TAMIL NADU PUBLIC SERVICE COMMISSION

SYLLABUS

Biochemistry
(PG Degree Standard)

CODE: 460

UNIT I: PROTEINS

Proteins - Classification based on solubility, nutrition & functions. Protein structure - Primary, secondary (helix and pleated sheet), tertiary and quaternary structures of protein. Amino acids - Structure & classification. Essential and non-essential amino acids. Peptides: structure of peptide bond. Denaturation and renaturation of proteins.

Biosynthesis of nonessential amino acids. Catabolism of amino acid nitrogen-transamination, deamination, ammonia formation and the urea cycle. Catabolism of carbon skeletons of amino acids. Conversion of amino acids to special products. Disorders of amino acid metabolism - phenylketonuria, alkaptonuria, albinism, and maple syrup urine disease. Biosynthesis and degradation of porphyrins and heme. Porphyrias.

Major milk proteins: caseins (acids and micellar), physico-chemical properties, casein micelle models. Alpha-Lactalbumin and beta-lactoglobulin, lactoferrin, bovine serum albumin.

UNIT II: LIPIDS

Fatty acids - saturated, unsaturated and hydroxy fatty acids. Phospholipids and glycosphingolipids - structure and biological functions. Steroids - animal sterols. Structure, properties and functions of cholesterol. Lipoproteins - classification and composition. Amphipathic lipids (membranes, micelles, emulsions and liposomes).

Oxidation of fatty acids - role of carnitine in fatty acid transport, α, β and ω-oxidation. Metabolism of ketone bodies. Biosynthesis of fatty acids - Fatty acid synthase complex - regulation of lipogenesis. Metabolism of triglycerides, phospholipids and sphingolipids. Cholesterol - biosynthesis, regulation, transport and excretion. Metabolism of lipoproteins and

lipoproteinemias. Metabolism of prostaglandins - COX and LOX pathways. Lipid storage diseases and fatty liver.

Milk lipids: classification and physical properties. Auto-oxidation, secondary products of auto oxidation, factors affecting, prevention and measurement; Antioxidants – enzymatic and non-enzymatic antioxidants.

UNIT III: CARBOHYDRATES, MINERALS AND VITAMINS

Carbohydrates: classification and characteristics of different carbohydrates. Cellulose, glycogen, hemicellulose and pectin. Production of dextrans and malto dextran. Aldoses and ketoses. Epimers. Lactose: occurrence, isomers, molecular structure. Milk oligosaccharides, structural, technological aspects and health promoting aspects.

Overview of glycolysis and gluconeogenesis- Regulation. The citric acid cycle and regulation. The pentose phosphate pathway and uronic acid pathway. Metabolism of glycogen and regulation. Glycogen storage diseases. Galactosemia. Fructose intolerance and fructosuria.The glyoxylate cycle.Cori cycle. Photosynthesis- light reaction, cyclic and noncyclic photophosphorylation. Dark reaction- Calvin cycle.

Minerals: major and minor minerals. Water soluble vitamins: thiamin; riboflavin; niacin; pantothenic acid; pyridoxine; biotin; folacin and cynocobalamin. Fat soluble vitamins - Vitamin A and D.

UNIT IV: ENZYMES

Enzymes - Classification and general characteristics. Effect of pH, temperature and substrate concentration. Enzyme inhibition – Effect of competitive, uncompetitive and non-competitive inhibitors. Coenzymes and cofactors. Regulation of enzymes – feed back inhibition and covalent modification. Abzymes, ribozymes, DNA enzymes.

Immobilized enzymes- methods of immobilization, applications. Enzyme Engineering with reference to T4 lysozyme. Enzyme electrode. Industrial and

Clinical Enzymology: Enzymes of industrial and clinical significance, sources and applications of amylases, protease and lipases. Therapeutic use of asparginase. Streptokinase. Enzymes and isoenzymes of diagnostic importance. LD, CK, transaminases, phosphatases and amylase. Enzyme patterns in diseases - liver disease and myocardial infarction. Indigenous milk enzymes:

UNIT V: BIOENERGETICS, BIOLOGICAL OXIDATION & APOPTOSIS

Free energy and entropy, endergonic and exergonic reactions Phosphoryl group transfers and ATP. Enzymes involved in redox reactions. The electron transport chain - organization of respiratory chain complexes and electron flow. Oxidative phosphorylation - electron transfer reactions in mitochondria. F1F0 ATPase - structure and mechanism of action. The chemiosmotic theory.Inhibitors of respiratory chain and oxidative phosphorylation - poisons, uncouplers and ionophores. Regulation of oxidative phosphorylation. Mitochondrial transport systems - ATP/ADP exchange, malate/glycerophosphate shuttle, creatine phosphate shuttle. Mitochondrial membrane potential, Apoptotic cell death – Intrinsic and extrinsic signal transduction pathways, ferroptosis and necrosis. Cell cycle analysis, cell survival metabolic assays.

UNIT VI: CELLULAR BIOCHEMISTRY

The cytoskeleton - microtubules, microfilaments and intermediate filaments. Types of tissues. Major classes of cell junctions - anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs) - cadherins, integrins. Composition of membranes - the lipid bilayer, peripheral and integral proteins. Endocytosis and exocytosis. Membrane transport: types. Diffusion - passive and facilitated. Active transport - primary and secondary. The P-type ATPases, F-type ATPases, ionophores, aquaporins, ion channels. Stem cells: types, isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues. Animal cell culture: Primary cell culture: disaggregation, separation of viable cells. Secondary culture maintenance of cell lines. Cancer cell lines. 3D culture. Scaffold preparation and organogenesis. Large - scale cell cultures. Commercial applications of animal tissue culture.

Fundamental concepts and general features of cell 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 pathways. Antisense RNA and RNA interference. Epigenetic gene regulation: DNA methylation, histone acetylation and deacetylation.

UNIT VII: IMMUNOTECHNOLOGY

Antigens and Antibodies Central and peripheral lymphoid organs. antigenicity, antigenic determinants, haptens and epitopes. Antibodies - structure, classification, functions. Types of immunity - innate and acquired immunity, Antigen recognition - T-cell and B-cell receptor complexes, antigen processing and presentation. Interaction of T and B-cells. Immunological memory, Effector mechanisms: phagocytosis, cell mediated cytotoxicity, antibody dependent cell mediated cytotoxicity. Vaccines-killed, attenuated organisms, toxoids, recombinant vaccines, subunit vaccines, DNA vaccines, synthetic peptide vaccines, antiidiotypic vaccines. Antibody diversity - mechanisms contributing to diversity- somatic recombination, rearrangement and generation of antibody diversity. Class switching. MHC complex- gene organisation - HLA genes class I and II antigens. Histocompatibility testing, cross matching. MHC & disease association. Transplantation-types - Graft versus host reactions. Immunosuppressive agents. Hypersensitivity - definition and classification - type I to type V (brief account only). AIDS- pathogenesis, diagnosis and treatment. Tumor immunology - immune surveillance, tumor antigens, immune response to tumors, cancer immunotherapy.

UNIT VIII: MOLECULAR BIOLOGY

The central dogma of molecular biology. Eukaryotic chromatin: nucleosomes, 30 nm fiber and higher order chromatin structure. Enzymes and proteins involved in replication: helicases, SSB, topoisomerases, DNA polymerases, DNA ligase. DNA replication in bacteria and eukaryotes. Inhibitors of replication. DNA damage by physical and chemical agents. DNA repair - photoreactivation, excision repair, mismatch repair, double strand break repair. Molecular biology of homologous recombination. Transposons:

mechanism of transposition and applications. RNA polymerase subunit structure, promoter sequence steps in transcription - template recognition, initiation, elongation and termination (intrinsic, rho-dependent). Transcription in eukaryotes: RNA pol I, II and III: subunit structure, transcription factors, promoters, inhibitors. Mechanism of RNA pol II transcription: preinitiation complex formation, transcription initiation (activator proteins, mediator, chromatin recruitment), elongation, termination. Classes of introns. Post-transcriptional processing of prokaryotic and eukaryotic rRNA, and tRNA. and eukaryotic mRNA. Brief account of ribozymes, RNA editing and Reverse transcription. point mutations and frameshift mutations. Suppressor mutations - nonsense and missense suppression. Mechanism of protein synthesis in bacteria and eukaryotes: amino acid activation, initiation, elongation and termination. Inhibitors of protein synthesis.

UNIT IX: BIOCHEMICAL TECHNIQUES

Absorption spectrum. Principle, instrumentation and applications of UV-visible spectrophotometry, spectrofluorimetry and luminometry. Atomic spectroscopy-principle and applications. NMR and ESR, ORD and CD. Autoradiography. Applications of radioisotopes in biology. Microscopy- basic principles, and components of light, bright field, phase contrast, and fluorescence microscopy. Electron microscopy - principle, preparation of specimens for TEM and SEM. Confocal microscopy. Atomic Force Microscopy (basic concepts). Electrophoresis - SDS-PAGE, isoelectric focusing, 2-D PAGE. Agarose gel electrophoresis, pulsed-field gel electrophoresis. Blotting techniques: Southern, Northern and Western blotting techniques. Chromatography - adsorption chromatography, gas chromatography, ion exchange, molecular exclusion, and affinity chromatography, HPLC, Analytical and preparative ultracentrifuge. Subcellular fractionation by differential centrifugation.

UNIT X: GENOMICS, PROTEOMICS AND BIOINFORMATICS

Genome Mapping and Sequencing Definition of genome and genomics. Molecular markers for mapping-RFLPs, microsatellites and SNPs. Physical mapping Chromosome walking and jumping. Whole-genome shotgun,

hierarchical shotgun. Next-Generation Sequencing. Exome sequencing. ORF scanning. The Human Genome Project. DNA microarrays, transcriptomics, ChIPs, knock-out analysis, genome editing – CRISPR/Cas9. Liquid-liquid chromatography. Edman degradation, mass spectrometry-basic principle and instrumentation, ESI, MALDI-TOF, SELDI-TOF, tandem MS. Peptide mass fingerprinting. Structural proteomics - X-ray and NMR for protein structure analysis. Comparative and homology modeling, secondary structure prediction, fold recognition and ab initio prediction. SCOP. Protein sequence analysis: Protein function determination: database search for homology. Protein-protein interactions: yeast 2 hybrid system, protein arrays and chips. Applications of proteomics. Bioinformatics workstation, Biological databases. Data submission and retrieval. Sequence alignment: substitution scores and gap penalties. BLAST, FASTA. Multiple sequence alignments: CLUSTAL. Gene discovery and prediction. Molecular phylogenetics: Identification of orthologs and paralogs. Protein structure database-protein structure visualization, comparison and classification.