Semester II [Core (CR)]

Course No: BT23201CR	**Credits: 4**
Course Title: Animal cell Science and Technology	
Maximum Marks: 100 [80 (SEE) + 20 (IA)]	

Course Objectives:
This Course will help students to familiarize themselves with animal cell, their culturing and maintaining them as *in vitro* cultures. The aim is to provide theoretical knowledge on animal cells for in vitro studies, manipulation of animal cells in vitro and application of molecular techniques to in vitro situations.

Unit I

Structure and organization of Animal Cell, Primary and established Cell lines, Setting up of Tissue culture facility; Equipment and facilities needed. Contaminations in cell culture; Types and their eradication/contamination control, Precautions in handling of cell lines. Introduction to balanced salt solutions and simple/complete growth medium, Role of CO2, serum and supplements. Serum components necessary for growth of cells in culture. Serum and serum free defined media. Limitations and applications of serum and serum free media.

Unit II

Cell Lines: Biology and characterizations of the cultured cells. Cryopreservation. Basic techniques of mammalian cell culture in vitro: Disaggregating of tissue and primary culture. Transfection of cell lines.Types and Methods of Transfection. Transfection applications. Scaling-up of animal cell culture.Equipment and reagents.Advantages and Disadvantages of Scale-up techniques. Cell synchronization, cell cloning and micromanipulation. Application of animal cell culture.

Unit III

Cell transformation: Properties of transformed cells. Methods of cell Transformation. Immortalization: Introduction. Methods used to immortalize cells. Mechanisms involved in cell immortalization. Measurements of viability and cytotoxicity assay: Cell viability assays using dye exclusion or dye uptake, MTT, TUNNEL and ELISA based assays. Fluorescence based cell viability assays. Cell culture based vaccines: Introduction to Subunit vaccines, peptide vaccines, recombinant vaccines, genetic vaccines and attenuated vaccines. Advantages and disadvantages of all the types of vaccines.

Unit IV

Three dimensional culture: Introduction. Multicellular tumour spheroids (MCTS).Spheroid culturing techniques. Tissue engineering: Introduction. Tissue Engineering of Skin, Nerve implants. Tissue engineered Urothelium implants. Design criterion for tissue engineering. Cell substrates and support material. Organ and Histotypic cultures: Introduction. Advantages and limitations.Differences between Organotypic and Histotypic cultures.Factors affecting the growth of Organotypic and Histotypic cultures.

Cloning of Animals. Strategies for Transgenic animal production using Microinjection, Somatic cell nuclear transfer technique, embryonic stem cells and using Viruses. Legal and ethical aspects of Animal Cloning.Application of Transgenic animals.

Learning Outcomes:

By the end of this course students will be able to comprehend the fundamental concepts of animal cell culture and its importance. Have knowledge for carrying out various assays and experiments in cultured cells.

Books Recommended:

1) Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, by, R. Ian Freshney, published by Wiley-Blackwell, UK.
2) Animal Cell Culture: A Practical Approach by JRW Masters, published by Oxford University Press, UK.
3) Basic Cell Culture: A Practical Approach by John M. Davis, published by Oxford University Press, UK.
4) Transgenic Animal Technology, 3rd Edition, A Laboratory Handbook by Carl Pinkert, Elsevier Press.
5) Selected Research and Review articles.

Semester II [Core (CR)]

Course No: BT23202CR	**Credits: 4**
Course Title: Molecular Biology II	
Maximum Marks: 100 [80 (SEE) + 20 (IA)]	

Course Objectives:
To emphasize on advanced concepts of molecular processes involved in expression of genetic information in eukaryotic cells, including transcription, splicing, translation and post-translational modification, and how these processes are regulated.

Unit I

Mechanism of Gene Regulation: Regulatory Elements and Transcription Factors: Enhancers, Silencer Elements, and Methods of Studying Transcription Factors. Recent Advances: Enhancer-promoter interactions and 3D genome organization in gene regulation.Domain Structure of Transcription Factors: DNA Binding Domains: Zinc Finger, Leucine Zipper, Homeodomains, Basic Domains. Transcription Activation Domains and Mechanism of Activator Function. Recent Advances: Discovery of novel transcription factor domains and interactions.Transcriptional Coactivators and Repressors: Activation Bypass, Mediator Complex, and Role in Transcriptional Regulation. Recent Advances: Insights into coactivator and corepressor functions.Gene Regulation During Development: Transcription Factors in Developmental Gene Expression and Homeobox Genes: Recent Advances: Epigenetic regulation and non-coding RNAs in developmental gene regulation

Unit II

Chromatin Structure and Epigenetic Regulation:Overview of Chromatin, Histones, and Nucleosomes: Euchromatin and Heterochromatin. Chromatin Remodeling and Nucleosome Positioning. Histone Modifications and the Histone Code Hypothesis: Histone Acetylation, Methylation, Phosphorylation, and Ubiquitination. Genome-Wide Analysis and Crosstalk between Histone Modifications

DNA Methylation and Epigenetic Control: Role of DNA Methylation in Gene Regulation. Epigenetic Reprogramming in Development and Diseases.Gene Regulation during Drosophila Development.

Unit III

Post-transcriptional RNA Processing:RNA splicing and spliceosome: Heteronuclear RNA (hnRNA), Exons, Introns, and Splicing Signals. Molecular Mechanism of RNA Splicing and Alternative Splicing

rRNA and tRNA Processing, RNA Editing, and Modifications: Ribosomal rRNA Processing in Eukaryotes and Prokaryotes. tRNA Processing and Modifications. RNA Editing Mechanism and Self-Splicing RNAs

Post-transcriptional Modifications of mRNA: Capping at the 5' End and Polyadenylation: Structure and Types of Caps: Function of 5' End Capping and Poly(A) Tail

Unit IV

Protein Translation and Translational Regulation:Translational Machinery and tRNA Charging: Structural Features of mRNA in Prokaryotes and Eukaryotes. Ribosome Structure and AminoacyltRNASynthetases. Genetic Code and tRNA Charging with Specific Amino Acids. Translational Initiation and Elongation: Prokaryotic and Eukaryotic Initiation Complex Formation. Mechanism of Translation Initiation and Cap-Dependent/Cap-Independent Translation. Translation Elongation, Proofreading, and Translocation Translation Termination and Translational Regulation: Termination Codons and Release Factors. Ribosome Dissociation and Factors Involved.Aberrant termination and molecular mechanism to deal with aberrant termination.Prokaryotic and Eukaryotic Translational Regulation.Role of mircoRNAs (miRNAs) in translation regulation.

Learning Outcomes:

Will enable students to understand different types, structure, and function of different types of eukaryotic polymerases, RNA polymerases, transcription factors and associated factors and the mechanism of their functioning. Besides students will be acquitted about posttrasncriptional events like splicing, capping and polyadenylation.

Books Recommended:

1) Transcriptional Regulation in Eukaryotes: Concepts, Strategies, and Techniques by Michael F Carey, Stephen T Smale and Craig L Peterson.
2) Gene Regulation by David S. Latchman fifth edition.
3) Molecular Biology by Robert F Weaver: McGraw-Hill Higher Education.
4) Molecular Biology of the Gene by James D. Watson, et al: Pearson.

Semester II [Core (CR)]

Course No: BT23203CR	**Credits: 4**
Course Title: Advanced Enzymology	
Maximum Marks: 100 [80 (SEE) + 20 (IA)]	

Course Objectives:
The objective of the course is to provide a deeper insight into the fundamentals of enzyme structure and function and kinetics enzymes. Also it deals with current applications and future potential of enzymes.

Unit I

Enzyme definition and characteristics, mechanism of enzyme action, activation energy, collision & transition state theories, lock and key model, induced fit hypothesis, active site - structure, substrate binding, role of catalytic amino acid residues. Derivation of MichaelisMenten equation using steady state and equilibrium assumptions, enzyme kinetics parameters (K_m, V_{max}, K_{cat}, K_{cat}/K_m). Transformation of Michaelis – Menten plot to linear forms. Lineweaver-Burk, Eadie-Hofstee, Hanes plots, Eisenthal and Cornish-Bowden plots.Merits and demerits of linear plots.Kinetics of bi-substrate reaction, ping-pong reaction, multi-substrate reaction.

Unit II

Enzyme Inhibition: irreversible and reversible inhibition: mechanism and kinetics of competitive, noncompetitive and uncompetitive inhibition. Methods of examining enzymes-complexes, trapping E-S complex, use of substrate analogs. Type of enzymatic catalysis; acid-base, nucleophilic-electrophilic, covalent catalysis.Mechanisms of action of chymotrypsin, ribonuclease, lysozyme; ribozymes, synthetic artificial enzymes.

Unit III

Enzyme regulation and feedback control, phosphorylation, regulation of aspartic transcarbamylase and metalloenzymes, carboxypeptidase-A, isozymes and their significance.Protein-Ligand binding including measurement, analysis of binding isotherm. Cooperatively phenomenon. Hill and Scatchard plots. Hemoglobin as a model for cooperativity.Allosteric enzymes, sigmodial kinetics and their physiological significance.Symmetric and sequential modes for action of allosteric enzymes and their significance.

Unit IV

Industrial enzymes: Sales value and manufacturers, Sources and engineering, Environmental benefits, Enzyme detection and quantification, Immobilized enzymes, Extremophiles, Enzymes in organic solvents.

Proteases and Carbohydrases: Proteolytic enzymes, Carbohydrases, Lipases, Penicillin acylase, Amino acylase and amino acid production, Cyclodextrins and cyclodextringlycosyltransferase, Enzymes and animal nutrition, Enzymes in molecular biology

Non-catalytic industrial proteins: Functional properties of proteins, Milk and milk proteins, Animal-derived proteins, Plant-derived proteins, Sweet and taste-modifying proteins.

Learning outcomes:

The student will be able to describe structure, regulation, functions and the mechanisms of action of enzymes. The student will get exposure to wide applications of enzymes and their future potential, and will learn the basics of drug designing, through ligand binding examples.

Books Recommended:

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer, Horwood Publishing
2. Fundamentals of Enzyme kinetics by Athel Cornish-Bowden, Portland press
3. Fundamentals of Enzymology by Nicholas Price and Lewis Stevens, Oxford University Press
4. Enzyme Structure and Mechanism by Alan Fersht, W. H. Freeman
5. Enzymology by T. Devasena , Oxford University Press

Semester II [Core (CR)]

Course No: BT23204CR	**Credits: 2**
Course Title: Environmental Biotechnology	
Maximum Marks: 50 [40 (SEE) + 10 (IA)]	

Course Objectives:

The aim of the course is to introduce the biotechnological tools and microorganisms both native and genetically modified to address the problems of environment. The biotechnological approaches to provide alternatives to compounds, which are sources of pollution, will be presented in detail.

Unit I

Basic components of environment, Concept of ecosystem, abiotic and biotic components. Environmental pollution: Air, water, and soil pollution. Microbial regulation of global biogeochemical cycles.Biomarkers and biosensors as environmental monitors. Biosurfactants and their application in environmental clean-up.Bioinsecticides: Bacillus thuringiensis, Baculoviruses, uses, genetic modificationsand aspects of safety in their use; Biofungicides: Description of mode of actions andmechanisms (e.g., Trichoderma, Pseudomonas fluorescens)

Unit II

Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioventing bioaugmentation). Technological aspects ofbioremediation (in situ, ex situ). Bioremediation of metals, organic pollutants (PAHs, PCBs, Pesticides etc.). Application of bacteria and fungi in bioremediation: White rot fungi vs specializeddegrading bacteria.Phytoremediation:Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltrationphytostabilization).Microorganisms and biotechnologicalinterventions for optimization of production of biofuels.

Learning Outcome:

After completion of course, students will be able to understand how biotechnological methods like microbial gene modification, biotransformations, etc are used to environmental quality evaluation, monitoring and remediation of contaminated environments.

Books Recommended:

1) G. M. Evans and J. C. Furlong (2003), Environmental Biotechnology: Theory and Applications, Wiley Publishers.

2) B. Ritmann and P. L. McCarty, (2000), Environmental Biotechnology: Principle & Applications, 2nd Ed., McGraw Hill Science.

Semester II [Discipline Centric (DCE)]

Course No: BT23201DCE	**Credits: 2**
Course Title: Microbiology	
Maximum Marks: 50 [40 (SEE) + 10 (IA)]	

Course Objectives:
The aim of this course is to give fundamental concepts of bacterial growth, mechanism of toxins, retroviral replication, mode of action of antimicrobial agent.

Unit I

Bacteria: Structure, functions & biosynthesis of Cell wall (Peptidoglycan), Outer membrane of Gram Negative bacteria; structure and formation of endospore; Bacterial growth phases & Kinetics. Toxins: Endo & Exotoxins and their mode of action. Antimicrobial agents & their mode of action; Anti-bacterial & anti-Fungal antibiotics, Mechanism of drug resistance.Structure & replication of retroviruses (HIV),General concept of pararetro viruses, Structure & function of viroids and Prions.

Unit II

Bacteriophage:, Life cycle of lambda phage, Regulation of gene expression in lambda phage (Lysogenic & lytic options). Transformation: Molecular mechanism of natural transformation. Conjugation: formation of F,HFr and F-prime. Transduction: Mechanism of specialized and generalized transduction. Structure of transposons (Composite & non Composite)

Learning Outcomes:
The course will enable students to understand the basics of microbial structure and microbial growth requirements and equipped with various methods of growth parameters. They can comprehend the mechanism of gene transfer and endmapping of bacteria.

Books Recommended:

1) Molecular Genetics of Bacteria. Jeremy W. Dale, Simon F. Park: Wiley-Blackwell.
2) Microbiology by Prescott, Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton: McGraw-Hill.
3) Fundamental Bacterial Genetics. Nancy Trun, Janine Trempy: Wiley- Blackwell.

Semester II [Discipline Centric (DCE)]

Course No: BT23202DCE	**Credits: 3**
Course Title: Intermediary Metabolism	
Maximum Marks: 75 [60 (SEE) + 15 (IA)]	

Course Objectives:

The objective of intermediary metabolism course is to provide fundamental knowledge regarding the various metabolic pathways and their regulation with reference to human cells and tissue.

Unit I

Carbohydrate Metabolism:Bioengertics and Thermodynamics.Glycolysis, fermentation, gluconeogenesis and their reciprocal regulation. Glycogen synthesis/degradation and their regulation. TCA cycle and oxidative phosphorylation. Pentose phosphate pathway and glyoxylate cycle. Carbohydrate related disorders.

Unit II

Protein and Nucleotide metabolism: Transamination and deamination reactions and their clinical significance. Urea cycle. Nucleotide metabolism: purine and pyrimidine synthesis (de novo and salv age pathway). synthesis of deoxyribonucleotides from ribonucleotides. Formation of uric acid and its clinical significance. Nucleotide synthesis inhibitors and their clinical significance. Protein and Nucleotide releated disorders.

Unit III

Fatty-acid Metabolism and metabolic syndrome:Beta-oxidation of saturated and unsaturated fatty acids. Fatty acid synthesis. Triglyceride systhesis. Ketone-body synthesis and degredation and their significance. Prostaglandin synthesis and their significance. Brown adipose and thermogenesis. Obesity and body mass. Role of adipose tissue. Leptin and obesity. genes that regulate body mass. Metabolic deregulation and type-2 diabetes. Mechanism and pathways involved in diabetic complications. Role of diet, medication and exercise in managing type-2 diabetes.

Learning outcomes:

By the end of the course, the students get holistic view of the human metabolism and its regulation. The students get to know the role of various food components in metabolism and the molecular mechanism of various metabolic disorders, like diabetes, obesity, etc.

Recommended Books:

1) Principles of biochemistry by david lee nelson, albert l. lehninger, michael m. cox publisher: w.h. freeman.
2) Biochemistry by Donald voet, Judith G. voet

Semester II [Discipline Centric (DCE)]

Course No: BT23203DCE	**Credits: 3**
Course Title: Laboratory Course-II	
Maximum Marks: 75 [60 (SEE) + 15 (IA)]	

Course Objectives:

The course is aimed to provide basic lab training in techniques like DNA/RNA isolation, protein-protein interactions, SDS-PAGE, western blot and enzyme assay. The students are also provided training in handling of plant tissue culture.

Practicals

- Isolation of Genomic DNA and total RNA by various methods. Quantification of DNA and RNA.
- Separation of DNA and total RNA by agarose gel electrophoresis.
- SDS-PAGE and Western blotting.
- Immunoprecipitation (IP).
- Enzyme Assay
- Effect of temperature and pH on enzyme activity
- Determination of Kinetic constants Km and V max.
- Bacterial growth curve and culture techniques.

Learning Outcomes:

Will enable the students to learn techniques like Nucleic acid isolation, Immunoprecipitation, SDS-PAGE western blot analysis, basic enzyme assays and Plant tissue culture.

Books Recommended:

1. Sambrook, J., Fritsch, E. R., &Maniatis, T. (1989). Molecular Cloning: A Laboratory Manual (2nd ed.). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Semester II [Generic Elective (GE)]

Course No: BT23002GE	**Credits: 2**
Course Title: Redox Biology	
Maximum Marks: 50 [40 (SEE) + 10 (IA)]	

Course Objective:
The goal of this course is to let students understand the basics of Oxidant molecules their production and their harmful effects.

Unit I

Reactive Oxygen Species.Origin, Production, Enzymatic and Non-enzymatic sources of reactive oxygen Species (ROS) production.Mitochondria as a source of ROS.Involvement of cytochrome complexes, Xanthine oxidase and NADPH oxidase.Effects on cell and biomolecules. Lipid peroxidation. Protein oxidation. Inactivation of different proteins.ROS as a secondary messenger.Regulation of signal transduction.Role in cancers.ROS detection in the cells. □

Unit II

Antioxidants. Enzymatic antioxidants. Glutathione Peroxidase. Superoxide dismutase. Catalase. Non- enzymatic antioxidants.Mechanistic involvement of Vitamin C, Vitamin A. Vitamin E. Protective effects on the cell. Aging. Mechanistic players in aging.ROS in aging.Yeast and C. elegansas a model to study aging. Pathways involved in aging. Role of ROS regulating protein in aging including p53 and p66shc. □

Learning Outcome:
Students will have clear concepts on basics of oxidants, Oxidative stress, oxidant production and possible effects on cellular systems.Students will know on different types of antioxidants and mechanism of their action.Students will know about the physiological role of oxidants.

Books/Readings Recommended:

1) Selected Research and Review Journals like Antioxidant Redox Signaling and Free Radical Biology Medicine.
2) Internet Resources: Pubmed, Google, Google Scholar.

Semester II [Open Elective (OE)]

Course No: BT23002OE	**Credits: 2**
Course Title: Nutritional Biotechnology	
Maximum Marks: 50 [40 (SEE) + 10 (IA)]	

Course Objectives:

This course will enable the student to learn about various food components, their nutritional aspects, diet management and biotechnological applications in agriculture and food production

Unit I

Nutrition, Energy requirements of the body, Recommended Dietary Intakes (RDI) and its uses.Factors affecting nutritional requirement of an individual, Malnutrition. Balanced diet and basic food components

Carbohydrates: Occurrence and physiological functions, Lactose intolerance. Dental caries. Sugar alternatives. Role of dietary fiber in health and disease. Disorders related to carbohydrate metabolism. Glycemic index and Glycemic load of foods and their uses.

Lipids – Classification and Functions, Concepts of visible and invisible fats, EFA, SFA, MUFA, PUFA – sources and physiological functions. Role of lipoproteins (Chylomicrons, VLDL, IDL, LDL, and HDL), cholesterol, triglycerides in health and disease.

Unit II

Proteins: Classification and Functions, Concepts of essential and non-essential amino acids – their role in growth and development. Physiological functions of proteins.Protein malnutrition and muscle wasting disorders.

Vitamins: Role of vitamins in health. Deficiency and toxicity and nutrient claims in food and dietary Supplement.

Genetically Modified Organisms and their role in modern nutrition, resistance to insects, diseases, etc

Learning Outcome:

By the end of this course, the students will have a clear understanding about the relationship between food, nutrition and health.

Books Recommended:

Biochemistry by Donald Voet and Judith G Voet, John Wiley & Sons Biochemistry by U. Satyanarayana.