

**Bachelor of Science
(With Biochemistry as one of the Subjects)**

2011-14

SYLLABUS

Structure of B.Sc. Programme with Biochemistry as one of the Subjects

I Semester

BCH 101 Biomolecules
BCH 102 Laboratory Course I

II Semester

BCH 201 Biophysical and Biochemical Techniques
BCH 202 Laboratory Course II

III Semester

BCH 301 Enzymology
BCH 302 Laboratory Course III

IV Semester

BCH 401 Intermediary Metabolism
BCH 402 Laboratory Course IV

V Semester

BCH 501 Molecular Biology
BCH 502 Laboratory Course V

VI Semester

BCH 601 Nutritional, Clinical and Environmental Biochemistry
BCH 602 Laboratory Course VI

I SEMSTER

BCH – 101: Biomolecules

UNIT I

Introduction

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson-Hasselbalch equation, physiological buffers, principles of glass and reference electrodes, types of electrodes complications of pH measurements (dependence of pH on ionic strength, electrode contamination and sodium error) and use of pH paper, fitness of the aqueous environment for living organism

UNIT II

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, alginic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, glycogen and starch, bacterial cell wall polysaccharides etc. glycoproteins

Lipids

Definition and classification, fatty acids : Introduction, classification, nomenclature, structure and properties of saturated and unsaturated fatty acids, essential fatty acids, prostaglandins. Triacylglycerols : 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, cerebroside, gangliosides, properties and functions of phospholipids, isoprenoids and sterols

UNIT III

Proteins

Introduction, classification based on solubility, shape, composition and functions. Amino acids : common structural features, stereoisomerism and RS system of designating optical isomers, classification and structures of standard amino acids, as zwitterions in aqueous solutions, physical and chemical properties, titration of amino acids, separation of amino acids, Essential amino acids.

Peptides : Structure of peptide bond, chemical synthesis of polypeptide- protection and deprotection of N terminal and C terminal ends and the functional groups in the side chains, formation of peptide bonds, condensing agents, strategy of chemical synthesis, Merrifield solid phase peptide synthesis, 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

UNIT IV

Nucleic Acids

Nature of genetic material : Evidence that DNA is the genetic material, composition of DNA and RNA, generalized structure plan of nucleic acids, nomenclature used in writing structure of nucleic acids, features of DNA double helix. Denaturation and annealing of DNA, structure and roles of different types of RNA. Size of DNA in prokaryotic and eukaryotic cells, central dogma of molecular biology, gene, genome, chromosome.

UNIT V

Porphyrins

Porphyrins ; Porphyrin nucleus and classification of porphyrins, important metalloporphyrins occurring in nature, detection of porphyrins spectrophotometrically and by florescence. Bile pigment : chemical nature and their physiological significance.

BCH 102: LABORATORY COURSE - I

1. Preparation of standard buffers and determination of pH of a solution
2. Qualitative tests for:
 - i. Carbohydrates
 - ii. Amino acids and proteins
 - iii. Lipids
3. Determination of saponification value and iodine number of fats
4. Determination of ascorbic acid
5. Titration curve for amino acids and determination of pKa value

II SEMESTER

BCH 202: BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES

UNIT I

Concept of Bioenergetics

Principles of thermodynamics and their application in Biochemistry- introduction, thermodynamic system, thermodynamic state functions, first and second laws of thermodynamics, concept of free energy, standard free energy, determination of ΔG of a reaction, relation between equilibrium constant and standard free energy change, biological standard state and standard free energy change in coupled reactions. Biological oxidation-reduction reactions- introduction, redox potential, relation between standard reduction potential and free energy change (derivation and numericals included). High energy phosphate compounds- introduction, phosphate group transfer- free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG

UNIT II

Hydrodynamic Methods

Sedimentation- Sedimentation velocity, preparative and analytical ultracentrifugation techniques, determination of molecular weight by hydrodynamic methods (derivations excluded and numericals included)

pH and buffers

Acid, base and buffers, buffering capacity, measurement of pH, principles of glass and reference electrodes, types of electrodes, complications of pH measurement (dependence of pH on ionic strength, electrode contamination and sodium error) and use of pH paper.

Radioisotopic Techniques

Types of radioisotopes used in Biochemistry, units of radioactivity measurements, techniques used to measure radioactivity (gas ionization and liquid scintillation counting), nuclear emulsions used in biological studies, ^{32}P , ^{36}S , ^{14}C and ^3H , autoradiography, Biological hazards of radiations and safety measures in handling radioisotopes, Biological applications.

UNIT III

Chromatography

General principles and applications of:

1. Adsorption chromatography
2. Ion exchange chromatography
3. Thin layer chromatography
4. Molecular sieve chromatography
5. Hydrophobic chromatography
6. Gas liquid chromatography
7. HPLC
8. Affinity chromatography
9. Paper chromatography

UNIT IV

Spectroscopic Techniques

Beer-Lambert's law, light absorption and its transmittance, determination and application of extinction coefficient, application of visible and UV spectroscopic techniques, (structure elucidation and numericals excluded), Principle and applications of NMR, ESR, Mass spectroscopy, Fluorescent and emission spectroscopy

UNIT V

Electrophoresis

Basic principles of agarose electrophoresis, PAGE and SDS PAGE, Two dimensional electrophoresis, its importance, isoelectrofocussing

Immunological techniques

Immunodiffusion, immunoelectrophoresis, radioimmunoassay, ELISA, immunofluorescence

BCH 202: LABORATORY COURSE - II

1. Verification of Beer Lambert's law
2. Determination of
 - a. Carbohydrates by anthrone method
 - b. Blood glucose by the methods (i) Folin-Wu (ii) Nelson Somogyi
3. Determination of amino acids by ninhydrin method
4. Separation and identification of amino acids by paper chromatography & thin layer chromatography
5. Isolation and assay of glycogen from rat liver
6.
 - i. Extraction of total lipids by Folch method
 - ii. Determination of food adulterant
7. Determination of DNA and RNA
8. Separation of sugars using paper chromatography

III SEMESTER

BCH – 301: ENZYMOLOGY

UNIT I

Introduction

History, general characteristics, nomenclature, IUB enzyme classification (rationale, overview and specific examples), significance of numbering system, Definition with examples of holoenzyme, apoenzyme, coenzymes, cofactors activators, inhibitors, active site (identification of groups excluded), metalloenzymes, units of enzyme activity, specific enzymes, isoenzymes, monomeric enzymes, oligomeric enzymes and multienzyme complexes, enzyme specificity.

Historical perspective, nature of non enzymatic and enzymatic catalysis, measurement and expression of enzyme activity-enzyme assays, Definition of IU, Katal, enzyme turn over number and specific activity, role of non protein organic molecules and inorganic ions, coenzyme, prosthetic groups, role of vitamins as coenzymes.

UNIT II

Enzyme Catalysis

Role of cofactors in enzyme catalysis: NAD/ NADP⁺, FMN/ FAD, coenzyme a, biocytin, cobamide, lipoamide, TPP, pyridoxal phosphate, tetrahydrofolate and metal ions with special emphasis on coenzyme functions, acid base catalysis, covalent catalysis, proximity and orientation effects, strain and distortion theory. Mechanism of action of chymotrypsin, carboxypeptidase, ribonuclease and lysozyme.

UNIT III

Enzyme purification

Methods for isolation, purification and characterization of enzymes

UNIT IV

Enzyme Kinetics

Factors affecting enzyme activity : enzyme concentration, substrate concentration, p and temperature. Derivation of Michaelis Menten equation for uni substrate reactions. K_m and its significance. Lineweaver Burk's plot and its limitations. Importance of K_{cat}/ K_m . Bi-substrate reactions ; brief introduction to sequential and ping pong mechanism with examples.

Kinetics of zero and first order reactions. Significance and evaluation of energy of activation and free energy.

Reversible and irreversible inhibition, competitive, non competitive and uncompetitive inhibitions, determination of K_m and V_{max} in presence and absence of inhibitors. Allosteric enzymes.

UNIT V

Industrial and Clinical Application of Enzymes

Immobilization of enzymes and their industrial applications. Production of glucose from starch, cellulose and dextran; use of lactase in dairy industry; production of glucose-fructose syrup from sucrose; use of proteases in food, detergent and leather industry; medical application of enzymes; use of glucose oxidase in enzyme electrodes.

BCH 302: LABORATORY COURSE - III

1. Estimation of urease from plant tissues
2. Estimation of acid phosphatase from plant seeds
3. Estimation of alkaline phosphatase from animal tissues
4. Determination of optimum pH, temperature and time
5. Determination of K_m value of urease
6. Preparation of starch from potato and its hydrolysis by salivary amylase
7. Determination of achromatic point in salivary amylase
8. Effect of sodium chloride on amylase

IV SEMSTER

BCH – 401: INTERMEDIARY METABOLISM

UNIT I

Introduction to Metabolism

General features of metabolism, experimental approaches to study metabolism: use of intact organism, bacterial mutants, tissue slices, stable and radioactive isotopes.

Carbohydrate Metabolism

Reactions and energetics of glycolysis. Alcoholic and lactic acid fermentation. Entry of fructose, galactose, mannose etc. Reactions and energetics of TCA cycle, gluconeogenesis, glycogenesis and glycogenolysis; Reactions and physiological significance of pentose phosphate pathway. Regulation of glycolysis and TCA cycle. Photosynthesis: a brief review.

UNIT II

Electron Transport Chain and Oxidative Phosphorylation

Structure of mitochondria, sequence of electron carriers, sites of ATP production, inhibitors of electron transport chain. Hypothesis of mitochondrial oxidative phosphorylation (basic concepts). Inhibitors and uncouplers of oxidative phosphorylation. Transport of reducing potential into mitochondria.

UNIT III

Lipid Metabolism

Introduction, hydrolysis of triacylglycerols, transport of fatty acid into mitochondria, 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. Biosynthesis of triglyceride and important phospholipids, glycolipids, sphingolipids and cholesterol. Regulation of cholesterol metabolism.

UNIT IV

Amino Acid Metabolism

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

UNIT V

Nucleotide Metabolism

Sources of the atoms in the purine and pyrimidine molecules. Biosynthesis and degradation of purine and pyrimidines. Regulation of purine and pyrimidine metabolism.

Porphyryn Metabolism

Biosynthesis and degradation of porphyrins. Production of bile pigments.

BCH 402: LABORATORY COURSE - IV

1. Separation of blood plasma and serum
 - a. Determination of proteins from serum by Biuret and Lowry method
 - b. Determination of albumin and A/G ratio in serum
 2. Estimation of bilirubin (conjugated and unconjugated) in serum
 3. a. Estimation of total lipids in serum by vanillin method
 - b. Estimation of cholesterol in serum
 4. Estimation of lipoproteins in plasma
 5. Estimation of lactic acid in blood before and after exercise
 6. Estimation of blood urea nitrogen from plasma
 8. Separation of polar and non polar lipids by thin layer chromatography
 9. Estimation of SGPT and SGOT in serum
 10. a. Assay of serum alkaline phosphatase activity
 - b. Inhibition of alkaline phosphatase activity by EDTA
 - c. Effect of substrate concentration on alkaline phosphatase activity and determination of K_m value
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V SEMSTER

BCH – 501: MOLECULAR BIOLOGY

UNIT I

Basic concepts of Genetic Information

- Nucleic acids as genetic information carriers, experimental evidences e.g. bacterial genetic transformation, Hershey Chase experiment, TMV reconstitution experiment
- Central dogma of molecular genetics- current version, reverse transcription and retroviruses
- Primary structure of nucleic acids and their properties, salient features of eukaryotic, prokaryotic and viral genomes; highly repetitive, moderately repetitive and unique DNA sequences
- Basic concepts about the secondary structures of nucleic acid acids, 5'→3' direction, antiparallel strands, base composition, base equivalence, base pairing and base stacking in DNA molecule, T_m and buoyant density and their relationship with GC content in DNA

UNIT II

Structural Levels of Nucleic Acids and DNA Replication

- Secondary and tertiary structure of DNA: Watson and Crick model, A, B and Z types of DNA, major and minor grooves, chirality of DNA, tertiary structure of DNA
- Structure and properties of RNA : clover of RNA, secondary and tertiary structure
- Nucleic acid hybridization : Cot curve and satellite DNA

UNIT III

DNA Replication

DNA replication in prokaryotes : Conservative, semiconservative and dispersive types, experimental evidence for semiconservative replication; DNA polymerases, other enzymes and protein factors involved in replication; Mechanism of replication; Inhibitors of DNA replication

UNIT IV

Transcription

Transcription in prokaryotes, RNA polymerase, promoters, initiation, elongation and termination of RNA synthesis, inhibitors of transcription; Reverse transcriptase, post transcriptional processing of RNA in eukaryotes.

Translation and Regulation of Gene Expression

- Genetic code : Basic features of genetic code, biological significance of degeneracy, Wobble hypothesis, gene within genes and overlapping genes.
- Mechanism of translation, Ribosome structure, A and P sites, charged tRNA, f-met-tRNA, initiator codon, Shine-Dalgarno consensus sequences (AGGA), formation of 70S initiation complex, Role of Ef-Tu, EF-Ts, EF-G and GTP, non-sense codons and release factors, RF1 and RF2.
- Regulation of Gene Expression in Prokaryotes : Enzyme induction and repression, operon concept, Lac operon, Trp operon.

UNIT V

Mutation and Repair

- Mutation : molecular basis of mutation, types of mutation, e.g. transition, transversion, frame shift, insertion, deletion, suppresser sensitive, germinal and somatic, backward and forward mutations, true reversion and suppression, dominant and recessive mutations, spontaneous and induced mutations- Lederberg's replica plating experiment.
- Mutagenicity testing : Correlation of mutagenicity and carcinogenicity : Ames testing, Random and site directed mutagenesis.
- DNA Repair : UV repair systems in *E.coli*, significance of thymine in DNA.

Recombinant DNA Technology

Restriction endonucleases, brief discussion of steps in DNA cloning, Applications of recombinant DNA technology.

BCH 502: LABORATORY COURSE - V

1. Extraction of DNA from plant sources
2. Determination of DNA by diphenylamine method.
3. Effect of temperature on the viscosity of DNA using Oswald's viscometer.
4. Determination of A_{260} and T_m of purified DNA
5. Extraction of RNA and its determination by orcinol method.

VI SEMSTER

BCH – 601: NUTRITIONAL, CLINICAL and ENVIRONMENTAL BIOCHEMISTRY.

UNIT-I

A. Nutritional Biochemistry

i) Nutrition and Dietary habits

- a. Introduction and definition of food and nutrition. Factors determining food acceptance, physiological, energy, body building (growth and development). Regulation of body temperature. Physiology and nutrition of carbohydrates, fats, proteins and water. Vitamin A, D, E, K, vitamin B complex and vitamin C and minerals like Ca, Fe and iodine and their biological functions. Basic food groups: energy giving foods, body building food protective foods.
- b. Composition of balanced diet, recommended dietary allowances (RDA) for average Indian, Locally available foods, inexpensive quality foods and food stuffs rich in more than one nutrients. Balanced vegetarian and non-vegetarian diets, emphasis on nutritional adequacy.

UNIT-II

ii) Nutritive and calorific value of foods

- a. Basic concepts of energy expenditure, units of energy, measurement of energy expenditure by direct and indirect calorimetry, calculation of non-protein RQ with respect to carbohydrate and lipids. Determination of heat production of the diet. The basal metabolism and methods of measuring basal metabolic rate (BMR); energy requirements during growth, pregnancy, lactation and various physical activities. Calculation of energy expenditure of average man and woman.
- b. Specific dynamic action (SDA) of foods, nutritive value of various kinds of foods generally used by Indian population. Planning of dietary regimes for infants, during pregnancy and old age. Malnutrition, its implications and relationship with dietary habits and prevention of malnutrition specially protein-calorie malnutrition (Kwashiorkor and Marasmus) by improvement of diets. Human milk and its virtues, breast vs formulated milk feeding. Food preservation standards. Food adulterations and precautions, Government regulations on preservation and quality of food.

UNIT-III

B. Clinical Biochemistry

i) Basic concepts of clinical Biochemistry

- a. Definition and scope of clinical Biochemistry in diagnosis, a brief review of units and abbreviations used in expressing concentrations and standard solutions. Quality control manual vs automation in clinical laboratory.
- b. Collection and preservation of biological fluids (blood serum, plasma, urine and CSF). Chemical analysis of blood, urine and CSF. Normal values for important constituents (in SI units) in blood (plasma/ serum), CSF and urine, clearance test for urea.

UNIT-IV

ii) Clinical Enzymology

- a. Definition of functional and non functional plasma enzymes. Isoenzymes and diagnostic tests. Enzyme pattern in health and diseases with special mention of plasma lipase, amylase, cholinesterase, alkaline and acid phosphatases, SGOT, SGPT, LDH and CPK.
- b. Functional tests of kidney, liver and gastric fluids.

iii) Diseases related to metabolism

Hypo- and hyper-glycemia, glycogen storage diseases; lipid mal-absorption, and steatorrhea, sphingolipidosis; role of lipoproteins. Inborn errors of amino acid metabolism- alkaptonuria, phenylketonuria, albinism, gout and hyper-uricemia.

UNIT V

C. Environmental Biochemistry

a. Air Pollution

Particulate matter, compounds of carbon, sulfur, nitrogen and their interactions, methods for their estimation, their effects on atmosphere.

c. Water Pollution

Types of water bodies and their general characteristics, major pollutants in domestic, agricultural and industrial wastes, methods of their estimation, effects of pollutants on plants and animals, treatment of domestic and industrial wastes, solid-wastes and their treatment.

BCH 602: LABORATORY COURSE - VI

1. Estimation of hemoglobin by measuring total iron content.
2. Estimation of calcium and phosphorus in serum and urine.
3. Estimation of creatine and creatinine in urine.
4. Estimation of immunoglobulins by precipitation with saturated ammonium sulfate.
5. a. Separation of proteins by column chromatography
b. Determination of proteins by dye binding assay.
6. Separation of proteins by SDS polyacrylamide gel electrophoresis.
7. Determination of biological oxygen demand
8. Determination of chemical oxygen demand