7. Course No.: BTY 607 Title: Introduction to Bioinformatics (2+1)

Theory

Lecture No.	Topics
UNIT I	
1 - 4	Introduction to bioinformatics, concept and history of databases, various primary databases resources
5	Nucleic acid databases and their variants
6	Protein databases and its variants
7	Specialized genomic resources
UNIT II	
8 - 9	DNA sequence analysis, introduction to concept indel, identity, mutations, gaps and penalties
10 - 12	cDNA library, its applications, EST, gene contigs, EST databases, EST analysis tools, sequence assembly tools and clustering EST libraries
13	Gene cloning vectors, their databases, tools and resources
14	Similarity vs homology, local and global alignments
15 - 18	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 multiple sequence alignments
19 - 20	Applications of phylogenetic analysis, type of phylogenetic trees

21	Introduction to methods/ matrixes used for construction of phylogenetic trees use of concept bootstrap value
UNIT III	
22	Introduction to concept secondary database, their applications
23	Genome databases, animal genome databases
24	RNA database and their variants with applications
25	Building search protocols, use of search tools for homology/ similarity identification
26 - 27	Secondary protein databases, their applications, protein sequence structure relationship and patterns protein folding
28 - 29	Introduction to chemo-informatics and its applications, Applications of computer aided drug designing
30	Basic concept of computer aided drug designing
31 - 32	Structure based computer aided drug designing, ligand-based computer aided drug designing, databases searching, de novo drug designing
UNIT IV	
33	Commercial databases and packages
34	GPL software for Bioinformatics
35	Web based analysis tools
36	Applications of bioinformatics in veterinary clinical research

Practical

Practical No.	Topics
1 - 2	Usage of NCBI resources, its variants and specialized databases
3 - 5	Retrieval of sequence/ structure from databases, retrieval of nucleic acid sequences and retrieval of protein sequence and structure studies
6 - 7	Protein's structure visualization, prediction using software and tools
8 - 9	Protein modelling.
10	Protein antigenicity prediction tools
11 - 12	Using of ligand database tools and ligand docking
13	RNA database searching
14 - 15	BLAST searching tools generalized and specialized searches
16 - 17	Pair wise sequence alignment, multiple sequence alignment
18	Phylogenetic analysis

8. Course No.: BTY 608 Title: Animal Genomics (2+1)

Theory

Lecture No.	Topics
UNIT I	
1 - 3	Historical perspective, Genome organization in eukaryotes- Chromosome numbers in farm animals – Physical and molecular structure of chromosomes -Chromosome abnormalities in farm animals
4 - 5	High order structures, Role of cohesions and condensins in chromosome structure- SMC proteins
6 - 7	Importance of repetitive DNA –Classical satellites, microsatellites and mini satellites-SINES and LINES- Minisatellite and microsatellite based fingerprinting techniques
UNIT II	
8 - 9	Importance of gene mapping in livestock, methods and techniques used for gene mapping
10 - 11	Physical mapping- cytogenetic techniques, FISH technique in gene mapping,
12 - 13	Gene mapping by somatic cell hybridization.
14 - 15	Radiation hybrid maps for gene mapping
16	Linkage analysis -comparative gene mapping.
UNIT III	
17 - 18	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.
19	Genetic characterization based on DNA markers, genetic distance analysis
20	Quantitative Trait Loci (QTL)-Candidate gene approach-QTL mapping Approach
21	Applications of DNA markers in livestock improvement- Marker Assisted Selection (MAS)
22	Marker Assisted Introgression –Parentage determination – SNP chips
23	Genomic selection based on SNP typing
24 - 25	Methods of genome editing –ZFN, TALENS, Meganucleases and CRISPR –Cas. Role of genome editing in livestock improvement.
UNIT IV	
26	Genome sequencing-Sanger Sequencing-Hierarchical shot gun approach
27 - 28	Next Generation Sequencing-Pyrosequencing-Semiconductor sequencing-Illumina sequencing-Helicos and SMRT sequencing platforms
29 - 30	Metagenomics –RNA Seq analysis
31	Exome sequencing and ddRAD sequencing for genome wide SNP Detection

32	Current status of whole genome sequencing and gene maps of livestock
33	Role of MHC in disease resistance
34	Genes influencing production traits
35	Mitochondrial DNA of farm animals, evolutionary significance
36	Applications of genome analysis in animal breeding.

Practical

Practical No.	Topics
1 -2	Chromosome preparation (normal karyotyping, different types of banding) in farm animals
3	Isolation and purification of animal genomic DNA from blood lymphocytes
4	Analysis of DNA by agarose gel electrophoresis
5	Analysis of DNA by polyacrylamide gel electrophoresis
6	Checking the quality and quantity of genomic DNA by Spectrophotometer
7 - 8	Restriction digestion and analysis
9	Southern hybridization
10	DNA testing by microsatellite markers
11 - 12	Techniques for revealing polymorphism- PCR-RFLP
13	Single Strand Conformational Polymorphism (SSCP) analysis
14	AFLP, SNP chips
15	Genomic DNA cloning or cDNA cloning
16	Differentiation of tissues of different species by mitochondrial genome analysis
17 - 18	NGS data analysis-metagenome, RNASeq, exome and ddRAD sequence data by bioinformatics software

9. Course No.: BTY 609 Title: Techniques in Molecular Biology and Genetic Engineering

Practical (0+2)

Practical No.	Topics
1 - 2	Isolation of DNA from blood and mammalian cells
3 - 4	Isolation of bacterial plasmids
5 - 6	Restriction endonuclease digestion of plasmid and chromosomal DNA
7 - 8	Agarose gel electrophoresis of RE digested DNA
9 - 11	Polymerase Chain Reaction using random primers as well as specific primers

12 - 14	Different types of PCR
15 - 16	Isolation of mRNA/ RNA, Quantization of nucleic acids
17 - 19	cDNA synthesis
20 - 21	Real time polymerase chain reaction
22 - 23	Synthesis of nucleic acid probes and hybridization
24 - 26	Cloning of bacterial and viral genes into plasmid vectors
27 - 29	DNA ligation and transformation and confirmation of recombinants
30 - 31	Purification of recombinant proteins
32 - 34	Polyacrylamide gel electrophoresis (PAGE)
35 - 36	Western blot analysis

10. Course No.: BTY 610 Title: Reproductive Biotechnology (2+1)

Theory

Lecture No.	Topics
UNIT I	
1 - 3	History, role of biotechnology in Assisted reproductive technology (ART)
4 - 5	Application of ART in human and animals
6 - 8	Multiple ovulation embryo transfer (MOET)- donor and recipient selection-synchronization-super ovulation-artificial insemination- embryo flushing- embryo evaluation- recipient management
UNIT II	
9 - 11	Oocyte recovery from slaughter house ovaries and live animals, oocytes evaluation and in-vitro maturation
12 - 14	In-vitro fertilization of oocytes, In-vitro culture and assessment of embryonic developmental stages
15 - 16	Micro assisted fertilization
17 - 18	Micromanipulation of gametes and embryos
19	Preservation of embryos and oocytes
UNIT III	
20 - 22	Semen sexing technology and semen analysis
23 - 24	Embryo splitting
25 - 27	Different methods of embryo sexing
28 - 30	Transgenic animal production, application, limitation and regulatory issue
UNIT IV	
31 - 32	Somatic cell nuclear transfer of domestic animals and application
33 - 35	Isolation and characterization of embryonic stem cells

36	Different applications of embryonic stem cells

Practical

Practical No.	Topics
1 - 3	MOET protocols for domestic animals
4 - 5	Oocyte and embryo freezing protocol
6 - 9	Oocyte collection and evaluation from live and slaughter house animals
10 - 12	In-vitro embryo production
13 - 15	Embryo quality analysis
16 - 18	Embryo biopsy and embryo sexing

Ph.D. (Veterinary Biotechnology)

1. Course No.: BTY-701 Title: Genetic Engineering (1+2)

Theory

Lecture Nos.	Topics
	Unit I
1-2	Cloning vectors- plasmids, phages, cosmids, BAC, YAC
3-4	Expression vectors- viral, baculo and yeast vectors, shuttle vectors
	Unit II
5-6	Restriction, ligation, transformation
7	Recombinant selection methods
8-9	Construction of genomic and cDNA library
10-11	Construction of full-length cDNA
12	Preparation of probe
13	Nick translation random hexamer and nick translation
	Unit III
14	Linkers, adapters, Cassettes
15	Screening the library
	Unit IV
16-17	Expressions of genes, prokaryotic and eukaryotic expression
18	Identification of protein, Purification of expressed protein

Practical

Practical Nos.	Topics
1-2	Preparation of vector
3-4	Restriction enzyme digestion of vector

5-7	Preparation of target DNA and Purification of DNA
8-9	DNA ligation
10-12	Preparation of electro-competent cells
13-15	Transformation
16-18	Calculation of transformation efficiency
19- 20	Screening by colony PCR
21-23	Selection of recombinant by insert release
24-26	Induction of expressed protein
27-32	Purification of expressed protein
33-34	SDS-PAGE
35-36	Western blotting.

2. Course No.: BTY 702 Title: Functional Genomics and Proteomics (3+0)
Theory

Lecture Nos.	Topics
Unit I	
1	Overview of Mammalian Genome: Mitochondrial genome
2	Protein coding genes
3-4	RNA genes and repeat sequences
5-6	Variations in the mammalian genome
7-8	Expression of mammalian genome
Unit II	
9-10	Overview of Mammalian Transcriptome
11-13	Different methods to study gene expression
14-15	Single gene analysis, Northern blots, Quantitative PCR
16-18	SAGE, MPSS and SSH
19-20	Introduction to basic microarray technology, Design of experiments
21-22	Types of microarrays
Unit III	
23-24	Mammalian Genome- Chromosome number, evolution in mammalian species
25	Chromosome territory
26-27	Karyotyping, FISH and Spectral karyotyping
28-29	Next Generation sequencing platforms chemistries and their applications
30	Mutation detection methods for single gene and genome wide scale
Unit IV	
31	Databases such as NCBI, EBI
32-33	Nucleotide, Genome, SNP, Gene, Unigene, Homologene, Protein, etc. under NCBI. Service databases under EBI
34-35	Genome browsers, The concept of Comparative genomics, Genome BLAST and BLAT

36-38	Proteomics technology, identification and analysis of proteins by 2D analysis
39-40	mass spectrophotometery
41-42	Circular Dischorism
43-44	Fluorescence Spectroscopy
45-46	NMR and X-ray crystallography
47-48	MALDI-TOF
49-50	Differential display proteomics
51-52	Protein-protein interaction, yeast two-hybrid system
53-54	Phage display

3. Course No.: BTY 703 Title: Advances in Cell and Molecular Biology (2+0)

Theory

Lecture Nos.	Topics
Unit I	
1	Cell chemistry and biosynthesis pathway
2	Molecular motors of cell biology
3	Cell signaling
4	Signal transduction
5	Chemotropic energy metabolism
6-7	Apoptosis pathways
Unit II	
8-9	Structure and functions of prokaryotic and eukaryotic operons
10-11	Recombination and genetic variability
12-14	Regulation of gene expression
15	Strategies of nuclear transport
16-17	Carrier proteins and active membrane transport methodologies
Unit III	
18	Protein biosynthesis
19-20	Protein transportation
21-22	Protein sorting
23	Enzymes in molecular biology
24-25	Post-transcriptional control strategies
26-27	Plasmids in recombinant DNA technology
Unit IV	
28-30	RNA interference technology
31-32	Insights into nanobiology - Biosensors
33	DNA Microarray
34-35	Peptide Synthesis
36	Reverse Genetics

4. Course No.: BTY 704 Title: Diagnostic Platform (1+1)

Theory

Lecture Nos.	Topics
Unit I	
1	History and evolution of diagnostic platforms

2	Methods for identifying agents for infection or disease, point-of-care assays
3	Point-of-care assays
4	Principles for specific identification of the analytes or clinical parameters, various assays for different platform
Unit II	
5	Catridges, polymer catridges- catridge based *in-vitro* diagnostics
6-7	Microfluidics/ nanotechnology sensors, complexity and diversity of samples
8-10	sample preparation, extraction of DNA/ RNA, PCR for marker DNA sequence
11	POC based on microfluidic chips
Unit III	
12	Detection principles- colorimetric- optical, electrochemical, magnetic, mechanical protein detection methods
13	Sensitive sensing principles- NASBA- RPA- LAMP with QUASR
14	Integrated microfluidic system
Unit IV	
15	Instrumentation for point of care diagnostic platform
16	Blood protein analyses, the Afinion platform from Axis-Shield
17	The Verigene® System by Nanosphere- Cepheid's GeneXpert cassette
18	NorChip, use of smart phone apps for real time monitoring and analysis

Practical

Practical Nos.	Topics
1-3	DNA/ protein extraction
4-5	RNA extraction
6-7	Polymerase chain reaction
8-10	NASBA
11-13	RPA
14-5	LAMP
16-18	Microfluidic assay

5. Course No.: BTY 705 Title: Gene Manipulation and Genome Editing (2+0)

Theory

Lecture Nos.	Topics
Unit I	
1	Genetic architectures of model organisms: yeast, *C. elegans*, *Drosophila*, Mouse, human
2	Chromosomal and Genomic overviews of cattle, buffalo, yak, Mithun, sheep and goat
3	Chromosomal and Genomic overviews of pigs and poultry genome
Unit II	

4-5	Tools to characterize transgene: Identification and characterization of suitable transgene
6-7	Vectors used to clone and expression of foreign gene in prokaryotic systems.
8-9	Vectors used to clone and expression of foreign gene in eukaryotic systems
10-11	Different types of promoters in prokaryotes and eukaryotes for tissue specific expression of transgene
12-14	Detection of transgene in the new-born
Unit III	
15-16	Methods of Gene transfer: Microinjection of recombinant DNA into fertilized eggs/ stem cells
17-19	Transfection of DNA totipotent/ ES cells and kerato-carcinoma cells,
20-21	Electroporation, gene transfer into cultured mammalian cells
Unit IV	
22-23	Zinc finger and TALEN types and their mechanism
24-26	CRISPR types and their mechanism
27-28	Applications of these tools for *in vivo* genome engineering
29-30	Mono allelic and biallelic gene editing
31-32	Screening for genome editing process in cells/ animals
33-34	Applications of these tools in animal science for genetic studies, therapeutic potential and transgenic animal as bioreactors
35-36	Recent examples of genome-edited animals and their applications in animal science

5. Course No.: BTY 706 Title: Trends In Vaccinology (2+1)

Theory

Lecture Nos.	Topics
Unit I	
1-3	Immunity against veterinary infectious agents: bacteria, virus, fungi and parasites
4	Immunoinformatics and its application to epitope mapping of pathogens, etc.
5-6	Advancement in vaccinology: Vaccinomics and Adversomics
7-8	Systems Vaccinology and Reverse vaccinology
Unit II	
9	Structural Vaccinology, computational vaccinology and its applications
10	Current trends in vaccine development against animal pathogens
11-13	Molecular approaches for vaccine development including: recombinant peptide vaccines, vectored vaccines, Marker vaccines, DNA vaccines, genetically manipulated live vaccines, etc.
14	Plant expression system based vaccines
15-16	Idiotype and synthetic peptide based vaccines
Unit III	

17-19	Vaccines and Immunotherapeutic for treating non-infectious Diseases: Cancer; obesity, neurodegenerative diseases, addictions, atherosclerosis, etc.
20	DIVA Vaccines for animal disease
21	Vaccines for emerging human and animal diseases
22-23	Novel immunomodulators: Immunomodulators including cytokines and new adjuvants
24-26	Novel vaccine delivery systems: delivery of immunogens through liposomes, microspheres, ISCOMS, nanotechnology based vaccine delivery, etc.
Unit IV	
27	Vaccine formulation: pharmacopeia requirements
28	Vaccine qualities and its control
29	Large scale vaccine production technology: cost effectiveness of preventive immunization programmes
30	Stages of development of vaccine, clinical trials of vaccine and its regulation
31-32	Commercial vaccines available against animal pathogens, its characteristics and immunization schedule
33	Vaccine stability, preservation and vaccination failure
34	Environmental concerns with the use of recombinant vaccines

Practical

Practical Nos.	Topics
1-3	Purification of immunoglobulins: gel filtration and ion exchange chromatography
4-6	Hybridoma technique for monoclonal antibody production
7-8	Preparation of gene construct for recombinant and nucleic acid vaccine.
9-12	Expression of gene encoding immunogenic protein in prokaryotic/ yeast/animal cell culture system.
13-14	Study of immune response against recombinant vaccine.
15	Use of modern adjuvants in vaccines
16-18	Isolation and characterization of antigens from viruses, bacteria, Immunoassays: ELISA, FAT, RIA

6. Course No.: BTY 707 Title: Advances in Bioinformatics (1+1)

Theory

Lecture Nos.	Topics
Unit I	
1	Introduction to Computational Gene Prediction and Genome annotation
2	Basic concepts in Computational Phylogenetic Analysis, phylogenetic dating genome annotation; Gene networks
3-4	Completed genomes and bioinformatics approaches to analyze the genomes of Viruses, Bacteria and Animals

Unit II	
5-6	Understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools
7-8	Methods of Genome sequencing, EST, STS, GSS database Whole Genome comparison
9	RNA folding, RNA loops, conformational study and specialized RNA databases
10	Whole genome analysis, whole genome regression and prediction methods
Unit III	
11-12	Transcriptome analysis and its applications, Animal QTL databases and SIGENAE analysis of breeding animals genome
13	Tools of proteome analysis, Motifs and Folds; Protein structure related databases, Protein Data Bank format, Concepts of B-factor and R-factor,
14	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
15 - 16	Molecular Docking and Drug design (Basic concepts) Molecular dynamics and simulation study of protein, Force field concepts
Unit IV	
17	Protein identification and characterization
18	Introduction to the concept of chemoinformatics, metabolomics and immunoinformatics

Practical

Practical Nos.	Topics
1-3	Gene annotation, sequence retrieval specialized searches
4-5	Phylogenetic tree construction and phylogenetic dating
6-8	RNA folding, RNA secondary structure prediction, DNA secondary structure prediction
9-10	Genome database searching, conting preparation
11-12	Protein folding and structure predictions
13-14	Analysis of 3D structure of protein using RasMol through command line
15	Molecular Docking of protein and ligand by HEX
16-17	Analysis of 3D structure of protein and nucleic acid using Cn3D
18	QTL databases

7. Course No.: BTY 708 Title: Advances in Reproductive Biotechnology (2+1)

Theory

Lecture Nos.	Topics
	Unit I
1-3	Micromanipulation of embryos and gametes, Somatic Cell Nuclear Transfer (SCNT), nuclear reprogramming
4-5	Transgenic animal production, Combining Transgenic and SCNT
6-7	Gene targeting
8-10	Genome editing and disease modeling
	Unit II
11-12	*In vivo* Vs *in-vitro* production of embryos
13-16	Embryos quality, Transcriptomics, Metabolomic approach
7-18	Sperm sexing technologies and their application
19-20	Preimplantation genetic diagnosis and screening
	Unit III
21-23	Epigenetic reprogramming
24-25	Large offspring syndrome
26-28	Sources of stem cells, Embryonic stem cells, Spermatogonial stem cells
29-30	Induced pluripotent stem cells
	Unit IV
31-32	Stem cells application in regenerative medicine and disease therapeutics.
33-34	Social, Ethical, Religious and regulatory issues related to assisted reproductive technology
35-36	Transgenic and stem cells therapy.

Practical

Practical Nos.	Topics
1-3	Micromanipulator, micro assisted fertilization, ICSI protocol
4-6	Embryo biopsy- sexing
7-9	Sperm preparation and sperm quality analysis by flow cytometry
10-12	Embryo quality analysis- Morphological assessment and Staining technique
13-14	SCNT protocol- enucleation, somatic cell injection, fusion activation and embryo culture
15-16	Isolation of inner cell mass from blastocyst, culture and characterization of embryonic stem cells
17-18	Gene expression in sperm and embryos

8. Course No.: BTY 709 Title: Advances In Animal Cell Culture (2+1)

Theory

Lecture Nos.	Topics
Unit I	
1-2	Development of cell lines using various methods
3-4	Characterization of cell lines by morphology
5-6	Characterization of cell lines by Chromosome analysis
7-9	Characterisation of cell lines by DNA content, isoenzyme analysis and antigenic markers
10-11	Characterisation of cell lines DNA fingerprinting
Unit II	
12-15	Setting of new cell culture lab
16-17	Detection methods for cell culture contaminants
14-16	Three-dimensional culture- classification of 3D culture methods and microfluidics
17-20	Tissue engineering- types of cells, Scaffold materials, Bioprinting, Bioartificial organs
21-22	Flow Cytometry and its applications in cell culture
Unit III	
23-25	DNA transfer by viral and non-viral methods
26-28	Expression of recombinant proteins in mammalian and avian cell lines.
29-31	Expression of recombinant proteins in mammalian and avian cell lines.
Unit IV	
32-34	Up-stream and downstream processing of cell culture-based vaccines, Diagnostic antigens and other pharmaceutical agents
35-36	Cell culture fermenters

Practical

Practical Nos.	Topics
1	Primary and secondary mammalian cell culture
2-3	Development of transformed cells
4-5	Characterization of cell lines by karyotyping
6-7	Transfection of cells with recombinant DNA
8-9	Expression of recombinant proteins
10-11	Scaling-up of cultures
12	Flow Cytometry
13-14	Immunization of mice
15	Maintenance of myeloma cell lines
16	Fusion

17-18	Characterization of Mabs

9. Course No.: BTY 710 Title: Industrial Biotechnology (2+1)

Theory

Lecture Nos.	Topics
	Unit I
1	Introduction to fermentation process, history of fermentation process
2	Enzymes of industrial importance, Microbes producing industrially important enzymes
3-4	Screening of microbes for enzyme production
5	Genetic improvement of microorganism for improved production
6-7	Microbial growth studies and their metabolites-primary and secondary
8	Product formation by substrate degradation
9	Production of recombinant products
	Unit II
10-11	Batch, continuous and fed batch fermentation
12-13	Kinetics of growth and product formation
14	Design of a fermenter, basic functions, types of fermenters
15	Animal cell culture by using bioreactors, Fermenters for animal cell culture
16-17	Aseptic operation, Containment, Sterilization
	Unit III
18-19	Medium formulation, precursors, metabolic regulators, antifoams
20-21	Upstream and down stream processing
22	Filteration, Centrifugation
23-24	EXtraction, Chromatography, membrane process
25-26	Drying crystallization, whole broth processing
	Unit IV
27	Bioenergy production
28-30	Biohydrogen, biomethane, biodiesel and biobutanol production
31	Microbial fuel cells
32	Aerobic treatment of waste water
33	Anaerobic waste water treatment
34	Singel cell protein production, Metal leaching
35	Food additives
36	Food supplements and health care products

Practical

Practical Nos.	Topics
1-2	Isolation of industrially important enzyme producing microorganism
3	Screening for enzyme production

4	EXtraction and characterization of enzymes
5	Enzyme kinetics
6-7	Strain improvement by different methods
8-9	Bioreactor operation
10-11	Optimization of enzyme and industrial compounds production using bioreactor
12	Filtration
13	Cell disruption
14	Chromatography
15	Microbial fuel cell design
16	Optimization of electrodes, catholyte
17-18	Waste water treatment

10. BTY 711 Title: Rumen and Feed Biotechnology (2+1)

Theory

Lecture Nos.	Topics
	Unit I
1-2	Rumen ecosystem – Classification of rumen microbes
3-4	Isolation – Cultural characters of rumen microbes
5-6	Rumen fermentation -Techniques to increase production of rumen microbes
7-8	Metabolic inter-relationship between rumen microbes.
	Unit II
9-11	Feed processing and preservation, Microbial bioconversion of lignin and cellulose rich feeds. Factors affecting delignification, Large scale bioconversion of substrates
12-13	Pretreatment of feeds, chemical vs microbial treatment of feeds, Anti-nutritional factors present in feeds
14-15	Microbial detoXification of aflatoXins, Mimosine and other anti-metabolites present.
	Unit III
16-17	Manipulation of rumen methane production – Addition of methane inhibitors
18-20	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
21-22	Genetic manipulation of rumen microflora to improve feed utilization. Manipulation of rumen microbes by recombinant DNA technology.
23-24	Inter species H_2 transfer and its importance –Single cell protein (SCP) as animal feed
25-26	Rumen. metagenomics- Methods of studying rumen metagenome-Conventional cloning and sequencing of metagenomic DNA
27-28	NGS based shot gun sequencing. Amplicon sequencing of 16 S/ 18S rRNA hyper variable regions

29-30	Bioinformatics analysis of metagenomicsequence data.
31-32	Use of probiotics. Microorganisms and proteins used as probiotics.
33-34	Mechanism of action of probiotics, Immune response to probiotics.
35-36	Anti-mutagenicand anti-tumour activities of probiotics.

Practical

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