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(Accredited by NAAC)

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GU/Acad –PG/BoS -NEP/2025-26/338 Date: 18.08.2025

CIRCULAR

The Academic Council & Executive Council of the University has approved Ordinance OA-35A relating to PG Programmes offered at the University campus and its affiliated Colleges based on UGC 'Curriculum and Credit Framework for Postgraduate Programmes'. Accordingly, the University has proposed introduction of Ordinance OA-35A from the Academic year 2025-2026 onwards.

The Programme structure of Semester I & II and syllabus of Semester I of the **Master of Science in Biochemistry** Programme approved by the Academic Council in its meeting held on 13th & 14th June 2025 is attached.

The Dean & Vice-Dean (Academic) of the School of Chemical Sciences are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.08.18 11:08:20 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,
1. The Dean, School of Chemical Sciences, Goa University.
2. The Vice-Dean (Academic), School of Chemical Sciences, Goa University.

Copy to:
1. Chairperson, BoS in Biochemistry, Goa University.
2. Programme Director, M.Sc. Biochemistry, Goa University.
3. Controller of Examinations, Goa University.
4. Assistant Registrar Examinations (PG), Goa University.
5. Director, Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY

MASTER OF SCIENCE IN BIOCHEMISTRY

(Effective from the Academic Year 2025-2026)

ABOUT THE PROGRAMME

This program is thoughtfully designed by integrating academic foundations with current research and industry requirements. Graduates of the M.Sc. Biochemistry program will be well-prepared for careers across diverse sectors such as pharmaceuticals, biotechnology, healthcare, agriculture, environmental sciences, and related industries. The curriculum emphasizes practical skills and research training through laboratory work, projects, and a dissertation, providing students with hands-on experience essential for pursuing advanced studies like Ph.D. programs. Equipped with in-depth biochemical knowledge and research proficiency, students will be well-positioned to excel in national competitive examinations such as CSIR-NET, GATE, and other qualifying tests for higher education and research opportunities.

OBJECTIVES OF THE PROGRAMME

1. To develop a strong theoretical and practical foundation in core areas of biochemistry, including genetics, molecular biology, enzymology, metabolism, and structural biology, enabling students to understand the molecular basis of life processes.
2. To equip students with advanced laboratory skills and techniques commonly used in biochemical research, fostering analytical thinking and problem-solving abilities essential for scientific inquiry and innovation.
3. To encourage independent and collaborative research by engaging students in research projects, seminars, and dissertations that promote critical evaluation of scientific literature and the ability to design and execute experiments.
4. To prepare students for professional careers in biotechnology, pharmaceuticals, healthcare, agriculture, and environmental sectors, through industry-relevant curriculum and exposure to real-world scientific applications.
5. To support academic and professional advancement by training students for competitive exams such as CSIR-NET, GATE, and entrance tests for doctoral programs, thereby paving the way for careers in research, teaching, and higher education.

Approved by: Academic Council on 13th & 14th June 2025

PROGRAMME SPECIFIC OUTCOMES (PSO) M.Sc. Biochemistry	
PSO 1.	Acquire the fundamentals of biomolecules, such as their structure and functions, metabolic processes, regulations, and associated disorders.
PSO 2.	Acquire in-depth knowledge about cellular components and mechanisms in living systems and demonstrate practical skills in handling cell cultures and biological samples.
PSO 3.	Develop fundamental concepts in human physiology to understand endocrinology and neurosciences.
PSO 4.	Comprehend infectious diseases and the immune system and acquire skills to handle and analyse, and safely dispose of clinical samples.
PSO 5.	Combine analytical techniques based on their fundamental principles to design strategies to separate, purify, and identify biological analytes.
PSO 6.	Apply conceptual knowledge of basic and advanced genetics and techniques based on molecular biology to solve problems in scientific investigations.
PSO 7.	Improve processing output using designed and optimized biochemical processes for the food, beverage and pharmaceutical industry.
PSO 8.	Empower students to gain technical knowledge and integrate disciplinary and interdisciplinary aspects of biochemistry.
PSO 9.	Critically analyze and interpret data using statistical and computational tools and effectively communicate scientific reasoning and data analysis in both written and oral forms.

PROGRAMME STRUCTURE

Master of Science in Biochemistry

Effective from Academic Year 2025-26

SEMESTER I				
Discipline Specific Core (DSC) Courses (16 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHB-5000	Concepts in Biochemistry-1	4	400
2	CHB-5001	Analytical Techniques in Biochemistry - I	4	400
3	CHB-5002	Concepts in Molecular Biology	4	400
4	CHB-5003	Cell and Cancer Biology	4	400
Total Credits for DSC Courses in Semester I			**16**	
Discipline Specific Elective (DSE) Course (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHB-5201	Biochemistry Practical – I	4	400
2	CHB-5202	Biochemistry Practical – II	4	400
Total Credits for DSE Courses in Semester I			**4**	
Total Credits in Semester I			**20**	

SEMESTER II				
Discipline Specific Core (DSC) Courses				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHB-5004	Concepts in Biochemistry- II	4	500
2	CHB-5005	Analytical Techniques in Biochemistry - II	4	500
3	CHB-5006	Concepts in Immunology	4	500
4	CHB-5007	Clinical Biochemistry	4	500
Total Credits for DSC Courses in Semester II			**16**	
Discipline Specific Elective (DSE) Courses (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHB-5203	Biochemistry Practical - III	4	400
2	CHB-5204	Biochemistry Practical - IV	4	400
Total Credits for DSE Courses in Semester II			**4**	
Total Credits in Semester II			**20**	

SEMESTER I

Discipline Specific Core Courses

Title of the Course	Concepts in Biochemistry -I
Course Code	CHB-5000
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To develop concepts about structures, reactivity and functions of different biomolecules. • To understand the metabolism of biomolecules and their regulation in living cells. • To develop and apply concepts about energetics involved in metabolic pathways in terms of number of ATPs • To understand the genetic defects and diseases associated with various metabolic processes	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. classify different biomolecules based on their structure and explain their 3-dimensional arrangement and biological functions.	PSO1, PSO2

	CO 2. illustrate the metabolic pathways for major macromolecules and recognize the chemical changes occurring at each step based on the functional groups involved.		PSO1, PSO 2	
	CO 3. compute the energetics involved in metabolic pathways in terms of number of ATPs and describe the different regulatory mechanisms.		PSO1, PSO2	
	CO 4. relate certain common diseases to the malfunctioning of respective metabolic pathways.		PSO1, PSO2	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1.Introduction to Biomolecules** Origin, aim and scope of Biochemistry; Introduction to various classes of major biomolecules. **1.2.Structure and properties of water** Structure and physico-chemical properties of water, Ionic product of water; Importance of water in biological systems.	**2**	CO1	K1, K2
	1.3.Chemical bonding, Stereochemistry and Reactions a. Properties of covalent bond, non-covalent bonds and their importance in biological systems. b. Brief revision of configurational nomenclature: R & S; D & L; E & Z; cis & trans and syn & anti nomenclature with respect to biomolecules. c. Types of biochemical reactions: oxidation-reduction, condensation, rearrangement, addition, elimination, group-transfer, resonance bond, electrophilic and nucleophilic substitution reactions.	**8**	CO1	K1, K2, K3, K4
Module 2:	**Structure and Biological functions of biomolecules** **2.1.Nucleotides and Nucleic acids** Structure and properties of nucleotides, nucleosides, purine (Adenine, Guanine) and pyrimidine (Cytosine, Thymine, Uracil) bases; Structural features of nucleic acids (DNA & RNA) and their biological functions.	**4**	CO1	K1, K2, K3, K4

	2.2.Carbohydrates Structure, stereochemistry, properties of monosaccharides, disaccharides and polysaccharides (storage, structural and extracellular) and their functions; Complex carbohydrates; peptidoglycan, amino sugars, proteoglycans and glycoproteins.	**6**	CO1	K1, K2, K3, K4
	2.3.Lipids Classification (Bloor's classification), structure and function of major lipid subclasses - Triacylglycerols, Phospholipids, Sphingolipids, glycolipids, Lipoproteins, chylomicrons (miscelles), LDL, HDL and VLDL, steroids, prostaglandins and bile acids; qualitative tests of lipids.	**5**	CO1	K1, K2, K3, K4
Module 3:	**Bioenergetics and Oxidative Phosphorylation** **3.1.**Thermodynamics: laws of thermodynamics, mechanism of exergonic and endergonic reactions, redox potential, high energy compounds, ATP structure and significance. **3.2.**Aerobic electron transport and oxidative phosphorylation, redox enzymes of ETC, Mitchell's chemiosmotic hypothesis and the role of ATP synthase.	**10**	CO3	K1, K2, K3, K4, K5
Module 4:	**Metabolism of Biomolecules: metabolic pathways, regulations and associated diseases.** **4.1.Carbohydrate metabolism** a. Stoichiometry and bioenergetics, significance of central pathways of carbohydrate metabolism: Glycolysis, TCA, Pentose phosphate pathway, Entner-Doudoroff pathway, glycolate cycle, Gluconeogenesis, gluconeogenesis from TCA intermediates/ amino acids / acetyl-CoA, glucuronic acid pathway and regulatory mechanisms. b. Utilization of sugars such as lactose, galactose, maltose and of polysaccharides such as starch, glycogen. c. Biosynthesis of polysaccharides and sugar interconversions.	**13**	CO2, CO4	K1, K2, K3, K4, K5
	4.2.Lipid metabolism Oxidation of fatty acids and its energetics: oxidation of saturated and unsaturated (mono	**6**	CO2, CO4	K1, K2, K3, K4,

	and polyunsaturated fatty acids (PUFA), Peroxisomal oxidation of fatty acids (Phytanic acid), Refsum's disease, ketone body formation and their clinical significance, diabetic ketoacidosis, Biosynthesis of fatty acids and regulation, Biosynthesis of triglycerides, cholesterol and phospholipids.			K5
	4.3.ucleotides and nucleic acids metabolism a. Purine and pyrimidine nucleotides, Deoxyribonucleotides: biosynthesis and its regulation. b. Biosynthesis of nucleotide coenzymes. c. Catabolism of purine and pyrimidine nucleotides.	**6**	CO2, CO4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. D. L. Nelson, M. M.Cox , Lehninger Principles of Biochemistry, W.H. Freeman; New York, NY, 7th edn., 2017. 2. D. Voet, J. G. Voet, C. W. Pratt, Fundamentals of Biochemistry, John Wiley & Sons Inc. Hoboken, New Jersey, 5th edn., 2016.			
References/ Readings:	1. J. M Berg, L Stryer, J. L Tymoczko, G. J Gatto, Biochemistry, W.H Freeman, New York, NY, 9th edn., 2019. 2. P. Kuchel, S. Easterbrook-Smith, V. Gysbers, J.M. Guss, D.Hancock, J. Johnston, A. Jones, J. Matthews, Schaum's Outline of Biochemistry, McGraw-Hill Book Co, New York, NY, 3rd edn., 2009. 3. U. Satyanarayana, U. Chakrapani, Biochemistry, Elsevier; 4th edn, 2013. 4. R. Singh, R. Goyal, D. R. Ferrier, Lippincott's Illustrated Reviews - Biochemistry, 2nd South Asian edn, 2024.			

Title of the Course	Analytical Techniques in Biochemistry – I
Course Code	CHB-5001
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To introduce various bioanalytical techniques for the separation and purification of biomolecules. • To understand the significance of sampling and calibration techniques. • To develop concepts for routine biochemical studies such as chromatography, spectrophotometry, centrifugation, microscopy, and electrophoresis techniques. • To evaluate the utility of various analytical techniques as a qualitative and quantitative tool.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. explain the principles of various separation techniques	PSO 5
	CO 2. differentiate between various analytical techniques for separation and purification of biomolecules based on their principles	PSO2, PSO5, PSO8
	CO 3. choose appropriate separation techniques and isolate and purify biomolecules	PSO2, PSO5

	CO 4. apply the knowledge of these techniques for designing various experiments in research and development.		PSO5, PSO7, PSO8	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1.General principles of analytical biochemistry** a. Selection of valid methods for analysis, Instrumental methods, physiological methods, assessment of analytical methods. b. Quality assurance in analytical biochemistry: quality control and quality assessment, c. Accreditation of laboratories: standard operating procedure and good laboratory practice, sampling for analysis, calibration and graphical representation of data	**4**	CO1, CO2	K1, K2, K3, K4
	1.2.Acid, bases and buffers a. Units used in quantitative biochemical measurements: molarity, normality, ppm and percentage by weight/ volume, concept of pH and measurement using pH electrode and other ion selective electrodes, redox potential (Eh), acid-base associations, pH scale of biological fluids.	**5**	CO1	K1, K2, K3
	b. Buffers, buffering capacity, mechanism of dissociation of macromolecules, dissociation constants, pKa, pI, solvents (eluotropic series), peroxide values, solubility and affinity constants.	**5**	CO1	K1, K2, K3
Module 2:	**2.1.Colligative Properties** a. Definitions, Factors affecting and Physiological Applications of Osmosis. b. Measurement of osmotic pressure, Osmoregulation, Adsorption, Colloids, Surface Tension and Viscosity. Numerical Problems based on above concepts.	**4**	CO1	K1, K2
	2.2.Centrifugation a. Principle of centrifugation, concepts of RCF, different types of instruments and rotors.	**4**	CO3	K1
	b. Preparative, differential and density gradient centrifugation, analytical ultra-centrifugation. Determination of molecular weights and other applications, subcellular fractionation.	**4**	CO1	K2, K3

Module 3:	**3.1.Electrophoretic techniques** a. Principles of electrophoretic separation, Types of electrophoresis including paper, cellulose acetate/nitrate and gel (introduction to concepts of slab gel, tube, continuous and discontinuous, etc). b. Gel electrophoresis - types of gels, Agarose, Polyacrylamide gel electrophoresis, SDS- PAGE, Isoelectric Focusing and ampholytes, 2-D, native, gradient gels, PFGE, DGGE, TGGE.	**5**	CO2, CO3	K1, K2, K3, K4
	c. Capillary electrophoresis - instrumentation, sample introduction in CE, types of CE, electrophoretic mobility and electroosmotic mobility, total mobility, efficiency and resolution in CE column. d. Separation of neutral molecules by Micellar electrokinetic chromatography. e. Staining strategies and procedures: Coomassie Brilliant blue R/G 250, Silver, Fluorescent stains Flamingo, Oriole, SYPRO- Ruby; Stain-free gels. f. Examples of separation of biomolecules by electrophoresis.	**5**	CO2, CO3	K1, K2, K3, K4
	3.2.Solvent extraction a. Principle, types of extractions and applications. b. Separations based on partitioning between phases based on chemical nature and polarity of analyte. c. Introduction to Soxhlet apparatus, solid phase extraction, microwave-assisted extraction, ultrasound-assisted extraction, counter-current extraction	**5**	CO1, CO2	K1, K2, K3, K4
	3.3.Dialysis a. Principles and applications of equilibrium dialysis and ultrafiltration and lyophilization. b. Dialysis and Concentration, reverse dialysis. c. Artificial membranes, semi-permeable membranes, Donnan membrane equilibrium. Biological significance of osmosis and micelles.	**5**	CO3	K1, K2, K3
Module 4:	**4.1.Chromatographic techniques:** a. Introduction to chromatography: Principle of chromatographic techniques, terms and parameters used in chromatography, classification of chromatographic methods, concept of mobile phases; gradient elution (concave, convex and linear) and	**7**	CO1, CO2	K1, K2, K3, K4, K5

	stationary phases. b. Basic principles, instrumentation and application of thin- layer, paper chromatography, column chromatography, HPLC, GC, ion-exchange chromatography, affinity chromatography, molecular exclusion chromatography and adsorption chromatography.			
	c. Special chromatographic techniques for nucleic acids: DEAE- cellulose chromatography, MAK hydroxyl-apatite chromatography. d. Introduction to Supercritical Fluid Chromatography and hyphenated techniques like LCMS, GCMS.	**7**	CO1, CO2	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	K. Wilson, J. Walker, Principles and Techniques of Practical Biochemistry; Cambridge University Press, England, 7th edn.,2010.			
References/ Readings:	1. G. D. Christian, P. K. Dasgupta, K. A. Schug, Analytical Chemistry, John Wiley & Sons, United States of America, 7th edn., 2013. 2. D. J. Homes, H. Peck, Analytical Biochemistry, Pearson Education Limited, England, 3rd Edition, 1998. 3. A. Skoog Douglas, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis, Cengage India Pvt. Ltd., Noida, Uttar Pradesh, India, 7th edn., Cengage Learning, 2016. 4. R. A. Day & A.L. Underwood, Quantitative Analysis, 6th ed., Pearson Education India, 2015. 5. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental methods of Analysis, 7th ed., HCBS Publishing, India, 2004.			

Title of the Course	CHB-5002
Course Code	Concepts in Molecular Biology
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• To acquaint the students with the basic concepts of inheritance. • To introduce nucleic acids' structure, folding and packaging inside living cells and viruses. • To acquaint the students with concepts of DNA damage, the repair mechanisms initiated by the cell. • To understand gene expression and regulation in prokaryotes and eukaryotes.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. The student will be able to outline and explain the fundamental concepts of genetics like structure and packaging of nucleic material.	PSO1, PSO2, PSO6
	CO 2. illustrate and explain the mechanisms of DNA damage, repair and recombination.	PSO1, PSO2, PSO6
	CO 3. describe and discuss the process of expression of genes in prokaryotes and eukaryotes	PSO1, PSO2, PSO6

	CO 4. gain the knowledge of basic molecular processes that occur within the cell.		PSO1, PSO2, PSO6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1.Basic concepts of Mendelian Genetics** Mendel's Principles, Mendel's experiment, allele, wild-type and mutant alleles, dominant and recessive alleles, homozygous and heterozygous, genotype, phenotype.	**3**	CO1, CO3, CO4	K1, K2, K3
	1.2.Laws of inheritance Mendel's law of inheritance, Law of segregation, monohybrid cross, test cross, Law of independent assortment, incomplete dominance and codominance, multiple alleles.	**4**	CO1, CO3, CO4	K1, K2, K3
	1.3.Prediction, expression and probability Predicting blood groups of progeny, lethal alleles, penetrance and expressivity, Predicting outcome of genetic crosses.	**3**	CO1, CO3, CO4	K1, K2, K3
Module 2:	**2.1.Structure and properties of DNA** DNA as genetic material: Structure of DNA and RNA, Types of DNA based on their structure and their importance in cell (A-DNA, B-DNA, Z-DNA), Types of DNA based on the functionality and their importance in cell (Satellite DNA, Palindrome DNA, Repetitive DNA).	**4**	CO1, CO3, CO4	K1, K2, K3
	2.2.Structure and properties of RNA Types of RNA (mRNA, antisense mRNA, rRNA, tRNA, siRNA), their structure and functions.	**3**	CO1, CO3, CO4	K1, K2, K3
	2.3.Functions and properties of DNA Fundamental functions of DNA, Buoyant density, melting temperature (Tm), DNA reassociation kinetics (Cot curve analysis), DNA methylation and epigenetic effects (Agouti gene methylation, maternal diet and offspring coat colour).	**5**	CO1, CO3, CO4	K1, K2, K3
Module 3:	**3.1.Genome organization and Packaging** a. Viruses (generalized and specialized) b. DNA packaging in prokaryotes	**6**	CO1, CO2, CO4	K1, K2, K3

	c. Eukaryotes (nucleosomes, histones, chromatin and chromosome; primary, secondary and tertiary packaging). d. Heterochromatin and euchromatin, Importance of structural features of chromosome (telomere, centromere and repetitive sequences), Functions of the chromosomes.			
Module 4:	**4.1.Model organisms and Mechanisms of gene transfer** **a.** *Escherichia coli* as a model prokaryotic organism. **b.** Yeast as a model eukaryotic organism. **c.** Mechanisms of Gene Transfer: transformation, transduction, conjugation.	**3**	CO1, CO2, CO4	K1, K2, K3
	4.2.Plasmids Introduction to plasmids, types of plasmids, artificial plasmids.	**2**		
Module 5:	**5.1.Mechanisms of DNA damage** Mutations and mutagenic agents: Types of mutations (point mutations: transitions and transversions, frameshift mutations, forward mutations, reverse mutations, suppressor mutations), Role of Mutagenic agents (spontaneous and induced mutagenic agents).	**4**	CO1, CO2, CO3, CO4	K1, K2, K3
	5.2.Mechanisms of DNA repair Direct (Photoreactivation) and Indirect repair (Base excision repair, NER, Mismatch repair, recombination repair, Error prone repair), SOS response.	**4**	CO1, CO2, CO3, CO4	K1, K2, K3
	5.3.Mechanisms of Genetic recombination Homologous and site-specific recombination, Role of synaptonemal complex, lamp brush chromosomes, chi sequences, Rec BCD system, Role of Rec A, Ruv A, B and C, Holliday junction model.	**4**	CO1, CO2, CO3, CO4	K1, K2, K3
Module 6:	**6.1.Flow of genetic information and expression of genes in prokaryotes and eukaryotes, Concept of Central Dogma** a. **Replication:** replication of DNA, semi-conservative nature of DNA replication. b. **Transcription:** transcription factors and machinery, formation of transcription initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation, and termination, RNA to DNA (reverse transcription); Post-	**11**	CO3, CO4	K1, K2, K3

	transcriptional modifications: attenuation, riboswitches, alternate splicing, RNA interference, RNA processing, RNA editing, polyadenylation and RNA transport. c. **Translation:** structure of Ribosome (eukaryotes and prokaryotes), formation of translation initiation complex, initiation factors and their role in regulation of initiation of translation, elongation and elongation, factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post translational modification of proteins.			
Module 7:	**7.1.Control of gene expression at transcription and translation level** a. Regulation of gene the expression of prokaryotic and eukaryotic genes. b. Role of chromatin in gene expression and gene silencing. c. Role of Recognition sequences or motifs of gene regulatory proteins, Genetic switches and their role in gene expression.	**4**	CO3, CO4	K1, K2, K3
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. J.D. Watson, Molecular Biology of the Gene. Pearson/Benjamin Cummings, United States, 7th edn., 2013. 2. B. Alberts, A. Johnson, Molecular Biology of Cell. Garland Science, United States of America, 2014. 3. N. Craig, O. Cohen-fix, R. Green, Molecular Biology: Principles of Genome function. Oxford University Press, England, 5th edn., 2014.			
References/ Readings:	1. H. Lodish, A. Berk, P. Matsudaira, C.A. Kaiser, M. Krieger, M.P. Scott, L. Zipursky, & J. Darnell, Molecular Cell Biology. W.H. Freeman, United States of America, 5th edn., 2008. 2. A. Vologodskii, The Basics of Molecular Biology.Springer International Publishing AG, 1st edn 2022 3. P.K. Gupta., Cell and Molecular Biology, Rastogi Publications, 5th edn, 2019			

Title of the Course	Cell and Cancer Biology
Course Code	CHB-5003
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• Offering detailed knowledge about cell biology and various cellular organelles. • Understanding the communication pathways associated with cellular processes. • Provide insights on basic cell culture techniques and their current applications. • Introducing the fundamental concepts of cancer biology.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. describe the cell structure, various cellular organelles and their functions and the processes of transport across cell membranes.	PSO 2
	CO 2. understand cell division and cell cycle mechanisms and various cellular communication pathways along with their significance.	PSO 2

	CO 3. apply the basic cell culture techniques needed to work in a biological research laboratory.		PSO 2, PSO 8	
	CO 4. understand the biochemistry of cancer development, causes and its classification.		PSO 2	
	CO 5. prepared for advanced courses in life science such as Neurochemistry and hormones, Immunology, Clinical biochemistry, etc.		PSO 1, PSO 2, PSO 8	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Introduction to cell biology and Biomembranes** **1.1.Structural organization of the cell** Prokaryotic and eukaryotic cells, animal and plant cells; Structure and functions of cellular and subcellular organelles.	**10**	CO1, CO5	K2
	1.2.Biological membrane structure and function Structure and functions of membrane, Transport across cell membrane: Passive and active transport of molecules across biological membranes, Membrane pumps.	**5**	CO1, CO5	K4
Module 2:	**2. Cell Cycle and Cellular Communication** **2.1.Cell division and cell cycle** Introduction to Cell cycle: Mitosis, Meiosis, Regulation of the cell cycle, Flow cytometry in cell cycle.	**5**	CO2, CO5	K4
	2.2.Cellular communication and Cell signalling Signal transduction pathways: Signalling molecules and their receptors, G-Protein Coupled receptors, Receptor Tyrosine Kinases, MAP kinase pathway and JAK-STAT pathway, Light signalling in plants, Bacterial chemotaxis and quorum sensing; Apoptosis: intrinsic and extrinsic pathways.	**10**	CO2, CO5	K4
Module 3:	**3. Cell and Tissue Culture Techniques and Applications** **3.1.Plant tissue culture** Introduction to plant tissue culture and various requirements, Preparation for tissue	**5**	CO3, CO5	K3

	culture, Tissue culture methodologies, Applications of PTC.			
	3.2.Animal tissue culture Introduction to animal tissue culture and various requirements, Typical cell lines, growing mammalian cells and general maintenance of cells, Applications of ATC.	**5**	CO3, CO5	K3
	3.3.Microbial culture Introduction to microbial culture and requirements, Microbial Nutrition and Growth, Applications in industry	**5**	CO3, CO5	K4
Module 4:	**4.1.Biochemistry of cancer** Etiology of cancer cells, types, Properties of cancer cells, Biochemistry and pathways of cancerous growth, Epigenetic factors of cancer, Mutagens and carcinogens, Apoptosis in carcinogenesis, Metastasis, Tumor markers in diagnosis, Cancer therapies.	**15**	CO4, CO5	K3
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. Karp, G.; Cell and Molecular Biology: Concepts and experiments; John Wiley and Sons Inc.; New York, 8th edn., 2015. 2. Lodish, H.; Berk A.; Kaiser, C. A; Krieger, M.; Bretscher, A.; HiddePloegh, Amon A.; Martin, K. C.; Molecular Cell Biology; W.H. Freeman and Company; New York, 8th edn., 2016. 3. Freshney, I.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; Hoboken, New Jersey,7th edn., 2016. 4. DeRobertis, E.D.P.; DeRobertis Jr. E.M.F; Cell and Molecular Biology; Saunders; United States, 8th edn., 2017. 5. Pelczar, M.; Reid, R.D.; Chan E.C.S.; Microbiology. MacGraw-Hill; United States, 5th edn., 2001.			
References/ Readings:	1. Smith, R.H.; Plant tissue culture: technique and experiments; Academic Press; Amsterdam, 3rd edn., 2012. 2. Wood, D., Sandman, K., & Willey, J. Prescott's Microbiology. McGraw-Hill Companies; United States of America, 12th edn., 2022.			

Discipline Specific Elective Courses

Title of the Course	Biochemistry Practical – I
Course Code	CHB-5201
Number of Credits	4
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• Understanding principles, theory and calculations of each experiment. • Gain hands on preparation of all the solutions and to standardize solutions individually. • Develop basic understanding and skills of various instruments and techniques used for analyzing biomolecules • Train in essential molecular and cell biology techniques, including DNA isolation, PCR, and cell culture methods for biological research.	
Course Outcomes:	The students will be able to	**Mapped to PSO**
	CO 1. Skillfully handle biomolecules and to quantify biomolecules with appropriate methods.	PSO 1
	CO 2. Choose between various separation techniques and carry out separation and purification	PSO 5

	of biomolecules.			
	CO 3. Carry out genomic DNA isolation and PCR amplification for its use in molecular research.		PSO 2, PSO 6	
	CO 4. Demonstrate the various cell culture techniques needed to work in a biological research laboratory.		PSO 2, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Fundamentals of Biochemistry** a. Estimation of reducing sugars by DNSA method. b. Colorimetric methods for protein estimation by Folin-Ciocalteau methods. c. Estimation of total sugars by anthrone method. d. Estimation of DNA by diphenylamine method. e. Estimation of RNA by orcinol reaction. f. Estimation of cholesterol by Zak's method. g. Estimation of iodine value of oils and fats. h. Qualitative determination of lipids, proteins and sugars.	**30**	CO 1	K1, K2, K3, K4, K5
Module 2:	**2. Analytical Techniques in Biochemistry - I** a. Calibration of pH meter using standard buffer solutions and determination of pH of given unknown solution b. Preparation of acetate and phosphate buffer and measuring their pH values using pH meter. c. Separation of mixtures of compounds (organic compounds including biomolecules) based on their chemical nature using solvent extraction. d. Separation of lipids by thin layer chromatography. e. Separation of carbohydrates by thin layer chromatography. f. Column chromatographic separation of mixtures of compounds (organic compounds	**30**	CO 2	K1, K2, K3, K4, K5

	including biomolecules). g. Separation of pigments by paper chromatography. h. Determination of turbidity of biological/ environmental sample using turbidimetry. i. Separation of mixtures of compounds (organic compounds including biomolecules) using HPLC.			
Module 3:	**3.Concepts in Molecular Biology** a. Procuring and maintenance of *E. coli* culture. b. Isolation of genomic DNA of *E. coli* cells. c. Estimation of quantity and purity of DNA by spectrophotometry. d. Agarose gel electrophoresis of bacterial DNA. e. PCR amplification of a specific gene using bacterial genomic DNA as a template. f. Agarose gel analysis of PCR product to determine amplicon size. g. Isolation of plasmid DNA from *E. coli* cells. h. Restriction enzyme digestion of plasmid DNA.	**30**	CO 3	K1, K2, K3, K4, K5
Module 4:	**4.Cell and Cancer Biology** a. Use of aseptic techniques of sterilization and disinfection in microbial culture. b. Isolation and enumeration of fungal and bacterial cells from an environmental sample such as soil and water. c. Primary identification and characterization of bacterial and fungal cells based on colony morphology. d. Determining the Gram character of a bacterial species via Gram's staining technique. e. Tentative identification of fungal isolates using lactophenol cotton blue staining technique. f. Isolation of animal tissues, culturing and maintenance of animal cell lines. g. Microscopic examination, cell counting, viability testing using a haemocytometer. h. Surface sterilization of plant material, excision, aseptic tissue transfer i. Induction of callus using plant explant and micropropagation.	**30**	CO 4	K1, K2, K3, K4, K5

Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.
Texts:	1. Wilson K, Walker J; Principles and Techniques of Practical Biochemistry; Cambridge University Press; New York, 7th edn., 2010. 2. Sawhney, S. K., Singh, R.; Introductory Practical Biochemistry; Narosa Publishing House; New Delhi, India, 2nd edn., 2005. 3. Freshney, I. R.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; Hoboken, New Jersey, 7th edn., 2016.
References/ Readings:	1. Kumar, D. K.; Plant Tissue Culture; New Central Book Agency; Kolkata, India,1st edn., 2008. 2. J. Kenkel, Analytical Chemistry for Technicians, 3rd ed., Lewis publishers, USA, 2002. 3. S. Carson and H.B. Miller, Molecular Biology Techniques: A Classroom Laboratory Manual. Elsevier Science Publishing Co. Inc USA, 2019

Title of the Course	Biochemistry Practical – II
Course Code	CHB-5202
Number of Credits	4
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• Understanding principles, theory and calculations of each experiment. • Gain hands on preparation of all the solutions and to standardize solutions individually. • Develop basic understanding and skills of various instruments and techniques used for analyzing biomolecules • Train in essential molecular and cell biology techniques, including DNA isolation, PCR, and cell culture methods for biological research.	
Course Outcomes:	The students will be able to	**Mapped to PSO**
	CO 1. Skillfully handle biomolecules and to quantify biomolecules with appropriate methods.	PSO 1
	CO 2. Choose between various separation techniques and carry out separation and purification of biomolecules.	PSO 5
	CO 3. Carry out genomic DNA isolation and PCR amplification for its use in molecular	PSO 2, PSO 6

	research.			
	CO 4. Demonstrate the various cell culture techniques needed to work in a biological research laboratory.		PSO 2, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Fundamentals of Biochemistry** a. Colorimetric methods for protein estimation by Biuret method. b. Estimation of total sugars by phenol sulfuric acid method. c. Estimation of determination of reducing sugar by Lane Eynon method. d. Estimation of DNA by Nile blue method. e. Estimation of RNA by orcinol reaction. f. Estimation of cholesterol by Folch method. g. Estimation of acid value of oils and fats	**30**	CO 1	K1, K2, K3, K4, K5
Module 2:	**2. Analytical techniques in Biochemistry-I** a. To study bacterial growth curve using turbidimetric method. b. Separation of proteins using DEAE cellulose column chromatography. c. Separation of pigments by thin layer chromatography. d. Separation of amino acids by thin layer chromatography. e. Preparation of citrate and Tris-HCl buffer and measuring their pH values using pH meter. f. Extraction of lipids from biological samples using solvent extraction techniques. g. Separation of amino acids by paper chromatography. h. Separation of mixtures of compounds (organic compounds including biomolecules) by thin layer chromatography.	**30**	CO 2	K1, K2, K3, K4, K5
Module 3:	**3. Concepts in Molecular biology** a. Procuring and maintenance of *Saccharomyces cerevisiae* culture.	**30**	CO 3	K1, K2, K3, K4,

	b. Isolation of genomic DNA of *S. cerevisiae* cells. c. Estimation of quantity and purity of DNA by spectrophotometry. d. Agarose gel electrophoresis of yeast DNA. e. PCR amplification of a specific gene using yeast genomic DNA as a template. f. Agarose gel analysis of PCR product to determine amplicon size. g. Isolation of plasmid DNA from *S. cerevisiae* cells. h. Restriction enzyme digestion of plasmid DNA.			K5
Module 4:	**4. Cell and Cancer Biology** a. Laboratory safety protocols and Preparation of media and sterilization techniques. b. Isolation and enumeration of bacterial and fungal cultures from various food samples. c. Identification of bacterial and fungal isolates based on morphological and biochemical identification techniques. d. Tentative identification of fungal isolates using wet mount technique. e. Determination of efficacy of cell disruption by sonication. f. Density gradient separation of cell biomolecules. g. Study of bacterial growth curve using spectrophotometer. h. Antibiotic sensitivity testing using Kirby-Bauer disk diffusion method	**30**	CO 4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. Wilson K, Walker J; Principles and Techniques of Practical Biochemistry; Cambridge University Press; New York, 7th edn., 2010. 2. Sawhney, S. K., Singh, R.; Introductory Practical Biochemistry; Narosa Publishing House; New Delhi, India, 2nd edn., 2005. 3. Freshney, I. R.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; Hoboken, New Jersey, 7th edn., 2016.			

References/ Readings:	1. Kumar, D. K.; Plant Tissue Culture; New Central Book Agency; Kolkata, India,1st edn., 2008. 2. J. Kenkel, Analytical Chemistry for Technicians, 3rd ed., Lewis publishers, USA, 2002. 3. S. Carson and H.B. Miller, Molecular Biology Techniques: A Classroom Laboratory Manual. Elsevier Science Publishing Co. Inc USA, 2019