REVISED CURRICULUM AND SYLLABI

(With effect for the 2021 – 2022 admitted batch onwards)

Modified in the Annual Board of Studies meeting held on 11.08.2021

M.Sc. Biotechnology

Department of Biotechnology
College of Science and Technology
Andhra University
Visakhapatnam

Program Outcomes

PO1:Students acquire insight in to subjects like Microbiology, Molecular Biology and Genetic Engineering.
PO2:Well versed with biotechnological remedies for human health and environmental problems.
PO3:Trained in basic and advanced areas in Biotechnology to develop Biotechnological processes and products.
PO4:Multidisciplinary proficiency will be attained by utilizing MOOCS courses.
PO5:Awareness will be created regarding intellectual property rights.
PO6:Development of human capital for advanced scientific research and entrepreneurship.

Program Specific Outcomes

PSO1:Students acquire knowledge, critical thinking skills and experience in conducting cutting edge research.
PSO2: Achieve expertise in a chosen specialized area of Biotechnology based on the research experience gained by their project work.
PSO3:Develop practical skills which will empower to enroll in research institutions and industries.
PSO4:Students will be well equipped to pursue higher studies.
PSO5:Able to produce innovative products, meeting the global demands in the field of applied Biotechnology.
PSO6:Students emerge with confidence by developing knowledge both in their subject and soft skills and will be ready to face the challenges in the society.

ANDHRA UNIVERSITY

M.Sc. BIOTECHNOLOGY- SEMESTER SYSTEM (CBCS)

(WITH EFFECT FOR THE 2021 – 2022 ADMITTED BATCH ONWARDS)

SCHEME OF INSTRUCTIONS AND EXAMINATION

Paper No.	Title of the Paper	Periods/ Week	Duration of Exam (Hours)	Maximum Marks*	Credits
I Semester					
BT 1.1	Cell Biology & Evolution	4	3	100	4
BT 1.2	Biomolecules	4	3	100	4
BT 1.3	Microbial Physiology & Genetics	4	3	100	4
BT 1.4	Analytical Tools and Techniques in Biotechnology	4	3	100	4
Practical					
BT 1.5	Lab-I: Cell Biology and Microbiology	12	6	100	4
BT 1.6	Lab-II: Biochemical Analysis and Techniques	12	6	100	4
Total Marks and Credits for I Semester				**600**	**24**
II Semester					
BT 2.1	Enzymology and Metabolism	4	3	100	4
BT 2.2	Molecular Biology	4	3	100	4
BT 2.3	Genetic Engineering	4	3	100	4
BT 2.4	Biology of Immune System	4	3	100	4
Practical					
BT 2.5	Lab-III: Molecular Biology & Genetic Engineering	12	6	100	4
BT 2.6	Lab-IV: Enzymology and Immunology	12	6	100	4
Total Marks and Credits for II Semester				**600**	**24**
III Semester					
BT 3.1	Cell Culture Technology and Tissue Engineering	4	3	100	4
BT 3.2	Plant Biotechnology	4	3	100	4
BT 3.3	Animal Biotechnology	4	3	100	4
BT 3.4	Medical and Environmental Biotechnology	4	3	100	4
Practical					
BT 3.5	Lab-V: Plant Tissue Culture Techniques	12	6	100	4
BT 3.6	Lab-VI: Animal Cell culture and Environmental Biotechnology	12	6	100	4
BT 3.7	MOOCs course I			100	4
BT 3.8	Intellectual Property Rights			50	2
Total Marks and Credits for III Semester				**700**	**28**
IV Semester					
BT 4.1	Heterologous Expression and Down Stream Processing	4	3	100	4
BT 4.2	Bioinformatics and Biostatistics	4	3	100	4
Practical					
BT 4.3	Lab-VII: Industrial Biotechnology and Bioinformatics	12	6	100	4
BT 4.4	MOOCs course II			100	4
BT 4.5	Value Added Course			50	2
BT 4.6	Project Work- Dissertation & Seminar			300	12
BT 4.7	Comprehensive Viva-voce			100	4
Total Marks and Credits for IV Semester				**800**	**32**
Grand Total Marks and Credits for 4 Semesters				**2,700**	**108**

***** Theory marks include 20 marks for internal assessment

Marks and credits for BT 3.8 and BT 4.5 not included in the total marks and credits.

M.Sc., (Previous) BIOTECHNOLOGY

SEMESTER – I

PAPER BT 1.1 - CELL BIOLOGY & EVOLUTION

Course Outcomes:

CO1.Gain knowledge on the basic components of bacterial, plant and animal cells.
CO2.Awareness regarding the general morphology and functions of endoplasmic reticulum, ribosomes, golgi, lysosomes and cytoskeletal elements.
CO3.Obtain knowledge on how cells generate energy in mitochondria.
CO4.Know the importance of the mechanism of photosynthesis.
CO5.Attain an insight in to the biology of cancer cells.
CO6.Familiarize with the origin of basic biological molecules and evolutionary time scale.

Learning Outcomes:

LO1.Able to differentiate bacterial, plant and animal cells and distinguish the cell organelles.
LO2.Gain knowledge regarding the different phases of cell cycle, checkpoints and regulation of cell cycle.
LO3.Understand concepts on signal hypothesis and cell interactions.
LO4.Obtain knowledge regarding the structure and function of mitochondria and chloroplast.
LO5.Comprehend the importance of cancer cell biology in modern science.
LO6.Apprehend the experimental evidences for origin of cells.

Course Specific Outcomes:

CSO1.Obtain knowledge regarding the cell, cell organelles and mechanism of cell division.
CSO2.Have a thorough understanding of mitochondria and synthesis of ATP, the energy currency.
CSO3.Awareness on types and causes of cancer.
CSO4.Understand the evolution of prokaryotes and eukaryotes.

UNIT-I

Structure of typical bacterial, plant and animal cells and functions of cell organelles. Mechanism of cell division. Cell cycle – Molecular events including cell cycle checkpoints and Cdk – cyclin complexes and their role in cell cycle regulation. Ultra-structure of plasma membrane - components and membrane asymmetry. Transport processes - active transport, Ionophores and Ion channels. Receptor mediated endocytosis.

UNIT-II

General morphology and functions of endoplasmic reticulum. Signal hypothesis. Ribosomes - eukaryotic and prokaryotic. Ribosomal proteins. Role of Golgi in protein secretion. Lysosomes and peroxisomes. Phago and Pinocytosis. Cytoskeletal elements. Cell – cell and Cell matrix interaction.

UNIT-III

Mitochondria - Structure, biogenesis and enzymatic compartmentation. Organization of mitochondrial respiratory chain, mechanism of oxidative of phosphorylation. Ultra structure of the chloroplast. Photophosphorylation. Photosynthesis - Carbon dioxide fixation in C-3, C-4 and CAM plants. Photorespiration.

UNIT-IV

Biology of cancer - Types of tumors and causes of cancer. Oncogenes, tumour suppressor genes, cancer and cell cycle. Virus-induced cancer, anticancer drugs and their mechanisms. Metastasis.

UNIT-V

Origin of Cells - Origin of basic biological molecules. Abiotic synthesis of organic monomers and polymers. Concept of Oparin and Haldane. Experiment of Miller. Evolution of prokaryotes. Evolution of unicellular eukaryotes. The evolutionary time scale - Eras, periods and epoch. Natural Selection.

Books suggested:

1.Molecular Biology of the Cell by B. Alberts et.al (Garland publications inc.).
2.Molecular Cell Biology, J. Darnell et. al (Scientific American Books).
3.Cell Biology by N.O.Thorpe (John Wiley and sons).
4.Principles of Heredity by Robert Tamarin.
5.Organic Evolution by Rastogi.
6.Principles of Organic Evolution by J.L. Stebbins (Prentic Hall).

PAPER BT 1.2 - BIOMOLECULES

Course Outcomes:

CO1.Gain knowledge on chemical foundations of biology.
CO2.Understand in detail about carbohydrates and lipids.
CO3.Obtain knowledge about amino acids, proteins and heterocyclic compounds.
CO4.Know the importance of nucleic acids and vitamins.
CO5.Familiarize with hormones and phytohormones.
CO6.Attain an insight in to bioenergetics.

Learning Outcomes:

LO1.Understand the different types of chemical bonds in biomolecules.
LO2.Have an insight on carbohydrates and lipids and their role in biological systems.
LO3.Understand the structure and properties of amino acids, proteins and biosynthesis of heme and chlorophyll.
LO4.Apprehend the types, structure and functions of nucleic acids and vitamins.
LO5.Perceive the importance of hormones, phytohormones and various secondary messengers in signal transduction cascade.
LO6.Comprehend the basic concepts of thermodynamics.

Course Specific Outcomes:

CSO1.Have a thorough knowledge of structure and functions of biomolecules produced by the cells.
CSO2.Develop awareness regarding the structure, classification and sequencing of proteins.
CSO3.Understand the mechanism of action of hormones in the body and phytohormones in cellular activities of plants.
CSO4.Awareness on equilibrium of biochemical reactions, redox reactions and free energy changes in biological reactions.

UNIT-I

Chemical foundations of Biology – pH, pK, acids, bases, buffers, weak bonds and covalent bonds. Classification, structure, properties and biological significance of carbohydrates. Monosaccharides, disaccharides and polysaccharides. Biological role of peptidoglycans, glycosaminoglycans and lectins. Lipids - classification, structure and properties of fatty acids, triglycerides, phospholipids, sphingolipids and cholesterol.

UNIT-II

Amino acids - Classification, structure and physico-chemical properties. Chemical synthesis of peptides. Solid-phase peptide synthesis. Proteins - classification, purification and criteria

of homogeneity. Structural organization, sequence determination and characterization of proteins. Conformation of proteins – Ramachandran plots. Denaturation of proteins. Hetero cyclic compounds – Heme and Chlorophylls.

UNIT-III

Structure and properties of purines, pyrimidines, nucleosides, and nucleotides. Covalent structure of DNA and different forms of DNA - A, B and Z. DNA super coiling. Types of RNA and covalent structure of t-RNA. Classification, structure and physiological roles of vitamins.

UNIT-IV

Hormones - classification and mechanism of action of steroid and protein hormones. Signal transduction cascade by cyclic AMP, phosphoinositate and calcium (Ca^{+}), G-proteins, growth factors and membrane receptor tyrosine kinases. Phytohormones and their physiological roles.

UNIT-V

Bioenergetics - Thermodynamics - basic concepts. First, second and third laws of thermodynamics - enthalpy and entropy, exothermic and endothermic reactions. Free energy - standard free energy. Temperature and pressure dependence of free energy. Equilibrium for biochemical reactions. High energy phosphates and free energy. Redox reactions and free energy changes in biological reactions.

Books suggested:

1.Principles of Biochemistry by A.L. Lehninger, 2 Ed. (Worth).
2.Biochemistry by L. Stryer 4 Ed. (Freeman-Toppan).
3.Text Book of Biochemistry by West et. al. (Mac Millan).
4.Principles of Biochemistry by Smith et. al. (McGraw Hill).
5.Harper's Biochemistry (Langeman).
6.Biochemistry by D.Voet and J.G.Voet (John Wiley).
7.Biochemistry by U. Satyanarayana (Books & Allied (P) Ltd).
8.Clinical Biochemistry and Metabolic Medicine Eighth Edition by Martin Andrew Crook, CRC Press.
9.Textbook of Biochemistry for Medical Students, 7th edition, by D M Vasudevan, Sreekumari S, KannanVaidyanathan (Jaypee).

PAPER BT 1.3 - MICROBIAL PHYSIOLOGY & GENETICS

Course Outcomes:

CO1.Gain knowledge on classification and growth of bacteria
CO2.Introduced to methods of sterilization, pasteurization and disinfection.
CO3.Understand the mechanism of recombination and transposition in prokaryotes.
CO4.Obtain knowledge on general characteristics of different plant and animal viruses.
CO5.Attain an insight in to the biology of clinically important bacteria, viruses and protozoans.
CO6.Familiarize with emerging, re-emerging diseases and biohazards with their safety precautions.

Learning Outcomes:

LO1.Understand the bacterial classification and reproduction.
LO2.Distinguish the physiological and growth aspects of microbes.
LO3.Appreciate the role of the different gene transfer methods in bacterial evolution.
LO4.Understand concepts of various medically important pathogenic microorganisms.
LO5.Interpret the importance of various emerging viruses and vaccines.
LO6.Aware of biohazards and its management.

Course Specific Outcomes:

CSO1.Knowledge of staining techniques to diagnose bacteria and microbiology of water, milk, air, soil and sewage.
CSO2.Knowledge of horizontal gene transfer and its role in acquiring antibiotic resistance in bacteria.
CSO3.Aware of clinically important bacteria, protozoans and viruses including the latest COVID-19.
CSO4.Understand the economic importance of algae and fungi and management of biohazards.

UNIT-I

Bacteriology - Classification and cultivation of bacteria. Bacterial reproduction and growth curve. Preparation of different types of bacteriological media. Staining techniques- Simple staining, spore staining, gram staining. Differences between gram- positive and gram-negative bacteria. Methods of sterilization, pasteurization and disinfection. Microbiology of water, milk, air, soil and sewage.

UNIT-II

Microbial genetics - Recombination in prokaryotes, transformation, conjugation, sex duction. Transduction, specialized transduction. Transposons - Classification of Transposons, retrotransposons and mechanism of transposition. Extra chromosomal inheritance. Structure and types of plasmids.

UNIT – III

Viral genetics - General characteristics of T-Phage, φx174(Phi X). Plant and animal viruses. Simian Virus 40, Tobacco Mosaic Virus. Retroviruses, Human Immuno Virus, Hepatitis B Virus and Viral infections. Multiplication of viruses. Chemical nature and classification of bacteriophages. Parasitic and temperate phages.

UNIT-IV

Emerging and Re-Emerging Diseases - Dengue virus, Zika virus, Ebola virus, Nipah virus, H5N1, H7N9 influenza virus, SARS-CoV-1, MERS-CoV. Coronavirus disease (COVID-19) SARS-CoV-2, COVID-19 Vaccines, Messenger RNA (mRNA) vaccine, Viral Vector COVID-19 Vaccines, Inactivated viral vaccine.

UNIT-V

Biohazards - safety precautions. Microbiology for the Health Sciences. Clinically significant protozoans, bacteria and viruses. Fungal infection after COVID-19, *Mucormycosis* (black fungus). General account of Algae, Molds and Yeasts. Economic importance of algae and fungi. Mendel's experiments. Gene Interaction. Multiple alleles. Sex determination. Linkage and recombination in diploids. Elements of gene mapping. Pedigree analysis.

Books suggested:

1.Textbook of Microbiology by Pleczar and Reid (McGraw Hill).
2.Microbiology by Tortora, Funke and Case.
3.Microbiology by Prescott.
4.Principles of Genetics by Sinnet et.al. (McGraw Hill).
5.Cell and Molecular Biology by E,D.P.DeRobertis. (International edition).
6. Emerging and Re-Emerging Infectious Diseases by Dutta Tarun Kumar (Jaypee Brothers Medical Publishers)

PAPER BT 1.4 - ANALYTICAL TOOLS AND TECHNIQUES IN BIOTECHNOLOGY

Course Outcomes:

CO1.Gain knowledge on basic tools and techniques of biotechnology and its principle and applications.
CO2.Obtain knowledge about microscopy and spectroscopy.
CO3.Know the importance of chromatography and centrifugation.
CO4.Familiarize with radioactivity, electrochemical techniques and electrodes.
CO5.Understand the basics of blotting techniques.
CO6.Attain an insight in to X ray diffraction and Flow cytometry.

Learning Outcomes:

LO1.Understand the different types of light and electron microscopy techniques.
LO2.Able to distinguish the different spectroscopic instruments.
LO3.Understand various techniques of chromatography like TLC, GLC and HPLC.
LO4.Perceive the advantages of electrophoresis and centrifugation.
LO5.Comprehend the techniques used in detection of radioactivity.
LO6.Familiarize with basic concepts on blotting techniques, DNA fingerprinting and X ray diffraction.

Course Specific Outcomes:

CSO1.Have a thorough knowledge on different types of microscopic and spectroscopic techniques.
CSO2.Awareness on concepts of different chromatographic and centrifugation techniques and applications of those techniques in analysis of biomolecules.
CSO3.Distingiush different types of electrophoresis and applications of different kinds of electrodes.
CSO4.Apprehend the significance of different hybridization techniques and DNA finger printing.

UNIT-I

Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Properties of electromagnetic radiations. Principles, instrumentation and applications of UV, Visible, NMR spectroscopy and Mass spectrometry.

UNIT-II

Principles and applications of gel-filtration, ion-exchange and affinity chromatography. TLC, GLC and HPLC. Basic principles of sedimentation. Applications of preparative and analytical ultracentrifuges. Principles and applications of lyophilization.

UNIT-III

General principles of electrophoretic techniques. Poly Acrylamide Gel Electrophoresis. Iso-electric focusing. Isotachophoresis. 2-D Electrophoresis. Capillary electrophoresis. Agarose gel electrophoresis of DNA and RNA.

UNIT-IV

Stable and radioactive isotopes. Detection and measurement of radioactivity. Applications of radioisotopes in biological sciences. Autoradiography. Non-isotopic tracer techniques. Principles and range of electrochemical techniques. Operation of pH electrodes. Principles and applications of ion-selective and gas sensing electrodes. Oxygen electrodes.

UNIT-V

Labelling of nucleic acid probes. Blotting techniques - Southern, Northern and Western. DNA fingerprinting. DNA foot printing. Manometric techniques. X-ray diffraction. Flow cytometry.

Books suggested:

1.Analytical Biochemistry by David J.Holme (Longman).
2.A Biologists guide to Principles and techniques of practical Biochemistry.
Ed.by.B.D.williams (Edward Arnold).
3.Instrumental methods of chemical analysis by G.K.Sharma (Goel).
4.Modern experimental Biochemistry by Rodney Boyer (Pearson Education).
5.Physical Biochemistry by Frefielder (Freeman & Co).
6.Biophysical chemistry principles and techniques by Upadyay, Upadyay and Nath (Himalaya publishing).
7.Instrumental methods of chemical analysis by Chatwal & Anand.
8.Biochemistry. 7th edition, (W.H. Freeman & Co.) New York.

BT 1.5: LAB - I: CELL BIOLOGY AND MICROBIOLOGY

1.Mitosis in onion root tip cells: All phases (Squash method).
2.Meiosis in onion flower buds: All phases including zygotene, diplotene and diakinesis of prophase I (Smear method).
3.Preparation of liquid and solid media for the growth of microorganisms.
4.Slants and Stab cultures, Isolation and maintenance of microorganisms by plating, streaking and serial dilution methods.
5.Simple staining and Gram's staining.
6.Acid fast and spore staining.
7.Microscopic examination of bacteria, yeast and molds.
8.Growth of a microorganism and growth curve.
9.Analysis of water for potability and determination of MPN.
10.Microbiological examination of milk.
11.Oligodynamic action of heavy metals.
12.Evaluation of disinfectants by phenol coefficient method.
13.Examination of external features and reproductive bodies of algae and fungi.
14.Representative species of protozoa.
15.Biochemical tests for characterizing bacteria.

Books suggested:

1.Handbook of Microbiological Media by Atlas R.L.
2.Manual of Clinical Microbiology by Lennettee E.H.
3.Manual of Clinical Microbiology by Murray PR.
4.A Laboratory manual of Microbiology - Microbes in action.

BT 1.6: LAB-II: BIOCHEMICAL ANALYSIS AND TECHNIQUES

1.Separation of amino acids by Paper chromatography.
2.Separation of amino acids/ sugars/ lipids by Thin Layer Chromatography.
3.Ultra violet absorption spectra of Nucleic acids and proteins.
4.Determination of molar extinction coefficient of Tryptophane / Tyrosine.
5.Gel filtration of proteins.
6.Ion exchange chromatography of amino acids.
7.Purification of enzyme by Affinity chromatography.
8.Sub cellular fractionation by differential centrifugation.
9.Determination of Isoelectric point of Glycine.
10.Estimation of Glycine by Formal titration.
11.Estimation of reducing sugars by Benedict's titrimetric method.
12.Estimation of total carbohydrates by Anthrone method.
13.Estimation of proteins by Lowry and Bradford methods.
14.Estimation of Ascorbic acid.
15.Estimation of Cholesterol.

Books suggested:

1.Hawk's physiological chemistry Ed. by Oser (McGraw Hill).
2.Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
3.An introduction to practical biochemistry by D.T.Plummer (McGraw Hill).
4.Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5.Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).

SEMESTER – II

PAPER BT 2.1 - ENZYMOLOGY & METABOLISM

Course Outcomes:

CO1.Gain knowledge on basic enzymology.
CO2.Familiarize with methods of measuring enzyme activity.
CO3.Understand the different metabolic pathways of glucose.
CO4. Know the importance of purines, pyrimidines and their metabolism.
CO5.Knowledge of therapeutic applications of enzymes.
CO6.Appreciate biological role and importance of minerals and trace elements in the human body.

Learning Outcomes:

LO1.To understand the different types of enzymes, enzyme kinetics and enzyme assays.
LO2.Able to distinguish the different mechanisms of enzyme action.
LO3.Comprehend the multiple processes of glucose metabolism.
LO4.Understand the synthesis of fatty acids, ketone bodies and recycling of cholesterol.
LO5.Comprehend the biosynthesis and degradation of amino acids, and nucleotides.
LO6.Apprehend the therapeutic uses of enzymes in clinical analysis and importance of minerals in biological systems.

Course Specific Outcomes:

CSO1.Have a thorough knowledge on different types of enzymes and nomenclature of enzymes.
CSO2.Awareness on importance of enzyme kinetics, assay methods, mechanism of enzyme action and enzyme inhibition studies.
CSO3.Understand the fundamental concepts on various metabolic pathways in biological systems.
CSO4.Familiarize with the clinical significance of enzymes, minerals and trace elements.

UNIT – I

Classification and nomenclature of Enzymes. Enzyme kinetics. Factors- affecting the rates of enzyme catalyzed reactions. Assay of enzyme activity – units of enzyme activity. Multi substrate reactions. Concept of Enzyme – substrate (protein ligand) binding. Methods for measurement of Km. Coenzymes, metalloenzymes, and isoenzymes with examples.

UNIT-II

Active site determination. Mechanism of enzyme action of Chymotrypsin and Trypsin, Carboxy peptidase-A and Ribonuclease A. Multienzyme systems. Covalent modification. Zymogen activation. Enzyme inhibition – Competitive, non-competitive and uncompetitive. Allosteric enzymes, Ribozymes and catalytic antibodies. Synzymes

UNIT – III

Glycolysis, Glycogenolysis, Glycogenesis, Gluconeogenesis, HMP shunt path way and their regulation. Tricarboxylic acid (TCA) cycle. Glyoxylate cycle and its significance. Biosynthesis and oxidation of fatty acids. Metabolism of cholesterol. Ketone bodies. Biosynthesis of Heme and chlorophylls.

UNIT – IV

Protein turnover. General metabolic reactions of amino acids. Urea cycle. Nitrogen fixation. Essential and non-essential amino acids. Biosynthesis and degradation of aromatic and branched chain amino acids. Biosynthesis of purine and pyrimidine nucleotides and their regulation. Catabolism of purines and pyrimidines.

UNIT-V

Clinical enzymology - Enzymes as thrombolytic agents, anti-inflammatory agents, digestive aids. Therapeutic use of asparginase, streptokinase. Minerals - Sources, biological role and clinical significance of calcium, phosphate and magnesium. Trace elements - role of copper, zinc, iron, cobalt, manganese and fluoride in biological systems. Clinical Biochemistry - Diabetes mellitus, pentosuria, galactosemia. Gaucher's disease, Tay-Sach's and Niemann-Pick disease. Phenylketonuria, alkaptonuria, albinism, Lesch-Nyhan syndrome.

Books suggested:

1.Principles of Biochemistry by A.L.Lehninger, 2 Ed. (Worth).
2.Lehninger Principles of Biochemistry by Nelson, D and Cox, D. (Mac Millan Pub.)
3.Biochemistry by L.Stryer 5 Ed. (Freeman-Toppan).
4.Text Book of Biochemistry by West et. al. (Mac Millan).
5.Principles of Biochemistry by Smith et. al. (Mc Graw Hill).
6.Harper's Biochemistry (Langeman).
7.Biochemistry by D.Voet and J.G.Voet (John Weily).
8.Enzymes by Palmer (East).
9.Clinical chemistry: Techniques, Principles, Correlations, 6th Edition, by Bishop, Fody and Schoeff.

PAPER BT 2.2- MOLECULAR BIOLOGY

Course Outcomes:

CO1.Gain knowledge on basic concepts of organization of genetic material and structure of gene.
CO2.Understand the mechanism of replication in prokaryotes and eukaryotes.
CO3.Understand the mechanism of transcription in prokaryotes and eukaryotes and post transcriptional modifications.
CO4.Attain an insight into the mechanism of protein synthesis in prokaryotes and eukaryotes and the significance of post translational modifications.
CO5.Understand the ways by which gene expression is regulated in prokaryotes and eukaryotes.
CO6.Familiarize with the factors responsible for DNA damage and different DNA repair mechanisms.

Learning Outcomes:

LO1.Understand the packing of DNA and genome organization.
LO2.Knowledge of the role of different enzymes involved in DNA replication process.
LO3.Understand the mechanism of transcription and post transcriptional modifications.
LO4.Attain knowledge on the mechanism of translation and protein sorting.
LO5. Knowledge of different ways by which gene expression is regulated.
LO6.Apprehend the types of DNA damage and repair mechanisms.

Course Specific Outcomes:

CSO1.Have a thorough knowledge on organization of genetic material, different types of genes and fine structure of the eukaryotic gene.
CSO2.Awareness regarding mechanisms involved in replication and gene expression in both prokaryotes and eukaryotes.
CSO3.Appreciate the control of gene expression at various levels.
CSO4.Familiarize with the concept of DNA damage and repair and have an idea of mutations.

UNIT – I

Organization of Genetic material - Packing of DNA into chromatin - protein components of chromatin, histones, nucleosome organization. Solenoid loops, domains and scaffolds. Gene amplification, polytene chromosomes. Nuclear genome. C - value paradox. Mitochondrial and plastid genomes. Fine structure of the eukaryotic gene. Different kinds of genes - Split genes, overlapping, assembled, polyprotein and nested genes. DNA replication – enzymes involved and mechanism of replication in prokaryotes and eukaryotes.

UNIT – II

Transcription in prokaryotes and eukaryotes. RNA polymerases, DNA binding domains in transcription factors - zinc finger, leucine zipper, helix-loop-helix and helix turn helix. Mechanism of transcription. Maturation and processing of m-RNA - splicing, 5' end capping and 3' end tailing. Alternative splicing. RNA editing and transport. RNAi and small RNAs.

UNIT – III

Translation in prokaryotes and eukaryotes. Genetic code - properties of the genetic code, deciphering of the genetic code. Ribosome as a translation factory. t - RNA as an adaptor, its mode of function. Post-translational modifications. Protein targeting.

UNIT – IV

Regulation of gene expression in prokaryotes. The operon concept - Lac and Trp operons. Transcriptional control. Translational control. Regulation of gene expression in eukaryotes - Control by promoter, enhancers and silencers. Cis-trans elements. Chromatin structure and gene expression.

UNIT-V

DNA damage – cellular and environmental factors. DNA repair mechanisms - Direct repair, Mismatch repair, Excision repair, SOS repair. Mutations - Chromosomal and gene mutations. DNA methylation and gene expression.

Books suggested:

1.Biochemistry by L.Stryer 5 Ed. (Freeman-Toppan)
2.Genes VIII by B.Lewin (Oxford)
3.Cell and Molecular Biology by E,D.P.DeRoberties (International edition)
4. Molecular Biology by David Frefielder.
5. DNA Science by David Micklos Carolina Publishing Company.
6. Molecular Biology of the Gene by J.D.Watson et al. (Pearson).
7.RNAi-Design and application by Barik, Sailen Eds. (Springer).
8. Small RNAs-Analysis and Regulatory functions by Nellen (Springer).

PAPER BT 2.3- GENETIC ENGINEERING

Course Outcomes:

CO1.Understand the overall concept of r-DNA technology.
CO2.Introduced to different enzymes used in genetic engineering.
CO3.Obtain knowledge on salient features and types of cloning vectors.
CO4.Know the different gene transfer techniques.
CO5.Attain an insight into selection of recombinant cells, PCR and microarray techniques.
CO6.Familiarize with the applications of genetic engineering in various fields

Learning Outcomes:

LO1.Obtain an overview of rDNA technology, isolation and purification of DNA, RNA and plasmid DNA.
LO2.Comprehend the types and usage of specific enzymes in genetic engineering.
LO3.Knowledge on the ability to create and use vectors in r DNA technology.
LO4.Able to differentiate between different gene transfer techniques.
LO5.Understand the screening methods employed in selecting recombinant clones in genetic engineering.
LO6.Apprehend the latest technologies like genome editing and protein engineering.

Course Specific Outcomes:

CSO1.Have a thorough knowledge on the steps involved in gene cloning.
CSO2.Awareness regarding the tools used in genetic engineering.
CSO3.Understand various techniques of gene transfer and selection of rDNA clones.
CSO4.Familiarize with applications of rDNA technology.

UNIT-I

Genetic Engineering Basics - Overview of recombinant DNA technology. Isolation and purification of genomic RNA and Plasmid DNA. Detection and quantification methods of nucleic acids.

UNIT-II

Enzymes used in genetic engineering. Restriction endonucleases - Classification, nomenclature and properties. Restriction mapping. DNA polymerase-I. Polynucleotide kinase. Terminal nucleotide transferase. Reverse transcriptase - structure, mechanism and functions. Alkaline phosphatase. S_1 nuclease. DNA Ligases and ligation of foreign DNA to vectors - cohesive and blunt end methods.

UNIT – III

Vectors - Salient features of cloning vectors. Types of cloning vectors - plasmids, cosmids, phages (lambda and M13 phage vectors), animal (SV40, Baculo) and plant (CMV) viral vectors. Yeast Artificial chromosomes (YACs). Techniques of gene transfer - transformation, transfection, micro-injection, electroporation, silicon carbide fiber method. Liposome mediated Gene transfer (lipofection). Biolistic Transformation (Gene gun method).

UNIT – IV

Selection of Recombinant cells after Gene transfer - Selection of r-DNA clones and their expression. Marker genes and reporter genes. Nucleic Acid Probes. Colony hybridization. Fluorescent in-situ hybridization. Polymerase Chain Reaction and its applications. Real-Time PCR. Reverse Transcription PCR. DNA microarray technology.

UNIT – V

Genome editing technology – CRISPR / Cas9. Applications of genetic engineering in agriculture, animal husbandry, medicine and industry. Protein Engineering - Overview of Protein Engineering. Alterations in protein sequence. Modification Methods of natural enzymes and proteins.

Books suggested:

1.Recombinant DNA technology by Watson et. al.(Scientific American Books).
2.Genes-VIII by Benjamin Lewin (Oxford).
3.Principles of Gene Manipulation by Old and Primrose (Blackwell).
4.DNA Science by David Micklos (Carolina Publishing Company).
5.From genes to clones by Winneker.
6.From genes to genomes concepts and applications of DNA technology by Jeremy W dale and Malcolm von Scrantz, Wiley Black well
7.Molecular Biotechnology by Glick.
8.Genetic Engineering by Sandhya Mitra.
9.Genomes by T.A. Brown.
10. Protein Engineering by Bornscheuer (Springer)

PAPER BT 2.4- BIOLOGY OF IMMUNE SYSTEM

Course Outcomes:

CO1.Gain knowledge on cells and organs of the immune system.
CO2.Obtain knowledge on cell mediated immunity.
CO3.Obtain knowledge on antibody mediated immunity.
CO4.Knowledge of the role of MHC in discrimination of self and non-self.
CO5.Understand various immunological techniques.
CO6.Able to understand hypersensitivity reactions and self-reactivity.

Learning Outcomes:

LO1.Attain fundamental knowledge on the architecture of the immune system.
LO2.Comprehend and articulate the principles of clonal nature of immune response, immunological memory and immune regulation.
LO3.Have knowledge regarding the structure and functions of different classes of MHC.
LO4.Understand the various immunological techniques like RIA, ELISA, FACS and hybridoma technology.
LO5.Recognize how hypersensitivity and allergy derive from "mis-direction" of normal adaptive immune responses.
LO6.Apprehend the immune response in humans against invading microorganisms and tumor immunology.

Course Specific Outcomes:

CSO1.Awareness regarding concepts of immunity, cells and organs of immune system.
CSO2.Have a thorough knowledge on components of immune system and immune response.
CSO3.Distinguish different types of immunological techniques and their application in disease diagnosis.
CSO4.Gain knowledge about autoimmunity and transplantation immunology.

UNIT-I

Types of immunity – innate, acquired, passive and active. Organization and structure of lymphoid organs – bone marrow, thymus, spleen and lymph nodes. Cells of the immune system – B-Lymphocytes, T-Lymphocytes, Monocytes, Macrophages, Neutrophils, Eosinophils, Basophils, NK cells and their effector functions.

UNIT-II

T-cell receptor – structure and function. T cell maturation, activation, and differentiation. Types of cells mediated immunity, effector functions of T_H and T_C cells and lymphokine

activated killer cells. Clonal nature of immune response. Immunological memory. Immunoregulation. Adjuvants and immunological tolerance.

UNIT-III

Components of Immune system - Nature of antigens and antibodies. Structure and function of antibodies. Isotypes, Allotypes and Idiotypes. Antigen – antibody interactions. B-cell development, activation, and generation of antibody diversity. Antigen receptors on B & T lymphocytes. Effector mechanisms of B-cells. Major Histocompatibility Complex (MHC). Human leukocyte antigens (HLA), MHC restriction and typing. Lymphokines, effector cell mechanisms. Complement system.

UNIT-IV

Immunological techniques - ELISA, RIA, Western Blot, Immunoblot and Immunofluorescence techniques. FACS. Hybridoma technology - production and applications of monoclonal antibodies. Antibody engineering, chimeric antibodies.

UNIT-V

Hypersensitivity - Types of hypersensitivity - immediate and delayed hypersensitivity. Autoimmune diseases, transplantation and immunity, immunity to infectious agents. Vaccines and Vaccination, types of vaccines including new generation vaccines. Tumor immunology.

Books suggested:

1.Essentials of Immunology by Roitt (ELBS).
2.Immunology by Roit et.al (Harper Row).
3.Textbook of Immunology by S.T. Barrot (Mosby).
4.Immunology by Kuby (8^{th} edition).
5.Principles of Microbiology and Immunology by Davis et.al (Harper).

BT 2.5 LAB III: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

1.Isolation of RNA from yeast.
2.Estimation of RNA using orcinol reagent.
3.Isolation of DNA from microbial, plant and animal sources.
4.Estimation of DNA using diphenylamine reagent.
5.Isolation of plasmid DNA.
6.Digestion of plasmid DNA with restriction endonucleases.
7.Separation of DNA fragments by Agarose gel electrophoresis.
8.Elution of DNA from agarose gels.
9.Ligation of DNA fragments.
10.Bacterial transformation and identification of transformants.
11.Cloning of green fluorescent protein.
12.Gene expression in bacteria.
13.Amplification of DNA by PCR.
14.Southern blotting technique.
15.RFLP mapping.
16.RAPD mapping

Books suggested:

1.Biotechnology-A laboratory course by Becker J.M.
2.Molecular Cloning-A laboratory manual Vols. 1-3, Sambrook, J.
3.Lab manual in Biochemistry by J.Jayaraman (Wiley Eastern Limited).
4.Biochemistry-A lab course by J.M.Becker (Academic Press).

BT 2.6: LAB: IV- ENZYMOLOGY AND IMMUNOLOGY

1.Assay of Amylase from Saliva.
2.Assay of Trypsin.
3.Assay of Acid-phosphatase from potato.
4.Assay of Lipase from serum.
5.Assay of Catalase from liver.
6.Time course of enzyme activity
7.Effect of pH and determination of optimum pH.
8.Effect of temperature on enzyme activity and calculation of energy of activation.
9.Effect of substrate concentration on enzyme activity and determination of Km.
10.Effect of metal ions on enzyme activity.
11.Determination of A, B, O and Rh blood groups in human beings.
12.Handling of mice and rats, techniques of immunization and bleeding.
13.Dissection and identification of thymus, spleen and lymph nodes.
14.Ouchterloney double diffusion.
15.Radial immunodiffusion.
16.Quantitative precipitin assay.
17.Immunoelectrophoresis.
18.Latex agglutination test.
19.Enzyme Linked Immunosorbent Assay (ELISA).
20.Western blotting.
21.Diagnostic test for typhoid fever by Widal test.

Books suggested:

1.Hawk's physiological chemistry Ed. by Oser (McGraw Hill).
2.Biochemical methods By Sadasivam and Manickam (Wiley Eastern limited).
3.An introduction to practical biochemistry by D.T.Plummer (McGraw Hill).
4.Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5.Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).
6.Immunology methods manual - The comprehensive source book by Lefkovits. I.
7.Manual of clinical laboratory immunology by Rose NR.
8.The experimental foundations of modern immunology by Clark W.R.
9.Laboratory Immunology by Bradshaw LJ.

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SEMESTER – III

PAPER BT 3.1 - CELL CULTURE TECHNOLOGY AND TISSUE ENGINEERING

Course Outcomes:

CO1.Gain knowledge on plant tissue culture media and techniques.
CO2.Familiarize with animal cell culture techniques.
CO3.Obtain knowledge about artificial tissues and organs.
CO4.Familiarize with different types of stem cells, their differentiation and propagation.
CO5.Understanding of applications of stem cells.
CO6.Attain knowledge on neuromorphology, neurophysiology and neurodegenerative diseases.

Learning Outcomes:

LO1.Understand the different types of plant cell culture techniques and their importance.
LO2.Able to distinguish the different mechanisms of mammalian cell culture techniques.
LO3.Understand production of various artificial tissues and organs and their role in transplantation studies.
LO4.Comprehend the importance of stem cells in bone marrow transplantation.
LO5.Apprehend the significance of morphology and physiology of nerve fibers.
LO6.Understand the different kinds of neurodegenerative diseases.

Course Specific Outcomes:

CSO1.Have a thorough knowledge on plant tissue culture technology and their applications in plant research.
CSO2.Understand the concept of animal cell and tissue culture and its utility in generation of artificial tissues and organs.
CSO3.Understand the biology and engineering of stem cells.
CSO4.Familiarize with neuro humoral transmission and neurodegenerative diseases.

UNIT-I

Plant tissue culture technology. Culture media - composition and preparation. Factors governing *in vitro* behavior. Somatic embryogenesis, organogenesis and plant regeneration. Culture types. Micro propagation. Haploids. Somaclonal variations. Metabolite production in cultures. Isolation of protoplasts, protoplast fusion and culture. Somatic hybridization.

UNIT-II

Animal cell and tissue culture - Primary culture, balanced salt solutions and simple growth medium. Serum and protein free defined media. Cell lines, primary and established cell line cultures. Basic techniques of mammalian cell culture in vitro. Tissue and organ culture. Production and use of artificial tissues and organs – Skin, liver and pancreas. Apoptosis - mechanism and significance.

UNIT-III

The biology of stem cells – Different types of stem cells. Embryonic stem cells, fetal tissue stem cells, adult stem cells. Stem cell differentiation. Stem cell plasticity – differentiation versus stem cell renewal. Isolation and propagation of embryonic stem cells. Chimeras. Generation of knockout mice and knock-in technology.

UNIT-IV

Hematopoietic stem cells and bone marrow transplantation - Cells for hematopoietic reconstitution. Cord blood stem cells. Cells for adoptive cellular immunotherapy. Bone marrow transplantation - advantages and disadvantages. Allogenic, autologous, syngenic and congenic transplantation. Clinical applications of stem cell therapy.

UNIT-V

Neuromorphology – Organisation of neuron, dendrites and axons. Glial cells – astrocytes, oligodendrocytes, ependymal cells, schwan cells. Nerve fiber types and functions. Neurophysiology – Excitation and conduction, generation and conduction of action potential, saltatory conduction, ion channels and transport of ions. Synaptic transmission. Neurotransmitters and Neurohormones – chemistry, synthesis, storage and release. Blood Brain CSF barrier – Characteristics and transport systems. Biochemistry of vision. Neurodegenerative diseases – Parkinson's disease, Alzheimers, spinal cord injury and other brain syndromes.

Books suggested:

1.Plant tissue culture – theory and practice by Bhojwani S.S.
2.Plant cell culture – A practical approach by Dixion R.A.
3.Culture of Animal cells by R.I.Freshney. Wiley – Liss.
4.Animal Cell Culture – A Practical approach Ed. by John R.W.Masters (IRL Press).
5.Animal cell culture techniques, Ed. Martin Clynes, Springer.
6.Plant Cell, Tissue and Organ Culture, By Reinert, J. and YPS Bajaj (Springer – Verlag).
7.Plant tissue and cell culture, by Street, HE (Blackwell).
8.Stem cells in regenerative medicine by Audet (Springer).
9.Cell and tissue reaction engineering by Eibl (Springer).

10.A text book of Medical Physiology by Guyton. A.C., H. (Saunders Philadelphia).
11.Introduction to Physiology by Davidson H and Segal M. B. (Academic Press).
12.Review of Medical Physiology-William F.Ganong.
13.Siegel et al., Basic Neurochemistry, 6th Edition, (Lippincott -Williams-Wilkins).
14.Kandel et al., Principles of Neural science, 4th Edition, (McGraw-Hill Medical).
15.Zegmond, Fundamentals of Neuroscience, 1st Edition, (Academic Press).

PAPER BT 3.2- PLANT BIOTECHNOLOGY

Course Outcomes:

CO1.Gain knowledge on basic concepts in different approaches involved in developing transgenic plants for human welfare.
CO2.Introduced to molecular markers and their applications.
CO3.Understand technological ideas in plant science to address disease resistant varieties and organic farming.
CO4.Know the importance of production of transgenic plants for the quality enhancement in crop production.
CO5.Attain insight in to the laboratory culturing and production of micro algae.
CO6.Acquire knowledge on different types of biofertilizers and biopesticides.

Learning Outcomes:

LO1.Perceive the fundamental aspects in plant biotechnology.
LO2.Understand various gene delivery strategies for producing transgenic plants.
LO3.Understand the use of molecular markers in crop improvement.
LO4.Understand the strategies for increasing nutritional value and yield in plants.
LO5.Apprehend transgenic technology for crop yield.
LO6.Gain knowledge on algal biotechnology with culturing of micro and macro algae and understand about concepts of bio fertilizers and bio pesticides.

Course Specific Outcomes:

CSO1.Have a thorough knowledge of plant genetic engineering.
CSO2.Awareness regarding transgenic science in plant improvement.
CSO3.Able to understand agricultural biotechnology.
CSO4.Familiarize with concepts of large-scale biomass production, development of biofertilizers and biopesticides for enhanced crop production.

UNIT-I

Plant Genetic engineering - Overview of Plant Biotechnology. Development of Genetically Engineered plants. Gene cloning techniques. Techniques for gene transfer into plants. Mechanism of gene transfer by tumor-inducing (Ti) and hairy root-inducing (Ri) plasmids as vectors. Regeneration of Transformants. Identification of transgenic plants. Reporter genes and marker genes.

UNIT-II

Transgenic science in plant improvement - Modern Plant Breeding. Molecular markers and their significance. Molecular markers based crop improvement. Quantitative trait loci (QTL)

in plants. Restriction fragment length polymorphism (RFLP). Amplified fragment length polymorphism (AFLP). Molecular mapping and crop improvement. Random amplified polymorphic DNA (RAPD).

UNIT-III

Agricultural Biotechnology - Engineering of herbicide tolerance in plants. Production of disease resistant plants by gene transfer. Development of insect resistant plants. Biotechnological strategies for engineering stress tolerance. Need of organic farming and biotechnological applications of organic farming.

UNIT-IV

Genetic Manipulation - Altering protein and oil quality traits in seeds. Chloroplast transformation – advantages in tobacco and potato. Plants for expression of bacterial, viral and eukaryotic genes. Edible vaccines and plantibodies. The genetic manipulation of crop yield by enhancement of photosynthesis.

UNIT-V

Algal Biotechnology - Laboratory culture of microalgae. Large scale biomass production. Marine macroalgae / seaweeds and their products. Edible seaweeds and their cultivation. Biofertilizers – Blue green algal fertilizers. Azolla, Anabaena and symbiotic association. Seaweed fertilizers. Mycorrhizal biofertilizers. Bacterial fertilizers. Biopesticides in agricultural production.

Books suggested:

1.Plant Biotechnology by A. Slater, N.W. Scott and M.R. Fowler (Oxford University press).
2.Biotechnology in Agriculture by Swaminathan, M.S (Mc. Milllan India Ltd).
3.Biotechnology and its applications to Agriculture, by Copping LG and P.Rodgers (British Crop Projection).
4.Plant Biotechnology, by Kung, S.and C.J.Arntzen (Butterworths).
5.Biotechnology in Sustainable and Organic Farming by A K Yadav S R Chaudhary N C Talukdar (Shree Publisher).

PAPER BT 3.3 - ANIMAL BIOTECHNOLOGY

Course Outcomes:

CO1.Gain knowledge on basic infertility conditions.
CO2.Familiar with methods of advanced techniques like IVF in biological systems.
CO3.Obtain knowledge about transgenesis in animals.
CO4.Know the important ecological sources of aquatic species.
CO5.Understand different methods for improving aquaculture.
CO6.Attain an insight on basic features of development in animals and cell culture assays.

Learning Outcomes:

LO1.Understand the different types and causes of male and female infertility in mammals.
LO2.Emphasize on IVF as a technique in improving livestock.
LO3.Familiarize with the methods of production of transgenic animals
LO4.Perceive the advantages of aquatic biotechnology with the versatile diversity in aquatic animals.
LO5.Comprehend the concepts on culturing of aquatic species.
LO6.Apprehend fundamentals of development biology in animals and cell culture assays used in animal cell cultures.

Course Specific Outcomes:

CSO1.Have a thorough knowledge on different types of infertility conditions and treatment methods available.
CSO2.Awareness regarding concepts of IVF, immunocontraception and biotechnological approaches for the management of pests, mosquitoes and nematodes.
CSO3.Understand the fundamental concept of production of transgenic animals.
CSO4.Familiarize with basic concepts on aquatic biotechnology and medical embryology.

UNIT-I

Types and causes of male and female infertility. Sperm collection. Cryopreservation. Artificial insemination. Oocyte recovery. Superovulation. Oocyte maturation in vitro. In vitro fertilization in humans and cattle. Embryo culture. Embryo transfer in farm animals. Immunocontraception - Hormonal methods. Biotechnological approaches for the management of pests, mosquitoes and nematodes. Live stock improvement.

UNIT-II

Production of transgenic animals - mice, sheep and fish. Molecular pharming and animal cloning. Somatic cell nuclear transfer in humans – Legal and ethical aspects. Potential

applications of transgenic animals. Animal models for diseases and disorders. Transgenic poultry and transgenic insects as bioreactor.

UNIT-III

The concept of Aquatic biotechnology and Blue revolution. Economically important aquatic resources from fresh water, brackish water and marine habitats – the finfish, shellfish, lime fish, algae, corals, and holothurians. Bioactive compounds from corals. Fish by-products. Pearl culture technology – principles and applications.

UNIT-IV

Aquaculture - Fresh water fish culture practices and types. Freshwater prawn culture. Brackish water fish, shrimp and crab culture practices. Fresh water fish hatchery and seed production. Hypophysation and induced breeding techniques. Eyestalk oblation. Techniques involved in transgenic fish production. Post-harvest technology. Diagnosis of shrimp and fish diseases caused by bacterial, fungal and viral pathogens using molecular methods.

UNIT-V

Basic concept of development - Basic features of development in animals. Gametogenesis, types of eggs, fertilization, cleavage, and blastula. Modification of development in evolution. Generation of multicellular embryo, formation of germ layers and patterning of vertebrate body plan. Hormonal regulation of gametogenesis in mammals. Cell culture assays (cell viability and cytotoxicity tests, migration and invasion assays). Applications of animal cell culture in testing of drugs and production of pharmaceutical proteins. Medical embryology and teratology.

Books suggested:

1.Elements of Biotechnology by PK Gupta (Rastogi & Co).
2.Biotechnology by Keshav. T (Wiley Eastern Ltd).
3.Concepts in Biotechnology by Balasubrahmanian (University press).
4.Principles and practices of aquaculture by TVR Pillay.
5.Coastal aquaculture by Santhanam.
6.Fisheries of India by CBL Srivatsava.
7.Molecular Biotechnology by Glick.
8.Developmental Biology by Scott F. Gilbert, (Sinauer Associates, Inc, MA, USA) 10th Edition.

PAPER BT 3.4- MEDICAL AND ENVIRONMENTAL BIOTECHNOLOGY

Course Outcomes:

CO1.Introduced to techniques involved in development of health care products.
CO2.Understanding PCR and its applications.
CO3.Familiar with biotechnological solutions for controlling emerging diseases, genetic diseases and gene therapy.
CO4.Gain knowledge on environmental pollution sources, adverse effects and biotechnological control.
CO5.Obtain knowledge on renewable sources of energy and bioleaching of ores.
CO6.Attain insight in to biotechnological remedies for environmental problems.

Learning Outcomes:

LO1.Apprehend the principles of biotechnological techniques used in the production of health care products.
LO2.Knowledge of PCR technology in disease diagnosis and latest biotechnology solutions for treatment of diseases.
LO3.Understand concepts and applications of biotechnology for control and management of pollution and global environmental problems.
LO4.Understand various methods of recycling of waste and conservation of biodiversity.
LO5.Have an idea of production of biofuels to save the environment.
LO6.Understand the relationship between environmental pollution and human health.

Course Specific Outcomes:

CSO1.Understand biotechnological strategies to combat pandemics and for the human health care products.
CSO2.Insight into biotechnological applications for disease diagnosis and therapy
CSO3.Have a thorough knowledge of global environmental problems and alternate strategies in producing biofuels.
CSO4.Awareness regarding the impact of environmental pollutants on human health.

UNIT-I

Medical Biotechnology - Overview of Medical Biotechnology. Human health care products from recombinant DNA Technology. Insulin, growth hormone, factor VIII, tissue plasminogen activator, interferons, lymphokines, Hepatitis-B vaccine and SARS-CoV-2 vaccine. Current strategies for development of vaccines against HIV, Malaria, Tuberculosis.

UNIT-II

Biotechnological applications for Disease diagnosis. DNA probes. Enzyme probes - glucose

oxidase, lactate oxidase, monoamine oxidase. Polymerase Chain Reaction amplification and diagnosis. PCR applications in forensic medicine. Biotechnological solutions for controlling emerging diseases. Genetic diseases and gene therapy.

UNIT-III

Global environmental problems - Greenhouse effect, global warming, ozone depletion and ultraviolet radiation. Environmental pollution – types, sources and control. Water pollution and removal of oil spills. Solid and liquid (sewage) waste – Treatment and recycling. Recovery of useful compounds/products from waste. Environmental monitoring. Biodiversity - benefits to mankind and its conservation.

UNIT – IV

Environment and energy - Damaging effects of Fossil Fuels. Alternatives Fuels. Types of Renewable sources of energy. Energy production using waste materials and energy crops. Biomass, cellulose and energy production from waste material. Production of energy and fuel using microorganisms – Bioethanol, biogas, and biodiesel. Bioleaching - Microorganisms for the recovery of valuable metals.

UNIT – V

Human Health and Environment - Impact of industrial effluents, chemical herbicides, pesticides, insecticides and fertilizers on human health and environment. Biotechnological remedies for medical and environmental problems. Bioremediation - Phytoremediation, microbial bioremediation and biosurfactants. Importance of urban forestry and greening. Hydroponics, aeroponics and vertical gardening. Healthy lifestyle and sustainable development.

Books suggested:

1.Biotechnology by B.D.Singh (Kalyani).
2.Ecology and Environment by PD Sharma.
3.Fundamentals of Ecology, by Odum, EP (McGraw Hill)
4.Environmental Biotechnology by Forster, C.F. and Wase D.A.J. (Ellis Horwood).
5.Biotechnological innovations in environmental management by Leach, CK and Van Dam Mieras, MCE (Butterworth Heinemann, Oxford (Biotol Series).
6.Molecular Biology and Biotechnology by Meyers, RA, A comprehensive Desk reference (VCH Publishers).
7.Biotechnology by U. Satyanarayana (Books & Allied (P) Ltd).
8. The Environment and Human Health. M Mccally (MIT Press)

BT 3.5: LAB - V: PLANT TISSUE CULTURE TECHNIQUES

1.Preparation of media for plant tissue culture (MS and B5).
2.Establishment of callus cultures from carrot cambial tissue.
3.Establishment of cell cultures and plating.
4.Embryo culture.
5.Organogenesis and regeneration of plants.
6.Another culture and production of haploids.
7.Micropropagation using the suitable system: Potato/*solanum sps.*
8.Isolation of protoplast and culture.
9.Polyethylene glycol (PEG) mediated fusion of protoplasts.
10.*Agrobacterium* culture and transformation.
11.Reporter gene assay (GUS).

Books suggested:

1.Plant cell culture – A practical approach by Dixion RA.
2.Plant tissue culture – theory and practice by Bhojwani, S.S
3.Biotechnology: A laboratory course by Becker, J.M.

BT 3.6: LAB-VI: ANIMAL CELL CULTURE AND ENVIRONMENTAL BIOTECHNOLOGY

1.Preparation of animal cell culture media and membrane filtration.
2.Preparation of single cell suspension from spleen and thymus.
3.MTT assay for cell viability.
4.Demonstration of sections of human ovary, testis and aborted human embryos.
5.Estimation of dissolved oxygen and salinity in water samples.
6.Estimation of Chemical Oxygen Demand (COD).
7.Estimation of Biochemical Oxygen Demand (BOD).
8.Determination of suspended solids in industrial effluents.
9.Removal of color of the industrial effluents by biological methods.
10.Reduction of pollution load in effluents by biological methods (laboratory models).

Books suggested:

1.Animal cell culture – A practical approach Ed. By John R.W. Masters (IRL Press).
2.Animal cell culture techniques, Ed. Martin clyenes (Springer).
3.Comprehensive Biotechnology. Vol. 4.M. Moo-Young (Ed-in-chief), (Pergamon Press) Oxford.
4.Environmental Chemistry. A.K.De, (Wiley Eastern Ltd,) New Delhi.
5.Introduction to Biodeterioration, D.Allsopp and K.J.Seal, ELBS/Edward Arnold.

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SEMESTER – IV

PAPER BT 4.1- HETEROLOGOUS EXPRESSION AND DOWNSTREAM PROCESSING

Course Outcomes:

CO1.Gain knowledge on fundamentals of industrial biotechnology.
CO2.Acquire knowledge on design and types of bioreactors and fermentation process.
CO3.Insight on production of active recombinant proteins of mammalian origin.
CO4.Gain knowledge on different methods of downstream processing.
CO5.Aware of the industrial production of various biotechnological products.
CO6.Familiarize with immobilization of enzymes and biosensors in the field of biotechnology.

Learning Outcomes:

LO1.Emphasize on basic concepts of bioreactors, growth kinetics and significance of different factors influencing microbial growth in fermenter.
LO2.Insight on types of fermentation strategies for the submerged and solid-state fermentations.
LO3.Understand the heterologous expression and GRAS strains in production of recombinant proteins
LO4.Importance of downstream processing in industrial production and processing technology in production of different microbial metabolites.
LO5.Understand various uses of free enzymes and immobilized enzymes involved in industrial biotechnology.
LO6.Understand how to evaluate and apply principles of biosensor technology in various fields.

Course Specific Outcomes:

CSO1.Have a thorough knowledge of types and operation of bioreactors.
CSO2.Awareness regarding production of active recombinant proteins of mammalian / eukaryotic origin.
CSO3.Indepth knowledge of downstream processing.
CSO4.Familiarize with enzyme technology and applications of enzymes in pharmaceutical, food processing and other industries.

UNIT-I

Bioreactors - Types and operation of bioreactors. Introduction to batch, fed-batch and continuous culture systems. Large scale fermentation system. Tandem Airlift reactors. Single stirred tank reactors. Limitations of bioreactors. Stages of fermentation processes. Media design for fermentation processes. Solid substrate fermentation. Advantages and disadvantages of solid substrate and liquid fermentations.

UNIT-II

Heterologous Expression - Expression vectors and hosts. Generally Regarded as Safe (GRAS) organisms. Production of active recombinant proteins of mammalian / eukaryotic origin in prokaryotes. Principles of microbial growth.

UNIT-III

Downstream processing - Harvesting microbial cells – Membrane filtration system, high speed semi continuous centrifugation and disrupting of microbial cells. Gram scale purification of recombinant proteins. Chromatography systems and analytical methods for large scale purification. Stabilization of the proteins.

UNIT-IV

Processing technology - Microbial metabolites - Organic solvents (alcohol, acetone, butanol). Organic acids (citric acid, lactic acid). Wines and beers. Antibiotics (penicillin, streptomycin, tetracycline, semi synthetic penicillins). Vitamins (Vitamin B_{12}, riboflavin). Amino acids (lysine, glutamic acid). Production of single cell proteins.

UNIT-V

Enzyme technology – Sources, production, isolation and purification of enzymes for industrial use. Application of enzymes in pharmaceutical, food processing and other industries. Different techniques of immobilization of enzymes. Applications and kinetics of immobilized enzymes. Design and operation of immobilized enzyme systems and bioreactors. Whole cell immobilization. Biosensors - principle and types.

Books suggested:

1.Biotechnology – Volumes 1 to 5 by Rehem.
2.Industrial Microbiology by LE Casida Jr.
3.Industrial Microbiology by Presscot and Dunn.
4.Biotechnology by BD Singh (Kalyani).
5.Biochemical engineering fundamentals by Bailey and Ollis.

PAPER BT 4.2 - BIOINFORMATICS AND BIOSTATISTICS

Course Outcomes:

CO1.Gain knowledge on basics of computer and its use in biological research.
CO2.Know the importance of internet and its applications in biotechnology research.
CO3.Understand types of biological databases and searching of databases.
CO4.Understand sequence alignment, protein structure prediction and phylogeny studies.
CO5.Obtain knowledge about biostatistics and its application in biological research.
CO6.Familiarize with drug development using tools of bioinformatics.

Learning Outcomes:

LO1.Understand the different types of operating systems.
LO2.Able to distinguish the different applications of internet in biological research.
LO3.Understand various online tools and offline tools and role of databases in bioinformatics.
LO4.Knowledge of the advantages of protein structure prediction and molecular phylogeny.
LO5.Comprehend the uses of biostatistics in data tabulation representation and error calculations.
LO6.Apprehend the significance of bioinformatics approach for drug development by molecular dynamic simulation.

Course Specific Outcomes:

CSO1.Have a thorough knowledge on computers and scope of computers in current biological research.
CSO2.Awareness on concepts of tools and databases of bioinformatics.
CSO3.Understand the fundamental concepts of genome annotation, sequence alignment and protein structure prediction.
CSO4.Familiarize with basic concepts of drug development using bioinformatics tools.

UNIT-I

Scope of computers in current biological research. Basic operations, architecture of computer. Introduction of digital computers. Organization, low level and high level languages. Binary number system. The soft side of the computer – Different operating systems – Windows, Linux. Introduction of programming in C. Introduction to Internet and its applications.

UNIT-II

Introduction to Bioinformatics – Genomics and Proteomics. Bioinformatics – Online tools and offline tools. Biological databases. Types of Data bases – Gen bank, Swiss port, EMBL, NCBI, and PDB. Database searching using BLAST and FASTA.

UNIT-III

Pair wise sequence alignment. Multiple sequence alignment by dynamic programming. Gene and genome annotation – Tools used. Physical map of genomes. Molecular phylogeny - Concept methods of tree construction. Protein secondary structure prediction. Protein 3D structure prediction. Protein docking. Introduction to homology modeling.

UNIT-IV

Brief description and tabulation of data and its graphical representation. Measures of Central tendency - mean, median, mode. Measures of Dispersion - range, standard deviation, variance. Simple linear regression and correlation. Types of errors and level of significance. Tests of significance – F & t tests, chi-square tests, ANOVA.

UNIT-V

Bioinformatics approach for drug development - Identification of potential molecules, chemical compound library preparation, identification of target in pathogen, ligand and protein preparation. Pharmacokinetics and Pharmacodynamics. ADME and toxicity prediction. Molecular dynamic simulation. Pharmacophore development. Quantitative structure activity relationship. 3D-QSAR. Techniques of developing a pharmacophore map covering both ligand based and receptor based approaches. Applications of Computer Aided Drug Design (CADD) in Drug discovery.

Books suggested:

1.Bioinformatics – D.Mount
2.Programming in C by Balaguru Swamy.
3.Introduction to Bioinformatics by Arthur M.Lesk, (Oxford).
4.Biostatistics – Daniel. (Wiley).
5.Statistics by S.C.Gupta.
6.Statistical Methods by G.W.Snedecor & W.G.Cochran.
7.Fundamentals of Biostatistics – Khan & Khanum.
8.Let us C – Kanetkar.
9.Fundamentals of Biostatistics by U.B.Rastogi (Ame Books Ltd).
10.Practical Application of Computer-Aided Drug Design, Ed. Charifson P., Marcel Dekker Inc.
11.3D QSAR in Drug Design: Theory, Methods and Applications, Ed. Kubinyi H., Ledien ESCOM.
12.Pharmaceutical Profiling in Drug Discovery for Lead Selection, Borchardt RT, Kerns EH, Lipinski CA, Thakker DR and Wang B, AAPS Press.

BT 4.3: LAB: VII: INDUSTRIAL BIOTECHNOLOGY AND BIOINFORMATICS

1.Production of protease/amylase by batch fermentation.
2.Immobilization of an enzyme (invertase/lipase/amylase) by gel entrapment.
3.Immobilization of whole cells for enzyme/antibiotic production by gel entrapment.
4.Screening of soil samples for isolation of Bacteria, Fungi and Actinomycetes.
5.Selective isolation of Actinomycetes from soil samples.
6.Microbiological assay of an antibiotic including the construction of standard curve.
7.UV survival curve.
8.Production of alcohol by *S.cerevisiae* and its estimation.
9.Production of citric acid by *A.niger.*
10.Production of red wine from grapes.
11.Searching Data from NCBI Database.
12.Working on EMBL.
13.Searching structural data from PDB.
14.Genome Map viewer from NCBI.
15.Database search using BLAST.
16.Sequence alignments.
17.Sequence and structure visualization.

Books suggested:

1.A manual of Industrial Microbiology and Biotechnology by Demain A.L.
2.Immobilization of enzymes and cells: Methods in Biotechnology vol.1 by Bickerstaff G.F.
3.Principle of fermentation technology by Stanbury.
4.Biotechnology - A laboratory course by Becker J.M.