Department of Studies & Research in Biochemistry

Lesson Plan

CPT 1.1 - Physicochemical Aspects of Biology (4 Credits: 64 h)

1. Introduction to atomic structure and concepts of atom and atomic structure
2. Introduction to molecules, Concept of molecular structure
3. Introduction to Electron and valancy
4. Concept of electron theory of valance. Atomic structure, Atomic shells, electrons and orbitals. Octet rule and stabilization of atom or molecule.
5. Chemical bonds, formation of chemical bonds and types of bonds. Covalent bond, covalent coordinate bond, ionic interactions and bond formation, hydrogen bond, Vander Waals interactions.
6. Hybridization of chemical bonds: electronic configurations. s, p, d, f orbitals and their hybridizations. sp, sp2 and sp3 hybridizations and the molecular topology.
7. Aromaticity, Kikules rule of aromaticity. Resonance
8. Coordinate bond and its importance in biology- Fe , Cu and Mg/ Mn coordination with proteins.
9. Crystal field theory
10. Ligand field theory
11. Valance bond theory, VSEPR and shape of molecules
12. Water, anomalous properties of water, water activity, Chemical bonding in water. BP, FP,
13. Bonding of iron in haemoglobin- heme porphyrin interaction with the tyrosine relaxes and constricts Hb and cytochromes
14. cobalt in Vit B12,
15. Magnesium in chlorophyll.
16. Chelates: Types of ligands and complexes.
17. Introduction to stereochemistry. Asymitricity and chirality of chemicals.
18. Isomerism, , Origin of isomerism, Isomers –Types: Stereoisomerism, optical isomerism
19. Concept of enantiomerism, enantiomers. Concept of diasteromerism- examples of diasteromers and difference between enantiomers and diasteromers. Epimers
20. Conformation and configuration of chemicals. Optical isomers, DL isomers, assymetric C and its role in conformational isomers
21. D L Isomers, RS notations with examples
22. Introduction to geometric isomerism, Concept of geometricl isomerism- Cis-trans isomerism with examples like fumaric acid etc., properties of geometric isomers
23. Naming of geometric isomers
24. Naming rules 1, 2 and 3. EZ convention
25. Introduction to chiral molecules. Concept of chiral molecules and their significance in biology.,
26. Biological importance of chiral molecules: Chiral molecules and their targets. Drug targets- enzymes and proteins Discrimination of D and L isomers by enzymes with examples like

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ಅಧ್ಯಯನ ಮತ್ತು ಸಂಶೋಧನಾ ವಿಭಾಗ
ತುಮಕೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ
ತುಮಕೂರು-572103

B-D-glucose, aminoacids, medicinal drugs

- Introduction to Bioorganic chemistry. Mechanism of Bioorganic reactions
- Types of chemical reactions- ionic, radical, concerted reactions
- Types of reaction and their mechanisms
- Substitution reactions, addition reactions, elimination reactions and rearrangement reactions
- What is an ion? Atom or Molecule that carry charge is an ion-Mechanism. Mechanism is ionic reactions
- What is radical chemistry? Unpaired electron containing ion is radical ion. Un paired atoms and molecules. Ions that does not carry charge is a radical-Mechanism. Mechanism of radical reactions.
- Mechanism of concerted reactions with examples. Simultaneous. Single step reactions. Reaction rates
- Energy profiles of reactions- reaction rates, order of a reaction, activation energy concept and reaction process
- Transition state theory of formation of a molecule
- Nucleophile? Concept of nucleophile. Nucleophilic substitution reaction – Mechanism of substitution nucleophilic reaction type 2- butyl halide
- Properties of SN1 reactions
- Mechanism of Substitution nucleophilic reaction type 1- butyl halide
- Properties of SN2 reactions
- Electrophilic substitution reactions. Mechanism of E1 and E2 reactions
- Curtin-Hammett principle. Mechanism of electrophilic addition to C=O addition
- Concept of Aldol condensation. Types of Aldol condensations, reverse a
- Aldol condensations. Adehyde or ketone reaction to alcohol.
- Mechanism of Michael addition. Concept of esterification reaction. Mechanism of Esterification and hydrolysis.
- What are heterocyclic chemicals? Examples. Importance of heterocyclic chemicals in chemistry
- Do heterocyclic chemicals occur in biological system? Examples of heterocyclic compounds present in biological systems- monosaccharides, amino acids, enzymes, proteins, nucleic acids, vitamins, phytochemicals etc
- Structure and properties of furan and its significance in biological molecules
- Structure and properties of pyrrole and its significance in biological molecules
- Structure and properties of indole and its significance in biological molecules
- Structure and properties of thiazole and its significance in biological molecules
- Structure and properties of immidazole and its significance in biological molecules
- Structure and properties of pyridine and its significance in biological molecules
- Structure and properties of pyrimidine and purine its significance in biological molecules
- Structure and properties of Quinine, pteredine and isoalloxazine its significance in biological molecules
- Concept of bioinorganic chemistry and its significance in biochemistry, Heme porphyrine

- Structure, properties and importance of Terpenes, Polyphenols
- Structure, properties and importance of procyanadines
- Structure, properties and importance of flavanoides and xanthones
- Procyanidins, Flavonoids, Xanthones, Alkaloids and Pigments.
- Introduction to free radicals. Concept of free radical generation
- Chain reaction in free radical generation
- Reaction of free radical with biological material and matrix
- Adverse effects of free radical attack on proteins, enzymes, DNA, RNA etc
- Basic concept of entropy, free energy change and standard free energy change
- Free energy change and equilibrium constant
- Oxidation reduction reactions
- oxidation reactions in biological systems.

CPT 1.2 - Analytical Biochemistry (4 Credits: 64 h)

Preliminary techniques in Biochemistry:

Animal models, Types of studies 1 Hr

Mutant organisms (auxotroph) 2 Hr

Cultured animal and plant cells and plant as models. 2 Hr

Cell fractionation techniques:

Cell lysis, homogenization, extraction, salting in and salting out. 1 Hr

Dialysis and ultrafiltration-Artificial membranes, semipermeable membranes, Donnan membrane equilibrium and biological significance of osmosis. 3 Hr

Centrifugation: Svedberg's constant, sedimentation velocity and sedimentation equilibrium. 2 Hr

Ultra centrifugation: Differential and density gradient centrifugation 3 Hr

Construction of preparative and analytical ultracentrifuge 3 Hr

Chromatographic techniques:

Principles, procedure and applications of paper, TLC, adsorption 1 Hr

Ion exchange, gel filtration, affinity, GLC, chromatofocusing 6 Hr

HPLC and FPLC 1 Hr

Electrophoretic techniques:

Polyacrylamide gel electrophoresis, SDS-PAGE, 2D-electrophoresis, 3 Hr

agarose gel electrophoresis, isoelectric focusing, pulsed field electrophoresis, high voltage electrophoresis, capillary electrophoresis, isotachophoresis 3 Hr

Separation of proteins, lipoproteins and nucleic acids. Visualizing separated components; staining, fluorescence, PAS staining, zymogram and reverse zymogram. 2 Hr

Spectroscopic techniques:

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Principles of colorimeter, spectrophotometer, fluorimeter. Beer- Lambert's Law and its limitations. Extinction coefficient 4 Hr

Fluorescent probes and their applications 2 Hr

Principle and applications of NMR, IR, CD/ORD. 4 Hr

Radioisotope techniques:

Radioactivity, stable and radioactive isotopes. 2 Hr

Methods of detection of isotopes. GM counters, liquid scintillation counters and autoradiography. 2 Hr

Units of radioactivity, half-life of radioisotopes. Radiation monitoring and its hazards. Application of radioactive tracer in biology. 2 Hr

Radioisotopes in Biology:

3H, 14C, 32P, 131I, 35S, concept of half-life, decay constant 2 Hr

Detection and quantitation- GM counter and solid and liquid scintillation counter. 2 Hr

Specific activity, autoradiography and their applications. 2 Hr

Mass spectroscopy:

Theory and construction of mass spectrometer. Ionization, fragmentation, m/e, time of flight, MALDI and ESI. 4 Hr

Labelling: Using plant system (monosaccharides and polysaccharides), animal system, chemical (Glucose1-14C) and enzymatic methods (disaccharides). 4 Hr

Labelling of ATP (α-P32 and γ-P32), proteins and nucleic acids. 2 Hr

CPT 1.3 – Biomolecules (4 Credits: 64 h)

Carbohydrates: Classification of carbohydrates. Chemistry of monosaccharides: pentoses. Hexoses, deoxyglucose, amino sugars muramic acid, Linkages in sucrose, lactose and maltose, trehalose and glycosides. Isolation of polysaccharides: Homopolysaccharides and heteropolysaccharides, starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell wall polysaccharides, blood group polysaccharides. 9 Hr

Structure elucidation: degradation, graded acid hydrolysis, periodate oxidation, degradation of oxopolysaccharides, methylation, acetylation,. Glycoproteins: N- and O-glycosylation, lectins, carbohydrates in tissue engineering. Proteoglycans; agreecan, syndecan, and decorin. Pectin and pectic polysaccharides. 6 Hr

Amino acids, Peptides and Proteins: Features of the peptide bond, naturally occurring peptides: glutathione enkaphalins and endorphins. Chemical synthesis of peptides; Khorana's solution phase synthesis, Merrifield's solid phase synthesis. 5 Hr

Determination of amino acid compositions: Acid and base catalyzed hydrolysis, separation, quantification, determination of N and C terminal residues, determination of site of glycosylation and type of linkage (o-glycosyl and n-glycosyl). 4 Hr

Elucidation of structure of proteins: Isolation of proteins; overview of purification and criteria of purity. Determination of primary structure: Sequencing strategies; N-terminal and C-terminal, sequencing methods. Automated sequanators. Determination of s-s-bond position. 5 Hr

Secondary structure of proteins: α, β sheet, β bend, β turn and super secondary structures. Secondary structure prediction methods: Ramachandran plot, Chou and Fasman algorithm. Tertiary and quaternary structures. 5 Hr

Factors responsible for protein folding: Anfinsen's experiment. Weak forces of interaction; hydrogen bonding, Vander Waal's forces, London forces, ionic interactions, hydrophobic interactions, S-S bridges, peptide bond, glycosidic bond, phospodiester bond, and allolysine. Denaturation and renaturation of proteins, molten globule. 3D Structure of myoglobin hemoglobin, immunoglobulin, collagen, chymotrypsin and keratin. Molecular Chaperons. 8 Hr

Lipids: Classification of lipids; oils, fats, and waxes. Occurrence and properties of fatty acids, esters of fatty acids, cholesterol, phosopholipids, glycolipids, sphingolipids, cerebrosides and gangliosides. 6 Hr

Lipid mediators: Eicosanoids, prostaglandins, leukotrienes, prostacyclins, thrombaxanes, DAG, ceramide and PAF. 3 Hr

Nucleic acids: Isolation of RNA and DNA from biological samples. Physico-chemical properties of nucleic acids- melting of DNA, Tm; factors affecting Tm, Cot curve, classification of DNA based on cot curve. Chemical reactions of DNA and RNA. 5Hr

Structure of nucleic acids: Primary, secondary and tertiary structure of DNA; Watson and Crick model; B and Z DNA, other models of DNA structure. palindromic sequences, cruciforms. DNA protein interaction; zinc finger,leucinc zipper, helix-turn-helix, other motifs, DNA bending and kinks. Secondary structure of tRNA and clover leaf model. Nucleic acid sequencing- Maxam- Gilbert method, dideoxy method. Chargaff's rule.

SPT 1.4.1 - Physiology and Nutrition (4 Credits: 64 h)

Physiology: Basic body plan in humans. 1 Hr
Location of organs and their basic functions. 1 Hr
Circulatory system: Blood-Composition, cells, plasma proteins and lipoproteins. 1 Hr
Erythrocytes; structure and function. 1 Hr
WBC; types, differential count, functions. 1 Hr
Platelets and their functions. 1 Hr

Blood as a Buffer system. 1 Hr
Hemostasis. 1 Hr
Mechanism of blood clotting. 1 Hr
Role of vit K, Digestion of clot, Anticoagulants, blood volume, blood pressure and their regulations. 1 Hr
Hematopoiesis. 1 Hr
Plasma lipoproteins and their functions, HDL, LDL, VLDL, chylomicrons. 1 Hr
CSF; composition and function. 1 Hr
Respiratory System: Lungs, structure and functions. 1 Hr
Gas exchange, oxygen binding by haemoglobin. 1 Hr
factors affecting oxygenation and acid-base balance. 1 Hr
Digestive secretions –
Composition, functions and regulation of saliva, gastric secretions. 1 Hr
Composition, functions and regulation of pancreatic, intestinal and bile secretions. 1 Hr
Mechanism of HCl production in the stomach. 1 Hr
Gastrointestinal hormones. 1 Hr
Digestion and absorption of carbohydrates, lipids and proteins. 1 Hr
Hepatobiliary System: Anatomy of the liver, blood supply, 1 Hr
Liver cells; hepatocytes, endothelial cells and Kupffer cells 1 Hr
Secretory and excretory function and formation of bile. 1 Hr
Excretory system- Structure of Kidney and nephron. 1 Hr
Formation of urine- glomerular filtration. 1 Hr
Formation of urine- tubular reabsorption of glucose, water and electrolytes. 1 Hr
Formation of urine -tubular secretion. 1 Hr
Kidney hormones. 1 Hr
Regulation of acid base, electrolyte and water balance. 1 Hr
Respiratory and metabolic acidosis and alkalosis. 1 Hr
Muscular system – Introduction to Smooth, skeletal and cardiac muscles. 1 Hr
Contractile and other proteins of muscle. 1 Hr
Fine structure of muscle fibre, neuromuscular junctions. 1 Hr
Mechanism of muscle contraction. 2 Hr

CPT 2.1 – Enzymology (4 Credits: 64 h)

Introduction to Enzymes-1h
Nature of enzymes -1h
Localization, isolation -1h
Purification and characterization of enzymes-1h
Criteria of purity of enzymes, fold purity -1h

Nomenclature and IUB classification of enzymes-1h
Enzyme specificity, specific activity-1h
Assay methods-1h
Coupled enzyme assays- 1h
Continuous, end point and kinetic assay-1h
Units of enzyme activity, IU and Katal -1h
Industrial and Biomedical applications of enzymes -1h
Enzyme kinetics: Michaelis-Menten equation-1h
Initial velocity approach, steady state approach-1h
Vmax, Km and their significance-1h
Linear transformation of Michaelis-Menten equation-1h
Lineweaver-Burk plot-1h
Eadie-Hofstee and Wolf plot -1h
Cornish-Bowden plot-1h
Scatchard plot-1h
Rate of a reaction, order and molecularity-1h
Ist order reaction kinetics. Rectangular hyperbola-1h
Michaelis- Menten equation as rectangular hyperbola-1h
Asymptote, linear transformation, calculation of slope, intercept -1h
Effect of pH, temperature and substrate concentration-1h
Enzyme Inhibition: Types of reversible inhibitors – competitive-1h
Non-competitive-1h
Un-competitive and mixed inhibitors-1h
Partial inhibition-1h
Substrate inhibition-1h
Allosteric inhibition -1h
Irreversible inhibition -1h
Kinetics of bi-substrate reactions: Sequential mechanism-1h
Compulsory order and random order mechanism-1h
Non-sequential mechanism, ping pong mechanism -1h
Distinction between different kinetic pathways using primary and secondary plots-1h.
Inhibition studies in the characterisation of bi-substrate reactions-1h.
Mechanisms of enzyme catalysis: Active site structure-1h
Methods of determining active site structure -1h
Isolation of ES complex- 1h
Affinity labelling, chemical modification studies-1h
Active site structure investigation-1h.
Nature of enzyme catalysis: Transition state theory-1h
Proximity and orientation-1h
Orbital steering, acid base catalysis-1h

Covalent catalysis, metal ion catalysis-1h,
Nucleophilic and electrophoilic catalysis-1h
Intramolecular catalyses, entropy effects-1h.
Effect of temperature and pH on enzyme catalysed reaction-1h
Mechanisms of action of specific enzyme: Chymotrypsin-1h
Zymogen activation-1h
Acid-base catalysis, charge relay network-1h
Lysozyme, alcohol dehydrogenas-1h
Ribonuclease-1h
carboxypeptidase A, RNA as an enzyme-1h
Coenzymes: The mechanistic role of the following coenzymes in enzyme catalyzed reactions
nicotinamide nucleotides-1h
flavin nucleotides, pyridoxal phosphate-1h
Coenzyme A, thiamine pyrophosphate-1h
Biotin, Folate coenzymes-1h
Monomeric and oligomeric enzymes: Monomeric enzymes-the serine proteases-1h
Zymogen activation. Sulphahydryl enzymes-papain-1h.
Oligomeric enzymes-isoenzymes (LDH) -1h
Multi-enzyme complexes- (Pyruvate dehydrogenase complex) -1h.
Allosteric enzymes: Binding of ligands to proteins - Co-operativity, the Hill equation-1h
Equilibrium dialysis technique-1h.
Sigmoidal kinetics: The MWC and KNF models-1h.
Significance of sigmoidal behaviour-1h
Allosteric enzymes and metabolic regulation-1h.
Study of ATCase- as typical allosteric enzyme-1h

CPT 2.2 – Metabolism of fuel molecules (4 Credits: 64 h)

Introduction: Basic concepts in metabolism: catabolism, anabolism, catabolic, anabolic and amphibolic pathways. 2 Hr

Carbohydrate metabolism: Introduction, glycolytic pathway, energetics and regulation of glycolysis, fate of pyruvate, oxidation of pyruvate. Citric acid cycle and its regulation, energetics, anaplerosis. Gluconeogenesis and its regulation, Cori cycle, glyoxylate cycle. glucose paradox. Futile cycles and their applications. Entry of other carbohydrates into glycolysis-fructose and galactose. 10 Hr

Glycogen and starch metabolism: Biosynthesis and degradation of starch and glycogen and its regulation. Glycogen storage disorders. Lactose intolerance, fructosuria, galactosemia. HMP pathway and its regulation. 4 Hr

Hormonal regulation of glucose metabolism: Effect of insulin and glucogon, catecholamines, growth hormones and carticosteroids on carbohydrate and lipid metabolism in different tissues. Action of thyroid hormones and their mechanisms. 4 Hr

Lipid Metabolism: Degradation of triacylglycerols, phospholipids and sphingolipids and regulations; lipase, hormone sensitive lipase, phospholipases and sphingomyelinase. Fatty acid degradation; α and β and ω-oxidation. Knoop's experiment, saturated and unsaturated fatty acids. Formation of ketone bodies and their oxidation. Energetics and biosynthesis of fatty acids; fatty acid synthetase complex, chain elongation and desaturation. Pathways in plants and animals, conversion of linoleate to arachiodnante (scheme only). 12 Hr

Cholesterol synthesis and degradation and regulations: Metabolism of circulating lipids; chylomicrons, HDL, LDL and VLDL. Reverse cholesterol transport by HDL. Oxidized lipids and their metabolism, Foam cell formation. Regulation of blood cholesterol, triglycerides, LDL and HDL. Obesity, and mechanisms, exercise and regulation of energy metabolism. 7 Hr

Phospholipid biosynthesis and regulations: Denovo pathway and inter conversion, biosynthesis of phospholipids, sphingolipids, ether lipids and glycolipids. Degradation and biosynthesis of gangliosides and cerebrosides. Biosynthesis of prostaglandins, thromboxanes andleukotrienes. 9 Hr

Integration of metabolic pathways: Integration of carbohydrate and lipid metabolism, and their regulation and manipulation. 2 Hr

Thermodynamics: I, II and III laws of thermodynamics. Enthalpy, entropy, free energy and chemical equilibrium. High energy compounds-Energy currency, ATP, ADP, creatine phosphate, phosphoenol pyruvate as energy rich compound. 5 Hr

Mitochondrial electron transport: Entry of reducing equivalents for oxidation; malate-aspartate shuttle, glycerol phosphate shuttle. Organization of respiratory chain complexes, structure and function of the components; Fe-S proteins, cytochromes, Q cycle, proton transfer, P/O ratio, respiratory control, oxidative phosphorylation, uncouplers and inhibitors, sequence of electron carriers based on redox potentials. ATP synthesis, ATP synthase complex, binding change mechanism, proton motive force, Mitchell's hypothesis.

SPT 2.3.1 - Cell Biology and Endocrinology (4 Credits: 64 h)

Cell Biology: Types of cells, Extracellular matrix.	1 Hr
Cytoskeletal elements and cell-cell Interactions-Adhesion.	1 Hr
Cell division and Cell Cycle-Mitosis and meiosis.	1 Hr
Cell cycle phases and Programmed cell death.	1 Hr

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Biomembranes-Composition of plasma and organelle membranes. 1 Hr
Singer and Nicholson's model and its salient features. 1 Hr
Membrane domains- Caveolae and Rafts. 1 Hr
Technique used to study the membranes structure-FRAP and single particle tracking. 1 Hr
Preparation and usage of liposomes and erythrocytes ghosts. 1 Hr
Membrane asymmetry. Protein-protein and protein-lipid interactions in membranes. Protein and lipid trafficking in membranes. 1 Hr
Membrane Transport: Passive, facilitated and exchange diffusion. Fick's law of diffusion and active transport. 1 Hr
Structure and function of Na-K ATPase and $Ca2^{+}$ATPase. 1 Hr
Ion channels. 1 Hr
ionophores and aquaporins. 1 Hr
Receptor mediated endocytosis and exocytosis. 1 Hr
Disorders associated with membrane transport Systems-Cystic fibrosis. Bacterial transport system. 1 Hr
Nervous system: Division of nervous system-neutron structure and types. 1 Hr
Role of NGF, N-CUM and other specialized proteins. 1 Hr
Resting membrane potential of excitable cells. 1 Hr
Mechanism of initiation and propagation of action potential. 1 Hr
Voltage gated ion channels (sodium, potassium and calcium). 1 Hr
Design and use of patch clamp in measuring membrane potential. 1 Hr
Depolarization and hyperpolarization in post-synaptic cells. 1 Hr
Synaptic transmission. 1 Hr
Neurotransmitters, biogenic amines, amino acids and neuropeptides. 1 Hr
Storage and exocytosis of neurotransmitters. 1 Hr
Termination of neurotransmitters action. 1 Hr
Acetylcholine receptors, nicotinic and muscarinic adrenergic receptors, other neurotransmitters receptors. 1 Hr
Mechanism of synaptic transmission. 1 Hr
Receptor integrated ion channels and G-protein mediated ion channels. 1 Hr
Use of agonists and antagonists of neurotransmitters in Biochemistry and medicine. 1 Hr
Endocrine System: Endocrine organs in man. 1 Hr
Location and inter relationship of endocrine glands in man. 1 Hr
Chemistry of hormones produced by hypothalamus, pituitary, thyroid, parathyroid. 2 Hr
Chemistry of hormones produced by pancreas, adrenals, gonads and intestine. 2 Hr
Functions and abnormalities- hypo and hyper production of hormones secreted by; pituitary, thyroid, pancreas. 1 Hr
Functions and abnormalities- hypo and hyper production of hormones secreted by adrenals and gonads. 1 Hr

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Structure and control of hypothalamus: Hormones produced; GRH, somatostatin, TRH, CRH, GnRH. 2 Hr

Pituitary-anatomy and structure- Hormones of anterior, posterior and median lobes. Proopiomelanocortin. 2 Hr

Testes and ovaries- hormones produced by testes and ovaries. 2 Hr

Menstrual cycle. 1 Hr

Regulation of hormone production and release: hypothalamus-pituitary-target organ axis and regulation by feedback mechanism. 2 Hr

Conversion of cholesterol to steroid hormone. 1 Hr

Mechanism of action of Hormone:

Peptide Hormones-General mechanisms of cell signalling by hydrophilic factors, transmembrane receptors. Isolation and characterization of insulin receptor. 1 Hr

General mechanisms of cell signalling by G protein coupled receptors. 1 Hr

General mechanisms of cell signalling by receptor tyrosine kinase, eicosanoid receptors. 1 Hr

Second messengers: 1P3, DAG, cAMP, protein kinases. 1 Hr

Nitric oxide signalling; generation and action. 1 Hr

Growth factors: Structure, mechanism of action and receptors of EGF, PDGF. 1 Hr

Structure, mechanism of action and receptors of NGF and IGF. 1 Hr

Steroid hormones- Steroid receptors, isolation and characterization of steroid receptors. 1 Hr

Receptor down regulation, desensitization and up regulation. 1 Hr

Pineal gland, Melotonin, circadian rhythm. 1 Hr

Insect hormones: Structure and function of moulting hormone, ecdysone. 1 Hr

Structure and function of juvenile hormones. 1 Hr

Biochemistry of Plant hormones. 1 Hr

Pheromones: Mechanism of perception and action. 1 Hr

Use of pheromones in control of agricultural pests. 1 Hr

OET 2.4 – Biological Macromolecules

Lipids: Brief account of the chemistry-1h

Classification of lipids (without structural elucidation) - 1h.

Biological role of the following: Fatty acids, Aryl glycerols-1h.

Cholesterol, Terpenes-1h

Waxes and Bile salts-1h

Phospholipids, Sphingolipid-1h

Glycolipids, Steriods-1h

Prostaglandins-1h

Thromboxanes and Leukotrienes-1h

Properties of lipids aggregates-micelles, Bilayer and Liposomes-1h

Nucleic Acids: Structure and properties of nucleosides and nucleotides-1h
Properties of nucleic acids in solution-1h
Hydrolysis of nucleic acids by acid and base-1h
Enzymatic hydrolysis-1h
Nuclease specificity -1h
Restriction endonucleases-1h
Chemistry of DNA- Structures and functions of DNA-1h,
Staining of DNA-1h
PCR and its applications-1h
Chemistry of RNAs: Structures and functions of mRNA-1h
tRNA and rRNA-1h

CPT 3.1 – Metabolism of nitrogen compounds

Nitrogen Cycle: Introduction to biological and non-biological nitrogen fixation-1h
Brief introduction to nifgenes-1h
Utilization of nitrate and nitrites, regulation of nitrate reductase-1h
Amino acids in animal, plant and microbial systems-Glucogenic and ketogenic amino acids and their significance-1h
Degradation of amino acids forming pyruvate alanine, glycine-1h
Degradation of Threonine, serine, cysteine, cysteine-1h
Degradation of Tryptophan, oxaloacetate (aspartic acid and asparagine) -1h
Degradation of α- ketoglutarate (glutamic acid, glutamine) -1h
Degradation of Arginine-1h
Degradation of Histidine-1h
Degradation of proline and succinyl CoA-1h
Degradation of valine, isoleucine, -1h
Degradation of threonine -1h
Degradation of methionine -1h
Degradation of phenylalanine, tyrosine -1h
Degradation of leucine-1h
Degradation of lysine -1h
Degradation of pyruvate -1h
Degradation of tryptophan-1h
Inherited disorders associated with glycine-1h
Aromatic, branched- chain, basic and sulfur containing amino acid metabolism-1h
Biosynthesis of amino acids: in animal, plant and microbial systems-1h
Biosynthesis of pyruvate (alanine) -1h
Biosynthesis of serine,-1h
Biosynthesis of tyrosine -1h

Biotransformation of serine to glycine and cysteine-1h
Biosynthesis of aspartic acid, asparagine, glutamic acid and glutamine -1h
Biosynthesis of glycine, proline and arginine -1h
Biosynthesis of cysteine -1h
Biosynthesis of threonine, -1h
Biosynthesis of lysine-1h
Biosynthesis of methionine-1h
Biosynthesis of valine and leucine) -1h
Biosynthesis of isoleucine -1h
Biosynthesis of phenylalanine-1h
Biosynthesis of tryptophan-1h
Biosynthesis of histidine-1h
Regulation of amino acid biosynthesis by sequential and concerted feedback inhibition. -1h
Amino acid Metabolism: General metabolic reaction of amino acids– transamination-1h
Pseudotransamnation-1h
Glucose–alanine cycle -1h
Oxidative deamination (glutamate dehydrogenase) -1h
Minor pathways of amino acid degradation - transdeamination, amino acid oxidase-1h
Nonoxidative deamination (deaminase, dehydrase, asparaginase and glutaminase) -1h
Assimilation of ammonia, formation of amino acid amides by glutamine synthetase and its regulation-1h
Urea cycle– regulation and metabolic disorders. -1h
Biosynthesis of creatine and creatine phosphate-1h
Polyamines– putrescine, spermidine and spermine,
Glutathione (γ-glutamyl cycle), -1h
Physiologically active amines (serotonin. γ-amino butyric acid, histamine-1h
Catecholamines – dopamine, epinephrine and epinephrine) -1h
Heme Metabolism: Biosynthesis of porphyrin-1h
Degradation of porphyrin -1h
Porphyrias, jaundice and Hemoglobinopathies-1h
Nucleotide Metabolism: Biosynthesis of purine -1h
Biosynthesis of pyrimidine nucleotides -1h
Nucleotides inter conversion-1h
Other pathways of purine nucleotide formation-1h
Biosynthesis of deoxyribonucleotides -1h
Biosynthesis of Coenzymes nucleotides -1h
Chemical inhibition of the biosynthesis of nucleic acid precursors-1h
Degradation of purine -1h
Degradation of pyrimidines-1h
Disorders associated with their metabolism; gout-1h

Lesch-Nyhan syndrome-1h
Oroticaciduria, and xanthinuria-1h

CPT 3.2 - Immunology

History and scope of immunology:
Types of immunity- innate and adaptive. Immune reactive cells. Humoral and cell mediated immunity. 1 Hr
Anatomy of lymphoid organs- primary lymphoid organs, secondary lymphoid organs and lymphtic system. 2 Hr
Antigens-chemical nature, types, antigenicity, haptens, epitopes, antigenic determinants, adjuvants and super antigens. 2 Hr
Valency of antigen, epitope analysis. 2 Hr

Immunoglobulins:
Basic structure, functions, theories of antibody formation, classes and immunoglobulin super family. 2 Hr
Antigenic determinants on immunoglobulins. 1 Hr
Methods of raising polyclonal antibodies. 2 Hr
Monoclonal antibodies – production and application. 2 Hr
Antibody diversity- mechanism contributing to diversity, somatic recombination, rearrangement and generation of antibody diversity. 2 Hr
Class switching. 1 Hr

Cellular Basis of Immunity:
Primary and secondary immune response. 2 Hr
Reticuloendothelial system, T, B and accessory cells. 2 Hr
Development of T and B cells. Sub sets of T and B cells. T-helper cells, T-killer cells, T-suppressor cells. 3 Hr
T and B cell receptors, antigen processing and presentation. 2 Hr
T and B interaction. 1 Hr
Cytokines and co-stimulatory molecules; lymphokines, interleukins, structure and function of IL-lβ, IL-2, TNF-α.
Suppression of immune response 1Hr
Immunoglobulin genes, generation of immunoglobulin diversity, gene rearrangement and other mechanisms, clonal selection theory of Burnet. 2 Hr

MHC: MHC gene and its polymorphism, role of MHC in immune response and transplantation. 2 Hr

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ಸ್ನಾತಕೋತ್ತರ ಜೀವರಸಾಯನಶಾಸ್ತ್ರ
ಅಧ್ಯಯನ ಮತ್ತು ಸಂಶೋಧನಾ ವಿಭಾಗ
ತುಮಕೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ
ತುಮಕೂರು-572103

T and B cell lymphocytes: origin, differentiation, characterization and functions. T cell and B cell receptor complexes. 3 Hr

Antigen processing and presentation. Cytokines and co-stimulatory molecules. Role in immune response. 2 Hr

T and B cell interactions. 1 Hr

Complement system:

Components, receptors, activation of complement pathways and its biological consequences.

Major histocompatibility complex (MHC) genes and products. 2 Hr

Role of MHC antigens in immune response, MHC antigens in transplantation. 3 Hr

Non-specific defences in man:

Barriers to infection; skin, mucous membrane, inflammation 3 Hr

Hyper sensitivity reactions (Type I, II, III and IV). 2 Hr

Transplantation:

Autograft, isograft, allograft and xenograft. 2 Hr

Graft rejection, graft vs. host reaction. 2 Hr

Tumour immunology:

Tumour associated antigens, factors favouring tumour growth, immune surveillance. 1Hr

Tumour necrosis factor-α and β. 1 Hr

Disorders of immunity:

Immunological tolerance, auto immune disorders, AIDS, SCID. 2 Hr

Vaccines:

Adjuvants, vaccines and their preparations. 2 Hr

Polyclonal and monoclonal antibodies; hybridoma technique. 2 Hr

In vitro antigen-antibody reaction:

Precipitation, agglutination, complement fixation, immuno diffusion, immunoelectrophoresis, immunofluorescence, RIA, ELISA. 4 Hr

Defence system in plants:

Host parasite interaction and defence system in plants. 3 Hr

SPT 3.3.2 - Clinical Biochemistry and Dietetics

Disorders of carbohydrate metabolism: Diabetes- aetiology, classification. 1 Hr
Diabetes- management, laboratory investigations. GTT, GlycatedHb. 1 Hr
Diabetic complications. 1 Hr
Inborn errors of carbohydrate Metabolism-Glycogen storage diseases. 1 Hr
Inborn errors of carbohydrate metabolism Galactosemia, Lactose intolerance, Pentosuria. 1 Hr.
Disorders of Lipid metabolism- Plasma lipoproteins and their functions. 1 Hr
Hyperlipoproteinaemia- classification, Primary and secondary. 1 Hr
Hypercholesterolemia, Ketosis and its significance. 1 Hr
Disorders of amino acid and protein metabolism- Inborn errors of amino acid metabolism- PKU, Alkaptonuria. 1 Hr
Disorders of purine and pyrimidine Metabolism-Gout, Lesch-Nyhan syndrome, Xanthuria, Oroticaciduria. 1 Hr
Cardiovascular disorders- Major cardiovascular system- 1 Hr
Atherosclerosis- risk factors, pathogenesis, diagnosis and prognosis. 1 Hr
Gastrointestinal disorders: Fractional gastric analysis. 1 Hr
Hypo and hyperacidity. 1 Hr
Gastric ulcers.
1 Hr
Malabsorption syndrome. 1 Hr
Dietetics: Introduction to nutrition. Food pyramid. 1 Hr
Diet planning and introduction to diet therapy. 1 Hr
Nutritional requirements for different age groups, anaemic child, expectant women, and lactating women. 1 Hr
Diet planning for prevention and cure of nutritional anaemia. 1 Hr
Diet therapy: Functional foods. 1 Hr
Dietary considerations during fever, and typhoid. 1 Hr
Dietary considerations during malaria, influenza and tuberculosis patients. 1 Hr
Prevention, and correction of obesity and underweight by diet therapy. 1 Hr
Prevention, and correction of metabolic diseases by diet therapy. 1 Hr
Dietary interventions to correct and or manage gastrointestinal diseases-indigestion and peptic ulcer. 1 Hr
Dietary interventions to correct and or manage gastrointestinal diseases- stomach carcinoma, and constipation. 1 Hr
Dietary interventions to correct and or manage gastrointestinal diseases-diarrhoea, steatorrhoea, and irritable bowel syndrome. 1 Hr
Diets in liver diseases – Hepatitis 1 Hr
Diets in liver diseases – Cirrhosis 1 Hr
Cholecysthetis and cholelithiasis. 1 Hr
Functional foods based diet therapy for diabetes and cardiovascular disease. 1 Hr

Functional foods based diet therapy for nephritis, and genetic disorders-PKU. 1 Hr
Functional foods based diet therapy for genetic disorders- galactosemia, lactose-intolerance and fructosurea). 1 Hr
Functional foods based diet therapy for cancers. 1 Hr

OET 3.4 - Biochemical Toxicology

Definition and scope of toxicology: Definition, types, toxins, toxic materials. Eco-toxicology and its environmental significance. 2 Hr
Toxic effects: Basic for general classification & nature. 1 Hr
Dose-Response relationship: 1 Hr
Synergism and Antagonism, 1 Hr
Determination of ED_{50} & LD_{50}. 1 Hr
Acute and Chronic exposures. 1 Hr
Factors influencing Toxicity. 1 Hr
Pharmacodynamics 2 Hr
Chemodynamics. 2 Hr
Diagnosis of toxic changes in liver and kidneys:
Metabolism of Haloalkanes 1 Hr
Metabolism of Haloalkenes 1 Hr
Metabolism of Paracetamol 2 Hr
Toxic effects Haloalkanes, Haloalkenes and Paracetamol on tissues. 2 Hr
Xenobiotics Metabolism: Absorption & distribution. 1 Hr
Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. 2 Hr
Phase II reaction/Conjugation: Methylation, Glutathione and amino acid conjugation. Detoxification. 2 Hr
Biochemical basis of toxicity: Metabolism of Toxicity: 1 Hr
Distrbances of Exitable membrane function. 1 Hr
Altered calcium Homeostasis. 1 Hr
Covalent binding of cellular macromolecules & Genoatoxicity. 1 Hr
Tissue specificity of Toxicity.
1 Hr
Toxicity testing: Test protocol, Genetic toxicity testing. 1 Hr
Mutagenesis assays: In vitro Test systems – Bacterial Mutation Test: 1 Hr
In vitro Test systems: Reversion Test, Ames Test, Fluctuation Tests. 1 Hr
Eukaryotic Mutation Tests. 1 Hr
In vivo Mammalian Mutation tests – Host mediated assay & Dominant Lethal Test. 1 Hr
Use of Drosophila in toxicity testing. 1 Hr
DNA repair assays. 2 Hr

Chromosome damage test. 1 Hr

Toxicological evolution of Recombinant DNA – derived proteins. 1 Hr

Pesticide toxicity:

Insecticides: Organochlorines, Anti cholinesterases – Organophosphates and Carbamates 3 Hr

Fungicides, herbicides 3 Hr

Environmental consequences of pesticide toxicity. Biopesticides. 6 Hr

Food Toxicity:

Role of diet in cardio-vascular disease and cancer. 3Hr

Toxicology of food additives. 3 Hr

Metal Toxicity:

Toxicology of Arsenic, mercury, lead and cadmium. 3 Hr

Environmental factors, affecting metal toxicity effect of light, temperature & pH. 3 Hr

Air pollution:

Common air Pollutant & their sources. 1 Hr

Air pollution & ozone. 1 Hr

Air pollution due to chlorofluorocarbons (CFCS) and asbestos. 3 Hr

CPT 4.2 - Biochemical genetics and gene regulation

- Introduction, Nature of genetic material
- Introduction Prion chromosomes and genes
- Concept of mutation, Classification of Mutation and types of mutation. Chemical and physical mutagens. mechanism of mutation
- Process of induction of mutagenesis in bacteria, fungi, plant, induction and isolation of mutants. Role of mutant organisms in genetic studies.
- Introduction to Classical genetics.
- Mendel's work on genetics, Selection of pea plants, its advantages in studying genetics
- Monohybrid cross between Tall and dwarf plant, Dihybrid cross using green round, yellow wrinkled, Mendel's laws- Law of dominance, Law of segregation, Law of independent assortment
- Introduction to Drosophila as model for studying genetics.
- Inheritance of acquired characters- Sex linked inheritance
- Population genetics
- Introduction to extra nuclear inheritance- Study of mitochondrial and Chloroplast DNA DNA, double helical, autonomously replicating circular CCC DNA, their comparison to bacterial DNA.
- Introduction to Sex determination, Sex determination in Drosophila XO pattern, Sex determination in humans XY pattern
- Sex-linked inheritance in Drosophila- X linked traits, Bar body, red eyed

- X-linked inheritance in humans. Haemophilia, colour-blindness. Isolation of chromosomes: Nuclei method, gentle disruption of cell membrane, Isolation of chromosomes.
- Chromosome staining and Identification of sex chromosomes 22 pairs and X Y or XX chromosomes. Mechanism-Females always showed XX and males XY pattern was the basis of Determination of sex chromosomes
- Detailed study of Bacterial chromosome. Plasmids and episomes; fertility plasmid, resistance plasmid- antibiotic resistance, toxicity resistant plasmids and colicinogenic plasmids.
- Introduction to genetic recombination's- Types. Homologous recombination, site-specific recombination and transposition in bacteria.
- Mechanism of homologus recombination- function of Rec A and BCD complex.
- site-specific recombination,
- conjugation and transposition
- Transposons and Insertional sequences, transposable genetic elements
- Introduction and concept of Genetic transformations in bacteria transformation (Ex., Pneumococci, Bacillus sp.) and
- conjugation (antibiotic resistance, biotin genes,) in E. coli. HFR cells.
- Linkage and crossing over- linkage map in bacterial DNA, operon system.
- Introduction to Human Genetics, higher orders of organization. Chromosome banding,.,..
- Biochemical events occurring during mitosis and meiosis: Different phases of mitosis and biochemical events
- Meiosis and the biochemical events
- Concept of chromosome staining, Giesma banding, fluorescence banding.
- Recombination frequency studies, chromosome mapping using recombination frequency
- Eukaryote genome, fine structure of gene. Concept of introns and exons and pseudogenes.
- Gene clusters, spacers, repetitive DNA sequences (Alu in human)
- Transposons Ac-DS system in maize and P system in Drosophila. Human genome project- EST database.
- Assignment of important genes. Transposition in human chromosomes. Chromosomal abnormalities
- Introduction to Regulation of gene expression in prokaryotes.
- Outline of transcriptional regulation, Induction, repression, constitutive/basal level expression.
- Regulator, promoter, operator and structural genes- activators and repressors. Identification of control regions by DNase-foot printing, gel mobility assay methods
- Concept of regulation of gene expression at transcriptional level.
- Operon concept and expression of inducible or non-inducible gene
- Inducers- substrate or gratuitous inducer, Induction. Repressor – gene product (negative regulation), Enhancer (Positive regulation)
- Constitutive and basal level of gene expression
- The operon model; Regulation of gene expression at transcriptional level -
- Concept of positive regulation and negative regulation.
- Operon concept- study of structure and regulation of Lac operon,
- Jacob and Monod hypothesis- Catabolite repression –Glucose as an example

- role of cAMP and cAMP-receptor protein (CRP/ CAP) in the expression of glucose
- sensitive operons, structure and functions of CAP.
- Concept of trp operon, regulation of trp operon in E.coli
- Mechanism of negative and positive regulation. I-gene product and tryptophan (repressor-corepressor complex) for negative regulation.
- Mechanism of attenuation using leader sequence. Transcription and translation of leader sequence.
- Regulation of arabinose operon and histidine operon
- Structure and functions of λ repressor, Cro, and λcII.
- Anti-termination as a mechanism of regulation.
- Introduction to gene expression in eukaryote organisms
- Levels of control of gene expression in eukaryotes
- Regulation of gene expressions in yeast.
- Regulation of galactose metabolism in yeast
- Regulation of expression of β-globin gene
- DHFR gene concept- local amplification of DHFR gens to hundreds of folds to overcome DHFR toxicity- a classical example.
- Histone modification. Brief study of regulation of developmental genes in Drosophila
- Protein-DNA interactions
- Mechanism of interaction by zinc finger, leucine zipper, helix-turn-helix and other motifs
- Regulation at the level of post translational modification:
- proteins stability, N-end rule, PEST and other sequences
- Ubiquitination of cargo proteins-ubiquitin mediated degradation.

SPT 4.3.1 - Genetic engineering and biotechnology

- Introduction to Genetic engineering. Definition, aims and objectives of recombinant DNA technology
- Extraction and purification of nucleic acids (DNA and RNA) from biological sources. Alkali lysis method, STET method, nuclei method,
- restriction-modification systems, restriction enzymes
- RE Type I, II and III, specificity, sticky ends and blunt ends, isoschizomers.
- What is the need to clone a gene, what is clone. Reagents and tools required for gene cloning
- Characteristics and applications of restriction endonucleases and modifying enzymes.
- Methods of Isolation of gene/ DNA fragment for cloning. Resin binding, alkali lysis, nuclei method, STET method
- Gene cloning method, Invivo using vector like p^{BR322} p^{UC} $p^{GEM,}$ a
- Gene amplification cloning by PCR
- Characteristics and applications of Plasmid and Cosmid
- Characteristics and applications of phagemid, M13 phage
- Characteristics and applications of λvector, BAC,

- λvector, BAC, PAC, and YAC PAC, and YAC
- Selection of suitable vectors for cloning, expression and sequencing of DNA fragments.
- Ligation of gene/ DNA to vector: Blunt end and sticky end ligation, use of linkers and adopters
- Homo polymer tailing, colony hybridization, plaque hybridization
- Micro injection, electroporation
- lipofection, calcium phosphate method
- protoplast fusion/somatic cell hybridization and biolistic methods.
- Transgenic plants and animals, gene knock out.
- Identifying the right clones: Direct screening;
- insertional inactivation of gene- compromised antibiotic resistance, blue white,
- Screening of clones to detect right clone by visual screening, and plaque phenotype.
- Detection of recombinant bacteria by Indirect screening; immunological techniques,
- hybrid arrest translation, hybrid select translation
- Screening using probes; construction of gene probes, hybridization and labelling
- DNA sequencing: Highthroput sequencing of DNA, shot gun fragment and
- Orderinf fragment sequences by chromosome walking,
- PCR purification and analysis of product DNA or gene
- Concept of nested PCR
- applications of PCR in cloning, agriculture and medicine
- RT-PCR technique and applications. Real time PCR for quantification
- Probing DNA fragments for gene analysis by Southern blotting
- Detection of RNA, m-RNA by directing complementary probe- Northern blotting
- Western blot, DNA finger print assay, gel retardation assay.
- Applications of genetic engineering in gene therapy, agriculture (terminator gene)
- Application of genetic engineering in medicine, diagnostic, food
- Negative impact of genetic engineering.
- Introduction to Industrial microorganisms and their characteristics,. Organism and strain improvement: origin of industrial
- Primary and secondary metabolites.
- Design of batch fermenter, CSTR, semicontinuous and continuous feed-batch fermenters
- Fermentation types. Bioprocess development.
- Isolation and improvement of microbial strain.
- Raw materials and fermentation media, optimization of growth and culture conditions,
- growth Kinetics and product formation kinetics,
- Rheological parameters to be considered for scale-up of bioprocess from lab to industrial scale.
- Methods of cell Immobilization, Fed-batch and continuous fermentations by immobilized systems
- . Downstream process, Recovery and purification of products
- Production of glutamic acid by fermentation process- homofermentation, heterofermentation,
- Production of lysine by fermentation process- Biotin, PUFA based accumulation of lysine
- Production of citric acid and itaconic acid by fermentation process
- Production of vitamins ex biotine by fermentation process
- Production of antibiotic ex. penicillin by fermentation process

- Production of solvents and alcohols, bioethanol and butanol.
- Production of Acrylonitrile, biogas and Biopolymers
- Production of enzymes (amylase, proteases, cellulases, xylanases,) from bacterial and fungal strains by solid-substrate and submerged fermentation
- Introduction to Environmental and agriculture Biotechnology, Application of biotechnology in the Natural control of insect pests
- Biotechnological applications in the Production of biopesticides.
- Development of specialized microorganisms for bioremediation of toxic environmental pollutants- PAHs and their derivatives
- Genetically engineered microorganisms for the degradation of toxic waste
- Biodegradation of industrial effluents, pesticides
- Bioremediation of toxic industrial pollutants
- and pesticide
- Bioremediation of contaminated sites for ex, metal contaminated site, crude oil contaminated site, nuclear residues, pesticide contaminated site

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