

REVISED CURRICULUM

M.V. Sc.

ANIMAL
BIOTECHNOLOGY



सत्यमेव जयते

Department of Biotechnology

Ministry of Science & Technology,
Government of India

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S.No.	Title	Credits		Page No.
SEMESTER - I		T*	P*	
1.	Biochemistry & Analytical Techniques	2	1.5	1
2.	Animal Cell Culture Technology	3	1.5	3
3.	Biostatistics and Computer Applications	2	1.5	4
4.	Embryobiotechnology	3	1.5	5
5.	Cell & Molecular Biology	2	1.5	6
6.	Elective I	2	1.5	
7.	Seminar/Journal Club/Assignment	1	0	
	Total (24)	15	9	
SEMESTER - II				
1.	Infection & Immunity	3	1.5	8
2.	Molecular Diagnostics	2	1.5	9
3.	Genetic Engineering	3	1.5	10
4.	Vaccinology & Bioprocess Technology	2	1.5	12
5.	Genomics & Proteomics	2	1.5	13
6.	Elective II	2	1.5	
7.	Seminar/Journal Club/Assignment	1	0	
	Total (24)	15	9	
SEMESTER - III				
1.	IPR & Biosafety	3		15
2.	Thesis Work	20		
	Total	23		
SEMESTER - IV				
1.	Thesis Work	23		
	Total	23		
	Total Credits		94	

* T-Theory

**P-Practicals

S.No.	Title	Credits	Page No.
LIST OF ELECTIVES			
1.	Bacteriology		
2.	General Virology		
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5.	Molecular Techniques in Animal Breeding		
6.	Biometrical Techniques in Animal Breeding		
7.	Animal Population Genetics		
8.	General Gynaecology		
9.	Female Infertility		
10.	General Andrology		
11.	Male Infertility		

**^Any two 1.5 credit courses can be taken up to make one 3 credit course.
 Contents for electives are given separately.**

Biochemistry and Analytical Techniques - (2+1.5)

Unit I

Chemicals basis of life

Chemical basis of life; Properties of water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure and functions of aminoacids; Peptides and covalent structure of proteins; Protein structures– Structure and function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin

Unit II

Carbohydrates and lipids

Carbohydrates and their functions in cellular structure, energy storage, signaling; Glycoproteins and glycolipids; Fatty acids; Structure and properties of important fatty acids in biomembranes and storage; Lipoproteins

Unit III

General principles of catalysis

General principles of catalysis; Enzyme catalysis; Quantitation of enzyme activity; Michaelis-Menten kinetics; Role of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes

Unit IV

Biomembrane organization

Biomembrane organization; Membrane bound proteins: structure and function; Nucleic acids – structure, diversity and functions; Basic principles of bioenergy – Glycolytic pathways, Kreb's cycle, Oxidative phosphorylation, Photosynthesis; Elucidation of metabolic pathways; Principles of metabolic regulation

Unit V

Biochemical techniques

Buffers, Methods of cell disintegration; Enzyme assays; Dialysis and ultrafiltration; UV, visible and Raman spectroscopy; Theory and application of circular dichroism; Fluorescence; MS; NMR; PMR; ESR and Plasma emission spectroscopy; Principles and applications of different chromatographic and electrophoretic techniques; Radioactive isotopes; Techniques in measurement of radioactivity; Biosafety measures in handling radioisotopes; Application of radioactive isotopes in biological research; Principles and applications of non-radioactive methods in biological research; Principles and types of Protein crystallization; API; Electrospray and MALDI-TOF; Enzyme and cell immobilization techniques; DNA and peptide synthesis.

Practicals

1. Fractionation of cell organelles from liver and plant tissues
2. Experiments on blood

- Identification and count of blood corpuscles
 - Estimation of haemoglobin
 - Determination of A/G ratio in serum
 - Serum creatinine and uric acid
 - Serum enzyme assays: alkaline phosphatase, SGOT, SGPT
3. Qualitative and Quantitative Analysis of :
 - Carbohydrates
 - Amino acids and proteins
 - Free and bound phosphate
 - Vitamin C
 4. Isolation and estimation of serum cholesterol
 5. Gel Electrophoresis of serum proteins
 6. SDS-PAGE of proteins
 7. Qualitative and quantitative analysis of:
 - Saliva (α -amylase)
 - Urine (urea, uric acid, glucose, proteins, Bence-Jones proteins, Cl^- , PO_3^{-3} , Ca^{2+})
 8. Assay of enzyme activity
 - Isolation and purification of urease
 - Time course of enzymatic reaction
 - Influence of substrate concentration on the rate of enzymatic reaction
 - Effect of pH and temperature on the rate of enzyme reaction
 - Specificity of enzyme action
 - Inhibition of enzyme activity. Determination of K_i values
 - Molecular weight determination of enzyme by gel filtration
 - Isozyme detection
 9. Paper chromatography – Separation of amino acids and carbohydrates in a mixture
 10. Thin layer chromatography of fatty acids
 11. Column chromatography

Texts/References

1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.
4. William H. Elliott & Daphne C. Elliott, Biochemistry Molecular Biology, 3rd Edition, Oxford University Press, 2004.
5. Basic Biochemical Laboratory Procedures & Computing- R. Cecil Jack – Oxford University press.
6. Laboratory Techniques in Biochemistry & Molecular Biology – Series – Elsevier Publications

Animal Cell Culture Technology - (3+1.5)

Unit I

Cell culture Laboratory design & Equipments

Planning, construction and services; Layout; Sterile handling area; Incubation; Hot room; Air circulation; Service bench; Laminar flow; Sterilizer; Incubator; CO₂ incubator; Refrigerators and freezers; Centrifuge; Inverted stage microscope; Magnetic stirrer; Liquid nitrogen freezers; Slow cooling system for cell freezing; Water bath; Autoclaves and hot air oven; Pipette washers; Water purification system; Fluid handling systems and other equipments; Washing, packing and sterilization of different materials used in animal cell culture; Aseptic concepts; Maintenance of sterility; Cell culture vessels.

Unit II

Media and reagents

Types of cell culture media; Ingredients of media; Physiochemical properties; CO₂ and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Foetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.

Unit III

Different types of cell cultures

History of animal cell culture; Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants.

Unit IV

Applications

Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Unit V

Scale-up

Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fiber perfusion; Matrix perfusion; Microencapsulation; Growth monitoring

Practicals

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of reagents and media for cell culture.
3. Primary culture technique for chicken embryo fibroblast.
4. Secondary culture of chicken embryo fibroblast.
5. Cultivation of continuous cell lines.
6. Quantification of cells by trypan blue exclusion dye.
7. Isolation of lymphocytes and cultivation of lymphocytes
8. Study of effect of toxic chemicals on cultured mammalian cells
9. Study of effect of virus on mammalian cells.
10. Suspension culture technique
11. Cryopreservation of cell primary cultures and cell lines.

Texts/References

1. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005
2. Ed. John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.
3. Ed. Martin Clynes, Animal Cell Culture Techniques., Springer, 1998.

Biostatistics and Computer Applications - (2+1.5)

Unit I

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations (variance known, variance unknown); Chi-square test for independence; P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformations

Unit II

Elements of programming languages - C and PERL; Data base concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

Unit III

Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods

Unit IV

Goals of a Microarray experiment; Normalization of Microarray data; Detecting differential gene expression; Principal component analysis; Clustering of microarray data; Structure determination by X-ray crystallography; NMR spectroscopy; PDB(Protein Data Bank) and NDB(Nucleic Acid Data Bank); File formats for storage and dissemination of molecular structure.

Unit V

Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation

Practicals

Introduction to MS EXCEL-Use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to SYSTAT package.

Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST, BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

Texts/References

1. Wayne W. Daniel, Biostatistics: A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.
2. Prem S. Mann, Introductory Statistics, 6th Edition, Wiley, 2006.
3. John A. Rice, Mathematical Statistics and Data Analysis, 3rd Edition, John A. Rice, Duxbury Press, 2006.
4. Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.
5. Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly Publication, 2001.

EmbryoBiotechnology - (3+1.5)

Unit I

Basic Reproduction Pattern in Animals

Reproduction System in Male and Females; Gametogenesis; Gamete transport; Fertilization; Maternal recognition of pregnancy; Early Embryonic Mortality.

Unit II

Animal Improvement Methods

Artificial insemination and crossbreeding; Constraints in Progeny Testing; Multiple Ovulation and Embryo Transfer; Open Nucleus Breeding System; Rate of Genetic Improvement using AI, MOET, ONBS.

Unit III

Artificial Reproduction Technologies

Oestrus synchronization; Superovulation and Embryo Transfer Technology; Factors affecting superovulatory

responses and conception rates; Alternate approaches to superovulation; Fertility vaccines; Current status of applications and limitations of ETT; In vitro maturation; Fertilization and culture of embryos; Somatic Cell Nuclear Transfer; Methods; Limitations; Genetics and Epigenetic alterations involved in ARTs.

Unit IV

Principles of Cryobiology

Methods in semen freezing and evaluation of sperm fertilizing ability; Cryopreservation of sperm and embryos; International trade of semen and embryos; Sperm and Embryo sexing; Disease transmission through semen and embryos; International standards.

Unit V

Transgenesis and Stem cell biology

Transgenic animal production; Methods of transgene delivery; Integration of foreign genes and their validation; Gene targeting; Methods and strategies; Improving transgene integration efficiency; Cell lineages and developmental control genes in drosophila and mice; Differentiation of germ layers; Cellular polarity; Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Differentiation of cancerous cells and role of proto-oncogenes; Stem cell markers; Methods of stem cell production in farm animals; Using stem cells for SCNT; Transgenesis and Xenotransplants.

Practicals

1. Synchronization and Superovulation protocols.
2. Collection of embryos using non-surgical procedures.
3. Transferring embryos using non- surgical procedures.
4. Embryo freezing protocols.
5. Oocyte collection and evaluation from slaughterhouse ovaries.
6. In vitro fertilization protocols.
7. Micromanipulation of early embryos.

Texts/References

1. B.Hafez, E.S.E Hafez, Reproduction in Farm Animals, 7th Edition, Wiley- Blackwell, 2000.
2. George E. Seidel, Jr. and Sarah Moore Seidel, Training Manual for Embryo Transfer in Cattle, FAO Animal Production and Health Paper-77, 1991.
3. Gordon, Laboratory Production of Cattle Embryos, 2nd Edition, CABI Publishing, CAB International, Wallingford, Oxon OX 10 8DE, U.K., 1994.
4. Louis-Marie Houdebine, Transgenic Animals: Generation and Use, 1st Edition, CRC Press, 1997.

Cell & Molecular Biology - (2+1.5)

Unit I

Structure and functions of cell

Structural and molecular organization of prokaryotic and eukaryotic cells; Functions of organelles; Cytoskeleton and cell motility; Cell cycle and division; Programmed cell death.

Unit II

Differentiation of specialized cells

Maternal gene effects; Embryogenesis; Cell lineages; Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Differentiation of cancerous cells.

Unit III

DNA replication

Concepts of replication in prokaryotes and eukaryotes; Enzymes involved in replication; Replication of single standard circular DNA; DNA repair; Recombination: homologous and non-homologous recombination; Gene targeting; Gene disruption.

Unit IV

Transcription and Translation

Prokaryotic and Eukaryotic transcription and regulation: Promoters, Regulatory elements, Operons, Processing of tRNA and rRNA; Translation machinery; Universal genetic code, Degeneracy of codons; Stop codons; Wobble hypothesis; Post translational modifications; Protein synthesis, transport and stability.

Unit V

Mutations, Oncogenes and tumor suppressor genes

Nonsense, missense and point mutations; Frameshift mutations; Mutagens; Transposons in prokaryotes and eukaryotes; Viral and cellular oncogenes; Tumor suppressor genes from humans; Activation of oncogenes; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.

Practicals

1. Isolation of genomic DNA from prokaryotic and eukaryotic cells
2. Isolation of RNA from tissues and reverse transcription
3. Amplification of specific gene sequences by polymerase chain reaction (PCR)
4. Restriction enzyme digestion of DNA and agarose gel electrophoresis
5. Isolation of plasmid DNA and cutting with restriction enzymes
6. Setting up a ligation reaction
7. Preparation of competent cells
8. Transformation of competent cells and plating
9. Screening of transformants by PCR/colony hybridization/ restriction digestion
10. Preparation of fibroblast cultures

Texts/References

1. Lodish *et al.*, Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
3. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
4. Watson *et al.*, Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.

Infection and Immunity - (3 + 1.5)

Unit I

Immunology- fundamental concepts

Innate and acquired immunity; Components of innate and acquired immunity; Antibody structure; Types of antibodies and their functions; Mechanism of antibody production; Characteristics of antigens and haptens; Antigen-antibody interactions.

Unit II

The anatomy of the immune response

Immune system: Bone marrow, thymus, spleen and lymphnodes; Cells of immune system: B and T lymphocytes, natural killer cells, Macrophages/monocyte lineage cells, dendritic cells; Ontogeny of Lymphocytes; Mechanism of regulation of immune response.

Unit III

Immunity to infection

Mechanism of cell mediated immune response and antibody mediated immune response; Cellular and humoral immune responses against important bacterial, viral, fungal and parasitic infections of animals and poultry.

Unit IV

Clinical Immunology

Hypersensitivity, Autoimmunity, Transplantation, Tumor immunology and Immunodeficiency.

Unit V

Immunotechnology

In vivo and *in vitro* methods including recombinant DNA technology for production of antibodies. Hybridoma technology for production of monoclonal antibodies, immunochemical and immunohistochemical techniques, and various cellular techniques.

Practicals

1. Preparation of antigens, selection of laboratory animals, immunization of animals, methods of bleeding of immunized animals.
2. Preparation of serum and its titration using ELISA
3. Immunoprecipitation based assays: agar gel immunodiffusion test, radial immunodiffusion test and immunoelectrophoresis,
4. Agglutination based assays: bacterial agglutination test, haemagglutination assay, haemagglutination inhibition assay.
5. Isolation of Immunoglobulins from serum

6. Isolation of lymphocyte and monocytes from animal blood using Histopaque/Lymphoprep/Ficoll Hypaque
7. Indirect ELISA, competitive ELISA, sandwich ELISA, dot ELISA
8. Fluorescent antibody test
9. Immunoperoxidase assays
10. Immunoblotting
11. Immunodiagnosics using commercial kits
12. Hybridoma technology

Texts/References

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
5. Goding, Monoclonal antibodies, Academic Press. 1985.

Molecular Diagnostics - (2 + 1.5)

Unit I

Introduction

Introduction; Importance and historical perspective of development of molecular diagnostic technology; Concept of development of group specific and strain specific nucleic acid based diagnostics; Basis for selection of gene/nucleotide sequence of pathogenic organisms to target for detection.

Unit II

Different Methods of Diagnosis

Application of restriction endonuclease analysis for identification of pathogens; Principle of development of bacterial, viral and parasitic pathogen specific nucleic acid probes; Southern and Northern hybridization assays for diagnosis of animal and poultry diseases.

Unit III

PCR Technology for Animal Poultry disease diagnosis

Theoretical background of development of PCR and Real time PCR and its variations; Application of PCR for diagnosis of infectious diseases of cattle, buffalo, sheep, goats, dogs, equines, swine and poultry; Nucleic acid sequence based diagnostics.

Unit IV

Molecular methods for epidemiological and zoonotic disease investigations

Molecular diagnostics and epidemiological typing methods for common food borne viral and bacterial diseases; Molecular methods for identification of zoonotic diseases; Detection of animal pathogens in environmental samples such as water, air, soil; Detection of pathogens in foods/feeds including vegetables, fruits, milk, meat, eggs, animal and poultry feeds.

Unit V

Advancements in diagnostic technology including nucleic acid and protein arrays; Biosensors and nanotechnology; Molecular diagnostics for detection of tumors; Molecular diagnostics for animal forensics; Detection of meat adulteration; DNA based methods for identification of animal species in theft cases; Religious disputes involving cow and pigs; Application of molecular diagnostics in wildlife forensics; DNA biosensor chips for GMO detection; Molecular methods for bioterrorism.

Practicals

1. Collection of clinical and environmental samples from animal and poultry farms for molecular detection of pathogens.
2. Isolation of bacterial pathogens from the samples.
3. Extraction of nucleic acids from bacteria and clinical specimens.
4. Restriction endonuclease digestion and analysis by agarose electrophoresis.
5. Development of animal pathogen specific nucleic acid probes.
6. Southern blotting for detection of pathogens.
7. Polymerase chain reaction for detection of pathogens in blood and other animal tissues.
8. RT-PCR for detection of RNA viruses
9. Real time PCR for detection of pathogens in semen and other animal tissues.
10. DNA fingerprinting for identification of animal species.
11. PCR based detection of meat adulteration in processed and unprocessed meats.
12. Detection of food borne pathogenic organisms in vegetables and fruits using PCR technology.
13. PCR based detection of potential pathogens in milk, eggs and meat.

Texts/References

1. Decker J & Reischl. U, Molecular Diagnosis of infectious diseases, 2nd Edition, Humana Press, 2004.
2. Rao JR, Fleming CC & Moore JE, Molecular Diagnostics, Horizon Bioscience. 2006.

Genetic Engineering - (3 + 1.5)

Unit I

Basics Concepts

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Unit II

Cloning Vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Unit III

Cloning Methodologies

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV

PCR and Its Applications

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

Unit V

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing;

Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Practicals

1. Isolation of nucleic acid from bacteria/viruses/eukaryotic cells
2. Amplification of the desired gene/fragment of the gene.
3. Analysis of the PCR/reverse transcriptase-PCR product in agarose gel.
4. Preparation of cloning vector (plasmid) from *E. coli* DH5 α and gel analysis.
5. Restriction digestion of the plasmid with suitable restriction endonuclease.
6. Insertion of the desired gene/gene segment and ligation with the help of ligase

7. Transformation of *E. coli* DH5 α
8. Isolation of plasmid and confirmation of the insert by touch PCR and RE digestion
9. Cloning of gene in expression vector and Transformation.
10. Expression of protein in suitable host system.
11. Analysis of recombinant protein in SDS-PAGE
12. Purification of protein on Ni-NTA column and analysis of purified protein in SDS-PAGE

Text/References

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.
6. J.D. Watson, M. Gilamn, J. Witkowski and M. Zoller, Recombinant DNA, 2nd Edition, Scientific American Books, NY., 1992.
7. Ed. A. Puller, Genetic engineering in Animals. VCH Publishers

Vaccinology & Bioprocess Technology - (2 + 1.5)

Unit I

Classification of vaccines

Conventional vaccines; Live and killed vaccines; New generation vaccines; Sub unit vaccines; Synthetic peptide vaccines; Anti-idiotypic vaccines; Recombinant DNA vaccines; Deleted mutant vaccines; Reassortment vaccines; DNA vaccines; Edible vaccines.

Unit II

Mass antigen production and processing

Microbial growth kinetics; Bioreactors; Hollow fibre technique; Up stream and down stream processing; Bioseparation; Cell disruption; Purification by chromatographic methods; Freeze drying, storage and packing; Treatment of effluents and its disposal.

Unit III

Vaccine delivery

Adjuvants; Carriers; Haptens; Vaccine delivery using nano particles; Standardization of vaccines; Safety, sterility and potency testing.

Unit IV

Industrial production of chemicals

Alcohol, Acids, Solvent, Antibiotics, Amino acids and Single cell protein; Fermentation economics of large-scale production.

Unit V

Enzyme production

Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications.

Practicals

1. Propagation of bacterial/viral cultures for antigen preparation
2. Attenuation and inactivation methods
3. Preparation of adjuvants
4. Preparation of live or killed vaccine
5. Immunization of animals, bleeding and testing antibody response by serological methods like ELISA/ Western blot
6. Isolation and screening of industrially important microbes
7. Microbial production of antibiotics (E.g. Penicillin)
8. Production and purification of microbial enzymes
9. Handling/observation of laboratory bioreactors
10. Techniques involved in downstream processing

Texts/References

1. Peters, Vaccines for Veterinary applications, Butterworth- Heinemann, 1993.
2. Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A Textbook of Industrial Microbiology, Sinauer Associates, 1990.
3. By open Universities, Netherland & Thames Polytechnic, Bioreactor Design & Product yield –UK, 1st Edition, Bulterworth - Heinemann. 1992.

Genomics and Proteomics - (2 + 1.5)

Unit I

Brief introduction to Mendelian genetics; Structure and organization of prokaryotic and eukaryotic genomes – nuclear and mitochondrial genomes; Qualitative and quantitative traits; Chromosomes of farm animals - their morphology and banding pattern; Eukaryotic genome; Genome complexity; Different types of DNA elements in genome of domestic animals; Satellite DNA; LINEs; SINEs; Trasposable elements; Retroelements and pseudogene.

Unit II

Gene Function; Basic protein synthesis apparatus in eukaryotic cell; Gene expression in eukaryotes and its regulation; Gene promoters and different controlling elements; Global gene expression analysis using RT-PCR, Real Time PCR (Different Chemistries); Microarray and RNAi approaches; Differential gene expression.

Unit III

Genetic Markers: Concepts of allele, gene family, Single locus and multi locus DNA markers; Tools for genome

analysis-RFLP, DNA fingerprinting, RAPD, PCR and Automated DNA sequencing; Linkage and pedigree analysis-physical and genetic mapping strategies(chromosome walking, chromosome jumping, exon trapping, in situ hybridization and chromosome painting, microarray technology) and present status of animal gene map; Marker-assisted selection for production and reproduction traits and disease resistance; Genome sequencing projects in bovine, porcine and other farm animals.

Unit IV

Proteomics- definition; Identification and analysis of proteins by 2D analysis; Mass spectrophotometry; MALDI-TOF; LC-MS; SAGE and Differential display proteomics; Protein-protein interactions; Yeast two hybrid system and phage display.

Unit V

Pharmacogenetics; High throughput screening for drug discovery; Identification of drug targets; Pharamacogenetics and drug development; Metabolomics and Systems Biology.

Practicals

1. Chromosome preparation (normal karyotyping, different types of banding) in farm animals.
2. Genomic DNA isolation from blood lymphocytes.
3. Analysis of DNA in agarose or in polyacrylamide gel electrophoresis.
4. Restriction enzyme analysis of genomic DNA, amplification of DNA by PCR.
5. Genomic DNA cloning or cDNA cloning.
6. Techniques for revealing polymorphism-DNA fingerprinting, RFLP, SSCP, AFLP, STRP etc.

Texts/References

1. Maxine Singer & Paul Berg, Genes and Genomes: A Changing Perspective, University Science Books, 1991.
2. David Latchman, Gene regulation: A Eukaryotic Perspective, 4th Edition, Nelson Thornes Ltd, 2002.
3. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
4. Anthony J.F. Griffiths, Jeffrey H. Miller, William M. Gelbart, William Gelbart, Jeffrey Miller, Modern Genetic Analysis, 2nd Edition, W.H. Freeman, 2002.

SEMESTER - III

IPR & Biosafety - 3 Credits

Unit I

Introduction to Intellectual Property

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP

IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS

Unit II

Concept of 'prior art'

Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation

Unit III

Basics of Patents

Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application

Unit IV

Patent filing and Infringement

Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US

Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives

Patent infringement- meaning, scope, litigation, case studies and examples

Unit V

Biosafety

Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Important Links

<http://www.w3.org/IPR/>

<http://www.wipo.int/portal/index.html.en>

http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html

www.patentoffice.nic.in

www.iprlawindia.org/ - 31k - Cached - Similar page

<http://www.cbd.int/biosafety/background.shtml>

<http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm>

<http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>