

CSJM UNIVERSITY, KANPUR

SYLLABUS

M.Sc. (BIOCHEMISTRY)

SEMESTER –I

PAPER –I

Max.Marks : 100

GENERAL BIOCHEMISTRY

- UNIT-I** Introduction to Biochemistry. Structure of water and interaction with ions, nature significance of weak acids and bases. Handerson–Hasselbalch equation. PH and buffers.
- UNIT - II** Structure of Monosaccharides. Stereoisomerisms and optical isomerism of sugars. Ring structure and anomeric forms, mutarotation. Important biological importance of monosaccharides, oligosaccharides and polysaccharides.
- UNIT-III** Classification of lipids. Fatty acids: introduction, classification, nomenclature and properties of saturated and unsaturated fatty acids. Essential fatty acids, Prostaglandins. Triacylglycerols: nomenclature, physical properties, chemical properties and characterization of fats-hydrolysis, saponification, rancidity of fats. Sphingolipids, Glycolipids. Properties and functions of Phospholipids, isoprenoid and sterols.
- UNIT-IV** Introduction, Classification and functions of proteins. Amino acids: Common structural features, stereoisomerisms and RS system of designating optical isomers, classification, physical and chemical properties, titration of amino acids. Essential amino acids. Peptides, Structure of peptide bond, Ramachandran Plot, Chemical synthesis of peptides protein structure: primary, secondary (helix and pleated sheet), tertiary and quaternary.
- UNIT-V** Nature of genetic material; evidence that DNA is genetic material. Structure, chemistry and biological properties of purine and pyrimidine bases, nucleotides and nucleosides. Structure, physico-chemical properties and functions of various DNA and RNA.

PAPER-II

MAX. MARKS: 100

CELL BIOLOGY AND MEMBRANE BIOCHEMISTRY

- UNIT-I** Cell classification- Cell Variability (size, shape, complexity, functions). Structural organisation of prokaryotic and eukaryotic cells, cell types, differences in plant and animal cells
- UNIT-II** Detailed description of eukaryotic cell structure. The ultra structure of nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes and peroxisomes and their functions.
- UNIT-III** The cytoskeleton- microtubules, microfilaments and intermediary filaments. Cellular interactions. Cell cycle and cell division. Cell differentiation- organogenesis, morphological, functional and biochemical maturation of tissues. Culture techniques to study cell division. Use of microscopy in the study of cells and cell organelles.
- UNIT-IV** Chemical Composition of biomembranes. Gap and tight junctions. Physical and biochemical methods to study membrane structure and properties. Different models of cell membrane- a historical perspective. Functions of biomembranes with examples-energy transduction, signal recognition. Specialized forms of membrane-brush border, flagella and pancreatic activity
- UNIT-V** Transport across biomembranes. Simple diffusion and Fick's law. Porins facilitated diffusion. Porter molecules, kinetics of facilitated transport. Symport, antiport and uniport. Red cell membrane proteins. Anion porter and glucose porter. Active transport, Proton and $\text{Na}^+\text{-K}^+$ pumps - examples and metabolic significance, Donan's membrane equilibrium.

BIOPHYSICAL CHEMISTRY, TECHNIQUES & ITS APPLICATIONS

- UNIT – I** Spectroscopic Techniques- Theory, instrumentation and techniques of absorption (UV, Visible and IR), emission, fluorimetry, NMR, E.S.R. and mass spectroscopy, X-ray crystallography.
- UNIT – II** Chromatography – Theory and general techniques of absorption, partition, ion exchange, gel filtration, reverse phase, covalent, affinity: Gas chromatography, HPLC and reversed phase HPLC.
- UNIT – III** Electrophoresis- Basic principles of agarose electrophoresis, PAGE and SDS-PAGE and their applications. Two-dimensional electrophoresis and its importance. isoelectric focussing, immunoelectrophoresis.
- UNIT-IV** Centrifugation techniques and their application: Differential, Zonal, density gradient and ultra-centrifugation. pH metery.
- UNIT – V** Tracer techniques – Detection and measurement of isotopes and application of isotopes in biochemistrey, RIA, IRMA and ELISA. Units of radioactivity. Biological hazards of radiation and safety measures in handling radioisotopes.

PAPER –IV

Max.Marks : 100

GENERAL MICROBIOLOGY

- UNIT-I** General characteristics of main group of microorganisms. Criteria used in the classification of microorganisms. Biosynthesis of bacterial cell wall and biochemistry of bacterial sporulation. Physiology and growth of bacterial cells
- UNIT-II** Special features of bacterial metabolism. Glyoxalate cycle and its role in conversion of fats into carbohydrates. Role of microorganisms on food spoilage.
- UNIT III** Microbial genetics and differentiation - adaptation and mutation, transformation, conjugation, sex types, transduction, transfection, protoplast fusion, genetics recombination.
- UNIT IV** Morphology and replication of viruses- Definition, virus structure, viral proteins, virus classification emphasizing importance of bacteriophage and virus as tool in modern biological research. Replication of RNA viruses negative strand (VSV), positive strand (Polio), retroviruses (Infection cycle), replication of DNA (adenovirus or SV40).
- UNIT V** Virus-host infection - Acute virus infection – influenza, persistent virus infection, Herpes/hepatitis A & B and AIDS; transformation and cancer – RNA & DNA tumor viruses; vaccines in prevention of viral infection – smallpox, Polio and AIDS.

LIST OF EXPERIMENTS

1. Biochemical estimation of carbohydrates ✓
2. Biochemical tests for proteins ✓
3. Fractionation of cellular organelles through centrifugation
4. Separation and estimation of lipids by using TLC
5. Estimation of protein by Lowry's method ✓
6. Estimation of DNA by DPA method ✓
7. Estimation of RNA by orcinol method ✓
8. Preparation of various culture media for growing microorganism

SEMESTER – II

PAPER – I

Max.Marks – 100

BIOENERGETICS AND INTERMEDIARY METABOLISM

- UNIT-I** Bioenergetics- Energy transformation, Laws of thermodynamics, Biological Oxidations. Gibbs energy, free energy changes and redox potentials, membrane potential. High-energy compounds and low energy compounds.
- UNIT-II** The mitochondrial respiratory chain, order and organization of carriers, proton gradient, cytochromes and their characterization. Respiratory controls and oxidative phosphorylation. Fractionation and reconstitution of respiratory chain complexes. ATP-ADP cycle.
- UNIT-III** Methods and Techniques in the study of Intermediary metabolism. Multienzyme complex. Metabolism of Carbohydrates and its Regulation, Biosynthesis of glycogen, Starch and oligosaccharides, Fatty acid biosynthesis & oxidation; lipid biosynthesis; biosynthesis of triglycerols, phosphoglycerides and sphingolipids. Biosynthesis of steroids. Ketone bodies formation and utilization.
- UNIT- IV** Biosynthesis and degradation of amino acids and their regulation, Specific aspects of amino acid metabolism, urea cycle and its regulation, in-borne errors of amino acids metabolism
- UNIT-V** Biosynthesis of purines and pyrimidines, degradation of purines and pyrimidines, regulations of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide reductase, Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, inhibitors of nucleic acid biosynthesis

PROTEIN CHEMISTRY AND ENZYMOLOGY

- UNIT – I Isolation and purification of proteins and enzymes. Criteria for purity, native state of protein and enzymes, its stability and measurements, Assembly of fibrous proteins Concepts of domain structure, proteins evolution and phylogenetic tree with particular reference to cytochrome-C. Synthesis of peptides. Protein degradation in prokaryotes and Eukaryotes.
- UNIT – II The mechanism of protein folding. Determinants of protein structure and folding with special reference to the role of molecular chaperons, post-translational modifications and environment in self assembly role of signal peptides in protein folding within the cell, Structural determination of proteins Introduction of metalloprotein.
- UNIT – III Introduction, classification, nomenclature of Enzymes. Co-factor, Coenzyme, Inducible and Constitutive enzymes. Enzyme activity modifier -negative and positive. General properties of enzymes and techniques of enzymes assay, Mechanism of enzymes action (Lysozyme, Serine protease, Ribonuclease reductase, Alcohol Dehydrogenase). Concept of enzyme active site. Techniques for study of mechanism of enzyme action.
- UNIT – IV Enzyme kinetics – Michaelis – Menten equation, Brigs – Halden Steady State approach, integrated form of michaelis equation, methods for determination of Km. And Vmax, Halden relationship. Enzyme inhibitions and activation. Determination of inhibitor constants and activator constant. Multisubstrate enzymes and its kinetics.
- UNIT - V Sub-cellular localization and organisation of enzymes, negative cooperative, half - site reactivity, Regulation of enzyme activity, feed back inhibition, Allosteric concept, Covalent modifications, Concerted and sequential model. Protein ligands. Enzyme Immobilization and its Industrial uses.

PLANT BIOCHEMISTRY

- UNIT-I** Structure and function of plant cell (including cell wall, plasmodesmata, meristematic cells, vacuoles, secretory systems & root quiescent zone), Isolation of cell organelles, absorption, adsorption & transport of water & ions in plants, Evapotranspiration.
- UNIT – II** Photosynthesis, Photosystem I &II, their location, Mechanism of quantum capture & energy transfer between photosystems. Hill reaction, Photophosphorylation & reduction of CO₂. C₃, C₄ and CAM metabolism, light and dark reaction. Light activation of enzymes, Regulation of photosynthesis, Photorespiration
- UNIT – III** Biological nitrogen fixation and ammonia assimilation, Nitrate and Sulphate reduction and their incorporation into amino acids, translocation of inorganic and organic substances.
- UNIT- IV** Special features of secondary plant metabolism, formation of phenolic acids, tannins, lignins, lignans, pigments, terpenes, terpenoids, plant phenolics, alkaloids and surface waxes – their biosynthesis and function, cell wall components.
- UNIT – V** Plant hormones – growth regulating substances and their mode of action. Molecular effects of auxin in regulation of cell extension and of Gibberlic, abscisic acids and cytokinins in the regulation of seed dormancy, germination, growth and development and embryogenesis. Biochemistry of seed development and fruit ripening. Defense system in plants.

BIOSTATISTICS AND COMPUTER APPLICATION

- UNIT I** Aim, scope and elementary idea of statistics in Biology, Tabulation and diagrammatic representation of statistical data. Concepts of statistical population and sample, elementary accounts of random samples – frequency distributions. Measures of central location and dispersion, simple measure of skewness and Kurtosis.
- UNIT II** Probability-definition, simple theorems on probability, conditional probability. Discrete and continuous variables. Standard distributions- Binomial, poisson, normal.
- UNIT III** Basic ideas of sampling distribution Statistical estimation and Tests of significance, confidence limits. Some commonly used tests of significance Normal tests students 't' test χ^2 and F tests. Analysis of variance.
- UNIT IV** Correlation and regression – Least square method of fitting, linear and quadratic regressions, standard error of estimate, correlation coefficient.
- UNIT V** History and development of computers, Computer peripherals and hardware description, operating systems, office applications, Logic development, Basic knowledge of computer softwares and scientific application packages.

LIST OF EXPERIMENTS

1. Isolation of enzymes from different sources ✓
2. Assay of enzyme activity (phosphatase, peroxidase etc.) ✓
3. Isolation of proteins from different sources ✓
4. purification of protein by column chromatography ✓
5. Separation of proteins by SDS-PAGE ✓
6. Separation of protein by 2D-PAGE
7. Western Blotting
8. ELISA

SEMESTER –III

PAPER-I

MAX. MARKS 100

PHYSIOLOGY AND CLINICAL BIOCHEMISTRY

- UNIT – I** Nutrition and balanced diet, vitamins, Digestion and Absorption of food (Carbohydrates, Lipid and Proteins), Chemistry of respiration, regulation of acid base balance, factors affecting acid base balance.
- UNIT – II** Body fluids – Composition, Function, Blood groups, Rh factor, Plasma protein, Coagulation, Clotting formation, Anemia Urine – Composition, Function, Formation in health and disease.
- UNIT – III** A brief outline of various endocrine glands. Classification, Structure, and function of Hormones. Feed back regulation of hormone secretion. Mechanism of extracellular and intracellular hormone action.
- UNIT – IV** Biochemical basis of Drugs Action Biotransformations and detoxification mechanisms, Role of glutathione in drug resistance.
- UNIT – V** Clinical and Bio – Chemical aspects of disease – Cancer, AIDS, Jaundice, Cushing syndrome, Diabetes mellitus, Atherosclerosis, Protein calorie mal nutrition.

PAPER-II

MAX. MARKS. 100

MOLECULAR BIOLOGY

- UNIT-I Nucleic acid as genetic information carriers, experimental evidences, current version of central dogma, unique Associated inverted repeats. Satellite DNA, Functions of Satellite DNA, Reassociation kinetics, C-value paradox, cot values.
- UNIT-II Organization of genetic material in viruses, Prokaryotes and eukaryotes. Concept of gene, fine structure of gene, Split gene, Transmission of genetic materials in sexual and parasexual system
- UNIT-III Genetic code, Evidence for triplet codon, properties of code, Nonsense code, Mutation, Mutagenic agents, Biochemical and Molecular basis of mutation. DNA replication in prokaryotes and in eukaryotes and its regulation. Genetic repair mechanism.
- UNIT-IV Transcription of RNA : RNA Polymerase, promoters, initiation, elongation and termination of RNA synthesis, inhibitors of transcription. Reverse transcriptase, Post transcriptional modification.
- UNIT-V Protein Biosynthesis and its regulation in prokaryotes and eukaryotes. Effect of hormones and antibiotics on protein biosynthesis, Post translational modification. Operon concept.

IMMUNOLOGY

- UNIT-I** The biochemical basis of immunology- Innate Immunity, Specific acquired immunity, Immunoglobulins, Classification, Structure and biochemical basis of function, variable domain bind antigen, MHC, T-Cells, B-Cells, receptors. Antigens Haptens, recognition of antigen-primary interaction its deletion and application.
- UNIT II** Major Histocompatibility Complex (MHC) Genes and Products- Polymorphism of MHC genes, Role of MHC antigens in immune responses, MHC antigens in transplantation.
- UNIT III** Measurement of Antigen interaction-Production of polyclonal and monoclonal antibodies: Principles, techniques and applications, Agglutination and precipitation techniques, RIA, ELISA, Immunofluorescence assays. Measurement of T Cell Activation.
- UNIT-IV** Acquired immune response: Consequences of antigen recognition, production of effectors, its control development, adversial strategies, Immunodeficiency. Elementary Knowledge of hypersensitivity.
- UNIT-V** Autoimmune diseases- Etiology, pathogenesis, diagnosis and treatment. Immune responses to infectious diseases (viral, bacterial and protozoal) Immuneprophylaxis. Role of vaccines in the prevention of diseases

ADVANCED BIOTECHNOLOGY

- UNIT-I** Basic elements and experimental techniques of the Biotechnology. Restriction enzymes and analysis. Cosmid. Plasmid (Vectors), Gene cloning, Gene library, Basic principles of nucleic acid probe
- UNIT-II** Isolation of genes (genes with Tissue specific expression; mutant complementation. transposon tagging); Sequencing of genes (Maxam-Gilbert's method); Synthesis of genes (organochemical synthesis of tRNA gene and interferon).
- UNIT-III** Gene transfer methods for animals and plants; Agro-bacterium mediated Gene transfer, electroporation and particle gun. Transgenic animals (mouse and rabbit); Transgenic plants (Herbicide insect and virus resistance).
- UNIT-IV** Cell and tissue culture techniques, Concept of totipotency, Introduction to Different types of culture, Cell induction and maintenance, Clonal multiplication, Protoplast fusion, Biochemistry of organogenesis and embryogenesis.
- UNIT-V** Biological and medical applications of Bio-technology -microbiology and Industrial Biotechnology, Food Biotechnology, Protein Engineering, Bioreactors, Concept design and control, downstream processing, Biofertilizers.

LIST OF EXPERIMENTS

1. Isolation of total DNA by rapid method ✓
2. Isolation of total RNA by GTC or CTAB method ✓
3. Separation of DNA and RNA by Agarose Gel Electrophoresis ✓
4. Microbial cultures, competent cell preparation and cloning ✓
5. Southern and Northern Blotting
6. Screening through probes
7. Sequencing of DNA and RNA on polyacrylamide gels
8. Preparation of Callus Culture

SEMESTER –IV

PAPER – I

MAX MARKS – 100

ENVIRONMENTAL BIOCHEMISTRY

- UNIT-I** Introduction of Ecology, Environmental factors, Biosphere, food web, trophic levels and their pyramids. Ecosystem – Types, development and evolution. Habitat and Niche. Concept of productivity and standing crops. Biome, ecological indicators, ecological efficiency, edge effect, Biogeochemical cycles.
- UNIT-II** Population ecology – definition and characters. Regulation of population size by density dependent and independent factors. Quantitative analysis of plant community. Biotic community – Characteristics of community. Ecological succession – causes, sera and climax community. Primary and secondary succession. Evolutionary ecology.
- UNIT-III** Pollution- Air, Water, Lignin, Detergent, Dyes, Heavy metal, Drugs. Industrial waste effluents (Pulp, sugar and paper mills), Pollution control device, Impact analysis of some common pollutants. Harmful effects of rays- UV, Gamma, ozone layer, ozone holes, green house effect. Degradation: environmental, biodegradable pollutants, non-degradable pollutants, Treatment of waste water and industrial effluent
- UNIT-IV** Metabolism and toxicity of agro and industrial chemicals to plants and animals. Toxicology of free radicals and its scavengers. Bioremediation, Vermiculture, Biochemical aspects, Environmental monitoring and ecosystem analysis.
- UNIT-V** Detection of Toxic exposure : Acute toxicity, Chronic and subcute exposure and their tests. Testing agents for carcinogenic, mutagenic and teratogenic actions. The basis of antidotal procedures.

PAPER – II

BIOINFORMATICS

- UNIT I** Computer basics – course introduction, MS windows basics, UNIX basics, PC X windows (NCD PCXWARE), file management, E-Mail, (PINE, EUDORA, NETSCAPE MAIL), file transfer (ftp, WSftp)
- UNIT II** Review of key molecular genetic internet sites & searching for similar sequence & multiple sequence alignment. - Internet worldwide web resources, Similarly searching BLAST/FASTA, Retrieving and installing a program (tree tool), Multiple sequence alignment (CLUSTAL W and bee).
- UNIT III** Construction of virtual library - Literature and journal search from MEDLINE and PUBMED search engine of NCBI, extraction of citation index and current content from ISE database.
- UNIT IV** Higher –order sequence analysis searching for simple repeat sequences restriction site analysis - MAR inder, Identifying Repetitive Elements, Identifying Transfactor binding site candidates, using tools of Basic Sequence Alignment and Multiple Sequence Alignment to predict genes.
- UNIT V** GCG sequence analysis or other comparable site, Introduction to GCG: sequence analysis, SeqLab : the X interface to GCG, Seqwebb : the web interface to GCG, Basic sequence analysis, Multiple sequence analysis.

PAPER –III

MAX MARKS – 100

Elect any one of the following

NEUROBIOCHEMISTRY

- UNIT I** Neuromorphology and neurocellular anatomy: Central Nervous System, Peripheral Nervous System (PNS), Spinal Cord.
- UNIT II** Neurophysiology : Neuronal membranes, excitability, ion channels and transport of ions. Nerve and synapse structures: structure function correlation at synapse. Transmission across the synapse. Electrophysiology of channels : EEG patterns, Patch Clamp, Nerve conduction velocity (NCV).
- UNIT III** Presynaptic events at the neuromuscular junction : Cholinergic and Non-cholinergic synapses. Postsynaptic events and the neuromuscular junction.
- UNIT IV** Neurotransmitter : Chemistry, synthesis, storage and release of nervous neurotransmitters, transmitter action, synaptic modulation and mechanism of neuronal integration. Neuropeptides.
- UNIT V** Disorders of metabolism of brain, neurotoxic agents and diseases related to them. Psychopharmacology and biochemical theories of mental disorders. Neurodegenerative disorders, Ageing, Neurological behavior.

ADVANCED GENETICS

- UNIT I** Mendel's laws. The chromosomal basis of inheritance, definition of genes, alleles, mutants. Sex linkage. Life cycles and nomenclature of key models. Haploid vs. diploid genetics, tetrad analysis in yeast. Genetic Linkage, Complementation.
- UNIT II** Molecular basis of the phenotype, Defining pathway : Suppression or pseudoreversion analysis, reversion, overproduction suppression. Unlinked noncomplementors, Synthetic lethal mutants. Dominant mutants. Pathway analysis, Genetic screens.
- UNIT III** Comparison of classical genetics, reverse genetics and genomics. Model Systems – Drosophila : isolation of lethal mutations that affect pattern formation, Modifier screens, P elements as mutagens, positional cloning, P element transformation, Genetic tricks, C. elegans.
- UNIT IV** Human Genetics : Disease loci and pedigrees. Mapping with DNA markers. Source of polymorphism. Simple vs. Complex traits. Genome scans for quantitative trait loci. Effect of imprinting on pedigrees.
- UNIT V** Possible approaches for tackling genetic disorders; Diagnosis of genetic defects; Positive eugenics; Negative eugenics; genetics counseling (Antenatal diagnosis, fetus sexing). Applied genetics, Achievements of applied genetics; need for future development.

BIOCHEMICAL ENGINEERING AND FERMENTATION TECHNOLOGY

- UNIT I** Biochemical Engineering principles, range of fermentation process : microbial biomass, microbial enzymes, microbial metabolites, recombinant products, transformation process. Chronological development of fermentation industry, component part of the fermentation process.
- UNIT II** Microbial fermentation kinetics : growth cycle, phase for batch cultivation, kinetics of fed batch type I and II fermentation systems, determination of kinetic parameters using batch reactor with and without inhibition. Thermal death kinetics.
- UNIT III** Transport phenomena in bioprocesses : Mixing and agitation, mechanical and non mechanical agitation, aeration and oxygen - substrate mass transfer equipment, heat transfer-energy balance and transfer correlations, sterilization, centrifugation, filtration and drying.
- UNIT IV** Introduction to bioreactors : Batch, CSTR and plug flow bioreactors, performance equations, fermenter design, elementary treatment of non-ideal bioreactors - TD functions and their applications
- UNIT V** Dynamic modeling of batch and CSTR type bioreactors, dimensional analysis and scale up, fermentation economics.