

## SCHOOL OF BIOCHEMISTRY

### SYLLABUS - M. Sc.

#### SEMESTER I

#### **PAPER I : ANALYTICAL BIOCHEMISTRY -- 3.5 CREDITS**

The concept of pH, dissociation and ionization of acids and bases, pKa, buffers and buffering mechanism, Henderson Hasselbalch equation, dissociation of amino acids and determination of pKa.

Chromatography: Principles and application of adsorption, partition and ion-exchange chromatography, gel filtration, affinity and high performance liquid chromatography.

Electrophoresis: Moving boundary and zonal electrophoresis, paper and gel electrophoresis, isoelectric focusing technique.

Molecular weight determination of macromolecules (in particular proteins) by gel filtration chromatography, gel electrophoresis and ultracentrifugation.

Radioactivity : Disintegration of radionuclides, half-life of radioactive compounds, determination of radioactivity and scintillation counting, isotopic tracer techniques and autoradiography.

Spectrophotometry: Electromagnetic radiation and its interaction with molecules. Molecular orbitals and hybridization. Beer-Lamberts law, extinction coefficient and its importance, design of colorimeter, spectrometer and spectrophotometer.

Principles of atomic absorption spectrophotometry and its application in Biology.

Principles of optical rotatory dispersion and circular dichroism and x-ray diffraction and their applications in structure determination.

Principle of NMR spectroscopy. Application of NMR in Biology.

#### **PAPER II: CELL BIOLOGY -- 3 CREDITS**

Structure of plant and animal cell, models of the biomembrane, structure, constituents and fluidity of plasma membrane, cell wall and its composition.

Transport of metabolites across the plasma membrane, non-mediated and mediated, passive and active transport.

Structure of mitochondria, different enzymes and their location, electron transport complexes, ATP synthase, mitochondrial DNA.

Structure of chloroplast ,protein complexes and photosynthetic electron transport chain ,DNA of the chloroplast.

Structure and functions of the ribosomes, endoplasmic reticulum, golgi body, lysosomes and nucleus.

### **PAPER III: CHEMISTRY OF BIOMOLECULES - 4.5 CREDITS**

Carbohydrates: Occurrence, classification, structure, properties and biological importance of carbohydrates. Mucopolysaccharides and amino sugars.

Proteins : Classification, structure and properties of amino acids, biologically active peptides, classification and properties of proteins, sequencing of proteins, conformation and structure of proteins-primary, secondary, tertiary and quaternary structure, coagulation and denaturation of proteins.

Lipids: Structure, distribution and biological importance of fats and fatty acids. Chemical properties and characterisation of fats. Waxes, cerebrosides, gangliosides, phospholipids and proteolipids. Steroids and bile salts. Prostaglandins.

Nucleic acids: Structure of purines, pyrimidines, nucleosides and nucleotides. Structure, types and biological role of RNA and DNA.

Vitamins: Structure and biochemical properties of water soluble and fat soluble vitamins and their coenzyme activity.

Hormones : Mechanism of hormone action and its regulation.

### **PAPER IV: MICROBIAL BIOCHEMISTRY - 3 CREDITS**

Cellular organisation of bacteria with special reference to molecular organisation of cell wall, flagella and pilli.

Identification and classification of bacteria.

Handling and sterility maintenance in microbiological work. Methods of isolation and pure culture techniques, culture media.

Microbial nutrition, bacterial growth and its kinetics.

Energy metabolism in bacteria - fermentation, aerobic and anaerobic respiration and bacterial photosynthesis.

Fermentation technology-Primary and secondary metabolites, Continuous and batch type culture techniques, Types and design of fermentors, fermentation processes-brewing manufacture of penicillin, production of other antibiotics and organic compounds, single cell proteins.

Application of microbes in food industry, dairy products and food preservation.

Microbial assay of vitamins and amino acids.

Viruses-Structure, proteins classification and methods of assay. Replication of RNA and DNA viruses. Virus-host interaction, Vaccines and prevention.

### **PAPER V : GENETICS AND MICROBIAL GENETICS - 3 CREDITS**

Mendelian laws of inheritance: concept of genetic linkage, sex linked inheritance, multiple alleles, crossing over, mapping by recombination frequency, non mendelian inheritance.

Microbial genetics: DNA as the genetic material.

Gene mutation: spontaneous and induced mutations, their mechanisms.  
Genetic analysis in microbes: DNA transfer, transformation, transduction and conjugation and their mechanisms, mapping by recombination, gene fine structure and genetic map of E. coli.

## **SEMESTER – II**

### **PAPER I : ENZYMOLOGY - 3 CREDITS**

Isolation and purification of enzymes.

Classification, nomenclature and general properties like effects of pH, substrate and temperature on enzyme catalysed reactions.

Kinetics of catalysed reaction : Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, Activation energy and Arrhenius concept. Michaelis pH functions.

Inhibition of enzyme activity.

Enzyme catalysis : enzyme specificity and the concept of active site, determination of active site. Stereospecificity of enzymes.

Mechanism of catalysis : Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis. Theories on mechanism of catalysis.

Mechanism of enzymes action : mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzymes system, Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex. Coenzyme action.

Enzyme regulation: General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes. Reversible and irreversible covalent modification of enzymes, cascade systems.

Immobilised enzymes and their industrial applications.

## **PAPER II: IMMUNOLOGY - 3 CREDITS**

Types of immunity, innate, acquired, passive and active, self vs nonself discrimination.

Physiology of immune response : HI and CMI specificity and memory, antigen-antibody reactions Antigen types.

Immunoglobulins- structure, distribution and function, Isotypic, Allotypic and Idiotypic variants.

Lymphoid tissue, origin and development, differentiation of lymphocytes, lymphocyte-sub-populations of mouse and man. Structure and function of lymphoid tissue. T and B cells and their antigens.

APC cells, lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK cells

MHC genes and products, polymorphism in MHC genes, Role of MHC antigens in immune responses, MHC antigens in transplantation and HLA tissue typing. Structure and function of class I and class II molecules.

Effector mechanisms in immunity, macrophage activation, cell mediated cytotoxicity, cytotoxicity assay.

Hypersensitivity reactions and types

The complement system, mode of activation, classical and alternate pathway, biological functions of C proteins.

Immunological tolerance and suppression.

Immunotechniques- Agglutination and precipitation, Single and double immuno diffusion, Immuno fluorescence, RIA and ELISA

## **PAPER III: GENERAL PHYSIOLOGY - 3 CREDITS**

Composition and function of blood, plasma and blood corpuscles, functions of plasma proteins, structure and function of haemoglobin, abnormal haemoglobins, Blood coagulation – mechanism and regulation. Blood groups.

Structure of nephron, composition and mechanism of urine formation, glomerular filtration, tubular reabsorption of glucose, water and electrolytes, tubular secretion.

Regulation of water and electrolyte balance, role of kidneys and hormones in their maintenance.

Hydrogen ion homeostasis, acid-base balance- metabolic and respiratory acidosis and alkalosis.

Respiratory unit, exchange and transport of respiratory gases in the body, role of 2,3 DPG, Bohr effect and chloride shift.

Classification of muscles, Structure of skeletal, smooth and cardiac muscles. Actin, myosin, tropomyosin, troponin, Z disc and H line components. The sliding filament mechanism and subcellular ion movements during the contraction cycle in skeletal muscles.

Structure of neuron, nerve impulse, origin and transmission, neuromuscular junction, mechanism of nerve conduction. Reflex action and reflex arc.

#### **PAPER IV: NUTRITIONAL BIOCHEMISTRY - 3 CREDITS**

Direct and indirect calorimetry, energy value of the foods, thermal equivalent of oxygen, respiratory quotient, calorific action of the foods, basal metabolic rate- definition and its measurement, factors affecting BMR, energy requirements of the human beings.

Nutritional aspects of the carbohydrates-- Different dietary types, requirements, utilization and functions. Special role of the non starch polysaccharides.

Nutritional aspects of the lipids-- Different dietary types, requirements, utilization and functions. Essential fatty acids.

Nutritional aspects of the proteins-- classification of amino acids and proteins, essential amino acids, nutritive value of proteins and the methods for its determination, amino acid imbalance, protein requirements, utilization and functions.

Nutritional aspects of the vitamins and minerals.

Food processing and loss of nutrients during processing and cooking.

Naturally occurring Anti-nutrients.

Balanced diet-- Recommended dietary allowances for different categories of the human beings.

Disorders related to the nutrition- Protein energy malnutrition, Starvation, Obesity.

#### **PAPER V : METABOLISM I - 3 CREDITS**

Bioenergetics : Laws of thermodynamics (no derivation). The concept of Gibbs free Energy, exergonic and endergonic reactions, redox potential. High energy bond and key position of ATP, substrate level and oxidative phosphorylation. The importance of organophosphates.

Carbohydrates : Digestion and absorption of carbohydrates, glycogenesis and glycogenolysis, glycogen storage diseases, interconversion of hexoses, glycolysis and gluconeogenesis.

Cori's cycle, pyruvate dehydrogenase complex, kreb-cycle, glyoxalate pathway, pentosephosphate pathway and uronic acid pathway. Regulation of carbohydrate metabolism.

Lipids : Digestion and absorption of fats. Oxidation of fatty acids-mitochondrial and peroxisomal  $\beta$ -oxidation,  $\alpha$ - and  $\omega$ -oxidation, oxidation of unsaturated and odd-chain fatty acids, ketone bodies. Biosynthesis of fatty acids, desaturases.

Phospholipids and glycosphingolipids-synthesis.

Porphyrins-Detection by spectrophotometry and by fluorescence.

Enzymes in differential diagnosis of diseases and their clinical significance.

Detoxification, Phase I and Phase II reactions, Enzymes of detoxication.

Carcinogenesis, characteristics of cancerous cells, agents promoting carcinogenesis.

Free radicals in biological system, Antioxidants.

**PAPER VI : METABOLISM II****- 3 CREDITS**

Proteins : Digestion and absorption of proteins, general reactions of protein metabolism, essential amino acids.

Metabolism of individual amino acids, One carbon metabolism, Inborn errors of protein metabolism.

Nucleic acids : Biosynthesis and degradation of purines and pyrimidines and their regulation. Inherited disorders of purine and pyrimidine metabolism.

Mineral metabolism : Biological role of minerals and trace elements, toxic effects of heavy metals.

**SEMESTER - III****PAPER I : PLANT BIOCHEMISTRY****- 3 CREDITS**

Photosynthesis : Ultrastructure and organisation of chloroplast membranes, lipid composition of chloroplast membranes, electron transport chain. Thylakoid membrane protein complexes

Calvin cycle : Biochemistry of RuBP carboxylase/oxygenase, activation of RUBISCO, oxygenation reaction, stereochemistry of RUBISCO, photorespiration and compensation point, photosynthetic efficiency and plant productivity.

Regulation of enzymes of carbon dioxide fixation by light; Hatch and slack pathway, CAM plants; productivity of C4 plants.

Nitrogen Metabolism : Nitrogen fixation, nitrogenase complex, electron transport chain and mechanism of action of nitrogenase. Structure of 'NIF' genes and its regulation. Hydrogen uptake and bacterial hydrogenases.

Nitrate Metabolism : Enzymes of nitrate metabolism, regulation of their synthesis and activity and properties.

Ammonium assimilation enzymes: glutamine synthetase, glutamate synthase and GDH.

Water and mineral balance in plants.

Structure, function and mechanism of action of phytohormones.

Defence system in plants.

**PAPER II : CLINICAL BIOCHEMISTRY - 3 CREDITS**

Automation in clinical biochemistry, Quality assurance, External and internal quality control measurements

Collection and preservation of biological fluids. Chemical analysis of CSF.

Electrolyte, blood gases and acid base balance.  
Disorders of carbohydrate metabolism, Diabetes mellitus, Glycohemoglobins, Hypoglycemia,  
Ketone bodies, Glucose tolerance test.  
Lipids, lipoproteins and apolipoproteins-role in diseases.  
Evaluation of organ function tests of gastric, pancreas, kidney and liver.  
Bilirubin, direct and indirect vanderwaal tests and their clinical significance, fatty liver, jaundice.  
Bile pigments- chemical nature and physiological significance.

### **PAPER III : MOLECULAR BIOLOGY - 3 CREDITS**

Concept and definition of the gene, complexity of the eukaryotic gene.  
Structural organization of the DNA in the nuclear material- General properties of histones, nucleosomes and solenoid structure.  
DNA synthesis : The enzymes of DNA replication in prokaryotes and eukaryotes, mechanism of replication in bacteria and viruses, reverse transcriptase, salient features of eukaryotic nuclear and mitochondrial DNA replication.  
RNA synthesis : The enzymes of transcription in prokaryotes and eukaryotes, mechanism of transcription in bacteria, heteronuclear RNA, post transcriptional processing of RNA, role of ribozymes.  
Protein synthesis : Concept of the genetic code, structure of tRNA and rRNA, enzymes of translation in prokaryotes and eukaryotes, mechanism of protein synthesis, post translational processing of proteins.  
Regulation of gene expression in prokaryotes, structure and mechanism of different operons.

### **PAPER IV : BIOTECHNOLOGY - 3 CREDITS**

Basic principles of genetic engineering : Methods of creating recombinant DNA molecule, splicing, properties of restriction endonucleases and their mode of action, construction of DNA library, genomic vs cDNA library, chemical synthesis of gene, cloning vectors (lambda phage plasmid, M-13 phage, cosmid, shuttle vectors, yeast and viral vectors, expression vectors).  
Selection/screening.  
Analysis of genomic DNA by Southern hybridization, Northern and Western blotting techniques.  
Restriction mapping : Restriction fragment length polymorphism (RFLP).  
DNA sequencing techniques : plus and minus, dideoxynucleotide, Maxam and Gilbert etc.  
Preparation of radiolabelled and synthetic probes.  
Amplification of DNA by polymerase chain reaction (PCR)  
Site directed mutagenesis.

Gene transfer methods for animals and plants; Agrobacterium mediated gene transfer, electroporation and particle gun. Transgenic animals and transgenic plants.  
Application of genetic engineering in medicine and agriculture, vaccine production.

#### **PAPER V : BIOSTATISTICS**

**- 1.5 CREDITS**

Representation of Data : Frequency distribution. Line diagram. Bar diagram. Histogram and Relative Frequency Histogram. Frequency Polygon and Frequency curve. Pie diagram, cumulative frequency distribution . Ogive.

Measures of Central Tendency : Arithmetic mean, Median, Mode, Geometric mean, Harmonic mean.

Measures of Dispersion : Range, Semi-interquartile range, Mean deviation. Standard deviation. Coefficient of variation.

Correlation and Regression : Scatter diagram. Correlation coefficient. Method of Least Squares. Fitting of regression line. Coefficient of determination. Non. linear regression.

Probability and Probability distributions : Classical and Statistical definitions of probability. Conditional Probability. Binomial. Poisson and Normal Distributions.

Tests of Significance : Tests based on t, z, F and Chi-square distributions.

Analysis of Variance : One way and Two classification.

#### **PAPER VI : COMPUTER APPLICATIONS IN BIOCHEMISTRY - 1.5 CREDIT**

Computer Fundamental : Introduction to computers. Application of computers. Introduction to

software and hardware. Introduction to software family. Concept of OS. Different types of OS.

Introduction to DOS/Basic commands of DOS.

Introduction to Windows operating system. Application of Windows. Tools of Win- /95/98/2000.

Introduction to MS-Office. Application of MS-Word. MS-Excel. MS-Powerpoint (with complete

Tools of each).

Definition of network. Application of networking. Introduction to Internet. Various application

components of Internet. Differentiate between Internet and Intranet. Introduction to E-Commerce

and M-Commerce concept.



Introduction to Data Base concept. Introduction to Programming concept. We Need  
Pis.,  
Application of Pis.  
Introduction to Graphics & Animations & Video clipping.

**SEMINAR: PRESENTATION OF RESEARCH PAPERS - 2 CREDITS**