UNIT: 1 - CELL–COMPONENTS,GENETICS AND BIOMOLECULES

Molecular organization of prokaryotic and eukaryotic cells. Structure and functions of sub cellular organelles including cytoskeleton. Types of Tissue, Types of adhesion molecules, extracellular matrix, Types of junctions.

Cell cycle and regulations- check points.
Genetics–phenotype, genotype, heterozygous, homozygous, allele (dominant, recessive, wild-type, mutant), character, gene, gene locus, pure line, hybrid. Mendel's laws. Monohybrid cross, multiple alleles, dihybrid cross, test cross, back cross, epistasis. Chromosome structure. Polytene and lamp brush chromosomes. Types of chromosomes, Karyotyping. Variation in chromosome number (euploidy, aneuploidy), arrangement (translocation, inversion), number of segments (deletion, duplication). Population genetics - The Hardy-Weinberg law
Carbohydrates: Sources, Structure, Classification, Properties and Biological roles of Simple sugars, Disaccharides, Homo and Hetero polysaccharides.
Amino Acids and Proteins: Structure, Classification, Properties and Biological roles of amino acids and proteins. Different structural organization of proteins.
Nucleic Acids: Structure, Classification, Properties and Biological roles of DNA and RNA. Chargaff's rule, Watson – crick model, bonds involved in nucleic acid.
Fatty acids and Lipids: Structure, Classification, Properties and Biological roles of Fatty acid and Lipids.
Bioenergetics: Bioenergetics Thermodynamics and biochemical equilibria – laws of thermodynamics, free energy, ΔG–Endergonic and exergonic reactions High energy phosphates. Components of Electron Transport chain, Mechanism of ATP synthesis; Oxidative phosphorylation – the chemiosmotic theory. Uncoupling of oxidative phosphorylation. Inhibitors of respiratory chain and oxidative phosphorylation. Mitochondrial transport systems,
ATP/ADP exchange, malate/glycerol phosphate shuttle.

UNIT : 2 BIOANALYTICAL TECHNIQUES

Concentration Expression: Normality, Molarity, Molality and milliosmol. pH, pOH, Henderson – Hesselbalch equation, buffers, pH of body fluids, Viscosity, surface tension and Donnan membrane equilibrium.
Chromatographic Techniques: Principles and Applications of Paper, Column, TLC, Adsorption, Ion exchanges, Gel filtration, Affinity, Analytical Ultracentrifugation, GLC, HPLC and FPLC.
Electrophoretic Techniques: Principles and Applications of Polyacrylamide gel electrophoresis, SDS-PAGE,

2D–PAGE, Isoelectric focusing, Agarose gel Electrophoresis, pulse field electrophoresis, high voltage electrophoresis, Capillary Electrophoresis, Isotachophoresis, RFLP, FISH. Blotting techniques and its applications.

Spectroscopic and Radio isotope techniques: Colorimetry, spectrophotometry – UV & visible, Principle – Beer & Lambert's law. Principle and applications of AAS and Fluorimetry. Basic principle and application of mass spectra, NMR, ESR, CD, MRI and CT scans and Biochips. Geiger Muller counters, scintillation counting, auto radiography and RIA, Application of isotopes in biological studies. Circular dichroism and XRD.
Microscopy: Principles and application of light, phase contrast, Fluorescence, scanning and Transmission electron microscopy.
Immuno-Molecular techniques: Antibody generation, detection of molecules using ELISA, RIA, Western blot, immuno precipitations. Isolation and purifications of RNA, DNA (Genomic and plasmid) and proteins.
Isolation and separation and analysis of carbohydrates and lipid molecules RLFP, RAPD, AFLP techniques.

UNIT : 3 - ENZYMES AND METABOLIC REGULATION

Nomenclature and properties: Nomenclature and IUB system of enzyme classification. Active site–Fischer and Koshland models. Formation of enzyme substrate complex evidence.
Enzyme kinetics: Kinetics of single substrate enzyme catalysed reaction–Michaelis- Menten (Briggs - Haldane) equation, Double-Reciprocal Plot, Lineweaver Burk plot, Eadie- Hofstee and Hanes-Wolf plots. Determination of Vmax, Km, Kcat, Specificity constant (Kcat/Km) and their significance. Factors influencing enzymatic activity, Arrhenius plot.
Enzyme inhibition: Reversible and Irreversible inhibition–Competitive, Non-competitive and mixed inhibition. Substrate inhibition and Feedback inhibition. Applications of enzyme inhibitors. Mechanism of enzyme
action-Lysozyme, Carboxypeptidase, Chymotrypsin and Ribonuclease.
Co-enzymes: Structure and functions – Pyridine and flavin nucleotides, coenzyme A, Pyridoxal phosphate and thiamine pyrophosphate, tetrahydrofolate and B12 coenzymes. Allosteric Interactions: Enzyme regulation, allosteric enzymes. Enzyme repression and covalent modification of enzymes. Zymogen activation and Isozymes.
Multi enzyme system: Multi functional enzymes. Multi-enzyme complexes (Pyruvate dehydrogenase complex, fatty acid synthase and Na–K ATPase) and Metalloenzymes, abzymes, Immobilised enzymes and their industrial applications. Enzymes–food and pharmaceutical enzymes and Biosensors.
Carbohydrate Metabolism: Pathway, regulation and energetic. Blood glucose homeostasis – role of tissues and hormones.
Amino acid metabolism: Biosynthesis and degradation of amino acids and their regulation. Transamination and Deamination, ammonia formation, Urea cycle and regulation of ureogenesis.
Lipids metabolism: Lipogenesis and regulations. Cholesterol–biosynthesis and regulations. Free Fatty acid and derivatives metabolism and regulations (All types of Oxidations). Ketogenesis and its control.
Lipoprotein metabolism–exogenous and endogenous pathways.

Nucleic acid metabolism: Biosynthesis and catabolism of purines and pyrimidines and their regulation.

UNIT : 4- CLINICAL BIO-CHEMISTRY AND ENDOCRINOLOGY

Biological fluid: Blood, Urine, CSF and Amniotic fluid. Composition and Clinical Diagnostic significance.
Disorders of carbohydrate metabolism: Hyper and Hypoglycemia, Types of Diabetes Millites, Carbohydrate intolerance. Glycogen storage disorders, Pentosuria and galactosemia.
Disorder of protein metabolism: Agammaglobulinemia, Alpha – fetoprotein, Amyloidosis. Cryoglobulinemia. Hypo and hyper gamma – globulinemia. Abnormalities in Nitrogen Metabolism, porphyrias and porphyrinuria.
Disorders of lipids: Plasma lipoproteins, cholesterol, triglycerides & phospholipids in health and disease.
Fatty liver, Hyperlipidemia, hyperlipoproteinemia, Major Cardiovascular diseases – Atherosclerosis and pathogenesis.
Inborn error of metabolic inheritance: Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Leish – Nyhan syndrome, Histidinemia, Gaucher's disease, Tay – sachs and Niemann – Pick disease. Sickle cell anemia and Thalassemia.
Disorders of liver and kidney: Hepatobiliary system–Liver function tests–jaundice–cirrhosis, Drug toxicity, hepatic coma, hepatitis, gallstones, cholecystitis and tumours. Renal function tests–acute and chronic renal failure–clearance tests–urinary calculi, renal hypertension–principles of peritoneal and hemodialysis. Nephritic syndrome.
Disorders of Endocrine system: Endocrine system: Laboratory diagnosis and investigations related to disorders of thyroid, pituitary, adrenal cortex, adrenal medulla, testes, ovaries–assay of hormones related to clinical diagnosis.

UNIT: 5 - MICROBIAL AND PLANT BIOCHEMISTRY

Growth and Staining: Structure of bacteria, fungi and algae. Microbial growth: physical and chemical requirements for growth, culture media, mixed and pure cultures, phases of growth, measurements of microbial growth. Sterilization and Staining techniques.
Soil Microbiology: Different soil microbes. Biogeocycle – carbon, Nitrogen and sulphur cycles.
Aquatic Microbiology: Freshwater microbial flora, effects of pollution, chemical pollution - test for water purity, salinity, BOD, COD, Microbial load. Water treatment–Sewage treatment- primary, secondary treatment – sludge digestion.
Food Microbiology: Microbial spoilage – Fresh food, milk and canned food. Food preservation – temperature, canning, pasteurization and sterilization methods in food industry.
Mycotoxicosis: Mycotoxins of food contaminants like A.flavus, P.rubrum, P.citrinum and A.canidus and stachybotrayacitra.
Photosynthesis: Chloroplast structure and function – CO_2 fixation by C3, C4 and CAM plants. Hill's reaction, Photorespiration, Photophospharylation. Nitrogen metabolism. Trace elements in

plant nutrition. Translocation of Organic and Inorganic substances. Plant pigments–isoprenoids, anthocyanina and secondary metabolites.
Seed Germination and Phytohormones: Germination changes in composition and enzyme activities in seed, factors affecting germination and vernalisation. Structure and functions of plant hormones–Auxins, gibberellins and absicic acid.
Plant pathogens: common plant pathogens of interest of India, portals of entry, transmission of plant pathogen by vector. Plant diseases caused by bacteria, fungi and viruses, Defensive mechanism including resistance to infections.

UNIT : 6 - HUMAN PHYSIOLOGY AND NEUROCHEMISTRY

Homoestasis: water, temperature regulations.
Gastro Intestinal Physiology: Digestive secretions and composition, assimilation of carbohydrate, protein, lipid and nucleic acid.
Circulatory system: Elementary principles of circulation, vasomotor circulation, blood pressure and structure of heart. Cardiac cycle, rhythm, tachycardia. ECG and EEG.
Renal Physiology: Structure of kidney and Nephron. Urine formation and regulations. Renal role in acid base balance, mechanism and regulation of micturition. Normal and abnormal constituents in urine.
Special Senses: vision and hearing.
Structure of Brain, Neuron and spinal cord. Central and peripheral nervous system, neural control of muscle tone and posture. Reflex arc. Sleeping and awakening.
Action potential: Neurotransmitters–examples, release and cycling of neurotransmitters. The neuromuscular junction. The acetylcholine receptor.
Structure of skeletal muscle: Muscle proteins–myosin, actin, troponin and tropomyosin and other proteins. Sequence of events in contraction and relaxation of skeletal muscle. Cardiac and smooth muscle
(Brief account only).

UNIT: 7- IMMUNO MOLECULAR CHEMISTRY

Immunoglobulins: Types of immunity-Innate and Adaptive. Humoral and cell mediated immunity. Central and peripheral lymphoid organs. Antigens, Immunoglobulin classifications. Haptens, adjuvants and abzymes. T and B Lymphocytes and their characterization; mono-clonal antibodies. Type of Immune cells.
Complement pathways: Complement system: components of complement activation and its biological consequences – classical, alternative and lectin pathways. Clonal selection theory. Organization and expression of immunoglobulin genes, generation of antibody diversity. Class switching.
Overview of B cell & T cell, types of immune response, T–cell, B-cell receptors, Antigen recognition – processing and presentation to T- cells. Interaction of T and B cells. Effector mechanisms – macrophage activation. Cell mediated cytotoxicity, Cytokines types, regulation of immune response: immune tolerance and immune suppression.

Major Histocompatibility complex (MHC): MHC genes and products. Polymorphism of MHC genes, role of MHC antigen in immune response, Transplantation types, allograft rejection mechanism. Immune response to Viral, bacterial and protozoal. AIDS, Immuno suppressive therapy, Tumorantigens, Proto-Oncogene and other immuno deficiency disorders. Autoimmunity: Mechanism of induction of organ specific and systemic autoimmune diseases. Hyper sensitivity reactions. Vaccines-Immunisation practices – active and passive immunization, types of vaccines-toxoids, DNA, recombinant, synthetic peptides.

UNIT: 8 - MOLECULAR BIOLOGY AND CELL SIGNALLING

Central dogma of life: DNA as the genetic material, super coiling, hybridization. Hierarchy of Chromatin Organisation, Central Dogma, Unique sequence DNA, Repetitive DNA – SINEs, LINEs, Satellite, Minisatellite and Microsatellite DNAs, C Value Paradox. E.Coli Chromosome and plasmids, Mitochondrial and Chloroplast Genomes. Concept of genes. Structure of Protein-coding genes in prokaryotes and eukaryotes.
DNA Replication: Mode of replication in prokaryotes and eukaryotes. Enzymes involved in replication and regulations of replication.
Repair and Mutation: Type of damages and mutation.
Transcription: prokaryotes and eukaryotes. RNA polymerases – structure and functions. Promoters, transcription factors, initiation, elongation and termination of transcription. Post transcriptional modification of RNA.
Genetic code–specificity, redundancy and wobble hypothesis. Mitochondrial and chloroplast genetic codons.
Translation: Components of protein synthesis – mRNA, rRNA and tRNA. Mechanism of protein synthesis. Regulation and Post translational modifications.
Gene expression and regulation: Gene regulations. Lac, Arb and Trp Operon model. Levels of gene expression. Principles of gene regulation. Genetic and epigenetic gene regulation by DNA methylation. Methylation and gene regulation in mammals and plants.
Cell signaling: Fundamental concepts and general features of cell signalling. Endocrine, paracrine, autocrine and juxtacrine signaling. Types of receptors. Transmembrane, nuclear and cytosolic receptors. G-protein coupled receptors. Second messengers: c-AMP, cGMP, diacylglycerol, inositol triphosphate and Ca2+. Receptor tyrosine kinases–insulin signalling, ras-raf-MAP kinase and JAK-STAT pathways. ATM signalling pathway.

UNIT : 9 -BIOSTATISTICS, ENVIRONMENTAL AND NUTRITIONAL BIOCHEMISTRY

Statistical analysis: Measure of central tendency and dispersal; sampling distribution, probability distribution, level of significance, t-test, analysis of variance; regression and correlation.
Environmental pollution: types, methods for measurement, biosensors to detect environmental pollutants, hazards from wastes and pollutants. Air pollution and its control through biotechnology. Water pollution and control.

Waste water treatment: physical, chemical and biological. Activated sludge–oxidation ditches and ponds, trickling filter, towers, rotating discs and drums. Anaerobic processes: anaerobic digestion and filters. Effluent treatment, B.O.D and C.O.D

Effluent treatment: Bioremediation, oil spill cleanup. Microbial mining. Biofertilizers bacteria, and blue green algae. Biopesticides in integrated pest management- Bacillus and Pseudomonas as biocontrol agents.

Single cell protein: microorganisms and steps in SCP production, biomass recovery, nutritional and safety evaluation, advantages.

Nutritional Biochemistry: Definition of BMR, SDA, Factors affecting BMR. Regulation of body temperature. Total energy requirement, estimation of energy requirement, energy value of food. Requirements of Carbohydrates and Lipids. Special aspects of Nutrition during pregnancy and lactation.

Protein energy malnutrition: clinical features, metabolic disorders and management of marasmus and kwashiorkor diseases: Basic food groups-Energy yielding, Body building, protective foods. Food production, Food storage, Functional foods, New protein and Fat foods, Changing food habits, Food adulteration and hygiene.

Improvement of protein quality by supplementation and fortification. Nitrogen balance–positive and negative.

Micro and macro mineral nutrients: Distribution sources, metabolic functions and deficiency manifestations – Calcium, Phosphorus, Sodium, Potassium, Iron, Copper, Selenium and Zinc. Role of Vitamin as Antioxidant. Special needs of Infants, children, adolescents, pregnant and lactating women, convalescents and old persons.

UNIT :10

BIOTECHNOLOGY AND GENETIC ENGINEERING

Bioprocess engineering: Isolation and screening of industrially important microbes. Maintenance and improvement of strains. Bioreactors–types, design, parts and their function. Media for industrial fermentation, air and media sterilization. Antifoaming devices.

Types of fermentation processes: Analysis of batch, fed-batch and continuous bioreactions, analysis of mixed microbial population, specialized bioreactors (pulsed, fluidized, photobioreactors).

Downstream processing: solid-liquid separation, release of intracellular compartments, concentration of biological products, purification, preservation and stabilization, product formulation. Monitoring.

Bioreactors: DNA fingerprinting and foot printing with its applications. Bacterial leaching and biomining. Bioreactors–Design and types of fermentors, batch and continuous bioreactors. Downstream processing.

Bioethics–Ethical issues in production of genetically engineered foods and transgenic plants and animals.

Immuno supressive therapy. Tumor antigens. Proto - Oncogene.

Vectors: Restriction enzymes and their types, DNA ligases, Alkaline phosphatase. Plasmids–pBR322 and pUC, Phage vectors–λ and M13, Cosmids and High capacity cloning vectors–YAC, PAC and BAC. Shuttle vectors. Genomic DNA library, cDNA synthesis and cloning, Chromosome walking.

Gene transfer methods (All methods): in plants and animals. Anti-sense RNA technology and applications.

PCR technology. Animal cell culture – Methods and Applications. Gene therapy. Principles and applications of stem-cell technology. Production of Insulin, Vaccines, Antibodies, Interferons and Somatostatin.

Industrial biotechnology: Industrial production of ethanol, lactic acid, butanol, penicillin and phenylalanine. Commercial production of fructose. Solvents, organic acids, amino acids and vitamins. Introduction to
synthetic biology.