

SYLLABUS

M. Sc. Biochemistry

(Semester-II)

Choice Based Credit System (CBCS)

Effective from June 2016



**Bhakta Kavi narsinh Mehta University
Junagadh**

Effective from November, 2018

M.Sc. Biochemistry Syllabus Choice Based Credit System (CBCS)

(Total 100 credits)

Effective from November, 2018

Name of Program	Semester	Course Group	Credits	Hours / Week	Internal marks	External Marks	Practical /Viva Marks	Total Marks	16 digit Number
M.Sc. Biochemistry	1	Core							
		CBC 1: Fundamentals of Biochemistry	04	04	30	70		100	
		CBC 2: Metabolism	04	04	30	70		100	
		CBC 3: Enzymology	04	04	30	70		100	
		Interdisciplinary							
		IBC 1: Analytical Techniques	04	04	30	70		100	
		Practical							
		PBC 1: Practical	06	18	-	-	150	150	
		Assignment							
		Assignment	02	02	-	50		50	
	2	Core							
		CBC 4: Cell Biology and Genetics	04	04	30	70		100	
		CBC 5: Human Physiology and Endocrinology	04	04	30	70		100	
		CBC 6: Molecular Biology	04	04	30	70		100	
		Interdisciplinary							
		IBC 2: Bioinformatics and Biostatistics	04	04	30	70		100	
		Practical							
		PBC 2: Practical	06	18		-	150	150	
		Seminar							
		Seminar	02	02		50		50	
	3	Core							
		CBC 7: Immunology	04	04	30	70		100	
		CBC 8: Clinical and Nutritional Biochemistry	04	04	30	70		100	
		Elective (Any one)							
		EBC 1: Microbial Biochemistry	04	04	30	70		100	

		EBC 2: Pharmaceutical Biochemistry and Regulatory Affairs	04	04	30	70		100	
		EBC 3: Plant Biochemistry	04	04	30	70		100	
		Practical							
		PBC 3: Practical	08	18		-	200	200	
		Seminar							
		Research article presentation	04	02		100		100	
	4	Elective (Any one)							
		EBC 4: Research Methodology	04	04	30	70		100	
		EBC 5: Animal Cell Tissue Culture	04	04	30	70		100	
		Project Work							
		Dissertation work	20	30	-	500		500	

SEMESTER-I

CBC 1: FUNDAMENTALS OF BIOCHEMISTRY

UNIT 1: Overview of Biochemistry

Properties of Aqueous Solutions, Concepts of Acid – Base, pH, pK, Titration Curve and Buffers. Different Kinds of Bonds, Molarity, Normality, Ionization, Molality, Osmolarity

UNIT 2: Bioenergetics

First and Second Law of Thermodynamic, Internal Energy, Enthalpy, Entropy, Concept of Free Energy, Standard Free Energy change of a Chemical Reaction, Redox Potentials, ATP and high Energy Phosphate Compounds

UNIT 3: Fundamentals of Proteins and Nucleic Acids

Protein structure, functions, Classification and Importance, Amino acids: Common structural features, Physical and Chemical Properties, Titration of Amino acids, Separation of Amino acids, Essential Amino acids. Nature of Genetic Material, Composition of DNA and RNA, Classification of Nucleic acids, Structure and Role of different types of RNA

UNIT 4: Fundamentals of Carbohydrates and Lipids

Carbohydrates: Classification, Basic Chemical structure, Monosaccharides, Aldoses, and Ketoses, Cyclic structure of Monosaccharides, Stereoisomerism, Anomers and Epimers. Sugar Derivatives, Deoxy Sugars, Amino Sugars, and Sugar acids, disaccharides, oligosaccharides and polysaccharides. Lipids: General Reaction and Properties. Classification, Structure and Function of major lipids, Circulating lipids, Separation Techniques lipoproteins, LDL, HDL, and VLDL.

CBC 1: FUNDAMENTALS OF BIOCHEMISTRY

Objectives:

The objective of this paper is to provide students with a basic understanding of...

- The physical and chemical properties of the components of living things
- The principles of bioenergetics
- Structural, chemical biology and three-dimensional construction of macromolecules (carbohydrates, proteins, nucleic acids and lipids)
- Functional properties and importance of carbohydrates, proteins, nucleic acids and lipids.

Outcome:

By the end of the course, the students will be able to demonstrate advanced knowledge and understanding of aspects of physical and chemical properties of aqueous solutions, concepts of free energy and different types of chemical bonding, molecular machinery of living cells, principles that govern the structures of macromolecules and their participation in living system, classification and structural properties of carbohydrates, proteins, nucleic acids and lipids

CBC 2: METABOLISM

UNIT 1: Carbohydrate Metabolism

Glycolysis, Feeder Pathways for Glycolysis, Gluconeogenesis, Pentose Phosphate Pathway, Glycogen Metabolism, Citric Acid Cycle, Glyoxylate Cycle, Regulation and Stoichiometry of Carbohydrate Metabolism, Integration of Metabolism – Tissue Specific Metabolism, Hormonal Regulation of Metabolism.

Unit 2: Metabolism of Proteins and Amino Acids

Metabolic Fates of Amino Groups, Amino Acid Degradation Pathway, Biosynthesis of Amino Acids, Amino Acid Decarboxylation, Protein degradation, Nitrogen Excretion and the Urea Cycle.

UNIT 3: Lipid & Nucleotide Metabolism

Lipids digestion, Absorption and Transport, Functions of Prostaglandins, Metabolism of Fatty Acids, Cholesterol and other Lipids, Stoichiometry of Fatty Acid Catabolism, Regulation of Fatty Acid Metabolism, Metabolism of Nucleotides

UNIT 4: Oxidative Phosphorylation

Architecture of the Mitochondrion, Electron-Transfer Reactions in Mitochondria: Components of the Mitochondrial Electron Transport System, Sequence of Electron Carriers, Structures and Functions of the Individual Complexes, Inhibitors of ETC

CBC 2: METABOLISM

Objectives:

The Metabolism paper aims to provide:

- An advanced understanding of the core principles and topics of metabolic process and their biochemical reactions.
- To enable students to acquire a specialized knowledge and understanding of how enzymes and metabolites in living system works to produce energy and synthesizing different biomolecules
- To study biochemical pathways involved in intermediary metabolism.
- The metabolism of dietary and endogenous carbohydrate, lipid, and protein
- To understand the principles and major mechanisms of metabolic control and of molecular signaling by hormones

Outcome:

Metabolism refers to all biochemical reactions which occur in the living organisms. By studying this paper students will be able to differentiate the anabolic and catabolic pathways and their important enzymatic steps, understand how glycolysis produces metabolic energy as well as producing intermediates for further metabolic reactions, understand the principles and basic mechanisms of metabolic control and how regulation of biochemical pathways leads to normal integrated metabolism, understand the organization of a typical mitochondrion, locating membranes, enzymes, respiratory complexes, the F_0 - F_1 complex, important transporter proteins and how it functions to synthesize ATP.

CBC 3: ENZYMOLOGY

UNIT 1: Introduction and basics of Enzymology

Scope of enzymology, Classification and Nomenclature, Specificity of enzyme action, kinetics and catalysis of chemical and enzymatic reactions

UNIT 2: Kinetics and Inhibition

Kinetics of single substrate enzyme-catalyzed reaction: M.M. equation, L.B. Plot, Edie-Hofstee and Hanes plot, Eisenthal and Cornish-Bowden plot, Haldane reaction, Rapid reaction kinetics, Kinetics of multi-substrate catalyzed reaction: Mechanism of enzyme reaction, Investigation of reaction mechanism, Enzyme inhibition: Reversible and Irreversible inhibition

UNIT 3: Enzyme Catalysis and Allostery

Enzyme Catalysis (Acid, Base, Electrostatic, Metal ion), Mechanism of enzyme action with and without cofactor, Active site determination, Cooperativity in Hemoglobin, Various Models of Allostery, Regulation of Enzyme Activity.

UNIT 4: Enzyme technology and applications

Immobilization of Enzymes, Enzyme Technology for Industrial, Medicine and Clinical Applications, Uses of Enzymes Electrodes and Biosensor, Biotransformation. Enzyme Engineering: Chemical Modification and Site Directed Mutagenesis to Study Structure and Functional Relationship, Asymmetric Reactions through Enzyme and Nonaqueous Enzyme Technology.

CBC 3: ENZYMOLOGY

Objectives:

- To study classification and basic structural properties of enzyme
- Detailed study on mechanical and kinetics properties of enzyme including various models of kinetics and various types of inhibition
- To acquire a detail knowledge of mechanism of enzyme action, regulation and allostery in enzyme
- To develop an understating on application and technological aspects of commercial valuable enzyme

Outcome:

Students will be prepared for theoretically & practically to understand properties of enzyme. Enzymes are functional and its role in living system is unique. Enzymology paper is core Biochemistry subject, detailed understating of enzymology will help students to prepare their mind for interdisciplinary functional properties of protein. This paper gives platform to develop vast range of application of industrially valuable enzymes.

IBC 1: ANALYTICAL TECHNIQUES

UNIT 1: Microscopy and Autoradiography

Theories of Tissue Fixation and Staining Techniques. Principles of Transmission and Scanning Electron Microscopy, Confocal Microscopy. Principles of Phase Contrast and Fluorescence Microscopy. Principle and Applications of Autoradiography

UNIT 2: Spectroscopy

Basic Principles of Spectroscopy, UV, IR, Raman, ESR, ORD. CD and Structure of Proteins using NMR and ESR. Neutron and X-Ray Diffraction for Elucidation of 3D Structure. Molecular Modelling, Mass Spectrometry

UNIT 3: Chromatographic Techniques

Basic Principle and types of Chromatography. Gas Chromatography, GC-MS, LC – MS / MS. Ion Exchange Chromatography, Gel permeation, Affinity and Reverse Phase Chromatography. HPLC and FPLC

UNIT 4: Centrifugation and Electrophoretic Techniques

Principle and Applications of Centrifugation Techniques. Basic Principles of Electrophoresis, Agarose Gel, Native and SDS-PAGE. Isoelectric Focusing, 2D-PAGE and their uses in Protein Research and Protein Fractionation.

IBC 1: ANALYTICAL TECHNIQUES

Objectives:

- The objectives of this paper is to develop student's knowledge and capabilities in areas of analytical chemistry that are particularly relevant to the analysis of a range of sample types.
- To understand the physical principles of a range of quantitative and quantitative analytical techniques.
- To study the range of spectroscopic technique to characterize the biomolecules.
- To understand the governing mechanisms and driving forces of various advanced separation processes.

Outcome:

Analytical science is the study of the determination of the chemical composition of natural and artificial materials using both classical and modern instrumental techniques. From this paper students will gain a deep understanding of chemical principles, especially those relevant to the chemistry of chemical analysis. Students will gain theoretical and practical knowledge of experimental methods and analytical instrumentation. Students will be able to safely and efficiently select and apply appropriate analytical methods to the analysis of real problems; able to interpret data from analytical methods, and will understand approaches for the validation of these analytical methods

SEMESTER II

CBC 4: CELL BIOLOGY AND GENETICS

UNIT 1: Cells, Cell Organelles & Membrane Biochemistry

Evolution and Introduction of Cell Types including Cellular Specialization and Differentiation, Differences in Plant and Animal Cells, Eukaryotic Cell Organelle's Structure, Functions and Biochemistry, Chemical Composition and function of Biomembranes, Model of Lipid Membranes, Models of Plasma membranes and techniques to study fluidity, Structural and Functional aspects of Cytoskeleton

UNIT 2: Cell Signaling and Developmental Biology

Signal Transduction: Heterotrimeric G-Protein, Tyrosine Kinase Based Signaling, Phosphoinositide Cascade. Embryogenesis, Patterning in Early Vertebrate Embryo, Control of Body Segmentation.

UNIT 3: Cell Cycle

Phases of Cell Cycle, Functional Importance of each Phase, Molecular Events during Cell Cycle, Cytoskeleton in Cell Division, Regulation of Cell Cycle, Apoptotic Pathway and Cell Death, Uncontrolled Cell Division (Mutations in Proto-oncogenes, tumor suppressor genes and DNA repair genes)

UNIT 4: Classical Genetics

Fundamentals of genetics: Mendelian pattern of Inheritance, Variations to Mendelian pattern (Incomplete dominance, epistasis, etc.). Quantitative inheritance (Inheritance of complex traits), Multiple alleles and physical basis of heredity, Population Genetics (Hardy-Weinberg's law), Linkage, Crossing over, Chromosome mapping and tetrad analysis in higher organisms. Molecular mechanisms of recombination.

CBC 4: CELL BIOLOGY AND GENETICS

Objectives

- To equip students with a basic knowledge of the structural and functional properties of cells.
- To examine properties of differentiated cell systems and tissues.
- Aspect of cell cycle and cell death.
- To introduce the fascinating mechanism of cell signaling along with brief overview on developmental biology.
- To provide thorough knowledge on classical genetics.

Outcomes

Students will understand the structures and purposes of basic components of cell, especially membranes and organelles. Appreciate the cellular components underlying cell division along with a deep insight to cell division, cell death and uncontrolled cell division. Students will learn the basic principles of inheritance and patterns of heredity. Students will test and deepen their mastery of genetics by applying this knowledge in a variety of problem-solving situations.

CBC 5: HUMAN PHYSIOLOGY AND ENDOCRINOLOGY

UNIT 1: Respiration, Renal Physiology and Fluid Balance

Functional Anatomy of Respiratory System, Pulmonary Ventilation, Lung Volumes and Capacities, Principles and Mechanism of Gas Exchange, Oxygen and Carbon-Dioxide Transport, Regulation of Respiration, Body Fluid Compartments, Regulation of Fluid Balance, Regulation of Extracellular Sodium and osmolarity, Acid-Base Balance, Functional Anatomy of Kidney, Glomerular Filtration, Urine Formation, Renal Mechanisms for The Control of Blood Volume, Blood Pressure and ionic Composition.

UNIT 2: Digestive System and Cardiac System

General Anatomy and Principles of Gastrointestinal Function, Propulsion and Mixing of Food in the Alimentary Tract. Composition, Mechanism of Secretion and Functions of Different Digestive Juices. Digestion and Absorption of Various Dietary Components in the Gastrointestinal Tract, Functional Anatomy of Heart, Blood Circulation, Cardiac Cycle, Electrocardiogram.

UNIT 3: The Muscular System and Nervous System

Contraction and Excitation of Skeletal Muscles, Smooth Muscles and Cardiac Muscle, Organization of the Nervous System, Basic Functions of Synapses, Sensory Receptors, Nerve Impulse Transmission, Neurotransmitters and their Receptors. Neurophysiology of Vision, Sense of Hearing, Chemical Senses, Motor and Integrative Neurophysiology.

UNIT 4: Endocrinology

Introduction to Endocrinology, Pituitary Hormones and Their Control by the Hypothalamus, Thyroid Hormones, Hormones of Adrenal Gland, Insulin, Glucagon, Parathyroid Hormone, Calcitonin. Reproductive Hormones of the Male and Female.

CBC 5: HUMAN PHYSIOLOGY AND ENDOCRINOLOGY

Objectives:

- The course is designed to assist the students to learn and understand fundamental concepts and principles of respiratory, renal, digestive, cardiovascular, muscle and neuro physiology.
- To develop a vocabulary of appropriate terminology to effectively communicate information related to anatomy and physiology.
- To study the interrelationships within and between anatomical and physiological systems of the human body.
- To understand the basic mechanisms of homeostasis by integrating the functions of cells, tissues, organs, and organ systems.
- To study the roll and mechanism of endocrine system in metabolism, regulation of normal homeostatic condition of body and other physiological functions.

Outcome:

This course will provide a sound basis in human physiology to support in-depth understanding of physiological processes of all body systems in detail and on an appropriate level. Students will be able to explain how the activities of organs are integrated for maximum efficiency. Students will be prepared to identify how changes in normal physiology lead to disease and it will support further study in health and medical sciences or related fields. This paper will also provide understanding of hormonal action in human body to regulate normal physiological activity of different organ system as well as metabolic process.

CBC 6: MOLECULAR BIOLOGY

UNIT 1: DNA Replication

DNA and Chromosome Structure, Importance of DNA Replication, DNA Polymerases, Other Enzymes and Protein involved in DNA Replication, Mechanisms and Regulations of DNA Replication, Inhibitors of DNA Replications, Major Differences between Prokaryotic and Eukaryotic DNA Replication.

UNIT 2: Transcription & Translation

Transcription in Prokaryotes, RNA Polymerases, Promoters, Initiation, Elongation and Termination of RNA synthesis, Inhibitors of RNA Synthesis, Concept of Reverse Transcriptase. Post-transcriptional Modifications, Basic Features of Genetic Code, Mechanisms of Translation, Ribosome Structure, A and P sites, Importance of Different Codon, Regulation of Gene Expression in Prokaryotes: Enzyme Induction and Repression, Operon Concepts, LAC Operon, TRP Operon

UNIT 3: Vectors and Characterization of Nucleic Acids

Principles and Uses of Nucleic Acid Hybridizations; Principles and Methods of Nucleic Acid Sequencing; Immuno-Chemical Techniques (DNA, RNA and Protein). Properties and Applications of Plasmids, Phagemids, Phage Vectors, Cosmids, YAC, BAC, etc.

UNIT 4: Molecular Markers and Techniques

Mapping and DNA Fingerprinting: Methodology and Applications of Restriction Mapping; RFLP; RAPD; AFLP; ChIP; Chromosome Walking; ARDRA; SSR; REMAP and SCAR Analysis. Polymerase Chain Reaction: Principle and Basic types of PCR; Reverse Transcription and Real Time PCRs; Factors affecting PCR; Applications and Precautions.

CBC 6: MOLECULAR BIOLOGY

Objectives:

- Detailed understanding of prokaryotic and eukaryotic replication, types of DNA polymerases and inhibitors of DNA replication
- To gain detail on prokaryotic and eukaryotic transcription, translation and gene expression regulation
- In depth study of various types of vectors, hybridization technique and its application
- To develop an understating of advanced technologies like RFLP, Sequencing, SSR, REMAP, SCAR and various types of PCR

Outcome:

Students will choose appropriate experimental strategy for research in basic and molecular biology. To perform laboratory techniques in basic biology, molecular biology, and advanced techniques. Explanation and integration of biological principles, as applied to basic and molecular biology. Development of strong diversified background in modern biology, appropriate to the individual student goals. Develop critical-thinking, and problem based learning skills. This paper will open an understanding of current trends in molecular and genetic research, and critically appraise published work. Students will be prepared to demonstrate an ability to design, undertake, and interpret, a research project, presented in the form of a dissertation.

IBC 2: BIOINFORMATICS AND BIOSTATISTICS

Unit 1: Basic concepts of Bioinformatics

Genome projects, History of Bioinformatics, Related disciplines of Bioinformatics (Branches of Bioinformatics), Nature of Biological data, Use of Databases and Tools in Biological Discovery, Major Bioinformatics Resources: NCBI, EBI, ExPASy, RCSB, JCVI, SANGER, etc., Literature databases, Scholarly Metrics-Journal, Article, Author & Book.

Unit 2: Biological Databases

Primary Sequence Databases - Nucleic acid and Protein, Protein Secondary databases, Protein three dimensional databases, Protein Structure Classification database, Genome databases, Proteomics databases, Protein model databases, Coding and noncoding RNA databases, Carbohydrate structure databases, Protein-protein and other molecular interactions databases, Signal transduction pathway databases, Metabolic pathway and Protein Function databases, Microarray databases, Exosomal databases, Mathematical model databases, PCR and quantitative PCR primer databases, Phenotype databases, Taxonomic databases, Chemical Databases, Drug & Drug Target / Therapeutic Target Databases, Disease databases, Immunological database, Antimicrobial peptide databases, and Specialized databases.

Unit 3: Bioinformatics Tools

Sequence submission tools, Computational methods of gene prediction, Database search tools: GQuery and EB-eye; Basic concepts of sequence alignment: pairwise & Multiple sequence alignment, Global & Local alignments, and Scoring matrix; Basic terminologies: motifs, fingerprints, domains, family, superfamily, profile, matrix, fold, Identity, similarity, positives, score, etc.; Basics of Database similarity search tools, and Phylogenetic analysis; Predictions: Post translational Modification, Protein secondary structure, Protein 3D structure & assessment, protein families, patterns and profiles, protein-protein interaction, RNA structure, Noncoding RNA prediction-methods & Tools; Chemical molecule designing software, Protein & Chemical molecule visualization tools, Docking software, Molecular dynamics software; New approaches / concepts: Subtractive Genomics, Reverse vaccinology, Target fishing, Polypharmacology, Bacteriocin prediction, QSAR, ADME Toxicity prediction, Allergen prediction, Venomics & Antivenomics.

UNIT 4: Statistical Tests in Biology

Mean, Median, Mode, Student's t Test, Meaning of Significance and Significance Levels Analysis of Variance. Analysis of Covariance, Regression and Correlation Analysis, Chi square test, Confidence limits

IBC 2: BIOINFORMATICS AND BIOSTATISTICS

Objectives:

- Detailed understanding of genome projects, related disciplines of Bioinformatics use of Databases and Tools in Biological Discovery, Major Bioinformatics Resources
- To gain detail on biological databases like primary sequence databases, protein three dimensional databases, Protein Structure Mathematical model databases, PCR and quantitative PCR primer databases, Chemical Databases, Drug & Drug Target / Therapeutic Target Databases, Disease databases, Immunological database.
- In depth study of various types of tools including sequence submission tools, Chemical molecule designing software, Protein & Chemical molecule visualization tools, Docking software, Molecular dynamics software; QSAR, ADME Toxicity prediction, Allergen prediction, Venomics & Antivenomics.
- To develop an understating of statistical methods and calculations

Outcome:

Students will choose appropriate experimental strategy for research in basic and applied biology. Explanation and integration of bioinformatics principles and its applications to basic and applied biology. Students will gain *in silico* training on data mining, database searching, software application, quantitative analysis and interpretation, molecular modeling, QSAR and various DNA, RNA and Protein analytical tools. Moreover, this paper enables students to acquire the knowledge of statistical analysis and its principles.