KARNATAKA EXAMINATION AUTHORITY SYLLABUS

BIOCHEMISTRY - 2021

COMPETITIVE EXAMINATION FOR THE POST OF ASSISTANT PROFFESSOR IN GOVERNMENT FIRST GRADE COLLEGES

1. FUNDAMENTALS OF CHEMISTRY

Measurement: SI Units, Derived Units,Significant figures ,Dimensional analysis for volume,Exponential notation –Graphical representation of data – Types of graphs. Errors in quantitative analysis.

Atomic structure: Electromagnetic radiation. Nature of wave particle.Quantum numbers & their significance. Shapes of Atomic orbitals. Pauli Exclusion Principle, Aufbau Principle, Hund's rule of maximum multiplicity. Oxidation numbers.

Chemical bonding: Ionic bond, Born – Haber cycle, Covalent bond. Valence bond theory – Molecular Orbital Theory .Shapes of molecular orbitals. Coordinate bond. Nuclear chemistry and Radioactivity. Characteristics of radioelements,Group displacement law. Decay law - decay constant,Half life period.

Acids, Bases and Buffers : Strong and weak acids -ionization constant Ka and pKa of weak acids, comparison of acid strength on this basis. Ionic product of water, common ion effect, ionic product and solubility product of sparingly soluble salts and its applications. Hydrogen ion concentration- pH, types of pH metric titrations, pH of some biological fluids and its importance. Buffers-, types, buffer action and buffer capacity. pH of buffers- Henderson-Hasselbalch equation-derivation, preparation of buffers.

Introduction to organic chemistry

IUPAC nomenclature,Inductive effect, resonance and hyperconjugation. Reactive intermediates, free radicals, carbocations and carbanions. Types of organic reactions.

Bio-inorganic and Environmental Chemistry: Metal ions in biological systems. Types of ligands; Role of iron in Myoglobin, Haemoglobin and cytochromes; Copper in Hemocyanin, Magnesium in chlorophyll, Cobalt in vitamin B-12 and Molybdenum in nitrogenase. Metaloenzymes; Geometrical and optical isomerism in coordination complexes.

Heterocyclic Compounds: Structural and nomenclature of furan, pyran, thiophene, thizole,pyrrole, imidazole, pyridine, pyrimidine, purine, isoalloxazine and indole.

Stereochemistry: Stereoisomerism-types, stereochemical terminology; optical isomerism. Molecular dissymmetry, chirality: glyceraldehyde, lactic acid, tartaric acid; Nomenclature of enantiomers – the RS system and DL notation; diasterioism, epimers, mutarotation, racemization and resolution; Fischer's projection formulae; Geometrical isomerism: *cis-trans* isomerism in alkenes and ring compounds; structure and properties of maleic and fumaric acids; (E)-(Z) system of specifying geometrical isomers; significance of chirality in biological system.

2. CHEMISTRY OF BIOMOLECULES :

Carbohydrates: Brief review of configurational and conformational aspects of carbohydrates. Structure, properties, importance of structural and storage polysaccharides, glycosamino glycans, cardioglycosides and bacterial cell wall polysaccharides. Structural elucidation of polysaccharides. Glycoproteins – structure and functions, blood group antigens. Lectins – characteristics and functions in biological system.

Lipids: Lipid classification, brief account of the chemical properties and structure of lipids & biological role of the following: fatty acids, acyl glycerols, phospholipids, plasmalogens, sphingolipids, glycolipids, steroids, eicosanoids – prostaglandins, thromboxanes, & leukotrienes, leptin and visfatin.

Amino acids and Proteins:

Classification and structure of amino acids, properties of amino acids. Naturally occurring peptides. Peptide synthesis. Primary structure: Determination of amino acid composition, end group analysis, cleavage by enzymes and chemicals, separation of fragments. Secondary structure: Peptide bond – structure and conformation, Ramachandran plot. Regular secondary structure: α – helix and other types of helices, β – pleated sheet, irregular, turns, loops and triple helical structures. Helix stabilizing and destabilizing amino acids. Structure of fibrous proteins: Motifs and domain structure. Tertiary structure: Forces stabilizing tertiary structure of proteins. Protein denaturation and renaturation. Quaternary structure and symmetry: Structure and function of myoglobin and hemoglobin. Sickle-cell hemoglobin. protein folding – Alzheimer's and mad cow disease.

Nucleic Acids: Structure and properties of Nucleosides and Nucleotides. Structure of nucleic acids–primary, secondary and tertiary structure of DNA. Properties of nucleic acids in solution. Secondary structure of tRNA and role of secondary structure in mRNA stability. Nucleic acid sequencing – Maxam and Gilbert, Sangers method.

3. ENZYMOLOGY

Introduction to Enzymes: Nomenclature and classification of enzymes. Specificity and active site. Fundamentals of enzyme assay – enzyme units, coupled kinetic assay, immobilized enzymes.

The investigation of active site structure: The identification of binding sites and catalytic sites –trapping the E-S complex, use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo – oxidation and chemical modification of amino acid side chains. Affinity labeling studies an and super reactive amino acid chains. Site directed mutagenesis.

Enzyme catalysis: Chemical nature of enzyme catalysis-General acid-base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis and enzyme catalysis with mechanisms.

Coenzymes: The mechanistic role of the following coenzymes in enzyme catalyzed reactions – nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B12.

Kinetics of enzyme-catalyzed reactions: Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies, rapid reaction techniques and relaxation technique. Enzyme kinetics of single substrate reactions – Michaelis-Menten and Briggs and Haldane theory. Kinetic data evaluation-linear transformation of Michaelis-Menten equation. Haldane equation. King-Altman rate equation. Effect of pH & temperature on enzymatic reactions, Arrhenius plot, determination of activation energy.

Enzyme Inhibition: Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial inhibition, substrate inhibition and allosteric inhibition. Irreversible inhibition.

Kinetics of bi- substrate reactions: Sequential mechanism, compulsory order and random order mechanism, non-sequential mechanism, ping pong mechanism, distinction between different kinetic pathways using primary and secondary plots.

Allostery of enzyme action: Binding of ligands to proteins, Co-operativity, the Hill equation, Adair equation, Scatchard plot and equilibrium dialysis techniques. Sigmoidal kinetics: MWC and KNF models. Significance of sigmoidal behavior.

4. METABOLISM

Carbohydrate metabolism: Introduction, glycolytic pathway and regulation. Gluconeogenesis. pathway and regulation. Role of LDH. The TCA cycle and its regulation. Alternate pathways: HMP pathway, Enter – Doudoroff, Glucuronate and Glyoxylate pathway, Cori's cycle, Futile cycles and anaplerotic reactions.

Glycogen and starch metabolism: degradation, synthesis and regulation, glycogen storage disorders, hypoglycemia and hyperglycemia. Diabetes mellitus, diagnosis of Diabetes mellitus and GTT. Pentosuria, Hexose interconversion, fructose and lactose intolerance, fructosuria, galactosemia. Glycosylation of proteins.

Lipid metabolism: Oxidation of fatty acids. Energetic of β-oxidation. Metabolism of ketone bodies. Biosynthesis of triacylglycerols, phospholipids and sphingolipids. Sphingolipidodystrophies. Biosynthesis of steroids. Metabolism of prostaglandins Cholesterol metabolism. Lipoproteinemias, fatty liver, hypercholesterolemia. Chemical composition, biological functions and metabolic fate of VLDL, LDL and HDL. Arachidonic acid metabolism-Leukotrienes.

Photosynthesis: Chloroplast/thylakoid structure. Photosynthetic reaction centre, photosynthetic apparatus, Hill reaction, light reaction, cyclic- and non-cyclic pho tophosphorylation. Dark reactions, CO2 fixation into C4-dicarboxylic acids. Bacterial photosynthesis, photorespiration, RUBISCO.

Bioenergetics: Basic concepts of metabolic energy capture and transfer. Biochemical energetic-group transfer reactions of ATP, phosphate group transfer potential of ATP and other high energy phosphate donors. Stages in extraction of energy from fuel molecules.

Biological oxidation: Biological redox couplers, participation in oxidative metabolism. Free energy changes in electron transfer reactions. Mitochondrial electron transfer system- Chemical nature, topology and thermodynamic design of electron carriers. Sequence of electron carriers-

isolation of mitochondrial complexes, reconstitution experiments and study of specific inhibitors of Electron Transport Chain.

Oxidative phosphorylation: Mechanism of proton pumping. Proton motive force and the Mitchell hypothesis. FoF1-ATPase- structure and mechanism. Uncouplers, inhibitors and ionophores, partial reactions of OP, P/O ratios. Mechanism of oxidative phosphorylation. Microsomal electron transport. Proton motive force in Halobacteria, ATP synthesis in bacteria. H+ pumping by bacteriorhodopsin Photosynthetic electron transport. Structure and function of chloroplast ATP- synthase.

Nitrogen Cycle: Introduction, biological and non-biological nitrogen fixation, nif genes, regulation and utilization of nitrate and nitrite, regulation of nitrate reductase. Assimilation of ammonia, formation of amino acid amides by glutamine synthetase and its regulation.

Nucleotide Metabolism: Biosynthesis of purine and pyrimidine nucleotides and their inter conversion, regulation of biosynthesis. Other pathways of purine nucleotide formation. Biosynthesis of deoxyribonucleotides and coenzymes nucleotides. Chemical inhibition of the biosynthesis of nucleic acid precursors. Degradation of purine and pyrimidines, and disorders associated with their metabolism; gout, Lesch-Nyhan syndrome, oroticaciduria, and xanthinuria.

Amino acid Metabolism: General metabolic reaction of amino acids. Urea cycle– regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines– putrescine, spermidine and spermine, glutathione (γ-glutamyl cycle), physiologically active amines.

Degradation of the individual amino acids: Pathways in animal, plant and microbial systems; Amino acids forming from pyruvate, oxaloacetate, α- ketoglutarate, succinyl CoA, acetoacetate and/or acetyl CoA, pyruvate, formaldehyde, acetoacetate and/or acetyl CoA and fumarate, acetoaetate and/or acetyl CoA. Inherited disorders of amino acid catabolism.

Biosynthesis of the individual amino acids: Pathways in animal, plant and microbial systems– biosynthesis of non – essential amino acids.

Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies.

5. ANALYTICAL BIOCHEMISTRY :

Introduction to Analytical Techniques : Overview of Biochemical Investigations: Introduction to biochemistry, outline of strategies in biochemical investigations employing whole animal studies, isolated organs, tissues, and cell cultures. Plant cell culture, media for plant cell culture, potential of plant cell culture in biochemical investigations.

Microscopic techniques: Resolution of microscopes, Optical contrast, phase contrast, and dark field microscopy. Electron microscopy; Working principle and applications, specimens for electron microscopy, fixatives, immune-gold microscopy and its advantages. Metalshadowing, design and applications of scanning electron microscopy (SEM), Transmission electron microscopy (TEM), and cryo-electron microscopy.

Fluorescence Microscopy: Fluorescence recovery after photo bleaching (FRAP) and Fluorescence resonance energy transfer (FRET). Use of ion-selective electrodes, light emitting indicators and optical tweezers in study of cellular dynamics.

Centrifugation: Principle of centrifugation, the Swedberg equation, types of centrifuges and rotors. Density gradient centrifugation- Caesium chloride and sucrose density gradients; examples of separations, Sub-cellular fractionation. Dialysis, principle and uses of equilibrium dialysis,. Precipitation; methods and applications. Flow Cytometry; Principle and design of flow cytometer, cell sorting. Detection strategies in flow cytometry and parameters measured by flow cytometry.

Biocalorimetry: Differential scanning calorimetry; design of experiment, application of DSC, microcalorimetry. Determination of thermodynamic parameters by non-calorimetric data.

Manometry: Instrumentation, types of manometry; Warburg constant volume manometer, Gilson's differential respirometer, applications.

Radioisotopic methods of analysis: Design and applications of Geiger-Muller Counter, and types of scintillation counters. Disadvantages of scintillation counters, quenching, Chemiluminescence and phospholuminescence counting efficiency, channel ratio, sample preparation, scintillation cocktails, Cerenkov counting. Autoradiography; types of emulsions and films for exposure to isotopes, suitable isotopes, times of exposure and processing films, direct autoradiography, fluorography, intensifying screens, quantification. Radio tracer techniques; Supply storage and purity of radio-labeled compounds, specific activity, radio-labeled nucleotides, metabolites. Pulse chase experiments.

Quantitative biochemical measurements: Experimental errors and types, precision, accuracy. Population statistics- student's t-test, standard error of mean. Q-tests, Null hypothesis. Calibration methods. Correlation and regression analyses. ANOVA.

Chromatography: Principle procedure and application of paper chromatography. Ion exchange, chromate-focusing, Gel filtration, Reverse phase, Hydrophobic interactions and affinity chromatography, Metal affinity chromatography, HPLC, two dimensional HPLC. Detectors: types, UV, visible fluorescence, electrochemical detectors. Fast protein liquid chromatography (FPLC).

Gas chromatography: GLC, principle and application. Thin layer chromatography, metabolic profiling, solvent systems for TLC. Detection of compounds on TLC plates.

Electrophoresis: Principle, non-denaturing PAGE, activity staining for enzymes, zymogram, denaturing electrophoresis (PAGE), SDS-PAGE, isoelectrofocusing. Immuno-electrophoresis: Agarose gel electrophoresis of nucleic acids, pulse field electrophoresis. Electroblotting: western, southern, northern equipments and application.

Spectroscopic techniques: UV-Vis spectrophotometry. Principle, design and application of fluorescence spectroscopy. Circular dichroism (CD), equipment for CD measurement, CD of biomolecules (proteins) and LD (linear dichroism) of biomolecules. IR spectroscopy: Instrumentation, use of IR in structure determination, Fourier transfer, IR spectroscopy, Raman IR spectroscopy. NMR: Principle, biochemical application of NMR. ESR: Principle,

measurement of ESR spectra uses of ESR in chemistry. Mass spectroscopy: Principle, MS with other methods. Uses of MS in Biochemistry.

Proteomics: Introduction, electrophoresis in proteomics, 2D SDS–PAGE, basic principle, instrumentation, analyses of cell proteins, free flow electrophoresis, blue native gel electrophoresis, Mass spectrometry in proteomics, tagging methods for MS proteomics, isotope coded affinity tagging, tagging for tandem MS. Microarrays, protein biochips. Post translational modifications in proteomics, proteolysis, glycosylation, oxidation, protein disulfides, phospho-proteins.

Bioinformatics: Sequence data, nucleotide and protein sequence, genome database, EST tag databases and SNP database. BLAST programme, FASTA, ClustalW, Cambridge database, PDB, specialist structural databases. RasMol/RasTop, protein explorer, Swiss-prot Pdb viewer.

6. MICROBIOLOGY :

Bacteriology: Classification of Bacteria. Eubacteria, Archaebacteria, Cynobacteria, Bergy's classification of bacteria. Brief study of important groups of bacteria:Coliform, spore formers, photosynthetic bacteria, lactic acid producing bacteria, actinomycetes, ricketisiae, mycoplasms.

Eukaryotic Microorganisms: Fungi- classification, cultivation and morphology of yeasts and molds. Control of fungal growth. Mycotoxins and their actions.

Staining techniques : Gram, Acid fast & flagellar. Detailed study of bacterial cell structures-genetic elements, ribosomes, membranes, cell envelope, capsule, flagella, pili and endospores. Mechanism of bacterial motility.

Pure culture techniques: Principles of microbial nutrition: Nutritional requirements, different kinds of media, factors affecting growth. Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. Modes of reproduction, Biosynthesis of cell wall components, enumeration, growth curve, generation time, synchronous growth, Chemostat.

Control of Microbial Growth: Principles of Microbial growth, Sterilization methods and sterility testing. Physical and chemical methods of controlling bacterial growth. Antibiotic-targets and action.

Food Microbiology: Food spoilage, food preservation, fermented foods, exotoxins produced by bacteria.

Dairy Microbiology: Contamination of milk by micro-organisms. Bacterial count, reactions occurring in milk, Pasteurization and sterilization. Fermented milk products, cheese.

Medical Microbiology: Normal mouth, nose, and throat flora, Mechanisms and control of bacterial pathogens. Antiseptic and disinfectant action; Antibiotic assay; Determination of minimum inhibitory concentration (MIC), endotoxins.

Virology: Classification and General Properties and structure of plant, animal and bacterial viruses. Bacteriophages; RNA phages. Plant viruses. TMV. Animal viruses- productive cycle of DNA viruses. Retrovirus. Cultivation and enumeration of viruses. Persistent chronic and acute

viral infections. Inhibition and inactivation of viruses by physical and chemical agents. Interferon- types, antiviral proteins- ds RNA dependent and independent pathways.

7. IMMUNOLOGY :

Infection: Types of infection and nature of infective agents. Nonspecific host defense mechanisms. Anatomical barriers; lysozyme and other antimicrobial agents. Phagocytosis and phagocytic cells, neutrophils, monocytes and macrophages.

Compliment system: Introduction, alternate and classical pathway, regulation 4hrs Immunity; States of immunity; innate and acquired immunity, naturally and artificial acquired passive and active immunity. Immunization practices, use of toxoids, killed and attenuated organisms. Surface components and newer vaccines, production of vaccines.

Immunoglobulins: Structure and functions of immnoglobulins Types; isotypes and idiotypes, isoantibodies. Methods of raising antibodies. Monoclonal antibodies, production and purification.

The Immune System: Recognition of self and non self, the major histocompatibility antigens, H-2 and HLA antigens, Antigenecity; humoral and cell mediated immunity. T and B lymphocytes; origin, differentiation, characteristics and functions, nature of surface receptors, antigen processing and presentation. T cell and B cell interaction. Cytokines, monokines, lymphokiness and their functions.

Molecular Immunology: Theories of antibody formation; clonal selection and network, Genetics of antibody diversity, germ line and somatic mutation theories, immunoglobulin, MHC a TCR gene organization and their recombination, class switch of Ig genes.

Clinical Immunology: Immune disorders; hyper sensitivity, autoimmune and immunodeficiency diseases. Tissue transplantation; auto – iso -, allo-, and xenografts, tissue matching, transplantations rejection, mechanism and control, tumor immunology.

Immuno assay methods: Antigen – antigen interaction – affinity and avidity, determination of affinity and avidity constants. Principle, procedure and applications of Immunoprecipitation, neutralization, agglutination, compliment fixation, immunodiffusion, immunofluorescence, RIA, ELISA, micro ELISA Techniques.

8. GENETICS :

Introduction: Nature of genetic material. Chromosomes and genes. Mutation: types of mutation, mutagens, mechanism of mutation, induction and isolation of mutants and their role in genetic studies.

Classical Genetics: Review of classical genetics; work on Pisum sativum, Drosophila Melanogaster, Neurospora Crassa etc. inheritance (sex-linked and others). Population genetics, extranuclear inheritance. Sex determination, Morgan's discovery of sex linked inheritance of sex linked genes, X;linked traits in humans. Identification of sex chromo;somes, XX,XY, mechanism of sex determination.

Quantitative Genetics: Human quantitative traits, discontinuous traits and continuous traits, Breeding analysis, genetics basis of quantitative variation, Multiple factor hypothesis and analysis of polygenes. Genotype-Environment Interaction and models for their measurement, estimation of Heritability Index.

Human Genetics: Biochemical events occurring during mitosis and meiosis. Structure of chromatin; nucleosomes and higher orders of organization. Chromosome banding, Chromosome mapping based on recombination frequency data. Transposons. Overview of human genome project, mapping of human genes; techniques used, assignment of important genes. Transposition in human chromosomes. Chromosomal abnormalities.

Bacterial Genetics: Bacterial chromosomes, plasmids; fertility, resistance, colicinogenic and others. Recombination in bacteria. Mechanism of recombination, transposable genetic elements, transformation and conjugation in bacteria. Linkage map of bacterial chromosomes.

Viral Genetics: Life cycles of bacteriophages, lytic cycle; replication of T-phages. Lysogeny and its regulation. Transduction; specialized, generalized and abortive. Fine structure analysis of T-phages; Benzers work, concept of cistrons.

9. GENETIC ENGINEERING :

Introduction : Introduction and over view of cloning procedures. Isolation of nucleic acids, characterization and purification of plasmid, bacteriophage genomic DNA for cloning purpose.

Restriction endonucleases and DNA modifying enzymes:

Discovery, classification, properties, and applications. Reactions, application of the following modifying enzymes employed in rDNA technology; DNA- and RNA ligase, Phosphatases and kinases DNase (DNase-I) and RNases (RNase A, H), S1- and Micrococcal numclease, double and single stranded exonucleases. DNA and RNA polymerases (Klenow fragment), template independent RNA polymerases. Topoisomerase. Linkers and adapters, TA-cloning.

Cloning Vectors: Basic properties of plasmids, desirable properties of vectors, plasmids as vectors. Directional cloning in plasmid vectors, blunt end cloning in to plasmids. Preparation and transformation of competent E.coli. electroporation, Screening colonies using X-gal and IPTG (-complementation),α screening by hybridization. Bacteriophage lambda vectors; Insertional and replacement lambda vectors, transfection, in vitro packaging, screening recombinant phages. Cloning in M13 vector and COSMID vectors and their applications. Expression vectors:Characteristics of expression vectors,expression vectors forcloning and expression in bacteria, yeast and mammalian cells. Super vectors; characteristic features and utility of BAC and YAC vectors.

Genomic and cDNA libraries: Outline of methodology for genomic library construction, creation of genomic libraries using lambda and cosmid vectors. Growth, evaluation and storage of genomic libraries. cDNA libraries; methodology, random arrayed and ordered cDNA libraries, screening cDNA libraries; probe selection, hybridization. Screening with antibodies, rescreening and sub-cloning. Characterization of plasmid clones, restriction digestion, southern blot, PCR and sequence analysis.

PCR: Discovery, principle and procedure, varients of PCR- RT-PCR, long PCR, differential PCR, and inverse PCR. Application of PCR; Rapid amplification of cDNA ends (5'and 3' RACE), Cloning PCR products, PCR in screening clones, colony PCR, Diagnositc application of PCR. Sequencing and mutagenesis: Principle of DNA sequencing, automated sequencing, extending the sequence, shot gun sequencing. Analysis of sequence data; annotation, ORF, exon-intron boundaries, identification of genes and their products.

Gene transfer to animals cells: over view of strategies, transfection methods, phospholipids as delivery vehicles, electroporation and direct transfer, transient and stable transformation, Cotransformation and selection of stable transformants, selectable markers for animal cells. Mammalian plasmid expression vectors, reporter genes. Gene transfer by viral vectors; adeno and baculo virues, retroviral vectors.

Gene transfer to plants: plant cell culture and proptoplast, callus and their manipulations. Agarobacterium mediated transformation, Ti plasmid, mechanism of T-DNA transfer, Function of T-DNA genes, Ti-plasmid derivatives as plant vectors (disarmed T-DNA), cointegrate and binary vectors, high capacity binary vectors, selectable markers for plants, control of transgene expression in plants. Direct DNA transfer to plants; protoplast transformation, particle bombardment, in-planta and chloroplast transformation. Plant expression vectors; CaMV and TMV vectors.

10. MOLECULAR BIOLOGY

Introduction: Historical perspective, composition of RNA and DNA. Bases, Chargaff s rule. Types of RNA. Isolation and purification of RNA and DNA, structure of RNA and DNA, central dogma of molecular biology.

DNA-antiparellel nature: Nearest neighbour base frequency analysis. Replication of DNA, semi conservative nature; Messelson and Stahl experiment. Replication of double stranded DNA, direction of replication, discontinuous replication, Okazaki fragements. DNA polymerase I II and III, DNA ligase, DNA topoisomerases. Fidelity of replication, replication in viruses, rolling circle model, single stranded DNA virus. Applications of mitochondrial DNA. Trombon model, translesion synthesis (DNA pol IV and V).

Transcription: Colinerity of genes and proteins, RNA polymerase I, II and III. RNA biosyntehsis in prokaryotes and eukaryotes; initiation, elongation and termination. RNA dependent RNA synthesis, RNA replicase of Q□ virus. Processing of cukaryotic RNA, cap addition, poly A tail addition, RNA editing. Processing of tRNA and mRNA transcripts.

Translation: Genetic code, triplet codon, universality features of the genetic code, assignment of codons, studies of Khorana, Nirenberg, triplet binding techniques, degeneracy, wobble hypothesis, evolution of genetic code and codon usage, variation in the codon usage. 3D structure of prokaryotic and eukaryotic ribosomes, ribosomal protein synthesis; initiation elongation and termination. Role of mRNA and tRNA. Aminoacyl tRNA synthesis and its role in translation accuracy. Post translation modification of proteins, signal cleavage, disulphide bond formation, O and N-glycosylation, folding of nascent protein, role of chaperones, attachment of glycosyl anchor, and other modifications.

Enzymes in DNA and RNA degradation: Nucleases, ribonucleases, classification and role.

11. PHYSIOLOGY :

Tissues: Formation of different kinds of tissues from primary germ layers. Types and functions of epithelial tissue, inter-cellular junctions. Connective tissue – extra cellular matrix, Collagens – types, composition, structure and synthesis, Elastin, fibronectins, and other proteins of the extra – cellular matrix. Basal lamina; laminins and associated proteins and their functions.

Cytoskeleton and Cellular dynamics: Microfilaments; Assembly and polymerization of G-actin, role of Thymosin-B4, Profilin and Cofilin in polymerization, structural and functional property of F-actin, Capping proteins and assembly of actin filaments, branched and unbranched 13 filament assemblies, Arp2/3, intracellular cellular movement and actin polymerization, use of toxins in study of actin dynamics. Role of cross-linking and adaptor proteins in actin bundling and membrane association. Structure and organization of microtubules; dynamics of microtubules, assembly by MTOC, dynamic instability, tubulin polymerization as target of drugs. Side and end-binding proteins, capping and severing proteins. Kinesins and dyneins; vesicular transport along microtubule, role of kinesin-1 and dynein motors in organelle transport. Role of microfilaments and microtubules in cell migration. Intermediate filaments; Assembly and tissue specific expression, dynamic nature of intermediate filaments, diseases associated with Lamins and Keratins defects.

Nervous System: Types and structure of neuron. Myelin sheath; composition and function. Resting membrane and action potent ial. Nernst and Goldman equations. Mechanism of initiation and propagation of action potential – voltage gated ion channels, ionophores and toxins in study membrane transport. Design and use of Patch-Clamp in measuring membrane potential. Neurotransmitters and receptors; synaptic transmission, post-synaptic potentials. Outline and functions of autonomic and central nervous systems.

Muscular System: Ultra structure of smooth, skeletal and cardiac muscle fibers. Contractile and other proteins of muscle. Energy metabolism in muscle; Phosphagens, neuro-muscular junctions, excitation of striated muscles. Organization of sarcolemma, transverse-tubular system and sarcoplasmic reticulum, mechanism of muscle contraction. Regulation of contraction in striated and smooth muscle. Calmodulin and its regulatory role, muscular dystrophies.

Digestive System: Secretion, regulation of secretion, composition and functions of saliva, gastric, pancreatic and intestinal juices and bile. Gastro-intestinal hormones. Digestion, absorption and transport of carbohydrates, proteins, lipids, nucleic acids and vitamins. Liver structure and functions. Detoxification mechanisms. Liver function tests.

Cardio – vascular System: Systemic and pulmonary circulation. Structure of blood vessels. Regulation of cardiac activity. Blood volume, blood pressure. Plasma composition and functions of plasma liproproteins. Mechanism of blood clotting, role of vitamin K, clot dissolution, anti-clotting factors, Formation, counting and functions of erythrocytes, leukocytes and thrombocytes. Lymph, Cerebro spinal fluid (CSF); composition and analysis in diagnosis.

Respiratory System: Mechanics and regulation of respiration, pulmonary and alveolar ventilation and its control, transport of respiratory gases, respiratory mechanism of acid-base balance.

Excretory System: Mechanism of urine formation and composition of urine. Urine analysis for abnormal constituents, tubular function tests. Nephritis and nephrosis. Kidney hormones. Regulation of acid-base electrolyte and water balance. Respiratory and metabolic acidosis and alkalosis.

Endocrine system: Hormones, feedback regulation, biosynthesis, storage, secretion, Circulation in blood. Degradation and peripheral transformation. Receptors and the mechanism of hormone action. Measurement of hormones, and receptors. Disorders of endocrine system.

Nerve signaling: Acetylcholine receptor (AchR) channel, origin and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate, aspartate, GABA, and glycine) and neuropeptides (somatostatin/enkephalins). Trafficking proteins of synaptic vesicles, vesicle cycle – exo – and endocytosis of synaptic vesicles. Structure, subtypes and functions of receptors of ACh, GABA, Glycine, Serotonin and glutamate and peptide neurotransmitters, activation by ligands & interaction with effectors. Role of agonists & antagonists of neurotransmitters. Biochemical basis of neurological diseases. Natural, genetic and environmental factors affecting the development of CNS, Co – ordination between nervous and endocrine systems.

Cell Cycle: Cell cycle and Regulation of M- phase. Role of ubiquitin. Growth factors and cytokines, growth phases and check points of cell cycle and their regulation. Cyclins and cyclin-dependent kinases.

Stem Cells: Embryonic, adult stem cells and potential applications.

Apoptosis: Discovery, morphological changes, mitochondrial regulation. Direct signal transduction. Distinguishing apoptotic cells from necrotic cells.

Cancer: Pathophysiology, diagnosis, prevention and management. Signaling cascades in cancer (MAP kinases, Ras pathways, JAK-STAT and TGF-β pathways). Etiology of breast, colon and prostrate cancer.

12. MEMBRANE BIOCHEMISTRY :

Introduction: Mono, bi-layers and micelles, Langmuir trough. Cell and organelle membranes; Physical properties of bi-layers. Models of membranes. Asymmetry of lipid distribution in bacterial, plant, and animal membranes and their properties. Liposomes; preparation, properties and application in membrane biochemistry.

Membrane proteins: Classification of membrane proteins based on membrane-protein interaction. Types of integral membrane protein, forces responsible for holding integral proteins in membranes, secondary structure of membrane spanning portions of integral membrane proteins; transmembrane α-helices and β-barrels, hydropathic plots. Role of integral proteins in cell-cell interaction and adhesion; selectins, integrins, cadherins. Lipid-anchored membrane protein-acyl- prenyl- and GPI-anchors.

Membrane transport: Membrane transport types, assay of membrane transport, mechanism for transport Kinetics and model of Glut-1 uniport, ATP–driven pumps, ABC-transporters; MDR1, CFTR Channels and pores. Ion channels; voltage gating, ionselectivity, electrochemical gradients, Nernst Equation, K-channels, aquaporinns, ionophores. Lactose permease, Phospho transferase and sugar binding proteins.

Intracellular compartments: Proteins sorting; Protein trafficking: Sorting signals. Mechanisms: Gated transport, transmembrane transport, vesicular transport. Signal sequences. Transport of molecules between nucleus and cytosol. Nuclear pore, nuclear localization signals, nuclear transport receptors, nuclear export: Ras-GTPases- directionality. Transport of protein into mitochondria and chloroplast. Signal sequence for thylakoid membranes, peroxisomes. ER and signal sequence for protein import. Signal Hypothesis: Signal Sequence, SRP-receptors for protein import to ER.

Biogenesis of lipid bilayers: Intracellular vesicular trafficking. Clathrin coated- Assembly and disassembly, Structure and function. significance. Coat assembly control by monomeric GTPases. Role of Rab proteins in vesicular targeting. SNARE proteins and their role in vesicular transport and membrane fusion. N-linked, proteoglycan assembly in Golgi. Transport through trans Golgi network to lysosomes. Mannose-6-phosphate receptors. Signal patch for mannose-6-phosphate lysosomal storage disease. Endocytosis: Phagocytosis, Pinocytosis- vesicles, receptor mediated endocytosis.

13. NUTRITION :

Principles of Nutrition: Balanced diet, energy source and nutrition, macro and micro nutrients, essential nutrients and their classification. Food groups, proximate analysis of foods, chemical and biological analysis for nutrients. Food as source of energy, methods of determining energy value of foods, calorimetry, physiological fuel value, daily requirement of energy, high and low calorie diets. Basal metabolic rate (BMR), factors affecting BMR, specific dynamic action of foods.

Dietary Nutrients: Dietary fiber, evaluation of nutritive value of dietary carbohydrates and proteins, nutritional classification of proteins, supplementary value of proteins, protein calorie malnutrition; Kwashiorkor and Marasmus. Fats-sources, invisible fat, essential fatty acids, PUFA.

Vitamins and Minerals: Fat soluble and water soluble vitamins. Water metabolism. Diet for nutrition therapy. Balance diet-dietary constitution and importance. Recommended daily allowances (RDA), special nutrition for infants, children, during pregnancy, lactation and old age. Nutrition for diabetes and cardiovascular disease patients. Wellness diets, fitness diets, obesity. BMI and its significance. Nutraceuticals, types and health importance. \

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