BIO- CHEMISTRY

Semester I

MBC-101: Introductory Biological Chemistry
(M.Sc.; Paper-I)

M.M. 100 (70+30)

Unit-I

Properties of Water, pH, Henderson-hasselbalch equation, Buffer, Significance of physiological buffer.

Carbohydrates: Classification and properties of simple carbohydrates, monosaccharides, disaccharides and polysaccharides, reducing and non reducing sugar, enantiomers, Structural polysaccharides: cellulose, Storage polysaccharides: starch and glycogen, glycoproteins and glycolipids, biological importance of carbohydrates.

Unit-II

Enzymes: Classification and nomenclature of enzymes, active site, factors affecting enzymatic catalysis, prosthetic groups and cofactors, structure and properties of important coenzymes, abzymes and ribozymes, biological importance of enzymes.

Unit-III

Lipids: Classification, structure, chemistry and biological significance of lipids, steroids, prostaglandins and eicosanoids, chylomicrons, LDL, HDL and VLDL.

Unit-IV

Proteins: General properties and configuration of amino acids, peptide bond formation and its characteristics, different types of protein structures, protein denaturation, biological importance of amino acids and proteins.

Unit-V

Nucleic Acids: Structure and properties of purines and pyrimidines, nucleosides and nucleotides, structure of DNA (A, B, & Z) and RNA, DNA as genetic carrier, physico-chemical properties nucleic acids, Chargaff's rule, DNA denaturation, Genetic code.

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MBC-102: Tools and Techniques in Biochemistry
(M.Sc.; Paper-II)

M.M. 100 (70+30)

Unit I

Spectroscopy– Concepts of spectroscopy, Visible and UV spectroscopy, Beer-Lambert's law, Principles and applications of colorimetry, Principles and biological applications of NMR, ESR, Raman, Mass, atomic absorption and atomic emission spectroscopy and X-ray crystallography.

Unit II

Chromatography & Microscopy – Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC.Transmission and scanning, freeze fracture techniques, specific staining of biological materials.

Unit III

Centrifugation & Radioactive techniques – Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation. Introduction to radiations and their uses in biology, safety measures, principles and applications of liquid scintillation counting (LSC), Gamma counting and autoradiography.

Unit IV

Electrophoretic techniques & Viscosity– Principles of electrophoretic separation. Continuous, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, pulse field gel electrophoresis. **Viscosity**– Viscosity of macromolecules, relationship with conformational changes.

Unit V

Biostatistics, Computers and Bioinformatics-Statistical analysis of biochemical data: standard deviation, variance, mean, median, mode. Basics of common application software packages for Word processing (MS Word), spreadsheets (MS Excel) and presentation (MS Powerpoint). Introduction to internet, Medline and Pubmed for accessing biological information. **Introduction to Bioinformatics-** Accessing and retrieving sequence information from genome sequence databases, use of genomic data. Overview of comparative and functional genomics, Introduction to protein modeling and proteomics.

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MBC-103: Bioenergetics
(M.Sc.; Paper-III)

M.M. 100 (70+30)

Unit I

Metabolism, living organism participate in the cycling of carbon and oxygen, nitrogen cycle, metabolism consists of catabolic pathways and anabolic pathways. Energy relationships between catabolic and anabolic pathways.

Unit II

Principle of bioenergetics, bioenergetics and thermodynamics – biological energy transformation obey the Laws of Thermodynamics, first law of thermodynamics, second law of thermodynamics; Gibbs free energy, enthalpy, entropy and their relationships; the change in free energy determines the direction and spontaneity of a chemical reaction. Free energy change and directly related to equilibrium constant; generation of concentration gradients and in understanding enzymes. Unfavourable chemical reactions can be driven by coupling to an energetically favourable reaction.

Unit III

Energy cycle and specialized role of ATP as universal currency in biological system; free energy change for ATP hydrolysis is large and negative; ATP hydrolysis drives metabolism by shifting the equilibrium of coupled reactions. Other phosphorylated compounds and thioesters – have large free energies of hydrolysis- but not suitable as currency of energy. ATP provide energy by group transfer; ATP donate phosphoryl, pyrophosphoryl and adenylyl groups. ATP drives many cellular process; trans-phosphorylation, Inorganic phosphate as a potential phosphoryl donor.

Unit IV

Flow of electrons can do biological work; oxidation- reductions as half reactions; oxidation-reduction involves dehydrogenation; reduction potential; standard reduction potentials and free energy change; certain coenzymes and proteins serve as universal electron carriers; NADH and NADPH with dehydrogennases serve as soluble electron carriers; Flavin nucleotides tightly bounds with flavorprotein also serve as electron carriers, coenzyme Q as lipid soluble electron carrier.

Unit V

Chemiosmotic theory of Peter Mitchell and its justifications. Electron transport chain; proton motive force. Oxidative phosphorylation and ATP synthesis uncouplers,

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MBC-104: Biosynthetic Pathways
(M.Sc.; Paper-IV)

M.M. 100 (70+30)

Unit I

Biosynthesis of disaccharides, starch, glycogen, cellulose and mucopolysaccharides gluconeogenesis, interconversion of sugars.

Unit II

Biosynthesis of Fatty acids, triglycerides, cholesterol and its regulation.

Unit III

Biosynthesis and regulation of: porphyrins, Purines and Pyrimidines, and Amino acids, Urea cycle,

Unit IV

Biochemistry of Nitrogen Fixation, Physiology of nodule formation, oxygen sensitivity of nitrogenase complex and protection methods, Regulation system of ammonia synthesis and its utilization, ammonium and nitrate transport and assimilation system, component of Diazotrophic symbiosis, nif gene, nod gene.

Unit V

Energy transduction in chloroplast: Structure of organelles involved in plant and bacterial photosynthesis, Light receptors and Light Harvesting complexes, Hill reaction and its components, , ETC and its differences from electron transport mechanism of Mitochondria, chemiosmotic theory of cyclic and non cyclic photophosphorylation,Carbon reduction Pathways in plants(C3,C4 and CAM), Photorespiration, Bioluminescence. . Chemiosmotic theory of transpiration.

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MBC-105: Laboratory Course – I

(M.Sc.)

M.M. 200

1. Qualitative and Quantitative Analysis of –

a) Carbohydrates

b) Amino acids and proteins

c) Free and bound phosphate

d) Vitamin C

2. Fats: Acid number, saponification, and iodine values.

3. Fractionation of egg proteins and its quantification.

4. Isolation of casein from milk and its quantification.

5. Isolation and estimation of serum cholesterol.

6. Qualitative and quantitative analysis of: (i) Saliva (α-amylase); (ii) Urine (urea, uric acid, glucose, proteins)

7. Experiments on blood: (a) Identification and count of blood corpuscles; (b) Estimation of haemoglobin

8. Determination of Serum creatinine and uric acid.

10. Determination of Serum enzyme assays: alkaline phosphates, SGOT, SGPT.

Semester II

MBC-206: Biomembranes and Transport
(M.Sc.; Paper-I)

M.M. 100 (70+30)

Unit I

Membrane lipids. Physical properties of lipids and their interaction with water to form membranes. Concept of fluidity and factors causing variations in fluidity. Appropriateness of varied lipid geometry for different membrane structures. Micelles, liposomes, planar bilayers and dark membranes. Lipid rafts. Membrane asymmetry.

Unit II

Biological membranes. Modification of lipid fluidity by membrane proteins. Arrangement of proteins within lipid bilayers. Hydropathy plots and prediction of membrane spanning domains. Organization of chloroplast and mitochondrial membrane systems.

Unit III

Techniques to study biomembranes. FRAP, FRET, Use of spin labeling and polarity dependent fluorescence probes to determine membrane state changes. Detergents. Solubilization, purification and reconstitution of membrane protein systems.

Unit IV

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

Unit V

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

MBC-207: Molecular Biology
(M.Sc.; Paper-II)

M.M. 100 (70+30)

Unit I

Organization of genetic materials: in prokaryotes-genome type and size, nucleoid, structural maintenance protein (SMP), Eukaryotes- nucleosome, histones, chromatin, remodeling, DNA binding proteins and motifs, concept of gene, fine structureof gene (intron, exon, replicon, recon, muton, cistron, genome organization, gene density, satellite DNA, mechanical strength, reassociation kinetics- COT value: associated repeats) Central Dogma.

Unit II

DNA replication; experimental evidences, Replicon, ARS (autonomously replicating sequences), ORE (origin replication element), DUE (DNA unwinding element), Replisome, DNA Polymerase in prokaryotes and eukaryotes, replication fork, Clamp loader complex, Helicase, topoisomerase: DNA gyrase, DNA ligase, Direction of replication, okazaki fragments, Primers for replication, reaction mechanism of polymerization, End replication problem, Telomerase, fidelity of replication, replication of RNA viruses, Inhibitors.

Unit III

Transcription: RNA polymerase in prokaryotes and eukaryotes and associated factors, Direction of transcription, Promotors and its recognition, initition, elongation and termination, regulation of transcription by inducers and repressor, Cis and trans acting elements, concept of operon (lac operon and trp operon), Catabolic activator, Post transcriptional processing (hn RNA, RNA splicing: modes and spliceosome, maturation of RNA and t-RNA), Transcriptional bursting, RNA editing, HomeoBox domain, HD proteins, Inhibitors.

Unit IV

Translation: sites, properties of genetic code, wobble hypothesis, involvement of ribosome and ribosomal proteins, amino acyl t-RNA, Shine dalgarno sequence, initiation, elongation and termination, role of various factors and GTP, recycling of ribosomes, ORF (open reading frame), t-RNA structure, ribosome subunits, regulation (by Pbodies, exosome, mi RNA, Riboswitches), ribosome recycling, post translational processing, protein secretion and targeting.

Unit V

Mutation: mutagenic agents, molecular basis of mutation, genetic repair mechanism, Cancer: types, molecular basis, prevention and cure, Genetic mapping by conjugation and transduction.

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MBC-208: Physiology and Clinical Biochemistry
(M.Sc.; Paper-III)

M.M. 100 (70+30)

Unit-I

Body fluids: Blood – function, composition, blood groups, Rh factor, plasma proteins, blood coagulation, clot formation and coagulation. Urine and its composition, alterations under pathological conditions, role of kidney in acid-base and electrolyte balance.

Unit-II

Physiological roles of hormones, mechanism of action of hormones and prostaglandins. Physiological roles of vitamins: Structure, function and their deficiency diseases.

Unit-III

Biochemistry of respiration, Muscle contraction, cell motility, role of calmodulin. Detoxification of Xenobiotic, Phase I and Phase II reactions.

Unit-IV

Nerve impulse transmission: nerve and synapse structure, excitation – its conduction and synaptic transmission by neural systems, neurotransmitters, venoms and nerve poisons.

Unit-V

Clinical and biochemical aspects of atherosclerosis, jaundice, diabetes, hepatitis, glomerular nephritis, gall stones, Addison's disease, Conn's syndrome, Cushing's syndrome, hypo & hyperthyroidism, Parkinson's disease and Alzheimer's disease.

MBC-209: Protein Chemistry & Enzymology
(M.Sc.; Paper-IV)

M.M. 100 (70+30)

Unit I

The native state of proteins; denaturation and inactivation of proteins; characteristics and importance of different levels of protein structure; protein evolution; assembly of fibrous proteins; the concept and importance of domain structures in proteins.

Unit II

Measurement of stability of the native state; the role of short-, medium-, and long-range interactions in protein folding; mechanism of protein folding; the thermodynamics and kinetics of protein folding; determinants of protein folding with special reference to the roles of molecular chaperones, signal peptides and the environment in protein folding; the problem of inclusion body formation and recovery of active proteins.

Unit III

The living state and role of enzymes in its sustenance; chemical catalysis: general-acid-base, covalent and intramolecular catalysis; detection of intermediates in enzymatic reactions; features and mechanism of action of lysozyme, chymotrypsin and carboxypeptidase A.

Unit IV

Steady state and equilibrium hypotheses of enzyme kinetics, Michaelis-Menten and Briggs-Haldane equations, significance of Michaelis-Menten parameters i.e. V_{max}, K_m, k_{cat} and k_{cat}/K_m ; mechanism and features of different types of enzyme inhibition; breakdown of the Michaelis-Menten equation; mechanism and kinetics of multisubstrate reactions.

Unit V

Enzyme induction, repression and covalent modification; feed back inhibition; importance of isozymes and zymogen in enzyme regulation; allosteric enzymes and their regulation; Hills coefficient and the determination of enzyme-ligand binding/dissociation constant.

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MBC-210: Laboratory Course-II
(M.Sc.)

M.M. 150

1. Titration of a weak acid using a pH meter, preparation of buffers
2. Verification of Beer-Lambert's law and determination of absorption coefficients
3. Paper chromatography – Separation of amino acids and carbohydrates in a mixture
4. Thin layer chromatography of fatty acids
5. Column chromatography – Separation of a mixture of proteins and salt using Sephadex column
6. Electrophoresis
7. Isolation and estimation of RNA and DNA from yeast, liver, and plants
8. Gel Electrophoresis of serum proteins
9. SDS-PAGE of proteins
10. Assay of enzyme activity
11. Isolation and purification of urease
12. Time course of enzymatic reaction
13. Influence of substrate concentration on the rate of enzymatic reaction
14. Effect of pH and temperature on the rate of enzyme reaction
15. Inhibition of enzyme activity.

MBC -211: Seminar and Interactive Course - I
(M.Sc.)

M.M. 50

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