U. P. HIGHER EDUCATION SERVICES COMMISSION, PRAYAGRAJ

Syllabus

BIO-CHEMISTRY

(Subject Code-74)

UNIT-1 : Macromolecules

Carbohydrates: Classification, structure, properties, and biological importance; homopolysaccharides, glycolipids, proteoglycans, mucopolysaccharides, peptidoglycans, hemicelluloses, lignins.

Lipids: Structure, properties, classification, function and biological importance; Storage lipids; Structural lipids in membranes; Phosphoglycerides, Plasmalogens, (Lecithins, PE, PS, Phosphatidyl Inositols), Splingomyelins, Ceramides, Glycolipids, Prostaglandins; Lipids as signals, cofactors and pigments; Isoprenoids and sterols.

Proteins: Classification and functional diversity of proteins; Amino acids: classification and properties; Overview of Protein structure: Primary, Secondary, Tertiary and Quaternary structures; Protein denaturation. Sequencing, Protein folding; Heat shock proteins; Structure-function relationship: Hair, Silk, Prions.

Nucleic acids:. Structure of nucleotides and formation of polynucleotide chain; Structure and function of DNA and RNA; Watson Crick model of DNA; Various forms of DNA; Nucleic acid chemistry; Cofactor functions of nucleotides.

Vitamins, Hormones and Polyphenols: Chemical nature, active form, and analogues; Classification, structure and biological activity.

UNIT-2 : Enzymology

Enzyme Classification & Chemistry: Systemic Nomenclature; Sub-cellular distribution of Enzymes; Isolation and Purification of Enzymes; Enzyme homogeneity; General Properties; Enzyme Activity; Specific Activity and Turnover Number; Marker Enzymes.

Enzyme Kinetics: Enzyme-Substrate Interaction, ES Complex, Binding Site, Active Site. Specificity, Steady-State, Pre-Steady State and Equilibrium-State Kinetics, Michaelis- Menten equation and its derivation, Graphical Methods for determination of K_m & V_{max} and its significance; Factors affecting Initial rate of Enzyme-catalyzed reaction.

Enzyme Action, Inhibition & Regulation: Stereochemistry of enzyme substrate action, factors associated with catalytic efficiency; Types of inhibition; Competitive non-competitive and Uncompetitive inhibitors, Determination of K_i, Suicide Inhibitors; Allosteric enzymes, Proenzymes-Zymogens and activation.

Structure and Function of Selected Enzymes: Active-site mapping; Chymotrypsin; Glyceraldehyde-3P- Dehydrogenase; Serine and Cysteine Proteases.

Enzyme engineering & Immobilized Enzymes: Ribozymes, Abzymes; Immobilization methods, Kinetics, Industrial applications.

UNIT-3 : Bioanalytical Tools and Techniques

Chromatography techniques: Paper chromatography, thin layer chromatography, column chromatography, gel filtration, ion exchange chromatography, affinity chromatography, gas

Chromatography, HPLC, Centrifugation: Concept of centrifugation, sedimentation coefficient, differential and density gradient centrifugation.

Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, NMR, X- ray Spectroscopy, ORD and Circular

dichorism, LASER.

Electrophoretic Techniques: Agarose gel electrophoresis, SDS polyacrylamide electrophoresis, Isoelectric focusing, pulse field gel electrophoresis, two-dimensional electrophoresis, Radioisotope Techniques, Autoradiography.

Microscopic techniques: Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy, electron cryomicroscopy, scanning tunneling microscopy, cytophotometry and flow cytometry.

Statistical analysis of biological data: mean, median, mode, Standard deviation, variance,

ANOVA, test of significance, Chi-square test, student's T-test. Introduction to commercial

computers: internet application, softwares and databases and their uses in biological studies. Biological Databases, Search and analysis.

UNIT-4 : Intermediary Metabolism

Carbohydrate metabolism: An overview of aerobic and anaerobic carbohydrate metabolism; Glycolysis and the catabolism of hexoses; Feeder pathways and Regulation; Pentose phosphate pathway; Utilization of glycogen; Citric Acid cycle; Anaplerosis, Regulation; The glyoxylate cycle. Carbohydrate biosynthesis; Gluconeogenesis; Glycogen synthesis; Glycogen storage diseases; Glucoronic acid pathway; Electron transport chain and formation of ATP and Regulation; Inhibitors and uncouplers of ETC.

Protein Metabolism: Metabolic fate of amino groups; Transamination, deamination and decarboxylation; Essential and non-essential amino acids; Nitrogen excretion and the urea cycle; Pathways of amino acid degradation; One carbon transfers, role of tetrahydrofolate and S- adenosyl methionine; Biosynthesis of amino acids and compounds derived from amino acids; Inborn errors of metabolism.

Photosynthesis: Light and dark reactions; Electron flow; ATP synthesis by photophosphorylation; Biosynthesis of starch and oligosaccharides; Nucleic acid metabolism: Biosynthesis and degradation of nucleic acid compounds.

Lipid metabolism: Introduction to Lipids as energy sources; β oxidation; Oxidation of unsaturated and odd chain fatty acids; Ketone bodies; Biosynthesis of: Fatty acids; Triacyl glycerols; Membrane phospholipids; Cholesterol, steroids and isoprenoids; Membrane Phosphoinositides; Ceremides.

UNIT-5 : Biological Membrane and Cellular Transport

Biomembrane and cell architecture: Lipid bilayer and membrane assembly, membrane carbohydrates, phospholipids and asymmetric organization; GPI-anchored protein and their dynamism, membrane transport of small molecules; Membrane transport of macromolecules, exocytosis, endocytosis (Fluid phase, receptor mediated) and transcytosis, ATP.

Biological membranes: Modification of lipid fluidity by membranes proteins; Arrangement of proteins within lipid bilayer; Hydropathy plots and prediction of membrane spanning domains; Organization of chloroplast and mitochondrial membrane system.

Techniques to study Biomembranes: Freeze-fracture technique, FRAP, FRET, Detergents, Solubilization, purification and reconstitution of membrane protein system.

Membrane transport: Channels, transporters and pumps. Active and passive transport, P and F type pumps and ABC transporters, Ion channels and electrical properties of membranes, Voltage, ligand and mechanically gated channels; Use of patch clamping to study ion channel activity.

Intracellular vesicular trafficking: Import of proteins into E.R. and processing in the E.R. and Golgi; Mechanism of vesicle formation and fusion; Import of relevant nuclear coded proteins; Import of proteins into chloroplast and mitochondria.

UNIT-6 : Physiology and Clinical Biochemistry

Blood: Composition of blood. Erythrocytes: Properties. Functions Hemopoiesis; Hemoglobin: structure and function; Anemias, Homeostasis and blood coagulation; Blood group substances, transfusion; Tissue transplant: Role of HLA typing.

Regulation of acid-base balance: Role of buffers in blood, respiratory control, renal controls; Transport and exchange of respiratory gases; Carbon Dioxide dissociation curve; Bohr's effect; Haldane effect.

Digestion and absorption and urine formation: Digestion and absorption of carbohydrates, fats, proteins, vitamins and minerals; Endocrine control of digestive and absorptive processes; Glomerular and tubular function; Mechanisms controlling of urine composition.

Nerve-impulse transmission system and Visual Cycle: Sensory and motor nerves, major levels of nervous system function, Central and autonomic nervous systems. Generation of nerve impulse: Membrane potentials, action potentials, transmission of nerve impulse, synapse, neurotransmitters; visual cycle.

Biochemical Assessment of health and diagnostic enzymes : Analytes in blood, urine, tissues; Overview of non-invasive techniques, their limitations and interpretation; Complete Blood Count: Hemoglobin, hematocrit, total and differential leukocyte count, microscopy of erythrocytes; Plasma proteins; Glucose tolerance test; Renal function tests; Liver function tests. Acid phosphatase, Alkaline phosphatase, Amylase, Angiotensin converting enzyme, cholinesterase, creatine phosphokinase, gamma glutamyltransferase, lactate dehydrogenase, rennin.

UNIT-7 : Molecular Cell Biology

General structure of Cell, Historical origins of cell biology: The discovery of cell, development of the cell theory, the molecular evolution, Intercellular communication-Gap junctions, tight junction and Desmosomes.

Structure of prokaryotic and eukaryotic cells: Isolation and growth of cells, Cellular organelles: Plasma membrane, cell wall, cytoskeleton, their structural organization, mitochondria, chloroplast, nucleus and other organelles and their organization, genetic constitution of mitochondria and chloroplast, lysosome, membrane models.

Cellular basis of differentiation and development: Cell division, gametogenesis and fertilization, differential gene activity and cell differentiation, morphogenetic determinants in egg cytoplasm and programmed cell death- apoptosis, Heterocyclic compounds and secondary metabolites in living system: Nucleotides, pigments, isoprenoids.

Cell cycle: Molecular events and regulation in model systems, Genes for social control of cell, Cellular responses to environmental signals in bacteria, plants and animals: Mechanism of signal transduction, Exocrine, Endocrine, Paracrine and Synaptic strategies of chemical signaling, surface receptor mediated transduction (DAG, Ca+2, c-AMP, G-Proteins), intracellular protein traffic, secretory and endocytic pathway.

Molecular biology and biochemistry of cancer, oncogenes, mutation, chemical carcinogenesis, viral and cellular oncogenes, tumor suppressor genes from humans, structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Antisense and Ribozyme Technology and their applications: Molecular mechanism of antisense molecules, inhibition of splicing and translation, disruption of RNA structure, biochemistry of ribozyme, hammer head, hairpin ribozymes, strategies for designing ribozymes.

UNIT-8 : Molecular Biology and Recombinant DNA Technology

DNA replication: Prokaryotic and eukaryotic DNA replication, mechanisms of DNA replication, enzymes and accessory proteins involved in DNA replication, DNA repair

and recombination, Homologous Recombination: Holliday junction, FLP/FRT and Cre/Lox recombination, RecA and other recombinases.

Transcription: Prokaryotic and eukaryotic transcription, RNA polymerase, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, transcriptional and post transcriptional gene silencing, Modifications in RNA: 5'- Cap formation, Transcription termination, 3'end processing and polyadenylation, splicing, editing, nuclear export of mRNA, mRNA stability.

Translation: Prokaryotic and eukaryotic translation, the translation machinery, mechanisms of initiation, elongation and termination, regulation of translation, co- and post-translational modifications of proteins. Protein localization: Synthesis of secretory and membrane proteins, import into nucleus, mitochondria, chloroplast, receptor mediated endocytosis.

Molecular mapping of Genome: Genetic and physical maps, simple sequence repeat loci, Southern and FISH for genome analysis. Molecular markers in genome analysis: RFLP, RAPD analysis, molecular markers linked to disease resistance genes, application of RFLP in forensic, disease prognosis. Metagenomics, Proteomics and Phenomics.

Recombinant DNA Technology: DNA methylation, restriction endonucleases , Class I, II and III, nomenclature, general properties, mode of action; Vectors and Cloning Strategies: plasmids, plasmid based vectors, lambda based vectors, cosmids, phagemids, YAC, expression vectors, chemical synthesis of DNA, DNA libraries; Molecular Techniques: Nucleic acid sequencing, blotting, polymerase chain reactions, gene transfer techniques, in vitro mutagenesis, HRT, HART, DNA footprinting; DNA fingerprinting.

UNIT-9 : Immunology and Microbiology

Introduction of cells and organs of immunity; basic concept of innate and acquired immunity, host specialization, granulocytes (neutrophils, eosinophils,basophils) and their functions. Antigens, immunogens and heptane, structure and classification of antibody, isotypes, allotypes, idiotypes.

Comparison of receptors on T and B lymphocytes, CD markers. Concept of Histocompitability: Major histocompitability complex (MHC), MHC restriction for CD4 and CD8 subset of T cells. Role of MHC complex and transplantation, Generation of diversity in immune response: clonal selection theory, the gene encoding antigen specific receptors on T and B lymphocytes immunoglobulin genes, Activation of T and B cells by antigen, antigen processing and presentation.

The complement system; biological role of complement system, components of classical and alternative pathways, mechanism of NK cell mediated cytotoxicity, Inflammation, its physiological basis and relevance. General properties of cytokines and interferons and their applications.

Allergey and hypersensitivity, autoimmunity, autoimmune diseases, Vaccines: preparation and delivery system, immunoadjuvants, Raising of antisera and monoclonal antibodies.

Measurement of antigen and antibody interactions: direct binding assay, agglutination and precipitation reactions in gels; immunoelectrophoresis, immunoprecipitation, RIA & ELISA, biotin-avidin based immunoassay, immunofluorescence assay (IFA); immunohistochemistry, immunoblotting.

Morphology and Structure of bacteria, gram positive and gram negative organisms; gram staining; Nutritional requirements and growth characteristics of bacteria, media for growing bacteria; Bacterial toxins; Cell cycle and Cell death; General structure, properties and classification of viruses; Virions, prions, lytic cycle, lysogeny, Types of toxins: Exotoxins, endotoxins, enterotoxins, their structure and mode of action; Antimicrobial agents, sulfa drugs, penicillins and cephalosporins, antibiotics, resistance to antibiotics.

UNIT-10 : Nutritional Biochemistry & Toxicology

Nutrients in maintenance of Health: Fuels: Carbohydrates, Protein and Fat. Energy requirements. Accessory nutrients: Vitamins (Vitamins A, D, E, K) Thiamine, Riboflavin, Niacin, pyridoxamine, folic acid, cobalamine etc., ascorbic acid; Minerals (Calcium, iron, magnesium, iodine, fluorine, trace elements); Requirements, Sources, Sub-clinical and clinical deficiencies. Recommended Dietary allowances: Statistical basis, Problems, Measurement of nutrient intakes, anthropometry, clinical assessment.

Nutrigenomics: Nutrient-disease interactions. Brief overview of Genomics; Transcriptomics, Proteomics, Metabolomics; Interplay between diet and gene expression: Role of SNPs, HapMaps. Role of folate in polymorphism; Role of nutrients as transcription factors (fatty acids, retinoids); Nutrient-gene-environment interactions on the metabolome; Role of epigenetics in nutrigenomics; Systems Biology and the dietary signature; Concept, interpretation and limitations.

Toxicology: Toxicants, therapeutic dose, dose-response curve, multiple toxicants response, serum enzymes behavior, hepatic and non-hepatic enzyme change during toxicity; Xenobiotic metabolism: Toxicants entry and fate in living system, absorption, distribution, excretion and detoxification, phase I and phase II reactions and their interrelationships;

Toxicity testing: Basic principles and test protocols.

Food Toxicology: Toxicology of food additives, animal and plant toxins, heavy metals.