B. Sc Biochemistry Syllabus

Revised 2011

B.Sc 1st year: 3 Theory papers and 1 Practical

PAPER I: Cell Biology and the physico- chemical basis of life
PAPER II: Chemistry of biomolecules
PAPER III: Tools and techniques in Biochemistry

PRACTICALS: Qualitative analytics of Biomolecules

B.Sc 2nd year: 3 Theory papers and 1Practical

PAPER I: Principles of Human Physiology and Nutrition
PAPER II: Genetics, origin of life and chemical evolution
PAPER III: Intermediary Metabolism

PRACTICALS: Nutritional and Clinical Biochemistry

B.Sc 3rd year (for students who opt for Biochemistry as one of their optional subjects): 4 Theory papers and 1 Practical

PAPER I: Molecular Biology
PAPER II: Microbiology
PAPER III: Biotechnology and Genetic Engineering
PAPER IV: Biochemistry of health and disease

PRACTICALS: Microbiology
Molecular Biology

Syllabus for the Course for Biochemistry as one subject in the B. Sc Revised 2011 session

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.

The chemical unity of life. Elements. Carbon based life. Molecular components. Dimensions of biomolecules, assemblies and cells. Macromolecules. Informational macromolecules.

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.

Evolutionary foundations of life: How life began. 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.

PAPER II: Chemistry of Biomolecules

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

PAPER III: Tools and techniques in Biochemistry

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

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

Centrifugation: Principles :- Centrifugal force, Sedimentation coefficient. Types of Centrifuges. Ultracentrifugation.

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

Electrophoretic techniques: General principles. Paper and gel electrophoresis. Polyacrylamide Gel electrophoresis. Agarose gel electrophoresis.

Colorimetry: Laws of Absorption. Extinction coefficient. General principles of Colorimeters and spectrophotometers.

Immunological Techniques: Immunodiffusion, Immunoelectrophoresis, radioimmunoassay, ELISA.

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.

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

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.

Section B: Nutrition

Scope of Nutrition

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

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

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

Proteins: Nutritional functions, concept of protein quality, dietary requirements, food sources.

Fats: Functions, Fat quality. Dietary considerations. Esssential fatty acids. Food sources.

The water soluble vitamins: Thiamine. Riboflavin. Functions. Requirements. Food sources.

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

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

PAPER II: Genetics, origin of life and chemical evolution

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

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.
Theories of evolution: Evolution at the molecular level, Structure functional relationship of Proteins, Proteomics.

PAPER III: Intermediary Metabolism

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

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.

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, plasmids, DNA packaging in prokaryotes.
Structure of chromosomes: Size of genes, Crossing over, the concept of Recombination.

Replication of DNA: DNA replication in prokaryotes and eukaryotes, Semiconservative nature, fidelity.

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, initiation, elongation and termination, regulation.

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.

Microbial cells: Nutrition, physiology and growth

Use of microorganisms in: Fermentation.
Control of microbial populations: Natural and drug-induced

PAPER III: Biotechnology and Genetic Engineering

Introduction to Biotechnology and genetic engineering

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:

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.

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.

Lipoproteins: Classification. Properties. Functions. Diagnosis of dyslipidemia.

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