

VIDYASAGAR UNIVERSITY
SYLLABUS OF M.Sc. COURSE IN BIOCHEMISTRY

Distribution of Marks.

I. M. Sc Part – I

SEMESTER – I - Theoretical - 200 marks
 Practical - 100 marks

- Paper – I (**BIC-101**) : Chemistry of Biomolecules
- Paper-II (**BIC-102**) : Biophysical Chemistry and
Bioenergetics
- Paper – III (**BIC-103**) : Physiological Chemistry
- Paper-IV (**BIC-104**) : Cell and Molecular Biology
- Paper – V (**BIC-105**) (Practical) : Physical Biochemistry
- Paper-VI (**BIC-106**) (Practical) : General Biochemistry

SEMESTER – II Theoretical - 200 marks
 Practical - 100 marks

- Paper – VII (**BIC-201**) : Microbiology
- Paper-VIII (**BIC-202**) : Enzymology and Nutrition
Biochemistry
- Paper – IX (**BIC-203**) : Intermediary metabolism
- Paper- X (**BIC-204**) : Biostatistics and Basic
computer Applications.
- Paper – XI (**BIC-205**)Practical) : Food and nutrition
Biochemistry
- Paper-XII (**BIC-206**) (Practical) : Microbiology

SEMESTER – I

Paper – I (BIC-101)

(40 marks)
(40 lectures)

CHEMISTRY OF BIOMOLECULES

1. Atom and Chemical Bonds:-
Atomic structure, ionization potential, nature of chemical bonding, Types of Chemical Bonding. (4L)
1. Carbohydrate Chemistry :-
General structure and classification of monosacchases, cyclic structure of monosacchases – Pyran, furan, Mutarotation. Isomerism. Compounds derived from monosacchases (Ascorbic acid, Sugar-alcohols, amino sugars), Chemical properties of monosacchases, homo- and heteropolysacchases. (7L)
3. Amino acid chemistry :-
Structure, classification, Physio-chemical properties, non-standard protein amino acids, non protein amino acids. Major chemical reactions of amino acids. (4L)
2. Peptide and Protein Chemistry:-
General idea about Peptides. Protein configuration – Primary, secondary, tertiary and quaternary structure. Globular proteins – insulin, myoglobin, haemoglobin; fibrous proteins – collagen and elastin. Classification of Proteins. Solid phase peptide synthesis. (8L)
3. Nucleic acid chemistry:-
DNA and RNA chemistry, Double helix model, DNAs with unusual structures, Single stranded DNA. Informosome. Denaturation and renaturation. (6L)
4. Lipid chemistry:-
Simple lipids (Fats and oils, waxes); Compound lipids (Phospho lipids, Phosphoglycerides, Phosphosphingosides, Glycolipids, sulfo lipids), derived lipids (Steroids, terpenes, Carotenoids). (5L)
5. Chemistry of purines and pyrimidines, Structure of FAD and NAD, Functional role of the structure of these molecules. (6L)

Paper – II (BIC-102)

(40 marks)

(40 lectures)

BIOPHYSICAL CHEMISTRY AND BIOENERGETICS

1. Chemical and Physical forces involved in Chemical bond formation between atoms and molecules, mechanism of bond formation based on electronic orbitals, sigma, Pi bonds, covalent, ionic, electrostatic, co-ordinate bonds, hydrophobic and vanderwaal interaction and their properties. Chemical bonds between Carbon and Carbon, Carbon and Nitrogen and Carbon with other atoms such as hydrogen, oxygen, Phosphorous and sulphur. (8L)
2. Biological system vs. physical system, Density, Viscosity, surface tension, electrical conductance and resistance affecting the properties of cell. (5L)
3. Bioenergetics – Coupling, the concept of free energy, Thermo dynamic principles (First law, second law, combination of two laws), Standard free energy change and equilibrium constant, ΔG and ΔG° . ΔG as universal currency of free energy in biological system free energy of hydrolysis of ATP and other organophosphates. Phosphoryl group transfer Potential of ATP. Biological oxidation – reduction reaction. (8L)
4. Isotopes and radioactivity :-
Radioactivity, decay laws, production of radio-isotopes, Radioactive transformation, detection and dose response.
Radiation safety. Use of radioisotopes in biological science. (8L)
5. Instrumentation:- (Working principle only)
Microscopy, Ultracentrifugation, viscometry, flame Photometer, Atomic absorption spectrophotometer, Mass spectrometry, UV-visible- IR spectrophotometry. Chromotography including HPLC. Electrophoresis including 2D gel, MMR and ESR. (11L)

PAPER III (BIC-103)

(40 marks)

(40 lectures)

PHYSIOLOGICAL CHEMISTRY

1. Introduction to Organic Chemistry:-
General nature of organic reactions, Reaction kinetics, Handerson – Hasselbatch equation and application (4L)
2. Alkanes:-
Structural formulae, Nomenclature, homologous series, Alkenes, Conformational analysis, Alkenes and Alkynes, Orbital Picture, Geometrical isomerism. (6L)
3. Monohydric alcohols, Polyhydric alcohols, Unsaturated alcohols, ether, and acids. (4L)
4. Nomenclature of aromatic compounds . (2L)
5. Structure and function of the cell and its organelle:-
Endoplasmic reticulum, Golgi Complex, Lysosome, mitochondria, chloroplast, nucleus and nucleosomes, ribosomes, Peroxisomes. (5L)
6. Membrane system :-
Models, membrane lipid, Membrane enzymes and receptors and their isolation. Transport through membranes (ionic Pumps, ionic channels, carriers). Preparation and structural arrangement in monolayer, bilayer and liposome. (6L)
7. Human Biology :- i) Gastrointestinal system, Digestion, absorption and nutrition.
ii) Chemistry and biology of Liver and biliary system.
iii) Haematopoietic system: Blood and buffer system (an overview)
iv) Overview of Heart and cardiovascular system.
v) Physiology of nerve and muscle :homeostasis.
vi) Excretion and acid-base regulation. (13L)

PAPER IV (BIC-104)

(40 marks)

(40 lectures)

CELL AND MOLECULAR BIOLOGY

1. Protein transport:-
Sites of synthesis of organelle and membrane Protein. Signal hypothesis. Glycosylation of proteins, Envelop carrier hypothesis. Protein targeting to nucleus, chloroplast, mitochondria, Peroxisomes and lysosomes. Eukaryotic Protein transport across membranes. Protein import by receptor mediated endocytosis. (8L)
2. Cell cycle and its regulation:-
Phases of the cell cycle. Mitosis and control of entry and exit from mitosis. Regulation of MPF activity, Cell cycle control in mammalian cells. Role of check points in cell cycle regulation. Meiosis and its significance. Crossing over. Cell cycle and cancer. Apoptosis. (10L)
3. Cytoskeleton:-
Types, tubulin and microtubules, Kinesin, Dynein, and intracellular transport. Cilia and flagella – Structure and movement. Action and myosin. Mechanism of muscle contraction. Intermediate filaments. (5L)
4. DNA metabolism:-
Enzymes, DNA replication in Prokaryotes and Eukaryotes. DNA topology, DNA repair. (6L)
5. Transcription, Transcription factors, RNA Processing, regulation of transcription initiation in prokaryotes and eukaryotes. (6L)
6. Protein biosynthesis in prokaryotes and eukaryotes.
Role of RNAs in Protein synthesis. Aminoacylation and translation mechanism in Prokaryotes and eukaryotes. Deciphering the genetic code. (5L)

PRACTICAL PAPERS

Paper-V(BIC-105) Physical Biochemistry

- 1) Chromatographic techniques-two dimensional paper chromatography. Thin layer chromatography, ion exchange chromatography.
- 2) Electrophoresis techniques: - SDS polyacrylamide gel electrophoresis.
- 3) Conductometric titration: - acid-base, precipitation by conductometer.
- 4) Potentiometric experiments: - acid-base, redox system by potentiometer.
- 5) Preparation of buffers (acetate, phosphate, tris-Hcl).
- 6) Colorimetric determination of pk.
- 7) Measurement of specific rotation by polarimeter.
- 8) Experiment on distribution law.
- 9) Determination of energy of activation.
- 10) Establishment of validity of lambert-beers' law and determination of extinction co-efficient of a protein.
- 11) Determination of reaction kinetics(0 order and 1st. Order)

Paper-VI (BIC-106) General Biochemistry

- 1) Determination of protein content by biuret method, Bradford's method and Lowry's method.
- 2) Determination of glycogen content in a given liver extract.
- 3) Determination of amino acids by formal titration and by ninhydrin method.
- 4) Determination of specific activity of alkaline phosphatase.
- 5) Determination of k_m and V_{max} value of alkaline phosphatase.
- 6) Isolation, determination and quantification of dna and rna.
- 7) Spectrophotometric estimation of α -amylase, protease and dehydrogenase.
- 8) Estimation of cholesterol by colorimetric method.
- 9) Determination of saponification value and iodine number of lipids.
- 10) Estimation of total and reduced ascorbic acid by DCIP and DNPH method.

SEMESTER – II

PAPER – VII (BIC-201)

(40 lectures)

(40 marks)

MICROBIOLOGY

1. Prokaryotic Organisms:-Characteristics, Classification and importance of microorganisms. Bergey's manual of systematic bacteriology. Contribution of Leeuwenhock, Pasteur, Koch, Jenner and other microbiologists. (6L)
2. Cell structure and other characteristics of Eubacteria, Rickettsiae, Mycoplasma, Spirochetes and Cyanobacteria. (3L)
3. Morphology and fine structure of bacteria. Bacterial cell wall. Peptidoglycan structures of Staphylococcus aureus, E. coli, Micrococcus luteus etc. Outline of bacterial cell wall biosynthesis and effect of various cell wall biosynthetic inhibitors. Cell wall hydrolytic enzymes. (8L)
4. Eukaryotic microorganisms:-Structure and reproduction of yeast and molds. (3L)
5. Growth Kinetics of bacteria:-Nutritional classification and requirements. Effects of Physical and Chemical factors on microbial growth. (5L)
6. Biogeochemical cycle: Nitrogen, Sulphur and Phosphorus emphasizing role of microorganisms. (3L)
7. Elements of Virology (3L)
8. Microbial genetics: Recent advances in molecular genetics of viruses and bacteria. Transformation, conjugation and transduction, complementation. (9L)

PAPER-VIII (BIC-202)

(40 marks)

(40 lectures)

ENZYMOLGY AND NUTRITION BIOCHEMISTRY

1. Classification of enzymes. General properties. Coenzymes – structure and function. Factors affecting enzyme properties. (5L)
2. Enzyme kinetics. Michaelis – Menten equation. Lineweaver – Bark equation. Enzyme inhibition (Competitive, non-competitive, uncompetitive and irreversible inhibition). (6L)
3. Enzyme specificity, Mechanism of Catalysis. Regulation of enzyme activity. Isozymes. (5L)
4. Allosteric control of enzyme activity, feed back inhibition. (3L)
5. Nutritional status: Dietary assessment, clinical assessment, Anthropometric measurements, proximate analysis of foodstuff. Transport of nutrients (active and passive transport mechanism, glucose transporter, ATPase transporter). BMR, SDA, RQ. Protein-Calorie malnutrition states. Specificity of amino acids in several physiological processes – eg. Suppression of pain, stimulation of appetite, Effect of metal and non-metal in nutritional Biochemistry. Nutritional status and toxicological interaction. (16L)
6. Vitamins: Fat soluble and water soluble vitamins – daily requirements, biosynthesis, role in maintaining nutritional balance, deficiency diseases. (5L)

PAPER-IX(BIC-203)

(40 marks)

(40 lectures)

INTERMEDIARY METABOLISM

1. Introduction to intermediary metabolism: Definition, Catabolism and anabolism, Metabolic flux. Nutrition importance of carbohydrate, protein and lipid. Digestive enzymes. (2L)
2. Carbohydrate metabolism: Digestion, absorption and intestinal transport of carbohydrates. Glycolysis, citric acid cycle, pentose phosphate pathway, glyconeogenesis, Glycogenolysis, Metabolism of sugar other than glucose. Glyoxalate cycle, electron transport system, oxidative phosphorylation. Metabolic regulation. (10L)
3. Amino acid and protein metabolism: Metabolism of a few individual amino acids. Amino acids as biosynthetic precursors. Protein Catabolism – proteolytic enzymes. Protein turnover. Nitrogen excretion and urea cycle, metabolic diseases. (7L)
4. Lipid metabolism: Biosynthesis of saturated and unsaturated fatty acids, formation of triglycides. Lipid breakdown- β - oxidation of fatty acids and its energetic, α -oxidation, ω - oxidation. Lipid storage and transport, lipoproteins, regulation of lipid metabolism. (5L)
5. Nucleic acid metabolism: Biosynthesis of purines and pyrimidines. Regulation, formation of nucleosides and nucleotide. Abnormal metabolism of purine, pyrimidines and associated diseases. (7L)
6. Integration of carbohydrate, lipid, protein and nucleic acid metabolism. Metabolism under different stress condition. (9L)

PAPER-X(BIC-204)

(40 marks)
(40 lectures)

BIostatistics AND BASIC COMPUTER APPLICATION

1. Scope of statistical methods in scientific studies: Frequency distribution, relative and cumulative frequencies. Diagrammatic representation of frequency polygons. (3L)
2. Measures of central tendency: Arithmetic mean, mode, median. Measures of variability, Range, mean deviation, standard deviation and coefficient of variation, skewness and kurtosis. (5L)
3. Probability: Events, sample space. Conditional probability and Bayes theorem, application of Bayes theorem in biological problems. (5L)
4. Standard Probability models: Binomial, poisson and Gaussian. (5L)
5. Population and sample: Random sample, use of table of random numbers, sampling distribution of sample means, standard error. (3L)
6. Hypothesis testing: Basic concepts and definitions, tests based on normal, student T, chi-square and F- distribution, Analysis of variance. (9L)
7. Computer basics: Operating systems, Windows and UNIX, Hardware, software disc operating system, multimedia network concepts. (5L)
8. Internet: LAN, Wide area network (WAN), Web servers, web access, HTML, HTTP and XML concepts. (5L)

PRACTICAL PAPERS

Paper-XI (BIC-205)

Food and Nutrition Biochemistry

- 1) Analysis of milk and milk products- lactose content of milk by phosphomolybdic acid. Lactose content by benedict titration. Protein content of milk by biuret method. Phosphatase test for pasteurization. Dry weight of milk powder.
- 2) Phosphorus content of milk powder. Calcium content of milk powder. Riboflavin content of milk powder. Vitamin a content of milk powder.
- 3) Analysis of cereal products: - dry weight of cereal powder. Ash content of cereal powder. Protein content of cereal powder by Zeldahl method. Carbohydrate content of cereal powder.
- 4) Analysis of fats oils:- iodine number, Vitamin A, Vitamin E, Vitamin D, Rancidity of Fat.
- 5) Detection of adulterants of food: - NaHCO_3 in milk. Glucose in milk. Starch in milk. Borax in milk. Argemone oil in oil. Mineral oil in vegetable oil. Dalda in ghee.
- 6) Chemical estimation of thiamine, riboflavin and niacin in foodstuffs.

Paper-XII (BIC-206)

Microbiology

- 1) Preparation and sterilization of culture media
- 2) Simple staining, gram staining, endospore staining and capsule staining.
- 3) Preparation of bacterial growth curve.
- 4) Estimation of viable cells in a bacterial suspension.
- 5) Determination on minimum inhibitory concentration (MIC) of antibiotic.
- 6) Isolation of microorganisms from air and soil
- 7) Bacteriological analysis of water – (1) presumptive test, (2) confirmed test, (3) completed test.
- 8) Biochemical tests of bacteria: - indole production. Tests for catalase, protease, amylase and oxidase. Starch hydrolysis test. Methyl red test.

IIIrd Semester:

Paper – XIII(BIC-301)

Methods and Techniques Employed in Biochemistry

1. **Spectroscopy:** Ultraviolet and visible adsorption spectroscopy, Infrared spectroscopy, Raman spectroscopy, Resonance Raman spectroscopy, Circular Dichroism (CD) spectroscopy. (8L)
2. **Viscosity:** Theory of viscosity, Measurement of viscosity, intrinsic viscosity and Molecular weight. (3L)
3. **Centrifugation:** Principles of Centrifugation, Density gradient Centrifugation, Analytical ultracentrifugation. Application of centrifugation. (4L)
4. **Determination of structure of proteins:** X-ray Crystallography, Nuclear Magnetic Resonance method. (3L)
5. **Electrophoresis:** Agarose Gel Electrophoresis, Pulsed Field Electrophoresis, Rotating Gel Electrophoresis, Disc electrophoresis, Isoelectric focusing, Two-dimensional electrophoresis capillary Gel electrophoresis. (6L)
6. **Chromatography:** Paper chromatography, Thin-layer chromatography, Ion exchange chromatography, Affinity chromatography. (5L)
7. **Electron Cryomicroscopy:** Freezing, sample preparation, Imaging, Low dose of electrons methods used in cryomicroscopy. (4L)
8. **Immunological Techniques:** Molecular basis of antigen – antibody reaction, Agglutination, Precipitation, Immuno diffusion, immuno-electrophoresis, ELISA, RIA, Western blot. Hybridome Technology. Production of toxoids and production of recombinant Vaccine. (7L)

Paper – XIV (BIC-302)

IMMUNOLOGY

1. **History of Immunology.**
2. **General Properties of Immune System:** Innate and adaptive immunity, cells of the immune system, primary and secondary lymphoid organs. (3L)
3. **Antigens and antibodies:** Immunogenicity, antigenicity, Haptens, adjuvants, Molecular structure of antibodies, Antibody classes and Biological activities. Immunoglobulin genes, antibody diversity. (6L)
4. **Major histocompatibility Complex (MHC):** Structure and Properties of MHC molecules, characteristics of Peptide –MHC interactions, Genomic expression of the MHC. MHC and immune responsiveness. (5L)
5. **Immune response:** T-Cell and B-Cell development. T-Cell Maturation, activation and differentiation, T-Cell receptor. Signal transduction by the TCR –Complex. Antigen processing and presentation. General features of humoral immune response, B-cell maturation, activation and antibody production. B-Cell receptor. Kinetics of immune response. (8L)
6. **Effector mechanism:** Overview of cytokines with special reference to TNF- α , IFN- γ , IL-2, IL-6, IL-12 etc. Development of Effector T-cells, migration of effector mechanisms of cell – mediated immunity Antibody mediated opsonization and phagocytosis. (6L)
7. **Hypersensitivity:** General features of hypersensitivity reactions overview of Type – I, Type – II, Type – III and Type – IV hypersensitivity. (6L)
8. **Immunodeficiencies:** Congenital immunodeficiencies and Acquired immunodeficiencies. General features of autoimmune diseases. (4L)

Paper – XV (BIC-303)

Gene and gene regulation

1. **Chromosomal basis of inheritance** (Mendelian inheritance, extension of Mendelian genetics, linkage and genetic mapping); Non-Mendelian inheritance (Extra-nuclear inheritance, maternal effect); pattern of single gene inheritance, molecular and biochemical basis of some genetic diseases; variation in chromosome number and structure, chromosomal basis of sex determination. (12L)
2. **Genome organization**, genome analysis, human genome project, sequence variation in the human genome, polymorphisms (SNPs, indels, length polymorphisms). (6L)
3. **Functional genomics**: experimental method to generate high throughput proteomic data, studying gene expression using microarray process and data, metabolomics and pharmacogenomics. ((6L)
4. **Regulation of eukaryotic gene expression**, transcription factors, translational regulation of gene expression. Development and environmental regulation of gene expression. Chromosome folding, HATs, Gene silencing, Exon shuffling, Frame shifting, Protein splicing, RNA editing and all other mode of regulation of gene expression, gene knockout and gene therapy technologies. (16L)

Paper – XVI (BIC-304)

Molecular Virology

1. **General Virology:** Morphology and ultra structure of Bacterial, Plant, and Animal Viruses. Viral enzymes. Viral nucleic acids. (3L)
2. **General idea about Bacteriophages:** Lambda phases, T4, T7 and M13 phases. RNA containing bacteriophages. (6L)
3. **Retroviruses:** Structure, replication, life cycle and transformation. Retrotransposons. Steps in HIV infection and pathogenesis. (6L)
4. **Fine structure analysis of a bacteriophage gene:** Recombination analysis of rII mutants, Deletion mapping, Defining genes by complementation (Cis-Trans) tests. (6L)
5. **Regulation of gene expression in phase lambda:** Early transcription events, Molecular basis of Lytic and Lysogenic pathways. Site specific recombination in bacteriophage lambda. (6L)
6. **Transduction:** Specialized transduction by bacteriophage lambda. Mapping bacteriophage genes. (4L)
7. **Viral vectors:** Baculoviruses, Adenoviruses, Adeno –associated viruses, pSV, pRSV, Bovine Papillomaviruses, Geminiviruses and Caulimoviruses as vectors for gene transfers in plants and animals. (10L)

Practical papers

Paper XVII (BIC-305)

Clinical Biochemistry

- Estimation of glucose by GOD-POD method.
- Estimation of cholesterol by enzymatic method.
- Estimation of triglyceride by enzymatic method.
- Estimation of SGPT and SGOT by enzymatic method.
- Estimation of alkaline phosphatase by KA method.
- Estimation of Bilirubin.
- Estimation of total protein, albumin and globulin.
- Estimation of urea DAM method.
- Estimation of uric acid by enzymatic method.
- Estimation of creatinin by alkaline pieret method.
- Biochemical detection of urine abnormalities.
- DC of human WBC and TC of human WBC and RBC.
- Estimation of ESR.
- Estimation of PCV.
- Estimation of haemoglobin.
- Examination of sputum sample.

PAPER XVIII (BIC-306)
(Practical Paper)
MOLECULAR BIOLOGY & IMMUNOLOGY

MOLECULAR BIOLOGY

- 1) Isolation of plasmid DNA from *E. coli* by Alkaline SDS method
- 2) Isolation of genomic DNA from bacteria
- 3) Isolation of genomic DNA from plant cell/animal cell
- 4) Transformation by CaCl_2 and PEG method
- 5) Selection of cloned micro-organism by blue/white colony
- 6) DNA amplification by PCR method

IMMUNOLOGY

- 1) Staining and identification of blood cells
- 2) Precipitation of immunoglobulins (Igs) from serum by ammonium sulphate precipitation followed by dialysis of ammonium sulphate precipitated Immunoglobulins.
- 3) Electrophoresis of the immunoglobulin preparation
- 4) Blood group testing
- 5) Immunoprecipitation test
- 6) Western Blotting.

IVth Semester :

Special Paper

Medical Biochemistry

Paper- BIC-401

1. Ionic equilibrium, acid-base balance and their disorders.

Definition of K_{eq} , K_w and pH, pKa. The Henderson-Hasselbalch equation. Na^+ , K^+ distribution and total body osmolality, membrane potential. Buffering systems, blood as a buffer, Definition of solvation and hydration, role of lung and kidney and their disorder .

(8 lectures)

2. Molecular basis of metabolic disorders.

Biochemistry and molecular basis of different disorders related to carbohydrate, protein fat and nucleic acids, Inborn errors of metabolism, Clinical manifestations and their precautions by nutritional management.

(10 lectures)

3. Regulations of vitamin and mineral metabolism and their clinical significances.

Hyper- and hypo- vitaminosis, Mineral metabolism and their clinical significances, Role of hormones in mineral and vitamin metabolism. Sex dimorphism in mineral and vitamin metabolism.

(10 lectures)

4. Endocrine disorders.

Disorders of pituitary, adrenal, pancreas, gonads, thyroid and their metabolic effects. Possible and respective clinical manifestations.

(12 lectures)

Special Paper

Pharmaceutical Biochemistry

Paper- BIC-402

1. Neurodegenerative disorders.

Alzheimer's disease, Parkinsonism, human multiple sclerosis. Molecular basis, biochemistry and clinical manifestations of different neurodegenerations. (12 lectures)

2. Stress and diseases.

Concept of stress, free radicals and antioxidant defense systems. Strategy for cellular adaptations against different types of stresses. Stress related disorders, Stress management. Heat stress and global warming. (08 lectures)

3. Drug and toxicity. (12 lectures)

Drug, toxin and venoms- types and chemistry. Allergens, Carcinogens. Plant products as a toxicant or medications. Drug metabolism, excretion. Environmental sources of toxicity, Clinical manifestations and precautions. Toxicity studies, LD₅₀, ED₅₀, EC₅₀. Possible sites for drug targets, Drug resistance.

4. Nanotechnology. (08 lectures)

Special Paper (Practical)

Medical and Pharmaceutical Biochemistry

Paper- BIC-403

Cell and tissue fractionation

ELISA

Western blot

Immunoelectrophoresis

Rocket immunoelectrophoresis

2-D gel electrophoresis

Auto-analyzer based estimation of clinical Sample.