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

Syllabus
Biochemistry

B. Sc. PART I:

PAPER I: Cell Biology and the physico- chemical basis of life

The molecular basis of life: The identifying characteristics of living matter: Simplicity underlying the complexity.

Cellular Basis of Life: The cell as the structural and functional unit of life. Prokaryotes versus Eukaryotes. Cellular architecture of prokaryotic cells and eukaryotic cells. Ultrastructure of the Eukaryotic Cell. Subcellular Organization of Cell. Ultracentrifugation, Marker enzymes.

The chemical unity of life. Elements. Carbon based life. Molecular components. Dimensions of biomolecules, assemblies and cells. Macromolecules. Informational macromolecules. Molecular asymmetry. Molecular interactions and bonds present in biomolecules: The significance of weak interactions.

Living cells and the Laws of thermodynamics: Living organisms in dynamic steady state. Living organisms as open systems. Entropy.

Bioenergetics. Energy transformations in living cells, Energy coupling of reactions. Free energy Introduction to high-energy bonds , Low-energy and High-energy compounds, Importance of ATP in integrating metabolic pathways. Feedback inhibition.

Evolutionary foundations of life: How life began. Morphological diversity, phylogeny and differentiation. An overview of biological organization.

Enzymes: The biological catalysts: the chemical and physical characteristics of enzymes – How enzymes accelerate reactions, Effect of pH, temperature,and other factors on enzyme action, Allosteric enzymes, enzyme-substrate interaction and the Michaelis-Menten constant, Inhibition of enzymes - General principles. Enzymes acting in sequence. Enzymes and Ribozymes.

Co-enzymes and co-factors: Brief introduction

PAPER II: Chemistry of Biomolecules

Water as a biological solvent: Weak acid and bases, types of bonds in biological systems, physiological buffers

Biomolecules: Their meaning and importance in the functional organization of the cell.

Carbohydrates: Structure of monosaccharide, stereoisomerism and optical isomerism of sugars, reaction of aldehyde and ketone groups , ring structure and anomeric form, mutarotation, reaction of sugar due to hydroxyl groups , important derivatives of monosaccharide,

disaccharides and trisaccharides (structure, occurrence and functions of important ones), structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides e.g. cellulose, chitin, agar, algenic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, glycogen and starch.

Lipids: Definition and classification, fatty acids : Introduction, classification, nomenclature, structure and properties pf saturated and unsaturated fatty acids, essential fatty acids, prostaglandins. Triacyglyderols : nomenclature, physical properties, chemical properties and characterization, of fats- hydrolysis, saponification value, rancidity of fats, Reichert Meissel number and reaction of glycerol, Biological significance of fat, Glycerophospholipids (lecithins, lysolecithins, cephalins, phosphatidylserine, phosphatidyl inositol, plasmalogens), sphingomyelins, glycolipids, cerebrosides, gangliosides, proerties and functions of phospholipids, isoprenoids and sterols

Proteins: Introduction, functional diversity of proteins, classification based on solubility, shape, composition and functions. Amino acids : common structural features, stereoisomerism, classification and structures of standard amino acids, as zwitterions in aquesous solutions, physical and chemical properties, titration of amino acids, Essential amino acids. Peptides : Structure of peptide bond, determination of the amino acid sequence of a polypeptide chain, specific chemical and enzymatic cleavage of a polypeptide chain and separation of peptides. Protein structure : levels of structure in protein architecture, primary structure of proteins, secondary structure of proteins- helix and pleated sheets, tertiary structure of proteins, forces stabilizing the tertiary structure and quaternary structure of proteins, denaturation and renaturation of proteins,, behavior of proteins in solutions, salting in and salting out of proteins. Structure and biological functions of fibrous proteins, (keratin, collagens and elastin), globular proteins (hemoglobin and myoglobin), lipoproteins, metalloproteins, glycoproteins and nucleoproteins. Colour reactions of proteins and amino acids. Protein folding & function.

Nucleic acids: Structure and function of DNA and RNA. Structure of nucleotides and formation of polynucleotide chain. Watson Crick model of DNA. Forms of DNA; DNA stability over RNA.

PAPER III: Tools and techniques in Biochemistry

Preparation of solutions: Concept of molar, molal, and normal solutions. Physiological saline.

pH and Buffers: Importance and measurement of pH. Buffer strength, Buffer capacity. Biological Buffers.

Centrifugation: Principles :- Centrifugal force, Sedimentation coefficient. Types of Centrifuges. Ultracentrifugation. Low speed vs. High speed vs. ultracentrifugation.

Chromatographic techniques: General principles. Partition and adsorption chromatography. Paper, thin layer, gas liquid, ion exchange and affinity chromatography. Gel filtration. High Performance Liquid Chromatography

Electrophoretic techniques: General principles. Paper and gel electrophoresis. Polyacrylamide Gel electrophoresis. SDS-PAGE Agarose gel electrophoresis, Zone electrophoresis.

Colorimetry: Laws of Absorption, Beer's Law and Lambert's Law. Extinction coefficient. General principles of Colorimeters and spectrophotometers.

Immunological Techniques: Immunodiffusion, Immunoelectrophoresis, radioimmunoassay, ELISA, Immunofluorescence.

B.Sc. PART II

PAPER I: Principles of Human Physiology and Nutrition

Section A: Physiology

Functional organization of the human body and homeostasis: Intracellular and extracellular division of body fluids, the concept of homeostasis and feedback control systems.

General organization of the Nervous system: Sensory and motor nerves, major levels of nervous system function, Central and autonomic nervous systems, transmission of nerve impulse, synapse, neurotransmitters.

Digestion and absorption in the gastrointestinal tract: Digestion and absorption of carbohydrates, fats and proteins

Blood: Composition of blood, functions of blood constituents in immunity, hemostasis, blood transfusion and tissue transplant

Regulation of acid-base balance: buffers in blood, respiratory control, renal control. Transport and exchange of respiratory gases: Carbon Dioxide dissociation curve. Bohr's effect. Haldane effect.

Body fluids and principles of urine formation:

Principles of endocrinology: Endocrine glands and hormones produced by them.

Section B: Nutrition

Scope of Nutrition

The fuels used by the body: Carbohydrates, proteins and fat. Composition of the human body. Composition of common foods. Units of energy.

Energy requirements: Components of energy requirements. Basal metabolic requirements. Energy requirements of BMR, activity, specific dynamic action of food, growth, pregnancy, lactation. Direct, indirect calorimetry. Reference Indian man and woman.

Concept of Recommended dietary allowances. Recommended allowances of energy requirement.

Carbohydrates: Types. Functions, dietary requirements, food sources. Fibre. Oligosaccharides.

Proteins: Nutritional functions, concept of protein quality, dietary requirements, food sources, deficiency symptoms, cure and prevention.

Fats: Functions, Fat quality. Dietary considerations. Esssential fatty acids. Food sources, effects of excess and deficiency. Interactions among the three fuels

The water soluble vitamins: Thiamine. Riboflavin. Niacin. Pyridoxine. Folic acid. Ascorbic acid. Functions. Requirements. Food sources. Fortifications. Deficiencies.

The fat soluble vitamins: Vitamins A, D, E, K. Functions. Requirements. Food sources. Fortifications. Deficiency and excess.

Minerals: Macrominerals. Microminerals. Calcium, Iron. Iodine. Flourine. Absorption. Functions. Requirements. Food sources. Fortification.

Balanced diet: Foods for energy. Protective foods. Nutritional adequacy. Locally available foods.

PAPER II: Genetics, origin of life and chemical evolution

Mendelian genetics: Mendel's laws of inheritance, Linkage and crossing over, Chromosome mapping.

Mutation: Molecular basis of mutation, Radiation induced and chemically induced mutations, Mutagens, Carcinogens, Practical applications of mutations.

Theories of origin of life: Archaebacteria, Significance of extremozymes. Evolution of Cell from Prokaryotes to Eukaryotes, Viruses.

Theories of evolution: Evolution at the molecular level, Evolution of proteins and nucleotide sequences, Structure functional relationship of Proteins, Proteomics Introns versus Exons: Role of non-coding RNA in Evolution.

PAPER III: Intermediary Metabolism

Introduction to metabolism, catabolism and anabolism: Integration of biochemical pathways.

Concepts in thermodynamics: Free energy, enthalpy and entropy in biochemical reactions Coupled Reactions ATP as energy currency of cell.

Carbohydrate metabolism: An overview of aerobic and anaerobic carbohydrate metabolism: Reactions and energetics of glycolysis. Alcoholic and lactic acid fermentation. Reactions and energetics of TCA cycle, gluconeogenesis, glycogenesis and glycogenolysis; Reactions and physiological significance of pentose phosphate pathway. Regulation of glycolysis and TCA cycle.

Electron transport chain and oxidative phosphorylation: Organisation of ETC, concept of redox potential, sites of ATP production, inhibitors of electron transport chain. Hypothesis of mitochondrial oxidative phosphorylation (basic concepts). Inhibitors and uncouplers of oxidative phosphorylation.

Lipid metabolism: Introduction to Lipids as energy sources, β oxidation of saturated fatty acids, ATP yield from fatty acid oxidation, biosynthesis of saturated and unsaturated fatty acids. Metabolism of ketone bodies, oxidation of unsaturated and odd chain fatty acids.

Photosynthesis: Light and dark reactions.

General reactions of amino acid metabolism: Transamination, oxidative deamination and decarboxylation. Urea cycle, glycogenic and ketogenic amino acids.

Nucleotide metabolism: Biosynthesis of purines and pyrimidines.

B.Sc. PART III

PAPER I: Molecular Biology

Organization of genome in prokaryotes and eukaryotes. Definitions of gene, genome and chromosome, chemical nature of gene, nucleoid in procaryotes, arrangement of prokaryotic DNA around scaffold, DNA supercoiling, HU proteins and supercoiling, plasmids, DNA packaging in prokaryotes, Histones in eukaryotes, acetylation of histones, euchromatin, heterochromatin, nucleosomes, chromatins, solenoid model, Structure of nucleic acids. C-value paradox. Structure of chromosomes: Size of genes, Crossing over, the concept of Recombination, the Cell cycle and cell division.

Replication of DNA: DNA replication in prokaryotes and eukaryotes, Enzymes and proteins involved in replication, salient features, Semiconservative nature, fidelity, regulation of replication.

Transcription: Transcription in prokaryotes and eukaryotes, Structure and Function of Enzymes and proteins involved in transcription, Types of RNA and their structure, visualization of the transcription process, Regulation of transcription in prokaryotes and eukaryotes.

Translation: The biosynthesis of proteins in prokaryotes and eucaryotes, Elements of initiation, elongation and termination, regulation of translation.

The Genetic code: The concept of codons, Properties of codons, Degeneracy, Universality. Regulation of gene expression: Control of gene expression in prokaryotes and eucaryotes, Regulatory genes, Structural genes, Repressors, the Operon concept.

PAPER II: Microbiology

Introductory concepts: Brief history: from the theory of spontaneous generation to modern microbiology and biotechnology.
Classification of microorganisms: Autotrophs and heterotrophs, other models of classification. Structure and properties of microorganisms: Prokaryotic, Eukaryotic: algae, fungi and protozoa, Viruses
Microbial cells: Nutrition, physiology and growth
Role of microorganisms in: Diseases, Food spoilage, Crop damage
Use of microorganisms in: Fermentation, Sewage purification, Industry
Control of microbial populations: Natural and drug-induced

PAPER III: Biotechnology and Genetic Engineering

Introduction to Biotechnology and genetic engineering
Genetic Recombination in Bacteria: Transformation, Conjugation and Transduction. The Basic **Features of Genetic engineering:** Release of DNA from host cells, Construction of recombinant DNA molecules. Role of enzymes- restriction endonucleases, DNA ligases, and reverse transcriptase, Introduction of recombinant DNA into host cells by DNA transformation, Selection and identification of transformed cells.
Introduction to Cloning: Expression of cloned genes, Cloning vectors
Applications of Biotechnology:
Ethical Concerns of biotechnology: Patenting, Health dilemmas, Gene therapy, Genetically modified foods etc.

PAPER IV: Biochemistry of health and disease

Meaning and scope of Health vs. Disease. Importance of Clinical Biochemistry.
Sources of variation in clinical biochemistry: Analytical, Physiological. Reference Ranges.
Clinical Utility: Sensitivity and. Specificity. False positives, false negatives.
Assessment of health: Measurement of dietary and nutrient intakes. Anthropometric measures: BMI, other measures and their clinically useful ratios, skinfold thickness, Clinical assessment for anemia, vitamin and mineral deficiencies. Choice of biochemical analytics such as blood, urine, saliva, other tissues.
Non-invasive techniques: limitations and interpretation.
Specimens used in clinical biochemistry: Collection, storage and use of blood, plasma, serum. Urine. Saliva, other tissues. Significance and limitations.
Commonly measured analytes in blood: Complete Blood Count: Hemoglobin, hematocrit, total and differential leukocyte count, microscopy of erythrocytes. Plasma proteins.
Blood glucose: Maintenance. Significance. Glucose tolerance test. The glycemic index.
Renal function tests: Kidney functions. Kidney diseases. Blood urea. Serum creatinine. GFR. Applications for disease diagnosis. Liver function tests. Liver functions, including detoxification. Liver diseases: Hepatitis, Cirrhosis. Alanine amino transaminase (ALT) and aspartate amino transferase (AST). Importance of ALT/AST ratio. Applications for disease diagnosis. Other Enzymes in diagnosis. Some examples such as amylase, alkaline and acid phosphatase.

Lipoproteins: Classification. Properties. Functions. Diagnosis of dyslipidemia. Specialized techniques for disease diagnosis: PCR, ELISA, fMRI. Advantages and limitations.

Section II: Biochemistry of Disease:

The meaning of disease:
Categorization of diseases:
Climatic and Environmental factors in disease: Disorders related to heat and cold.
A brief overview of the following categories of diseases:
Nutritional diseases: Marasmus, Kwashiorkar, Beri beri, Scurvy, Rickets
Metabolic diseases: Diabetes, Obesity, Alkaptonuria, Phenylketonuria, Goitre
Parasitic diseases: Dengue, malaria
Bacterial diseases: Plague, Diptheria, Typhoid , Bacillary dysentery, Cholera
Viral diseases: Measles, Mumps, Chicken pox, AIDS, Hepatitis