

Devi Ahilya Vishwavidyalaya, Indore
Syllabus for M.Sc. (Biochemistry) for Colleges
Semester System 2012-14

Semester I

Paper 1. Chemistry of Biomolecules (85+15 marks)

Paper 2. Analytical Biochemistry (85+15 marks)

Paper 3. Cell Biology (85+15 marks)

Paper 4. Biostatistics (85+15 marks)

Practical (100 marks)

Semester II

Paper-1. Physiology (85+15 marks)

Paper-2. Microbial Biochemistry (85+15 marks)

Paper 3. Nutritional Biochemistry (85+15 marks)

Paper 4. Genetics (85+15 marks)

Practical (100 marks)

Semester III

Paper 1. Enzymology (85+15 marks)

Paper 2. Metabolism I (85+15 marks)

Paper 3. Plant Biochemistry (85+15 marks)

Paper 4. Biotechnology (85+15 marks)

Practical (100 marks)

Semester IV

Paper 1. Molecular Biology (85+15 marks)

Paper 2. Metabolism II (85+15 marks)

Paper 3. Immunology (85+15 marks)

Paper 4. Clinical Biochemistry (85+15 marks)

Practical (100 marks)

Project (50 Internal+ 50 External=100 marks)

Passing marks 28/85 in Theory, for CCE 05/15 and for Practical 17/50

M.Sc. Semester I (Admission 2012-14)
Paper I Chemistry of Biomolecules

Unit I

Carbohydrates: Occurrence, stereochemistry, classification, structure, properties and biological importance of carbohydrates, mucopolysaccharides and amino sugars.

Unit II

Proteins: Classification, structure and properties of amino acids, essential amino acids, biologically active peptides.

Classification and properties of proteins, sequencing of proteins, conformation and structure of proteins-primary, secondary, tertiary and quaternary structure, coagulation and denaturation of proteins.

Unit III

Lipids: Structure, distribution and biological importance of fats and fatty acids, chemical properties and characterization of fats, waxes, cerebrosides, gangliosides, phospholipids and proteolipids. Steroids and bile salts. Prostaglandins.

Unit IV

Nucleic acids: Structure of purines, pyrimidines, nucleosides and nucleotides, structure, types and biological role of RNA and DNA.

Unit V

Vitamins: Structure and biochemical properties of water soluble and fat soluble vitamins and their coenzyme activity.

Hormones : Mechanism of hormone action and its regulation.

Paper 2. Analytical Biochemistry

Unit I

The concept of pH, dissociation and ionization of acids and bases, pKa, buffers and buffering mechanism, Henderson Hasselbalch equation, ionization of amino acids and proteins, measurement of pH.

General principle and different types of chromatography, adsorption and partition, Column, Paper and Thin layer.

Unit II

Principle, materials used and applications of Ion-exchange chromatography, gel filtration chromatography, affinity chromatography and high performance liquid chromatography.

Unit III

Electrophoresis: Moving boundary and zonal electrophoresis, paper and gel electrophoresis, PAGE and SDS-PAGE, isoelectric focussing technique.

Sedimentation: Sedimentation velocity, preparative and analytical ultracentrifugation techniques, differential and density gradient centrifugation, subcellular fractionation.

Unit IV

Radioactivity: Disintegration of radionuclides, half-life of radioactive compounds, measurement of radioactivity, scintillation counting, use of radioisotopes, *in vivo* and *in vitro* labeling, isotopic tracer techniques, autoradiography.

Unit V

Spectrophotometry: Beer-Lamberts law, extinction coefficient and its importance, design of colorimeter and spectrophotometer, applications of uv-vis spectrophotometry.

Atomic absorption spectrophotometry and its application in biology.

Principle of optical rotatory dispersion, circular dichroism and X-ray diffraction and their applications in structure determination.

Principle of NMR spectroscopy, application of NMR in Biology.

Paper 3. Cell Biology

Unit I

Structure of plant and animal cell, plant cell wall and its composition, plasmodesmata, models of the biomembrane, structure, constituents and fluidity of plasma membrane, cytoskeleton

Unit II

Transport of metabolites across the plasma membrane, non-mediated and mediated, passive and active transport, primary and secondary active transport.

Unit III

Structure of mitochondria, different enzymes and their location, electron transport complexes, ATP synthase, mitochondrial DNA.

Structure of chloroplast, protein complexes and photosynthetic electron transport chain, DNA of the chloroplast.

Unit IV

Structure and functions of ribosomes and endoplasmic reticulum, protein sorting and signal hypothesis

Unit V

Structure and functions of golgi body and lysosomes, mechanism of secretory processes, Structure of nucleus, nuclear membrane and chromatin.

Paper 4. Biostatistics

Unit I

Types of data, collection of data, sampling and non sampling methods
Representation of Data: Frequency distribution, Line diagram, Bar diagram, Histogram and Relative Frequency Histogram. Frequency polygon and Frequency curve. Pie diagram, cumulative frequency distribution. Ogive and curve.

Unit II

Measures of Central Tendency: Arithmetic mean, Median, Mode, Geometric mean, Harmonic mean.

Measures of Dispersion: Range, Semi-interquartile range, Mean deviation, Standard deviation, Coefficient of variation, Skewness and their applications in biochemistry.

Unit III

Correlation and Regression: Scatter diagram. Correlation coefficient, Method of Least Squares, Fitting of regression line, Coefficient of determination. Non - linear regression.

Unit IV

Probability and Probability distributions: Classical and Statistical definitions of probability. Conditional Probability. Binomial, Poisson and Normal Distributions and their applications in Biochemistry.

Unit V

Tests of Significance Tests based on t, z, F and Chi-square distributions. Analysis of Variance: One way and Two way classification and their applications in biochemistry. P-value and its significance.

List of Practicals Semester I:

1. Qualitative identification of carbohydrates and proteins.
2. Normal and abnormal constituents of urine.
3. Free & total acidity in gastric juice
4. Quantitative estimation of proteins by different methods.
5. Quantitative estimation of carbohydrates.
6. Estimation of Amino Acids by Sorenson formol titration.
7. Separation of amino acids, sugars and phospholipids by chromatography.
8. Isolation of casein from milk, lecithin from egg yolk and glycogen from liver.
9. Isolation of cell organelles.

M.Sc. Semester II (Admission 2012-14)
Paper-1. Physiology

Unit I

Composition and function of blood, plasma and blood corpuscles, functions of plasma proteins, structure and function of haemoglobin, abnormal haemoglobins, Blood coagulation - mechanism and regulation. Blood groups.

Unit II

Structure of nephron, composition and mechanism of urine formation, glomerular filtration, tubular reabsorption of glucose, water and electrolytes, tubular secretion. Regulation of water and electrolyte balance, role of kidneys and hormones in their maintenance.

Unit III

Hydrogen ion homeostasis, acid-base balance, metabolic and respiratory acidosis and alkalosis. Respiratory unit, exchange and transport of respiratory gases in the body, role of 2,3 DPG, Bohr effect and chloride shift.

Unit IV

Classification of muscles, Structure of skeletal, smooth and cardiac muscles. Actin, myosin, tropomyosin, troponin, Z disc and H line components. The sliding filament mechanism and subcellular ion movements during the contraction cycle in skeletal muscles.

Unit V

Structure of neuron, nerve impulse, origin and transmission, neuromuscular junction, mechanism of nerve conduction. Reflex action and reflex arc.

Paper-2. Microbial Biochemistry

Unit I

Cellular organisation of bacteria with special reference to molecular organisation of cell wall, flagella and pilli. Identification and classification of bacteria.

Unit II

Handling and sterility maintenance in microbiological work, Methods of isolation and pure culture techniques, culture media. Microbial nutrition, bacterial growth and its kinetics.

Unit III

Energy metabolism in bacteria- fermentation, aerobic and anaerobic respiration and bacterial photosynthesis, application of microbes in food industry, dairy products and food preservation.

Unit IV

Fermentation technology- Primary and secondary metabolites, continuous and batch type culture techniques, Types and design of fermentors, fermentation processes - brewing, manufacture of penicillin, production of other antibiotics and organic compounds, single cell proteins.

Microbial assay of vitamins and amino acids.

Unit V

Viruses- Structure, proteins, classification and methods of assay. Replication of RNA and DNA viruses. Virus-host interaction, Vaccines and prevention.

Paper 3. Nutritional Biochemistry

Unit I

Direct and indirect calorimetry, energy value of the foods, thermal equivalent of oxygen, respiratory quotient, calorogenic action of the foods, basal metabolic rate- definition and its measurement, factors affecting BMR, energy requirements of the human beings.

Unit II

Nutritional aspects of the carbohydrates- Different dietary types, available and unavailable carbohydrates, requirements, utilization and functions. Special role of the non-starch polysaccharides.

Nutritional aspects of the lipids- Different dietary types, requirements, utilization and functions. Essential fatty acids.

Unit III

Nutritional aspects of the proteins- Quality of proteins, digestibility coefficient, net protein utilization, biological value and amino acid score, protein requirements and functions.

Unit IV

Nutritional aspects of the vitamins and minerals.

Unit V

Balanced diet- Recommended dietary allowances for different categories of human beings.

Food processing and loss of nutrients during processing and cooking. Naturally occurring anti-nutrients.

Disorders related to the nutrition - Protein energy malnutrition, Starvation, Obesity.

Paper 4. Genetics

Unit I

Mendelian Inheritance: Segregation and Independent Assortment, Extension of Mendelism: Incomplete dominance, Codominance, Multiple Allelism, Testing for Allelism, Gene Interaction, Epistasis, Pleiotropy

Linkage, recombination and crossing over

Unit II

Genetic mapping by recombination frequency in diploids: Two factor and three factor genetic crosses, Interference, Mapping functions,

Linkage detection in fungi by tetrad analysis,

Unit III

Linkage in humans: Somatic cell hybridisation,

Definitions of the gene, complementation test and its limitations, complementation mapping,

Viral genetics Recombination in bacteriophages, Genetic fine structure.

Unit IV

Genetic analysis in microbes: DNA transfer, transformation, transduction and conjugation and their mechanisms, mapping by recombination, genetic map of E. coli.

Unit V

Gene mutation: Molecular basis of mutation, Types of mutation, e.g. transition, transversion, frame shift, insertion, deletion, suppressor sensitive, true reversion and suppression, dominant and recessive, spontaneous and induced mutations, Mutagenicity testing. Chemical and physical mutagens and their actions DNA repair mechanisms, Transposable elements.

List of Practicals Semester II:

1. Estimation of reducing sugars by Nelson Somogyi Method.
2. Estimation of maltose by DNS Method.
3. Estimation of creatinine, chloride and inorganic phosphate in urine sample.
4. Estimation of ascorbic acid and riboflavin.
5. Estimation of methionine, tyrosine and tryptophan.
6. RBC and WBC Count, Hb estimation and blood group determination.
7. Cultivation, isolation and staining of microorganisms.
8. Determination of iodine value and saponification number of fats.

M.Sc. Semester III (Admission 2012-14)

Paper 1. Enzymology

Unit I

Isolation and purification, Classification and nomenclature of enzymes.
Enzyme catalysis: enzyme specificity and the concept of active site, determination of active site. Stereospecificity of enzymes.

Unit II

Enzyme kinetics: Factors affecting rates of enzyme catalyzed reactions, unisubstrate reactions, concept of Michaelis - Menten, Briggs - Haldane relationship, Determination and significance of kinetic constants, catalytic rate constant and specificity constant, Limitations of Michaelis-Menten Kinetics.

Unit III

Classification and kinetics of multisubstrate reactions.
Reversible and irreversible inhibition, competitive, non competitive and uncompetitive inhibitions.

Unit IV

Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis. Theories on mechanism of catalysis.
Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase. Multienzyme system, Mechanism of action, regulation and coenzymes of pyruvate dehydrogenase and fatty acid synthetase complexes.

Unit V

Enzyme regulation: General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes. Reversible and irreversible covalent modifications of enzymes.
Immobilised enzymes and their industrial applications.

Paper 2. Metabolism I

Unit I

The concept of Gibbs free energy, exergonic and endergonic reactions, redox potential. High energy bond and key position of ATP, substrate level and oxidative phosphorylation. ETC, Inhibitors and uncouplers of ETC.

Unit II

Carbohydrates :, glycogenesis and glycogenolysis, glycogen storage diseases glycolysis and gluconeogenesis, Cori's cycle,

Unit III

Pyruvate dehydrogenase complex, Krebs-cycle, glyoxalate pathway, pentose phosphate pathway and uronic acid pathway.
Regulation of carbohydrate metabolism.

Unit IV

Lipids. Oxidation of fatty acids- mitochondrial β -oxidation, α - and ω -oxidation, oxidation of unsaturated and odd-chain fatty acids, ketone bodies.
Biosynthesis of fatty acids, desaturases.

Unit V

Phospholipids and glycosphingolipids- synthesis and degradation, lipid storage diseases. Salient features of the metabolism, cholesterol and bile acids.
Regulation of lipid metabolism.

Paper 3. Plant Biochemistry

Unit I

Structure of chloroplast, Photosynthesis, dissipation of excitation energy by chlorophyll, Photosynthetic electron transport chain. Thylakoid membrane protein complexes - PS I, PS II, LHC II, Cyt b_6/f , ATP synthase complexes, cyclic photophosphorylation.

Unit II

Calvin cycle : Biochemistry of RuBP carboxylase/oxygenase, activation of RUBISCO, oxygenation reaction, stereochemistry of RUBISCO, photorespiration and compensation point, photosynthetic efficiency .

Unit III

Regulation of enzymes of carbon dioxide fixation by light; Hatch and Slack pathway, CAM plants; productivity of C4 plants.

Unit IV

Nitrogen Metabolism : Nitrogen fixation, nitrogenase complex, mechanism of action of nitrogenase. Structure of 'NIF' genes and its regulation. Hydrogen uptake and bacterial hydrogenases.

Nitrate Metabolism : Enzymes of nitrate metabolism, regulation of their synthesis and activity.

Unit V

Special features of secondary plant metabolism,
Water and mineral balance in plants, structure, function and mechanism of action of phytohormones, Defence system in plants.

Paper 4. Biotechnology

Unit I

Basic principles of genetic engineering: Methods of creating recombinant DNA molecule, splicing, properties of restriction endonucleases and their mode of action, Construction of DNA library, chemical synthesis of gene,

Unit II

Cloning vectors (lambda phage, plasmid, M-13 phage, cosmid, shuttle vectors, expression vectors). Selection/screening.

Unit III

Analysis of genomic DNA by Southern hybridization, Northern and Western blotting techniques.

Restriction mapping : Restriction fragment length polymorphism (RFLP).

Unit IV

DNA sequencing techniques: plus and minus, dideoxynucleotide, Maxam and Gilbert method, Amplification of DNA by polymerase chain reaction (PCR)
Site directed mutagenesis.

Unit V

Gene transfer methods for animals and plants; Agrobacterium mediated gene transfer, electroporation and particle gun
Application of genetic engineering in medicine and agriculture, vaccine production.

Semester III

List of Practicals

- 1 Extraction and estimation of proteins from plant material.
- 2.Extraction and estimation of RNA from biological material
- 3 Extraction and estimation of DNA from biological matyerial
- 4 Estimation of phosphate in serum.
- 5 Estimation of creatinine in serum.
- 6 Estimation of calcium in serum.

M.Sc. Semester IV (Admission 2012-14)

Paper 1. Molecular Biology

Unit I

Concept and definition of the gene, complexity of the eukaryotic gene. Structural organization of the DNA in the nuclear material- General properties of histones, nucleosomes and solenoid structure.

Unit II

DNA synthesis: The enzymes of DNA replication in prokaryotes and eukaryotes, mechanism of replication in bacteria and viruses, reverse transcriptase, salient features of eukaryotic nuclear and mitochondrial DNA replication.

Unit III

RNA synthesis: The enzymes of transcription in prokaryotes and eukaryotes, mechanism of transcription in bacteria, heteronuclear RNA, post transcriptional processing of RNA, role of ribozymes.

Unit IV

Protein synthesis: Concept of the genetic code, structure of r-RNA and t-RNA, enzymes of translation in prokaryotes and eukaryotes, mechanism of protein synthesis, post translational processing of proteins.

Unit V

Regulation of gene expression in prokaryotes and eukaryotes, structure and mechanism of various operons, such as Lac, Trp and Ara.

Paper 2. Metabolism II

Unit I

Proteins: Digestion and absorption of proteins, general reactions of protein metabolism, nitrogen balance, ammonia transport, urea cycle.

Unit II

Amino acid metabolism: Glucogenic and ketogenic amino acids, One carbon metabolism, Biosynthesis of non essential amino acids, Pyruvate forming and glutamate forming amino acids, Inborn errors associated with them.

Unit III

Catabolism of methionine, aspartate, lysine, branched chain and aromatic amino acids. Inborn errors associated with them

Unit IV

Biosynthesis and degradation of purines and pyrimidines and their regulation. Structure and regulation of ribonucleotide reductase. Inhibitors of nucleic acid biosynthesis. Inherited disorders of purine and pyrimidine metabolism.

Unit V

Mineral metabolism : Biological role of minerals and trace elements, toxic effects of heavy metals, such as, Hg, Cd, Pb, As.

Paper 3. Immunology

Unit I

Types of immunity, innate, acquired, passive and active, self vs nonself discrimination. Physiology of immune response : HI and CMI specificity and memory, antigen-antibody reactions. Antigen types. Immunoglobulins - structure, distribution and functions, Isotypic, Allotypic and Idiotypic variants. Immunoglobulin superfamily.

Unit II

Lymphoid tissue, origin and development of T- and B- lymphocytes, differentiation of lymphocytes, lymphocyte-sub-populations of mouse and man. Structure and function of lymphoid tissue. T and B cells and their surface antigens. Activation of T- and B- lymphocytes and signaling pathways in T- and B- cells. Antigen Processing and Presentation, Lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK cells

Unit III

MHC genes and products, polymorphism in MHC genes, Role of MHC antigens in immune responses., MHC antigens in transplantation and HLA tissue typing. Structure and function of class I and class II molecules. Effector mechanisms in immunity, macrophage activation, cell mediated cytotoxicity, cytotoxicity assay,

Unit IV

Hypersensitivity reactions and types. The complement system, mode of activation, classical, alternate and lectin pathway, biological functions of C proteins. Immunological tolerance and suppression.

Unit V

Immunotechniques- Agglutination and precipitation, Single and double immuno diffusion, Immunoelectrophoresis, Immuno fluorescence, RIA and ELISA, Monoclonal antibodies.

Paper 4. Clinical Biochemistry

Unit 1

Collection and preservation of biological fluids and their significance, chemical analysis of CSF and its significance.

Water and electrolyte balance. Acid base balance.

Unit II

Disorders of carbohydrate metabolism, Postprandial and Glucose tolerance test. Biochemical changes in diabetes mellitus, Hypoglycemia, Ketone bodies. Biochemical changes in diabetes mellitus, glycohaemoglobin, serum lipids and other complication of diabetes mellitus.

Lipids, lipoproteins and apolipoproteins-role in diseases.

Unit III

Evaluation of organ function tests of gastric, pancreas, kidney and liver.

Bilirubin, direct and indirect Vanderwal tests and their clinical significance, jaundice.

Fatty liver, Bile pigments - chemical nature and physiological significance.

Unit IV

Porphyrins chemistry and disorders, structure of Hb, derivatives and abnormal Hb. Detection by spectrophotometry and by fluorescence.

Enzymes in differential diagnosis of diseases and their clinical significance.

Unit V

Detoxification, phase I and phase II reactions, Enzymes of detoxification. Carcinogenesis, characteristics of cancerous cells, agents promoting carcinogenesis.

Free radicals in biological systems, Antioxidants.

Semester IV List of Practicals

1. Assay of serum enzymes- acid and alkaline phosphatase, SGOT and SGPT and amylase.
2. Estimation of cholesterol in serum
- 3 Assay of enzymes of N-metabolism: NR, GDH.
4. Assay and kinetic analysis of salivary amylase and serum alkaline phosphatase. Effect of enzymes and substrate concentration, pH, and temperature on enzyme activity.
5. Estimation of chloride, urea, bilirubin, uric acid in serum
- 6 Electrophoretic separation of proteins

SCHEME OF PRACTICAL EXAMINATION FOR M.Sc. I to IV SEMESTER

Duration 7 hr

1. Two experiments from the Semester wise list (**60** marks)
 2. Viva (**30** marks) Record (**10** marks)-
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