



शिवाजी कॉलेज  
(दिल्ली विश्वविद्यालय)  
*Shivaji College*  
(University of Delhi)



NAAC ACCREDITED "A" GRADE COLLEGE

## Biochemistry

### Learning Outcomes

#### B.Sc. (Honours) Biochemistry

##### Programme Learning Outcomes (PO)

The curriculum is designed to achieve the following outcomes:

PO1: Inculcate the basic concepts of biochemistry including an understanding of the fundamental biochemical principles and their applications in a systematic, methodical, scientific, evidence-based process. The programme will also provide a general understanding of the related disciplines with a holistic knowledge generation in biological sciences.

PO2: 2 Develop problem solving and analytical skills through case studies, research papers and hands on-experience, especially integrated into skill enhancement courses.

PO3: Students will gain proficiency in basic laboratory techniques and be able to apply the scientific method to the processes of experimentation, hypothesis testing, data interpretation and logical conclusions.

PO4: Provide requisite knowledge of laboratory safety, data replication and quality control, record keeping and other aspects of "responsible conduct of research".

PO5: Ability to employ modern library search tools to locate and retrieve primary literature on a topic and critically evaluate the literature.

PO6: Students will be able to apply and effectively communicate scientific reasoning and data analysis in both written and oral forms. They will be able to communicate effectively with well designed posters and slides in talks aimed at scientific audiences as well as the general public.

PO7: Students will learn to work collaboratively in a team.

PO8: Students will gain knowledge of ethical and good laboratory practices, health and biohazard regulations, plagiarism and intellectual property rights related issues practiced in modern era of scientific investigation.

PO9: Graduates will be able to apply the major theories and research procedures to contemporary social problems.

PO10: The programme will prepare students to plunge into various fields of higher education or related profession in various disciplines, armed with plethora of knowledge, hands on experience and scientific attitude, at national and global levels.

# **B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE PAPER**

## **Molecules of Life (BCH C-1)**

### **Semester - I**

#### **1. Course Objectives**

The course aims to provide students with an understanding of biomolecules, the basic building blocks of living organisms, focusing on their structural underpinnings, unique properties, biological roles and functions and inter relations. The course will outline the importance of water as a biological solvent and vitamins as vital ingredients of life. Emphasis will be on the association between structure and function of various biomolecules at a chemical level with a biological perspective as well as hands on approach and laboratory techniques.

#### **2.1 Course Learning Outcomes**

On successful completion of the course students will be:

- Acquainted with chemical and molecular foundations of life and appreciate the role of water in biological systems.
- Able to comprehend the structure, function and acid base properties of amino acids.
- Introduced to the structure, properties and roles of carbohydrates, lipids and nucleic acids.
- Aware of the importance of vitamins in biological systems.
- Able to independently identify and quantitate various biomolecules in the laboratory.

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE PAPER**  
**Cell Biology (BCH C-2)**  
**Semester I**

**1. Course Objectives**

The objective of this paper is to offer insights into the basic structure and function of a cell and cellular organelles. The course also aims to impart understanding of cell cycle, cell death, cell renewal processes and various techniques of cell biology.

**2.1 Course Learning Outcomes**

The objective of this paper is to offer insights into the basic structure and function of a cell and cellular organelles. Students will:

- Learn about cell theory and basic cell structure
- Be introduced to cell fractionation and cell visualization techniques
- Gain knowledge about the structure and function of various cell organelles in a eukaryotic cell
- Acquire knowledge about the composition of cytoskeleton and extracellular matrix
- Acquire insight into cell division and cell death mechanisms

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE**  
**PAPER**  
**Proteins (BCH C-3)**  
**SEMESTER –II**

**1. Course Objectives**

The course aims to introduce “proteins” and their importance to modern biochemistry, highlighting their structural features and unique characteristics that help them participate in every physiological process in life, thus also playing important role in disease manifestation and their interventions.

**2.1 Course Learning Outcomes**

After completion of the course, a student will

- Understand the diverse functions of proteins in a cell

- Understand the hierarchy of protein architecture – primary, secondary, tertiary & quaternary structure, with the ability to distinguish features of globular & fibrous proteins
- Be able to comprehend the fundamental mechanisms of protein folding and stability and their relation to conformational diseases
- Be able to describe and discuss the separation and purification techniques used in protein chemistry
- Learn to access and use the databases related to protein sequence and structure
- Understand specialized proteins like membrane proteins, defense proteins and motor proteins
- Gain comprehension of structure-function relationship of proteins and their significance in physiology, diseases and applications in industry and medicine.

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE  
PAPER**

**Enzymes (BCH C-4)**

**Semester - II**

**1. Course Objectives**

The objective of the course is to provide detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life, so as to develop an understanding of enzyme kinetics, mechanism of enzyme action and their regulation. The course also aims to outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry.

**2.1 Course Learning Outcomes**

- Students will learn the nature and importance of enzymes in living systems
- Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity
- Students will understand the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors
- Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell
- The course will introduce students to the applications of enzymes in research and medicine as well as in industry, which will bolster their foray into industrial and biomedical research.

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE  
PAPER**

**Metabolism of Carbohydrates and Lipids (BCH C-5)**

**Semester - III**

## 1. Course Objective

The objective of this course is to provide an understanding of metabolism of carbohydrates and lipids, the enzymes involved in various metabolic pathways and regulation of metabolism in cells. The course also aims to outline the importance of such pathways in relation to metabolic defects.

### 2.1 Course Learning Outcomes

The learners will be able to:

- Understand the concepts of metabolism, characteristics of metabolic pathways and strategies used to study these pathways.
- Gain a detailed knowledge of various catabolic and anabolic pathways
- Understand the regulation of various pathways
- Gain knowledge about the diseases caused by defects in metabolism with emphasis on the metabolic control

## **B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE PAPER**

### **Membrane Biology and Bioenergetics (BCH C-6)**

#### **Semester III**

## 1. Course Objective

The objective of the course is to provide students with the basic understanding of membrane composition, structure-function relationship and properties of membranes. The course will also provide an understanding of the various types of membrane transporters and their molecular mechanisms. The course will introduce students to the basic tenets of Bioenergetics and detail out the molecular mechanisms of oxidative phosphorylation and photophosphorylation.

### 2.1 Course Learning Outcomes

On successful completion of the course, students will:

- Understand the general composition and structure of biomembranes.
- Understand the basic properties of membranes such as membrane fluidity.
- Have knowledge about the various types of membrane transport mechanisms.
- Understand the basic tenets of Bioenergetics.
- Understand the concept of chemi-osmotic theory and the mechanism of Oxidative phosphorylation and ATP synthesis.
- Understand the basic mechanisms of photophosphorylation in plants and microbes.

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE  
PAPER**

**Hormone : Biochemistry and Function (BCH C-7)**

**Semester - III**

**1. Course Objectives**

The course is designed to provide an understanding of the process of cellular communication including signal reception, transduction, amplification and response. The course will enable students to understand and appreciate the delicate network and balance of hormones required for the healthy functioning of the human body. It imparts an understanding of the different endocrine factors that regulate metabolism, growth, ionic homeostasis, glucose homeostasis and reproductive function. It outlines the consequences of any hormonal imbalances with special emphasis on human diseases. The course will also prepare a student for postgraduate studies in any course related to molecular medicine.

**2.1 Course Learning Outcomes**

On successful completion of the course, a student will:

- Understand and appreciate the different cognate and non-cognate modes of communication between cells in a multi-cellular organism
- Understand the role of endocrine system in maintaining ionic and glucose homeostasis
- Be able to describe molecular, biochemical and physiological effects of all hormones and factors on cells and tissues.
- Understand the integrative communications that regulate, growth, appetite, metabolism and reproduction\
- Be prepared for interpreting clinical parameters in a real life situation

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE PAPERS**

**Human Physiology (BCH C-8)**

**Semester – IV**

**1. Course Objectives**

The objective of the course in human physiology is to provide a comprehensive study of the molecular and cellular mechanisms that govern the integrative working and regulation of the various organ systems in the human body. The course will provide a foundation of the physiological principles and the application of the same in real-life situations. It also outlines the factors and biochemical events that disrupt homeostasis leading to pathophysiology. The course will prepare students for higher education in any field related to molecular medicine.

## 2.1 Course Learning Outcomes

On successful completion of this core paper, students should be able to:

- Understand the basic organization and homeostatic control of the human body from the cell itself to organ systems and the functioning of the whole body.
- Comprehend and appreciate the importance of the fluid components of the body in regulating and connecting the various organ systems; particularly the heart and vascular system.
- Appreciate and understand the biochemical, molecular and cellular events that orchestrate the coordinate working of the organ systems that regulate life processes.
- Get a holistic understanding of the different organ systems with respect to their basic functioning, which involves both integrative learning and the regulatory roles of the Nervous and Endocrine system.
- Develop in students an inquisitive learning approach to seek answers regarding the complex workings of brain.
- Understand the factors that cause an imbalance to the Homeostatic control in the body and how these lead to disorders and diseases.
- Perform and analyze various physiological tests that examine the function of various systems of the human body.

## **B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE PAPER Gene Organization, Replication and Repair (BCH C-9) Semester - IV**

### 1. Course Objectives

The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides comprehensive understanding of DNA replication, recombination, mutations and repair processes in a way that students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.

### 2.1 Course Learning Outcomes

- Students will acquire basic information about the structure of DNA and various forms of DNA, about organization of genome in various life forms, supercoiling of DNA and its significance
- Students will learn about the molecular basis of processes like DNA replication, recombination and transposition and understand the significance of these processes
- Students will learn about the various ways in which the DNA can be damaged leading to mutations and lesions and different ways to repair DNA damage

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE  
PAPER**

**Metabolism of Amino Acids and Nucleotides (BCH C-10)**

**Semester - IV**

**1. Course Objective**

The main objective of the course is to offer detailed and comprehensive knowledge about the synthesis and degradation pathways of amino acids and nucleotides and their importance in the proper functioning of the cells. This course also interrelates the metabolism of these molecules with respect to health diseases in addition to providing overview of inhibitors of metabolism for treating the diseases of metabolic disorders.

**2.1 Course Learning Outcomes**

At the end of the course the students will be able to:

- Extend their school level concepts of nitrogen cycle to understand the mechanism by which nitrogen is fixed by microbes and how it's incorporation in diet is critical to human nutrition as well as comprehend the mechanism by which ammonia is incorporated in biomolecules
- Systematically learn the breakdown and synthesis of amino acids and nucleotides in humans and recognize its relevance with respect to nutrition and human diseases
- Gain knowledge of how amino acids are converted into a variety of precursors
- Acknowledge the role of inhibitors of nucleotide metabolism which are potentially being used as chemotherapeutic drugs
- Comprehend how the amino acid and nucleotide metabolism are integrated with carbohydrate and lipid metabolism

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE  
PAPER**

**Concepts in Genetics (BCH C-11)**

**Semester – V**

**1. Course Objectives**

The aim of the course is to provide students with an understanding of both classical and modern concepts in genetics with special emphasis on the areas of transmission genetics, molecular and developmental genetics, mapping techniques, chromosomal aberrations and population genetics. Students will gain a hands-on training experience of culturing and conducting experiments on the genetic model system *Drosophila melanogaster*. The course also works as preparation for further studies in a Master's programme in molecular biology or related topics.



## 2.1 Course Learning Outcomes

On successful completion of the course, the students will be:

- Understanding the principles of Mendelian genetics, extensions and applications
- Learning and appreciating the various factors that confer genotypic and phenotypic variability.
- Using the concepts of bacterial and viral genetics to understand resistance patterns and to create linkage and genetic maps.
- Able to use statistical tools to analyze biological data.
- Able to apply the principles of transmission and inheritance in real life situations.

## **B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE PAPER** **Gene Expression and Regulation (BCH C-12)** **Semester - V**

### 1. Course Objective

The objective of the course is to introduce to the students the basic knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes and how these processes are regulated, so that students can apply this knowledge in enhancing their analytical and problem solving skills.

### 2.1 Course Learning Outcomes

After completion of the course students will:

- acquire basic knowledge about the processes of transcription and translation in prokaryotes and eukaryotes
- learn about the features of the genetic code and various experimental approaches used to crack the code
- develop understanding of the molecular basis of RNA processing and RNA splicing
- learn about the various ways in which these biological processes are regulated and the significance of regulation in maintaining life forms

## **B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE** **PAPER** **Genetic Engineering and Biotechnology (BCH C-13)** **Semester – VI**

### 1. Course objectives:

The objective of the course is to teach the basics of theoretical and practical aspects of recombinant DNA technology and various techniques for DNA manipulation in prokaryotes and eukaryotes. Applications of these techniques in production of recombinant therapeutic proteins and vaccines will also be outlined in this course.

## **2.1 Course Learning Outcome**

The students will be able to understand:

- The process for isolation and engineering of DNA using restriction and modification enzymes.
- Use of cloning and expression vectors.
- The methods for creation of genomic and cDNA libraries, their applications and use.
- Understanding the methods for protein production and their application in industrial production systems.

## **B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) CORE PAPER Immunology (BCH C-14) Semester VI**

### **1. Course Objective**

This course describes the molecular and cellular basis of the development and function of the immune system. The course will provide the basic framework in immunology that will cover the major topics including innate and adaptive immunity, antibodies and antigens, the molecular events leading to the generation of antibody, humoral and cell mediated adaptive immune response, hypersensitivity, self-tolerance, autoimmunity and vaccines.

## **2.1 Course Learning Outcomes**

Upon completion of this course, a student will be able to:

- Trace the history and developments in immunology.
- Have an overview of the immune system including cells, organs and receptors.
- Describe the basic mechanism, differences and functional interplay of innate and adaptive immunity
- Understand Antigens & its Recognition, antigen processing and presentation
- Understand the structure & functions of different classes of Immunoglobulins, and understand the genetic basis of antibody diversity
- Define the cellular and molecular pathways of humoral and cell-mediated immune responses
- Describe the mechanisms involved in different types of hypersensitivity
- Explain the principles of tolerance and autoimmunity
- Understand Immunotherapies and basic concept of Vaccines

- Summarize role of immunity in protection against pathogens

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)  
DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES**

**Advanced Cell Biology (BCH DSE-2)**

**Semester - V**

**1. Course Objective**

The course aims to provide advanced knowledge of the function of cellular organelles, the structure and function of cytoskeleton and its role in motility. The course will also provide details of cellular interaction with cells and tissues around and the molecular regulation of cell growth and cell death. The course will outline the molecular details of the origin of cancer and the diagnosis and treatment.

**2.1 Course Learning Outcomes**

The learning outcomes will be as follows:

- Students will develop understanding of the principle and application of some of the classical and advanced cell biology techniques
- Students will be able to describe the role of organelles in the secretion of mature proteins and key role of the cytoskeleton in the living cell.
- Students will be able to understand the factors regulating mitosis, meiosis, apoptosis and necrosis. They will also be able to comprehend the role and therapeutic value of stem cells.
- Students will be able to understand the genetic basis of development of cancer, the molecular diagnosis and molecular drugs which are used for chemotherapy.

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)  
DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES**

**Microbiology (BCH DSE-3)**

**Semester - V**

**1. Course Objectives**

The objective of the course is to trace the history of development of the discipline of Microbiology and to emphasize the existence of the immense diversity in the microbial world and maintenance of microbes under laboratory conditions. The course also aims to make the students aware of both pathogenic as well as beneficial microbes to prepare students for higher education in microbiology-related disciplines.

## 2.1 Course Learning Outcomes

On successful completion of this paper, students should be able to:

- Identify different microbes
- Perform routine microbiological practices including sterilization, media preparation, maintenance of microbial culture, staining etc.
- Carry out research using microbes.
- Test microbial culture for antibiotic resistance.

## **B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)**

### **DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES**

#### **Molecular Basis of Infectious Disease (BCH DSE-4)**

#### **Semester - VI**

### 1. Course Objective

The course aims to provide knowledge about various microbial infectious agents that cause diseases in humans, the concepts of treatment and the biochemical basis of mechanism of action and drug resistance for various antimicrobial agents. The course will also provide outline of the various strategies that are employed for preventing infectious diseases and the role of vaccination in eradication of diseases. It will cover the concept of emergence and reemergence of diseases and idea of bio-terrorism and its impact worldwide. The course will also summarize the significance of hygiene, sanitation, drugs and vaccination in prevention and eradication of infectious diseases.

### 2.1 Course Learning Outcomes

- Students will understand various classes of pathogens and their mode of action and transmission.
- Students will be exposed to molecular basis of treatment, diagnosis and vaccine design strategies for all the diseases listed.
- Students will gain insight into host immune responses that ensue subsequent to infection.
- Students will learn the details of diseases such as tuberculosis, AIDS and malaria which are highly prevalent in Indian subcontinent.

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)**  
**DISCIPLINE SPECIFIC ELECTIVE PAPER**  
**Advanced Methodologies (BCH DSE-6)**  
**Semester – VI**

**1. Course Objectives**

The objective of the course is to provide students with a sound background of latest techniques used in biochemistry research and to provide them with an understanding of the principles underlying these techniques. The course is designed to impart laboratory skills in the form of practical exercises so that students can apply this knowledge to augment their research acumen and improve their understanding of the subject.

**2.1 Course Learning Outcomes**

- Students will acquire knowledge about the principles and applications of latest methods used to analyze nucleic acids and proteins.
- Students will learn about the principle and applications of microscopy and various cell biology techniques.
- Students will also be exposed to various methods of labeling DNA, proteins and whole cells and their applications in research.
- The course will also provide them an opportunity for hands-on-experience to develop their laboratory skills expected of any biochemist working in a research lab.

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)**  
**SKILL ENHANCEMENT ELECTIVE (SEC) COURSES**  
**Biochemical Techniques (BCH SEC-1)**  
**Semester - III**

**1. Course Objectives**

The objective of the course is to introduce to the students, various techniques that are used in a biochemistry lab and to provide them with an understanding of the principle underlying these techniques and laboratory skills in the form of practical exercises so that students can apply this knowledge to pursue research.

**2.1 Course Learning Outcomes**

The course is designed for undergraduate students to learn the basic concepts of various techniques used in Biochemistry. The course will enable students to:

- Acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab.
- Learn about the principle and applications of electrophoresis and centrifugation techniques.
- Obtain hands-on-experience and laboratory skills expected of any biochemist working in a research lab.

**B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)**  
**SKILL ENHANCEMENT ELECTIVE (SEC) COURSES**  
**Bioinformatics (BCH SEC-4)**  
**Semester - IV**

**1. Course Objectives**

The objective of this course is to impart basic understanding of bioinformatics and computational biology. The course will introduce the broad scope of bioinformatics by discussions on the theory and practices of computational methods in biology. This course also aims to provide students with a practical hands-on experience with common bioinformatics tools and databases. Students will be trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein structures.

**2.1 Course Learning Outcomes**

After completion of the course, a student will:

- Understand the basics of bioinformatics and computational biology and develop awareness of the interdisciplinary nature of this field.
- Gain the ability to use several softwares/tools in biology
- Gain confidence to discuss, access and use biological databases in public domain
- Understand protein structure using visualization softwares
- Be able to gain understanding of sequence alignments
- Be able to analyze phylogeny using alignment tools
- Comprehend the fundamental aspects of in-silico protein structure prediction
- Understand how theoretical approaches can be used to analyze biological systems
- Obtain knowledge on applications of bioinformatics from genomes to personalized medicine.