SYLLABUS OF BIOTECHNOLOGY COURSES OFFERED FOR B SC DEGREE PROGRAM

Semester-I

Course title: Biomolecules and Cell Biology

Semester-II

Course title: Enzymology & Metabolism

Semester-III

Course title: Bio-Techniques and Bio-Statistics

Semester-IV

Course title: Microbiology, Immunology & Animal Cell Science

Semester-V

Course title: Molecular Biology and Genetic Engineering

Semester-VI

Course title: Plant Biotechnology & Bioprocess Engineering

Semester-I

Course title: Biomolecules and Cell Biology

Unit-I

Water and its Physicochemical Properties; Dissociation and Association Constants, pH,Buffers, pI, pKa, Solubility and Criteria for Solubility, Hydrophobicity and Hydrophilicity; Aminoacids: Structure and classification. Importance of non-protein amino acids. Essential amino acids. Dielectric Constant. Laws of Thermodynamics, open and closed systems, isolated system. Gibbs Free Energy, Enthalpy and Entropy with special reference to Biological systems.Structure, Classification, Physical and Chemical Properties of Amino Acids. Peptide bond. Primary structure, Secondary structure, & Ramachandran Plot, Tertiary Structure of Proteins. Forces stabilizing protein structure.

Unit-II

Definition and Properties of Carbohydrates; Structure and Function of Mono, Di and polysaccharides (Glucose, Mannose, Fructose, Galactose, Lactose, Sucrose, Glycogen, Starch and Cellulose); Isomerism of Carbohydrates; Mutarotation; Glycoproteins, Peptidoglycans, Lipopolysaccharides.

Classification of Lipids and Fatty Acids; Structure and Function of Saturated and Unsaturated Fatty Acids, Triglycerides and Cholesterol; Structure & function of Phospholipids, Sphingolipids, Cerbrosides.

Unit-III

Vitamins: Structure and function of water soluble (B1, 2, 6, 12, C) & lipid soluble (A,D, E, K). Hormones: properties and function of Peptide hormones, steroid hormones & Amino-acid derivatives.

Structure of Purines, Pyrimidines, Nucleosides and Nucleotides; Structure of Biologically important Nucleotides and their function (FADH, NADH, NADPH, Co-A).

Unit- IV

Structure of Prokaryotic and Eukaryotic Cells. Structure and Function of: Plasma Membrane, Endoplasmic Reticulum, Mitochondria, Golgi Apparatus, Ribosomes, Lysosomes, Chloroplast. Nucleus: structure of nuclear envelop & nuclear pore. Nucleolus function & composition. Organization of genomic DNA in the Nucleus. Histones & their role in packing of DNA. Nucleosomes as basic unit of eukaryotic chromosome structure.

Practicals

1. Preparation of physiological buffers.
2. Estimation of carbohydrate in given solution by anthrone method.
3. Estimation of sugar in biological samples by Dubois method.
4. Protein estimation by colorimetric method.
5. Chromosome Analysis & Karyotyping

Books Recommended:

1. Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox
2. Biochemistry by Jeremy M. Berg, John L. Tymoczko and Lubert Stryer
3. Cell biology: organelle structure and function by David E. Sadava

Semester-II

Course title: Enzymology & Metabolism

Unit-I

Nature of Enzymes, Holoenzyme, Apoenzyme, Prosthetic Group, Cofactors, Coenzymes, Enzyme Activity, Units of measurement, Nomenclature and Classification of Enzymes, Nature of Active Site. Activation energy, Enzyme Substrate Complex, Enzyme Kinetics, Michealis-Menten Equation, Km, Vmax, Kcat; Factors effecting enzyme reactions, Enzyme inhibition (Competitive, Non- Competitive, Un-competitive).

Unit-II

Carbohydrate Metabolism: Glycolysis, Gluconeogenesis, TCA cycle, Electron Transport Chain, Oxidative Phosphorylation, Pentose Phosphate Pathway, Glyoxylate cycle and their regulation.

Unit-III

Lipid Metabolism, Transport of Fatty Acids across the Mitochondrial Membrane, Beta Oxidation of Saturated, Unsaturated Fatty Acids, Biosynthesis of Fatty Acids and Triglycerides. Prostaglandins and their synthesis.

Unit-IV

Digestion & absorption of protein in Gastrointestinal tract. Transamination and Deamination reactions involved in Amino Acid metabolism, Urea Cycle and its Regulation. Metabolic disorders of Amino Acid Metabolism.

Denovo and salvage pathway of purine and pyrimidine biosynthesis; Degradation of purines and

pyrimidines; Conversion of Ribonucleotide to Deoxyribonucleotide and its Regulation.

Practicals

1. Determination of pKa value of P-nitro phenol and amino acid.
2. Enzyme activity assay: Acid/Alkaline phosphatase.
3. Effect of temperature on enzyme activity.
4. Effect of pH on enzyme activity.
5. Estimation of DNA by DPA method.
6. Estimation of DNA by spectrophotometry.

Books Recommended:

1. Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox
2. Biochemistry by Jeremy M. Berg, John L. Tymoczko and Lubert Stryer
3. Enzymology by T. Devasena
4. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer

Semester-III

Course title: Bio-Techniques and Bio-Statistics

Unit-I

Centrifugation: Principle, theory and Application of Differential and Analytical Centrifugation, Derivation of Sedimentation Coefficient, Density gradient centrifugation. Types of rotors.

Electrophoresis: Principle, Theory Application of Agarose, Poly Acrylamide Gel Electrophoresis (under native and denaturating conditions).

Unit-II

Principles and methodology of: Isoelectric focussing and 2D Gel Electrophoresis, Western, Northern & Southern Blotting, Polymerase chain reaction (PCR),PCR and hybridization based markers (RFLP, RAPD and AFLP). Immunodiffusion, Immmunoelectrophoresis, ELISA, RIA.

Unit-III

Chromatography: Principle, Theory and Application of, Thin layer, Ion Exchange, Gel exclusion, Affinity, HPLC Chromatography; Spectrophotometers: Beer and Lamberts Law and its Applications.

Unit-IV

Sample, Population, sampling techniques. Mean, Median, Mode and their comparison; Frequency Distribution; Standard Deviation, Standard Error of Mean (SEM); p-Value; Student t-Test (Paired and Unpaired); Chi square Test; Graphical Representation of Data (Histogram, Bar Chart, Pie chart, Frequency curve, etc).

Practicals

1. Paper and Thin layer chromatography.
2. SDS-PAGE.
3. Demonstration of Western blotting.
4. Use of excel for calculating: Mean, Mode, Median.
5. Use of excel for drawing, histogram, bar-chart & pie-chart.

Books Recommended

1. Principles and Techniques of practical Biochemistry: Keith Wilson, John Walker
2. Principles and Techniques of Biochemistry and Molecular Biology: Keith Wilson, John Walker.
3. Basic Biostatistics: Bert Gurtsman

Semester-IV

Course title: Microbiology, Immunology & Animal Cell Science

Unit-I

Introduction to bacterial cell: Bacterial Cell wall structure & biosynthesis, structure and functions of outer membrane flagella, cell inclusions.. Introduction to Viruses. Classification of viruses: RNA and DNA viruses, plus & negative stranded, Genome & life cycle of lambda phage. Gene transfer in bacteria: Transformation, Conjugation and Transduction.

Unit-II

Anatomical barrier to infections (mechanical, chemical, biological). Cellular barrier to infection. Phagocytosis & intracellular killing. Respiratory burst & intracellular killing. Mechanism of inflammation, Acute phase proteins. Lymphatic System, Organization and Structure of Lymphoid Organs; Hematopoiesis and Differentiation, Basic concept of cytokines. Toll like receptors. B and T Lymphocytes (TH1 & TH2), Dendritic Cells, Eosinophils, Neutrophils, Mast Cells, Natural Killer.

Unit-III

Mechanism of Humoral and Cell mediated Immune Response. Primary and secondary immune responses. Complement System (pathways) & its Regulation. Nature of Antigens. Structure, types and function of Antibody. Monoclonal antibodies; Antigen-Antibody interaction, Antigen Processing and Presentation; Structure and Function of MHC Molecules.

Unit-IV

Primary and Secondary Cell Line Cultures. Media for cell lines, Suspension & Adherent monolayer cultures, Commonly used Cell Lines; Basic Techniques of Cell culture in vitro, Disaggregation of tissue and primary culture, Maintenance of cell culture. Laminar flood hood, CO2 incubator, asceptic conditions for cell culture.

Practicals:

1. Sterilization techniques for glassware and Plastic ware. Operational use of autoclave and laminar airflow.
2. Media preparation and sterilization.
3. Gram staining
4. Study of microbial growth kinetics.
5. Separation of serum from blood.
6. Blood grouping.

Books Recommended:

1. Immunology by Janis Kuby
2. Immunology: An Introduction by Ian R Tizard
3. General Microbiology: Roger Stanier, Ingraham, Wheelis, Painter
4. Animal Cell Science: by Ian R Freshney

Semester-V

Course title: Molecular Biology and Genetic Engineering

Unit-I

Structure of DNA and its various forms (A, B, Z); Forces stabilizing the DNA Structure. General features of Replication (mode of replication, directionality of replication, primer synthesis). Enzymes and Proteins involved in Replication; Origin of Replication & its organization with examples from prokaryotic & eukaryotic systems. Mechanism of Replication Initiation, Elongation and Termination in Prokaryotes and Eukaryotes. End Replication of Linear DNA & Role of Telomerase.

Unit-II

Transcription, Structure and Function of RNA Polymerase; Basal Transcription machinery, Organization of promoter in prokaryotic & eukaryotic systems. Enhancers and Silencer elements. Transcription initiation, elongation & termination. Operon Concept: Positive and Negative Regulation with reference to lac and trp operons. Post Transcriptional Modifications: Mechanism of RNA splicing, capping and polyadenylation.

Unit-III

Translation: Structural features of eukaryotic and prokaryotic mRNAs. Genetic Code: General features of genetic code. Wobble hypothesis. Basic features of translation machinery: Ribosome, t-RNA, protein factors involved in translation, amino-acyl t-RNA synthetases. Mechanism of translation initiation, elongation and termination (Prokaryotic and eukaryotic).

Unit-IV

Recombinant DNA technology tools: Restriction enzymes, Ligases, Phosphatases, T4 Polynucleotide kinase, DNA Pol I and Klenow fragment. Cloning vectors: General Features of Plasmids, Bacteriophages (lambda & M-13), Cosmids & Phagemids as cloning vectors. Selection marker genes of bacterial vectors & yeast vectors. Blue-white selection. Ethics & Biosafety of DNA recombinant technology.

Practicals:

1. Isolation of genomic DNA and its analysis by agarose gel electrophoresis.
2. Restriction digestion of isolated DNA/plasmid DNA.
3. Quantification of DNA by spectrophotometry.
4. Formation of bacterial competent cells
5. Transformation of plasmid in competent cells

Books Recommended:

1. Genes-XI: Benjamin Lewin
2. Molecular Biology: Robert Weaver
3. Molecular and Cell Biology: John Reece
4. Principles of gene manipulations: Old And Primrose

Semester-VI

Course title: Plant Biotechnology & Bioprocess Engineering

Unit-I

Concept of Plant cell Totipotency. Organization of Root apical meristem and shoot apical meristem. Plant Tissue Culture media composition (M.S media and others) Role of micro, macro nutrients, vitamins & hormones in plant tissue culture; Initiation and maintenance of Callus and Suspension cultures. Shoot Tip Culture; Production and applications of Haploids. Isolation, culture & fusion of Protoplast; Cybrids; Somatic Embryogenesis. Cryopreservation.

Unit-II

Gene Transfer in Plants using Agrobacterium tumefaciens, featutes of Ti plasmid, role of virulent proteins in T-DNA transfer. Concept of Binary vectors. Vectorless Gene Transfer (Gene Gun, whisker method, electroporation, Polyethylene glycol) General Concept of Transgenic Plants, and their utility, Golden Rice, Bt Cotton. Issues with Genetically Modified plants

Unit-III

Kinetics and growth of microbial cells. Methods for measuring cell growth. Concept of Fermentation; Types of fermenters. Batch type Continuous type. Substrate and Product inhibition of Product Biosynthesis, Effect of pH, Temperature and inducers on Product Synthesis; Fermentation Media composition and Sterilization;

Unit-IV

Bioreactors: Design and Types, Agitation and Aeration, Impeller and Sparger. Steps involved in Down Stream Processing; Separation of Cells and Broth, Sedimentation, Filtration, Centrifugation, Solvent extraction, Chromatography: Gel filtration, ion-exchange and Affinity (all the above methods are with special reference to product

recovery in bioprocess technology) Immobilization of enzymes, Industrial Applications of Enzymes.

Practicals:

1. Preparation of plant tissue culture media.
2. Explant culture (embryo/ovary).
3. Protoplast isolation.
4. Immobilization of sheep RBC's in alginate.

Books Recommended:

1. Plant Biotechnology: Slater, Scott and Fowler.
2. Introduction to Plant Biotechnology: H.S. Chawla
3. Principles of Fermentation technology: Stanbury and Whitaker.