Master of Science (BioChemistry)
Faculty of Science
SRI RAM VIDYAPEETH, BALLIA

M. Sc. (Previous)
Biochemistry
PAPER-1 BIOPHYSICAL AND ANALYTICAL TECHNIQUES

Electrochemistry: pH Buffers Enzyme Electrode, Biosensors
Energetics and Thermodynamic considerations: Laws of Thermodynamics, Gibbs Free, Energy, Biological Order. Coupled Reactions, Ion-Electrochemical potentials. Entropy, Energy Compounds, Energy Interconversions.
Photometry: Principle and Instrumentation of a simple and double beam spectrophotometer, applications of Colorimetry, Spectrophotometry (Visible, UV and IR), Fluorometry.
Spectroscopy: Principles and Applications to Biological Problems Atomic Absorption and Emission Spectroscopy, NMR, EPR Spectroscopy, ESR Spectroscopy, Mass Spectroscopy, X-Ray Diffraction, Circular Dichroism, MALDI-TOF.
Centrifugation Techniques: Differential, Zonal, Density-gradient and Ultracentrifugation.
Chromatography: Adsorption, Partition, Ion-Exchange, Chromatofocussing, Reverse- Phase, Covalent, Gel Filtration. Affinity Chromatography, GPLC, FPLC.
Electrophoretic Techniques: Paper and Gel Electrophoresis (Agarose, and SDS) 2-D Gel Electrophoresis, Pulsed-Field Gel Electrophoresis, Isoelectric Focussing. Immunological Techniques Gel Diffusion, Immunoelectrophoresis, Ouchterlony. Radioimmunoassay, ELISA, Immunoblotting. Fluorescent Immunoassays.
Microscopy: Principles and applications of Light, Phase-contrast and Electron- Microscopy (SEM, TEM and Immune electron microscopy [IEM]).
Radioisotopic Tracer Techniques: Detection and measurement of isotopes, GM and Scintillation Counters, Autoradiography, Fluorography, Applications in biology.

PAPER 2 CHEMISTRY OF BIOMOLECULES

The molecular logic of life: The identifying characteristics of living matter. The chemical unity of diverse living systems.
Biomolecules: Their meaning and importance in the functional organization of the cell. Informational and non informational biomolecules.
Carbohydrates: Structure, properties, classification, function and biological importance. Mono-, di-oligo- and polysaccharides. Chain and ring structures. Optical isomerism. Homopolysaccharides, glycolipids, proteoglycans, mucopolysaccharides, peptidoglycans, hemicelluloses, lignins. Bioactive carbohydrates
Lipids: Structure, properties, classification, function and biological importance. Storage lipids. Structural lipids in membranes. Phosphoglycerides, Plasmalogens, (Lecithins, PE, PS, Phosphatidyl Inositols),

Splingomyelins, Ceramides, Glycolipids, Prostaglandins. Lipids as signals, cofactors and pigments. Phosphatidylinositol-based lipids in cell signaling. Isoprenoids and sterols.
Proteins: Classification and functional diversity of proteins. Amino acids: classification and properties. Overview of Protein structure: Primary, Secondary, Tertiary and Quaternary structures. Protein denaturation. Sequencing, Protein folding. Role of Heat shock proteins. Structure-function relationship: Hair. Silk. Prions.
Nucleic acids:. Structure of nucleotides and formation of polynucleotide chain. Structure and function of DNA and RNA. Watson Crick model of DNA. Various forms of DNA. Nucleic acid chemistry. Cofactor functions of nucleotides.
Plant-based polyphenols:-Classification, structure and biological activity.
Vitamins and Hormones: Chemical nature, active form, and analogues.

PAPER 3 HUMAN PHYSIOLOGY AND ENDOCRINOLOGY

Functional organization of the human body and homeostasis: Intracellular and extracellular division of body fluids, the concept of homeostasis and feedback control systems. Major transport mechanisms through the cell membrane.
Nerve-impulse transmission system: Sensory and motor nerves, major levels of nervous system function, Central and autonomic nervous systems. Generation of nerve impulse: Membrane potentials, action potentials, transmission of nerve impulse, synapse, neurotransmitters.
Digestion and absorption in the gastrointestinal tract: Digestion and absorption of carbohydrates, fats, proteins, vitamins and minerals. Endocrine control of digestive and absorptive processes.
Blood: Composition of blood. Erythrocytes: Properties. Functions Hemopoiesis. Hemoglobin: structure and function. Anemias. Hemostasis and blood coagulation. Blood group substances, transfusion. Tissue transplant: Role of HLA typing.
Resistance of the body to infection: Leucocytes in immunity. Elements of the immune response. Humoral and cell mediated immunity. Clonal Selection theory. Immunoglobulins: structure and functions. Principles of vaccination.
The Cardiac cycle and ECG: The heart as a pump. The normal ECG. Applications in diagnostics. Regulation of acid-base balance: Role of buffers in blood, respiratory control, renal controls. Transport and exchange of respiratory gases. Carbon Dioxide dissociation curve. Bohr's effect. Haldane effect. Principles of urine formation: Glomerular and tubular function. Mechanisms for control of urine composition.
Vision: the visual cycle.
Endocrinology: Mechanism of hormone action, signaling pathways, G proteins, second messengers, lipids as signaling molecules. Chemistry, functions, deficiency conditions and feedback controls of hormones produced by: Pituitary. Thyroid. Parathyroid. Pancreas. Gonads: Ovary, Testis. Pineal gland. Other hormone producing structures. Autocrine and paracrine compounds. Prostaglandins.

PAPER-4 ENZYMOLOGY

Historical Perspective
Enzyme Classification : Recommendation and Systemic Nomenclature.
Enzyme Chemistry: Subcellular Distribution of Enzymes. Isolation and Purification of Enzymes, Criteria for Enzyme homogeneity, General Properties, Enzyme Activity , Specific Activity and Turnover Number, Marker Enzymes.
Enzyme Kinetics: Enzyme-Substrate Interaction, ES Complex, Binding Site, Active Site. Specificity, Steady State, Pre- Steady State and Equilibrium-State Kinetics, Michael- Menten Equation and its derivation, Graphical Methods for determination of Km,. Vmax. Significance. Factors affecting Initial rate of Enzyme catalysed Reaction: Enzyme, Substrate, pH, temperature. Collision and transitional state theories,

Significance of Activation, Energy, Mechanism of bisubstrate and multisubstrate reaction, Methods for identifying mechanism.

Enzyme Inhibition and Activation: types of inhibition, and activation, Competitive non-competitive and Uncompetitive inhibitors, Determination of Ki, Suicide Inhibitors.

Mechanism of Enzyme action: enzyme-substrate complementarity, Stereochemistry of enzyme substrate action, factors associated with catalytic efficiency.

Enzyme regulation: Allosteric and Hysteric Enzymes, Proenzymes-Zymogens and activation. Structure and Function of Selected Enzymes: Chemical modification of active-site group, substrate /- driven mutagen etc. Chymotrypsin, Glyceraldehyde-3P- Dehydrogenase, Serine and Cysteine Proteases.

Multi Enzyme Complexes: Significance. Examples.

Immobilized Enzymes: Immobilization methods, Kinetics, Industrial applications

Enzyme engineering and Co-Factor Engineering: Ribozymes, Abzymes.

M.Sc Previous
List of Practicals

I. Laboratory practices: Familiarity with common laboratory equipment such as distillation sets, balances, pH meter, centrifuge, etc. and glassware. Safety in the lab. First aid.

II. Qualitative analysis

A. Analysis of biomolecules

1. Carbohydrates
2. Proteins
3. Lipids

B. Analysis of Biofluids

1. Physiological constituents of urine (Normal)
2. Pathological constituents of urine (Abnormal)
3. Saliva: Determination of achromic point

III. Preparation of buffers and titration curves: for acidic, basic and neutral amino acids. Determination of Isolectric Point, pK values.

IV. Titrimetric Determinations: i. Formol titration.

ii. Ascorbic acid

V. Photometry based Quantitative Analysis

a. Principles of photometry.
b. Blood hemoglobin
c. Blood glucose
d. Blood calcium
e. Total protein in biological tissue
f. Ascorbic acid.
g. Glycogen in biological tissue
h. Starch estimation
i. Phosphorus in biological tissue
j. Serum and urinary creatinine.

VI. Preparative techniques for common proteins:

a. Casein from milk
b. Gluten, Glutelin and gliadin from wheat.

VII. Subcellular fractionation and Marker proteins

M. Sc FINAL
Biochemistry
PAPER 1 INTERMEDIARY METABOLISM

Introduction to metabolism: Basic concepts and design. High energy compounds.
Carbohydrate metabolism: An overview of aerobic and anaerobic carbohydrate metabolism. Glycolysis and the catabolism of hexoses. Feeder pathways. Regulation. Pentose phosphate pathway. Utilization of glycogen. The Citric Acid cycle. Anaplerosis. Regulation. The glyoxylate cycle. Carbohydrate biosynthesis. Gluconeogenesis. Glycogen synthesis. Glycogen storage diseases. Glucoronic acid pathway, Photosynthesis. Light and dark reactions. Electron flow. ATP synthesis by photophosphorylation. Biosynthesis of starch and oligosaccharides.
Oxidative phosphorylation: Electron transport chain and formation of ATP. Regulation. Inhibitors and uncouplers of ETC.
Lipid metabolism: Introduction to Lipids as energy sources. □ oxidation. Oxidation of unsaturated and odd chain fatty acids. Ketone bodies. Biosynthesis of: Fatty acids. Triacyl glycerols. Membrane phospholipids. Cholesterol, steroids and isoprenoids. Membrane Phosphoinositides, Ceremides.
Protein Metabolism: Metabolic fate of amino groups. Transamination, deamination and decarboxylation. Essential and non-essential amino acids. Nitrogen excretion and the urea cycle. Pathways of amino acid degradation. One carbon transfers, role of tetrahydrofolate and S- adenosyl methionine. Overview of Nitrogen Metabolism. Biosynthesis of amino acids and compounds derived from amino acids. Inborn errors of metabolism. Biochemical role of vitamins and minerals as coenzymes and cofactors. Integration and hormonal regulation of metabolism.
Biochemistry of starvation: Alternate methods of energy generation, organ interrelationships during starvation,

Paper-2 CELLULAR AND MOLECULAR BIOLOGY

Ultra structure of cell: Study of cells, organization of cellular components.
Biomembrane and cell architecture: Lipid bilayer and membrane assembly, membrane carbohydrates, phospholipids and asymmetric organization. GPI-anchored protein and their dynamism, membrane transport of small molecules. Membrane transport of macromolecules, exocytosis, endocytosis (Fluid phase, receptor mediated) and transcytosis, ATP Membrane Traffic and sorting events: Compartmentalization of higher cells, nuclear export and import of proteins, mitochondrial export and import of proteins, signal hypothesis, secretory-Endocytic vesicular path-ER-Golgi Lysosome and secretory vesicles, cotranslational and post translational modifications (of proteins and sorting events, Anterograde and Retrograde hypotheses)
Cell cycle and programmed cell death: Cell cycle. Yeast as a model system, Yeast odc. Genes for social control of cells, mechanism of cell division (cyclins). Apoptosis.
Organization of genetic material in prokaryotes and eukaryotes: Concept of gene, Satellite DNA, Cot value, Reassociation kinetics, C value paradox, nucleosome structure
Gene transfer mechanisms in Bacteria: Transformation, Conjugation, Transduction, Transfection.
DNA replication mechanism: DNA ligase, DNA gyrase, Nuclease, Okazaki fragments, different types of **DNA replications**: Rolling circle, bidirectional theta replication, Difference between Prokaryotic and Eukaryotic replication. DNA damage and repair mechanisms
Replication of viruses: Replicase and Reverse transcriptase
Transcription mechanism: Process of transcription in prokaryotes and eukaryotes, post transcriptional modifications (capping, poly A tailing, splicing, intron exon splicing) Splicosome, Ribonucleoparticles, structure of mRNA, tRNA transcription in vitro. RNA polymerase and factors, Ribozyme.

Translation: Mechanism and regulation of translation in Pro and eukaryotes, structure of ribosome, translation factors: initiation, elongation and termination of polypeptide
Regulation of gene expression: Regulation of gene expression mechanisms in Prokaryotes and Eukaryote, differences in regulation of gene expression in Pro and Eukaryotes. Housekeeping and Master Regulatory Genes.
Mutation and cancer: Molecular basis of mutation: Insertional mutation, Frame shift mutation, suppressor mutation. Cancer molecular genetics: Classification of cancer, cancer development, genetic basis of cancer, c DNA microarrays, analysis of cancer cells, Retroviruses in cancer, protooncogenes and oncogenes.
Recombinant DNA Technology: Basic experimental techniques, cloning vectors, plasmids, Bacteriophages, cosmids, phagemids, BACs, YACs and HACs as cloning vectors, genome and C DNA libraries.
Mapping of bacterial chromosome: Site directed mutagenesis, PCR Technology, DNA – Footprinting.

PAPER-3 MICROBIOLOGY AND IMMUNOLOGY

Section-A: Microbiology

Biology of Microbes: Classification of bacteria, Bacterial cell wall biosynthesis and action of antibiotics, Nutrition, physiology and growth characteristics of bacteria. Special features of bacterial metabolism. Protozoa. Host-parasite interaction. Food-borne infections.
Microbial Genetics: Gene transfers in bacteria.
Microbial fermentation: Antibiotics, organic acids, and vitamins, Microbial transformations. Microbes in Decomposition and Recycling Processes: Symbiotic and non-symbiotic, Nitrogen Fixation, Microbiology of water, air, soil, and sewage. Microbial leaching of minerals
Applications of microbes: in medicine, industry, agriculture and environment.
Viruses: General Properties and Classification, Replication, Retroviruses and Reverse Transcriptase, Interferons, Bacteriophages.

Section-B: Immunology

Introduction to immune system: Specific and Non-Specific immune responses. Cells of the immune system. Humoral versus Cell-mediated immunity. Immunological memory. T and B lymphocytes. Antigens. Immunogen, Haptens, Adjuvants.
Immunoglobulins: Structure, Classes, properties and functional significance of Immunoglobulins. Isotypic, allotypic and idiotypic variations. Clonal selection theory. Generation of Antibody Diversity. Monoclonal antibodies, Hybridoma technology. Antigen-Antibody Interaction Agglutination, Opsonization, precipitation, neutralization. T and B-cell interactions. Lymphokines. Perforins, Interleukins. Alternate versus Classical pathway of complement activation, Natural Killer cells.
Major histocompatability complex (MHCs): HLA typing. Role in antigen processing and presentation. Transplantation antigens. T cell Receptor Biology. Autoimmunity.
Hypersensitivity Reaction: Overview.
Vaccines: Active and passive immunization, Types of vaccines.

PAPER 4 BIOCHEMISTRY OF HEALTH AND DISEASE

Meaning and scope of Health vs. Disease. Importance of Clinical Biochemistry.
Statistical procedures in Clinical and Nutritional Biochemistry: Sources of variation in a clinical setting: Analytical, Physiological. Sampling techniques. Measures of Central Tendency, class intervals. The Gaussian Probability Distribution. Standard deviation. Variation. Significance testing. Reference Ranges.
Clinical Utility: Sensitivity and. Specificity. Use of Correlation. Chi square. ANOVA and other measures in data analysis.

Nutrients in maintenance of Health: Fuels: Carbohydrates, Protein and Fat. Energy requirements.
Accessory nutrients: Vitamins (Vitamins A, D, E, K, Thiamine, Riboflavin, Niacin, pyridoxamine, folic acid, cobalamine etc., ascorbic acid. Minerals (Calcium, iron, magnesium, iodine, fluorine, trace elements). Requirements. Sources. Sub-clinical and clinical deficiencies. Recommended Dietary allowances: Statistical basis. Problems. Measurement of nutrient intakes, anthropometry, clinical assessment.
Biochemical Assessment of health: Analytes in blood, urine, tissues. Brief overview of noninvasive techniques, their limitations and interpretation. Complete Blood Count: Hemoglobin, hematocrit, total and differential leukocyte count, microscopy of erythrocytes. Plasma proteins. Glucose tolerance test, Renal function tests, Liver function tests.
Other enzymes in disease diagnosis: acid phosphatase, alkaline phosphatase, amylase, angiotensin converting enzyme, cholinesterase, creatine phosphokinase, gamma glutamyltransferase, lactate dehydrogenase, rennin,
Free radicals and the link between diet and disease: Generation, stability and quenching of free radicals. ROS and RNS. Role in intracellular signaling. Concept of oxidative stress and resulting damage to biomolecules. Antioxidant defence systems. Dietary antioxidants.
Aging: Theories of aging. Changes during the aging process: Caloric restriction. Anti aging strategies. Obesity. Etiology. Treatment. Strategies. Problems. Set Point theory.
Diabetes: Classification, diagnostic parameters, biochemical alterations, late complications, natural products as anti diabetic agents. Role of diet.
Alterations in lipid metabolism: Lipoprotein metabolism: chylomicrons, VLDL and IDL, HDL, LDL. Implications in disease. Formation of atherosclerotic plaque. Effects of dietary and other factors.
Cancer: Etiology, diagnosis, treatment strategies. Carcinogens. Nutrigenomics. Nutrient-disease interactions. Brief overview of Genomics, Transcriptomics. Proteomics. Metabolomics. Interplay between diet and gene expression: Role of SNPs, HapMaps. Role of folate in polymorphism MTFHR677-> T. Role of nutrients as transcription factors (fatty acids, retinoids). Nutrient-gene-environment interactions on the metabolome. Role of epigenetics in nutrigenomics. Systems Biology and the dietary signature. Concept, interpretation and limitations.
Introduction to Bioinformatics: Biological Databases, Search and analysis.

M.Sc Final
List of Practicals

I. Quantitative techniques:
a. Estimation of fructose and glucose in honey
b. Estimation of cholesterol in biological tissue
c. Estimation of Ribonucleic acid
d. Estimation of Deoxyribonucleic acid
II. Enzyme assays
a. Salivary amylase
i.Activity
ii.Determination of optimum pH
iii.Determination of optimum temperature
iv.Determination of Km
v.Determination of specific activity
b. Alkaline Phosphatase in serum
c. Acid phosphatase in plant tissue
d. Acetyl choline esterase in biological tissue
e. Urease estimation by Titrimetric and Colorimetric Procedure
III. Microbiology

a. Sterilization and other basic procedures
b. Culture of microorganisms: bacteria, molds, yeast
c. Staining techniques
d. Plasmid purification
e. Preparation of Transformation competent cells
f. Transformation of E. Coli with recombinant plasmids
IV. Immunology
a. Purification of serum immunoglobulins
b. Preparation of titration curves
c. Antigen- antibody titration
d. Immunodiffusion assays
e. Ouchterlony technique
V. Other analytical Techniques
a. Gel filtration: Calibration and fractionation of proteins from biological samples
b. Column chromatography: Separation of proteins and amino acids
c. SDS PAGE
d. Purification of cytochrome c from animal heart tissue
e. Nucleic acid electrophoresis (submarine gel electrophoresis)
f. Purification of enzymes
g. Isolation of bacterial DNA (different sources) and Determination of Tm of Nucleic Acid
h. Isolation of RNA and Electrophoretic Analysis
i. Restriction MAP Preparation of DNAs (Plasmids) Recombinant plasmids