

## Course Outcomes – Program Outcomes (COPO) Mapping

### Program Outcomes (PO): B.S.C. (Hons.) Biochemistry

#### Learning Outcome-based Curriculum Framework (LOCF)

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner.

#### ABBREVIATIONS / NOMENCLATURE

Sno.	Nomenclature	Description	Aggregate Courses
1	PO	Program Outcome	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10
2	CO	Course Outcome	CO1, CO2, CO3, CO4, CO5, CO6, CO7
3	CC	Core Courses	CC1, CC2, CC3, CC4.....CC11, CC12
4	DSE	Discipline Specific Electives	DSE1, DSE2, DSE3, DSE4
5	GE	General Electives	GE1, GE2, GE3, GE4

S. No.	Program Outcomes (PO): B.S.C. (Hons) Biochemistry	Statements
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1.	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.
2.	PO2	Develop problem solving and analytical skills through case studies, research papers and hands-on-experience, especially integrated into skill enhancement courses.
3.	PO3 (Laboratory Outcome)	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.
4.	PO4(Laboratory Outcome)	Provide requisite knowledge of laboratory safety, data replication and quality control, record keeping and other aspects of “responsible conduct of research”.
5.	PO5	Ability to employ modern library search tools to locate and retrieve primary literature on a topic and critically evaluate the literature.
6.	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.
7.	PO7	Students will learn to work collaboratively in a team.
8.	PO8 (Laboratory Outcome)	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.
9.	PO9	Graduates will be able to apply the major theories and research procedures to contemporary societal issues.
10.	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.

**Course Outcomes (CO): B.S.C (Hons) Biochemistry**

<b>SEMESTER 1:</b>			
<b>CC1: Molecules of Life</b>			
<b>Unique Paper Code</b>	<b>Name of the Paper</b>	<b>Course Outcome: CO</b>	<b>Statement</b>
<b>32491101</b>	<b>Molecules of Life (CC1)</b>	CO1	Acquaintewth chemical and molecular foundations of life and appreciate the role of water in biological systems.
		CO2	Able to comprehend the structure, function and acid base properties of amino acids.
		CO3	Introduced to the structure, properties and roles of carbohydrates, lipids and nucleic acids.
		CO4	Aware of the importance of vitamins in biological systems.
		CO5	Able to independently identify various biomolecules in the laboratory.
<b>CC2: Cell Biology</b>			
<b>32491102</b>	<b>Cell Biology (CC2)</b>	CO1	Learn about cell theory and basic cell structure
		CO2	Be introduced to cell fractionation and cell visualization techniques
		CO3	Gain knowledge about the structure and function of various cell organelles in a eukaryotic cell
		CO4	Acquire knowledge about the composition of cytoskeleton and extracellular matrix
		CO5	Acquire insight into cell division and cell death mechanisms
<b>GE 1: Biomolecules</b>			
<b>32495108</b>	<b>Biomolecules (GE1)</b>	CO1	Students will acquire knowledge about structure and function of proteins, RNA, DNA, carbohydrates and co-enzymes.
		CO2	The course will provide an understanding of how structure of biomolecules determines their chemical properties.
		CO3	Students will develop understanding of biochemistry at atomic level and appreciate the biological importance of each biomolecule

**COPO (Course Outcome Program Outcome) MAPPING**

<b>SEMESTER I: COPO MAPPING</b>											
<b>Papers</b>	<b>(PO)</b>										
	<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CC1</b>	CO1	✓						✓			
	CO2	✓	✓					✓			
	CO3	✓	✓					✓			
	CO4	✓						✓			
	CO5	✓			✓			✓	✓		
<b>CC2</b>	CO1	✓						✓			
	CO2	✓						✓			
	CO3	✓						✓			
	CO4	✓				✓		✓			
	CO5	✓						✓			
<b>GE1</b>	CO1	✓						✓			
	CO2	✓						✓			
	CO3	✓						✓			

<b>SEMESTER II</b>			
<b>CC3: Proteins</b>			
<b>Unique Paper Code</b>	<b>Name of the Paper</b>	<b>Course Outcome: CO</b>	<b>Statement</b>
<b>32491201</b>	<b>Proteins (CC3)</b>	CO1	Understand the diverse functions of proteins in a cell.
		CO2	Understand the hierarchy of protein architecture – primary, secondary, tertiary & quaternary structure, with the ability to distinguish features of globular & fibrous proteins.
		CO3	Be able to comprehend the fundamental mechanisms of protein folding and stability and their relation to conformational diseases.
		CO4	Be able to describe and discuss the separation and purification techniques used in protein chemistry
		CO5	Learn to access and use the databases related to protein sequence and structure
		CO6	Understand specialized proteins like membrane proteins, defense proteins and motor proteins
		CO7	Gain comprehension of structure-function relationship of proteins and their significance in physiology, diseases and applications in industry and medicine.
<b>CC4: Enzymes</b>			

<b>32491202</b>	<b>Enzymes (CC4)</b>	CO1	Students will learn the nature and importance of enzymes in living systems.
		CO2	Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity.
		CO3	Students will understand the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors.
		CO4	Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell.
		CO5	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>GE 2: Techniques in Biochemistry</b>			
<b>32495205</b>	<b>Techniques in Biochemistry (GE 2)</b>	CO1	Students will acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab.
		CO2	Students will learn about the principle and application of electrophoresis, centrifugation techniques, cell culture and microscopic techniques.
		CO3	It will also give them an opportunity to get hands on experience to develop their experimental skills expected from any biochemist working in a research lab.

<b>SEMESTER II: COPO MAPPING</b>											
<b>Papers</b>	<b>(PO)</b>										
	<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CC3</b>	CO1	✓						✓			
	CO2	✓						✓			
	CO3	✓						✓			
	CO4	✓						✓		✓	
	CO5	✓					✓	✓			
	CO6	✓					✓	✓			
	CO7	✓					✓	✓		✓	
	CO1	✓				✓		✓			
	CO2	✓						✓			
	CO3	✓				✓		✓			

CC4	CO4	✓				✓		✓			
	CO5	✓				✓	✓	✓		✓	
GE 2	CO1	✓							✓		
	CO2	✓				✓			✓		
	CO3	✓	✓						✓		

**SEMESTER III:**

**CC5: Metabolism of Carbohydrates and Lipids**

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
32491301	Metabolism of Carbohydrates and Lipids (CC5)	CO1	Understand the concepts of metabolism, characteristics of metabolic pathways and strategies used to study these pathways.
		CO2	Gain a detailed knowledge of various catabolic and anabolic pathways.
		CO3	Understand the regulation of various pathways.
		CO4	Gain knowledge about the diseases caused by defects in metabolism with emphasis on the metabolic control

**CC6: Membrane Biology and Bioenergetics**

32491302	Membrane Biology and Bioenergetics (CC6)	CO1	Understand the general composition and structure of bio-membranes.
		CO2	Gain knowledge of the basic properties of membranes such as membrane fluidity.
		CO3	Have knowledge about the various types of membrane transport mechanisms.
		CO4	Understand the basic tenets of Bioenergetics.
		CO5	Be able to imbibe the concept of chemi-osmotic theory and the mechanism of oxidative phosphorylation and ATP synthesis.
		CO6	Understand the basic mechanisms of photophosphorylation in plants and microbes.

**CC7: Hormone: Biochemistry and Function**

		CO1	Understand and appreciate the different cognate and non-cognate modes of
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<b>32491303</b>	<b>Hormone: Biochemistry and Function(CC7)</b>		communication between cells in a multi-cellular organism.
		CO2	Understand the role of endocrine system in maintaining ionic and glucose homeostasis.
		CO3	Be able to describe molecular, biochemical and physiological effects of all hormones and factors on cells and tissues.
		CO4	Understand the integrative communications that regulate, growth, appetite, metabolism and reproduction
		CO5	Be prepared for interpreting clinical parameters in a real life situation

**GE 3: Proteins and Enzymes**

<b>32495902</b>	<b>Proteins and Enzymes (GE 3)</b>	CO1	Familiar with unique features and characteristics of proteins and enzymes and their applications in research, medicine and industry RNA, DNA, carbohydrates and co-enzymes.
		CO2	Aware of the relationship between three-dimensional structure of proteins and enzymes and their functions..
		CO3	Able to comprehend the basic mechanism of action of enzymes and their remarkable regulation
		CO4	Aware of the principles of protein isolation, purification and characterization
		CO5	Able to gain hands-on-experience in handling proteins and enzymes from various sources, thus improving their ability of learning and imbibing the basic concepts.

**SEMESTER III: COPO MAPPING**

<b>Papers</b>	<b>(PO)</b>										
	<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CC5</b>	CO1	✓				✓		✓			
	CO2	✓				✓		✓			
	CO3	✓				✓		✓			
	CO4	✓				✓		✓		✓	
<b>CC6</b>	CO1	✓				✓		✓			
	CO2	✓				✓		✓			
	CO3	✓				✓		✓		✓	
	CO4	✓				✓		✓			
	CO5	✓				✓		✓		✓	

	CO6	✓	✓	✓		✓		✓	✓	✓	
<b>CC7</b>	CO1	✓				✓		✓			
	CO2	✓				✓		✓			
	CO3	✓				✓		✓			
	CO4	✓				✓		✓			
	CO5	✓				✓		✓		✓	
<b>GE 3</b>	CO1	✓				✓		✓			
	CO2	✓				✓		✓			
	CO3	✓				✓		✓			
	CO4	✓				✓		✓			
	CO5	✓	✓	✓	✓						

**SEMESTER IV:**

**CC8: Human Physiology**

<b>Unique Paper Code</b>	<b>Name of the Paper</b>	<b>Course Outcome: CO</b>	<b>Statement</b>
<b>32491401</b>	<b>Human Physiology (CC8)</b>	CO1	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.
		CO2	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.
		CO3	Appreciate and understand the biochemical, molecular and cellular events that orchestrate the coordinate working of the organ systems that regulate life processes.
		CO4	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.
		CO5	Develop in students an inquisitive learning approach to seek answers regarding the complex workings of brain.
		CO6	Understand the factors that cause an imbalance to the Homeostatic control in the body and how these lead to disorders and diseases.
		CO7	Perform and analyze various physiological tests that examine the function of various systems of the human body.



<b>CC9: Gene Organization, Replication and Repair</b>			
<b>32491402</b>	<b>Gene Organization, Replication and Repair (CC9)</b>	CO1	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.
		CO2	Students will learn about the molecular basis of processes like DNA replication, recombination and transposition and understand the significance of these processes
		CO3	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>CC10: Metabolism of Amino Acids and Nucleotides</b>			
<b>32491403</b>	<b>Metabolism of Amino Acids and Nucleotides (CC10)</b>	CO1	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
		CO2	Systematically learn the breakdown and synthesis of amino acids and nucleotides in humans and recognize its relevance with respect to nutrition and human diseases
		CO3	Gain knowledge of how amino acids are converted into a variety of precursors
		CO4	Acknowledge the role of inhibitors of nucleotide metabolism which are potentially being used as chemotherapeutic drugs
		CO5	Comprehend how the amino acid and nucleotide metabolism are integrated with carbohydrate and lipid metabolism
<b>GE4: Biochemical Correlations of Diseases</b>			
<b>32495401</b>	<b>Biochemical Correlations of Diseases (GE 4)</b>	CO1	Students will develop understanding about the importance of balanced diet, regular exercises and healthy lifestyle.
		CO2	Students will gain insight into various disorders associated with imbalanced diet and poor lifestyle.
		CO3	Students will learn various strategies employed for preventing various human diseases.
		CO4	Students will understand the molecular basis of microbial pathogenicity, drug resistance and implications in public health management.

		CO5	Students should be able to handle and solve analytical problems related to theory classes.
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SEMESTER IV: COPO MAPPING											
Papers	(PO)										
	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CC8	CO1	✓				✓		✓			
	CO2	✓				✓		✓			
	CO3	✓				✓		✓			
	CO4	✓				✓		✓			
	CO5	✓				✓		✓			
	CO6	✓				✓		✓			
	CO7	✓	✓	✓	✓	✓		✓			
CC9	CO1	✓				✓		✓			
	CO2	✓				✓		✓	✓		
	CO3	✓				✓		✓	✓	✓	
CC10	CO1	✓				✓		✓			
	CO2	✓				✓		✓			
	CO3	✓				✓		✓			
	CO4	✓				✓		✓			
	CO5	✓				✓		✓			
GE 4	CO1	✓				✓		✓			
	CO2	✓				✓		✓			
	CO3	✓				✓		✓			
	CO4	✓				✓		✓		✓	
	CO5	✓	✓			✓		✓			

### SEMESTER V

#### CC11: Concepts in Genetics

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
32491501		CO1	Understanding the principles of Mendelian genetics, extensions and applications
		CO2	Learning and appreciating the various factors that confer genotypic and phenotypic variability.

	<b>Concepts in Genetics (CC11)</b>	CO3	Using the concepts of bacterial and viral genetics to understand resistance patterns and to create linkage and genetic maps.
		CO4	Able to use statistical tools to analyze biological data.
		CO5	Able to apply the principles of transmission and inheritance in real life situations.
<b>CC12: Gene Expression and Regulation</b>			
<b>32491502</b>	<b>Gene Expression and Regulation (CC12)</b>	CO1	acquire basic knowledge about the processes of transcription and translation in prokaryotes and eukaryotes
		CO2	learn about the features of the genetic code and various experimental approaches used to crack the code
		CO3	develop understanding of the molecular basis of RNA processing and RNA splicing
		CO4	learn about the various ways in which these biological processes are regulated and the significance of regulation in maintaining life forms
<b>DSE 1: Nutritional Biochemistry</b>			
<b>32497901</b>	<b>Nutritional Biochemistry (DSE 1)</b>	CO1	Critically analyze and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition..
		CO2	Appreciate the biochemical underpinning of human nutrition in maintaining health.
		CO3	Demonstrate understanding of the biochemical basis of essentiality of macro and micronutrients and their nutritional deficiencies.
		CO4	Be aware of techniques used in the assessment of nutritional status and nutritional disorders.
		CO5	Understand drug nutrient interactions.
<b>DSE-2 : Advanced Cell Biology</b>			
<b>32497906</b>	<b>Advanced Cell Biology (DSE 2)</b>	CO1	Students will develop understanding of the principle and application of some of the classical and advanced cell biology techniques
		CO2	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.
		CO3	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.
		CO4	Students will be able to understand the genetic basis of development of cancer, the molecular diagnosis and molecular drugs which are used for chemotherapy.

SEMESTER V: COPO MAPPING											
Papers	(PO)										
	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CC11	CO1	✓						✓			
	CO2	✓				✓		✓			
	CO3	✓				✓		✓			
	CO4	✓				✓	✓	✓			
	CO5	✓				✓		✓		✓	
CC12	CO1	✓						✓			
	CO2	✓				✓		✓			
	CO3	✓				✓		✓			
	CO4	✓				✓		✓		✓	
DSE1	CO1	✓						✓			
	CO2	✓				✓		✓		✓	
	CO3	✓				✓		✓			
	CO4	✓			✓	✓		✓			
	CO5	✓				✓		✓			
DSE2	CO1	✓		✓				✓			
	CO2	✓						✓			
	CO3	✓				✓		✓			
	CO4	✓				✓		✓		✓	✓

SEMESTER VI:			
CC13: Genetic Engineering and Biotechnology			
Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
		CO1	The process for isolation and engineering of DNA using restriction and modification enzymes.
		CO2	Use of cloning and expression vectors. features of globular & fibrous proteins.

32491601	Genetic Engineering and Biotechnology (CC13)	CO3	The methods for creation of genomic and cDNA libraries, their applications and use..
		CO4	Understanding the methods for protein production and their application in industrial production systems.
<b>CC14: Immunology</b>			
32491602	Immunology (CC14)	CO1	Trace the history and developments in immunology.
		CO2	Have an overview of the immune system including cells, organs and receptors.
		CO3	Describe the basic mechanism, differences and functional interplay of innate and adaptive immunity
		CO4	Understand Antigens & its Recognition, antigen processing and presentation
		CO5	Understand the structure & functions of different classes of Immunoglobulins, and understand the genetic basis of antibody diversity.
		CO6	Define the cellular and molecular pathways of humoral and cell-mediated immune responses
		CO7	Describe the mechanisms involved in different types of hypersensitivity.
		CO8	Explain the principles of tolerance and autoimmunity
		CO9	Summarize role of immunity in protection against pathogens
<b>DSE 3: Molecular Basis of Infectious Disease</b>			
32497904	Molecular Basis of Infectious Disease (DSE 3)	CO1	Understand various classes of pathogens and their mode of action and transmission.
		CO2	Be exposed to the molecular basis of treatment, diagnosis and vaccine design strategies for all the diseases listed.
		CO3	Gain insight into host immune responses that ensue subsequent to infection.
		CO4	Learn the details of diseases such as tuberculosis, AIDS and malaria which are highly prevalent in Indian subcontinent.
<b>DSE4: Plant Biochemistry</b>			
		CO1	Understanding of plant cell structure and organization.
		CO2	Concept of the biochemical processes and metabolic pathways specific to plants, including photosynthesis, photorespiration, cell wall

32497907	Plant Biochemistry (DSE 4)		biosynthesis, nitrogen fixation and assimilation and plant secondary metabolism.
		CO3	Insight on how plants have evolved to cope up with the different stress conditions
		CO4	Knowledge of the basic concepts of plant tissue culture and its application in generating transgenic crops.

SEMESTER VI: COPO MAPPING											
Papers	(PO)										
	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CC13	CO1	✓						✓			
	CO2	✓						✓			
	CO3	✓						✓		✓	✓
	CO4	✓						✓		✓	✓
CC14	CO1	✓						✓			
	CO2	✓						✓			
	CO3	✓						✓			
	CO4	✓						✓			
	CO5	✓				✓		✓			
	CO6	✓				✓		✓			
	CO7	✓				✓	✓	✓			
	CO8	✓						✓	✓		✓
DSE3	CO1	✓						✓			
	CO2	✓				✓		✓			
	CO3	✓				✓	✓	✓			
	CO4	✓				✓		✓		✓	✓
DSE4	CO1	✓				✓					
	CO2	✓				✓					
	CO3	✓				✓	✓				
	CO4	✓				✓	✓			✓	✓