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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS -NEP/2025-26/614 Date: 08.12.2025

CIRCULAR

In supersession to the Circular No. GU/Acad –PG/BoS -NEP/2025-26/338 dated 18.08.2025, the syllabus of Semester II of the **Master of Science in Biochemistry** Programme approved by the Academic Council in its meeting held on 13th September 2025 is attached. The syllabus of Semester I approved earlier 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: 2025.12.08 13:05:53 +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.

PROGRAMME SPECIFIC OUTCOMES (PSO) M.Sc. Biochemistry	
PSO 1.	Demonstrate comprehensive knowledge of core concepts in biochemistry including biomolecular structure, metabolism, enzymology, cell and molecular biology, immunology, and genetic engineering.
PSO 2.	Develop proficiency in modern biochemical techniques such as chromatography, electrophoresis, spectroscopy, PCR and protein purification, along with safe laboratory practices and data analysis and interpretation skills.
PSO 3.	Apply scientific methodology to design, conduct, and analyze biochemical experiments, enabling critical thinking, hypothesis testing, and problem-solving in research and applied settings and effectively communicate scientific ideas and research findings.
PSO 4.	Integrate biochemical knowledge with other disciplines like biotechnology, microbiology, pharmacology, and bioinformatics to address complex biological and health-related problems.
PSO 5.	Translate theoretical knowledge into innovative applications in areas such as drug discovery, clinical diagnostics, nutraceuticals, agricultural, environmental and industrial biochemistry, leading to successful careers in academia, research, industries and allied sectors.

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-I	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-	PSO1

	dimensional arrangement and biological functions.			
	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, PSO3	
	CO 3. compute the energetics involved in metabolic pathways in terms of number of ATPs and describe the different regulatory mechanisms.		PSO1, PSO3, PSO4	
	CO 4. relate certain common diseases to the malfunctioning of respective metabolic pathways.		PSO1, PSO 3, PSO 4, PSO 5	
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	**4**	CO1	K1, K2, K3, K4

	acids (DNA & RNA) and their biological functions.			
	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, CO3 CO4	K1, K2, K3, K4, K5

	4.2 Lipid metabolism Oxidation of fatty acids and its energetics: oxidation of saturated and unsaturated (mono 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.	**6**	CO2, CO3, CO4	K1, K2, K3, K4, K5
	4.3 Nucleotides 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, CO3, 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 Ed., 2017. 2. D. Voet, J. G. Voet, C. W. Pratt, Fundamentals of Biochemistry, John Wiley & Sons Inc. Hoboken, New Jersey, 5th Ed., 2016.			
References/ Readings:	3. J. M Berg, L Stryer, J. L Tymoczko, G. J Gatto, Biochemistry, W.H Freeman, New York, NY, 9th Ed., 2019. 4. 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 Ed., 2009. 5. U. Satyanarayana, U. Chakrapani, Biochemistry, Elsevier; 4th Ed., 2013. 6. R. Singh, R. Goyal, D. R. Ferrier, Lippincott's Illustrated Reviews - Biochemistry, 2nd South Asian Ed., 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	PSO2
	CO 2. differentiate between various analytical techniques for separation and purification of biomolecules based on their principles	PSO2
	CO 3. choose appropriate separation techniques and isolate and purify biomolecules	PSO2, PSO3, PSO4

	CO 4. apply the knowledge of these techniques for designing various experiments in research and development.		PSO2, PSO3, PSO4	
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, CO2	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, CO2	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, CO2	K1, K2, K3

	2.2 Centrifugation **a.** Principle of centrifugation, concepts of RCF, different types of instruments and rotors. **b.** Preparative, differential and density gradient centrifugation, analytical ultra-centrifugation. Determination of molecular weights and other applications, subcellular fractionation.	8	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
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. **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.	10	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
	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,CO 2	K1, K2, K3, K4
	3.3 Dialysis **a.** Principles and applications of equilibrium dialysis and ultrafiltration and lyophilization.	5	CO1, CO2 CO3	K1, K2, K3

	b. Dialysis and Concentration, reverse dialysis. **c.** Artificial membranes, semi-permeable membranes, Donnan membrane equilibrium. Biological significance of osmosis and micelles.			
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 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.	14	CO1, CO2 CO3, CO4	K1, K2, K3, K4, K5, K6
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 Ed. 2010.			
References/ Readings:	1. G. D. Christian, P. K. Dasgupta, K. A. Schug, Analytical Chemistry, John Wiley & Sons, United States of America, 7th Ed., 2013. 2. D. J. Homes, H. Peck, Analytical Biochemistry, Pearson Education Limited, England, 3rd Ed, 1998. 3. A. Skoog Douglas, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis, Cengage India Pvt. Ltd., Noida, Uttar Pradesh, India, 7th Ed, 2016. 4. R. A. Day & A.L. Underwood, Quantitative Analysis, Pearson Education India, 6th Ed, 2015. 5. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental methods of Analysis, HCBS Publishing, India, 7th Ed, 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. outline and explain the fundamental concepts of genetics like structure and packaging of nucleic material.	PSO1, PSO2, PSO3, PSO4,
	CO 2. illustrate and explain the mechanisms of DNA damage, repair and recombination.	PSO1, PSO3, PSO4
	CO 3. describe and discuss the process of expression of genes in prokaryotes and eukaryotes	PSO1, PSO2, PSO3, PSO4, PSO5

	CO 4. explain basic molecular processes that occur within the cell.		PSO1, PSO3, PSO4	
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,
	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, K4, K5
	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, K4, K5, K6
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, K4
	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, K4, K5
	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, K4, K5

Module 3:	**3.1 Genome organization and Packaging** **a.** Viruses (generalized and specialized) **b.** DNA packaging in prokaryotes **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.	**6**	CO1, CO2, CO4	K1, K2, K3, K4, K5
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, K4
	4.2 Plasmids Introduction to plasmids, types of plasmids, artificial plasmids.	**2**	CO1, CO2, CO4	K1, K2, K3, K4
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, K4, K5
	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, K4, K5
	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	**4**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5

	A, B and C, Holliday junction model.			
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-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.	**11**	CO3, CO4	K1, K2, K3, K4, K5
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, 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. J.D. Watson, Molecular Biology of the Gene. Pearson/Benjamin Cummings, United States, 7th Ed, 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 Ed, 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 Ed., 2008. 2. A. Vologodskii, The Basics of Molecular Biology. Springer International Publishing AG, 1st Ed, 2022 3. P.K. Gupta., Cell and Molecular Biology, Rastogi Publications, 5th Ed, 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.	PSO1
	CO 2. understand cell division and cell cycle mechanisms and various cellular communication pathways along with their significance.	PSO1

	CO 3. apply the basic cell culture techniques needed to work in a biological research laboratory.		PSO1, PSO2, PSO4, PSO5	
	CO 4. understand the biochemistry of cancer development, causes and its classification.		PSO1, PSO4, PSO5	
	CO 5. prepared for advanced courses in life science such as Neurochemistry and hormones, Immunology, Clinical biochemistry, etc.		PSO1, PSO4, PSO5	
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	K1, 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	K1, 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	K1, K2, 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**	5	CO3, CO5	K1, K2, K3

	Introduction to plant tissue culture and various requirements, Preparation for tissue 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	K1, K2, K3
	3.3 Microbial culture Introduction to microbial culture and requirements, Microbial Nutrition and Growth, Applications in industry	5	CO3, CO5	K1, K2, 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 Ed., 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 Ed., 2016. 3. Freshney, I.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; Hoboken, New Jersey, 7th Ed., 2016. 4. DeRobertis, E.D.P.; DeRobertis Jr. E.M.F; Cell and Molecular Biology; Saunders; United States, 8th Ed., 2017. 5. Pelczar, M.; Reid, R.D.; Chan E.C.S.; Microbiology. MacGraw-Hill; United States, 5th Ed., 2001.			
References/ Readings:	1. Smith, R.H.; Plant tissue culture: technique and experiments; Academic Press; Amsterdam, 3rd Ed., 2012. 2. Wood, D., Sandman, K., & Willey, J. Prescott's Microbiology. McGraw-Hill Companies; United States of America, 12th Ed., 2022.			

Discipline Specific Elective (DSE) 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.	PSO1, PSO4, PSO5
	CO 2. choose between various separation techniques and carry out separation and	PSO2, PSO3, PSO4,

	purification of biomolecules.		PSO5	
	CO 3. carry out genomic DNA isolation and PCR amplification for its use in molecular research.		PSO2, PSO4, PSO5	
	CO 4. demonstrate the various cell culture techniques needed to work in a biological research laboratory.		PSO2, PSO3, PSO4, PSO5	
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**	CO1	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	**30**	CO2	K1, K2, K3, K4, K5

	compounds 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. **j.** Separation of mixtures of compounds (organic compounds including biomolecules) by thin layer chromatography.			
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**	CO3	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.	**30**	CO4	K1, K2, K3, K4, K5

	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.			
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 Ed., 2010. 2. Sawhney, S. K., Singh, R.; Introductory Practical Biochemistry; Narosa Publishing House; New Delhi, India, 2nd Ed., 2005. 3. Freshney, I. R.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; Hoboken, New Jersey, 7th Ed., 2016.			
References/ Readings:	1. Kumar, D. K.; Plant Tissue Culture; New Central Book Agency; Kolkata, India,1st Ed., 2008. 2. J. Kenkel, Analytical Chemistry for Technicians, Lewis publishers, USA, 3rd ed, 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.	PSO1, PSO4, PSO5
	CO 2. choose between various separation techniques and carry out separation and purification of biomolecules.	PSO2, PSO3, PSO4, PSO5

	CO 3. carry out genomic DNA isolation and PCR amplification for its use in molecular research.		PSO2, PSO4, PSO5	
	CO 4. demonstrate the various cell culture techniques needed to work in a biological research laboratory.		PSO2, PSO3, PSO4, PSO5	
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**	CO1	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**	CO2	K1, K2, K3, K4, K5
Module 3:	**3. Concepts in Molecular biology** **a.** Procuring and maintenance of *Saccharomyces cerevisiae* culture.	**30**	CO3	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**	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. Wilson K, Walker J; Principles and Techniques of Practical Biochemistry; Cambridge University Press; New York, 7th Ed., 2010. 2. Sawhney, S. K., Singh, R.; Introductory Practical Biochemistry; Narosa Publishing House; New Delhi, India, 2nd Ed., 2005. 3. Freshney, I. R.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; Hoboken, New Jersey, 7th Ed., 2016.			
References/	1. Kumar, D. K.; Plant Tissue Culture; New Central Book Agency; Kolkata, India,1st Ed., 2008.			

Readings:	2. J. Kenkel, Analytical Chemistry for Technicians, Lewis publishers, USA, 3rd Ed, 2002 3. S. Carson and H.B. Miller, Molecular Biology Techniques: A Classroom Laboratory Manual. Elsevier Science Publishing Co. Inc USA, 2019

SEMESTER II

Discipline Specific Core (DCS) Courses

Title of the Course	Concepts in Biochemistry -II
Course Code	CHB-5004
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 Courses
Course Objectives:	• To develop knowledge about protein structure, function and its metabolism and regulation pathways. • To introduce classification, nomenclature and types of enzymes and develop comprehensive knowledge of enzyme properties, including enzyme activity, substrate specificity, and kinetics of enzyme catalysed reaction and their inhibition. • To understand the mechanisms of enzyme catalysis and enzyme regulation and their significance in metabolic pathways. • To analyse and employ different analytical techniques for isolation and purification of enzymes.

Course Outcomes:	Students will be able to:		**Mapped to PSO**	
	CO1. explain protein structure, functions and outline their metabolic and regulatory pathways.		PSO1, PSO3	
	CO2. classify enzymes and elaborate on their types and properties, and evaluate the kinetics involved in enzyme catalysed reactions and their inhibition.		PSO1, PSO3	
	CO3. analyse the mechanisms of enzyme catalysis and their regulation and illustrate on their significance in biochemical pathways		PSO1, PSO3, PSO 4, PSO5	
	CO4. develop methods for the isolation and purification of enzymes using various analytical techniques.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Amino acids, Peptides and Proteins** a. Amino acids: Structure, Classification, b. Physico-chemical properties of amino acids and role of non-protein amino acids. c. Peptides: Peptides of physiological significance, peptide bond. Proteins: Primary (importance of primary structure),secondary (alpha-helix, β –structure, β-helix, super secondary structure), tertiary (stabilizing forces, unfolding/refolding) and quaternary structures (e.g.: Haemoglobin, Myoglobin)	**6**	CO1	K1, K2, K3
	1.2 Amino acid and protein metabolism a. General reactions of amino acid metabolism: Transamination, decarboxylation, oxidative and nonoxidative deamination of amino acids. b. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine, and polyamines. Urea cycle and its regulation. c. Overview of biosynthetic pathways of amino acids and their regulation; Assimilation of ammonia, biosynthesis of essential and non-essential amino acids, regulation of glutamine synthetase and the aspartate family of amino acids d. Protein metabolism: Protein hydrolysis, disulfide, Mechanism of protein degradation	**12**	CO1	K1, K2, K3, K4

Module 2:	**2.1 Introduction to enzymes** a. Simple enzymes, conjugated enzymes. b. Coenzymes and cofactors and their role in enzyme activity, prosthetic group, and metalloenzymes. c. Enzyme Commission nomenclature and classification of enzymes d. Structure and specific sites: Enzyme structure, enzyme substrate complex, binding sites, concept of active site, stereospecificity e. Enzymes as catalysts: lock and key model, induced fit model f. Mechanism of action of enzymes as catalysts: Role of enzymes to increase reaction rates, transition state theory, and activation energy.	**6**	CO2	K1, K2, K3
	2.2 Enzyme Kinetics and Enzyme-Substrate Interactions a. Basic concepts of Kinetics: Enzyme activity, Enzyme Assay, specific activity (Definition and units). b. Methods for Enzyme Kinetics: Michaelis-Menten Equation: formula and derivation, Lineweaver-Burk plot for one-substrate reactions. c. Parameters of Kinetics: Significance of Vmax and Km, Kinetics of bi- or multi-reactant systems. d. Factors affecting Enzyme catalysis: Effect of pH, temperature on enzymes, Enzyme inhibition: reversible (competitive, uncompetitive, mixed inhibition) and irreversible inhibition e. Enzyme turnover: Ks, Kd, and measurement of enzyme turnover, Correlation between the rates of enzyme turnover, structure and function of enzymes, significance of enzyme turnover.	**11**	CO2	K1, K2, K3, K4, K5
Module 3:	**3.1 Mechanism of Enzyme Action and Enzyme regulation** a. Active centre of Enzyme catalysis: Determination of the active centre of catalysis of enzymes b. Identification of functional groups; Factors affecting catalytic efficiency: proximity, orientation, strain; Enzyme catalytic strategies: covalent, acid-base catalysis, metal	**12**	CO3	K1, K2, K3, K4

	ion catalysis. c. Mechanism of action of enzymes: lysozyme, chymotrypsin, aspartate protease, RNase A. d. Enzyme Regulation: control of enzyme activity, control of enzyme availability, inhibitor or enhancer molecules. e. Mechanisms of enzyme regulation and their significance in Metabolism: Allosteric regulation (aspartate transcarbamylase), Reversible covalent modification (glycogen phosphorylase), Feedback inhibition and feedback repression.			
Module 4:	**4.1 Enzyme systems** a. Zymogens and Isozymes. b. Multienzyme systems: disassociated system (catabolic enzymes), multienzyme complex (pyruvate dehydrogenase), membrane-bound system (electron carrying enzymes). c. Nucleic acid as catalysts: Ribozyme, DNAzyme; Abzyme.	**8**	CO3	K1, K2, K3, K4, K5
	4.2 Enzyme purification techniques a. Isolation of intracellular and extracellular enzymes from plant and animal tissues and microbial cells. b. Application of separation and purification techniques for proteins: differential centrifugation, salt precipitation, dialysis, ultrafiltration, molecular exclusion chromatography, affinity chromatography, ion exchange chromatography. c. Determination of Enzyme activity by different methods; Purification table (specific activity and fold purification as criteria of purity of enzymes). d. Zymograms e. Molecular weight determination by SDS-PAGE and gel filtration	**5**	CO4	K1, K2, K3, K4, K5, K6
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 and Co. Ltd.; New York, 7th Ed., 2017. 2. D. Voet, J. G. Voet, C. W. Pratt, Fundamentals of Biochemistry, John Wiley & Sons Inc. Hoboken, New Jersey,			

	5th Ed., 2016.
References/ Readings:	1. D.T. Plummer, An introduction to practical biochemistry. TATA McGraw Hill, New York, 3rd Ed., 2006. 2. R.O. Okotore, Essentials of Enzymology. Xlibris-US, New York, 1st Ed., 2015. 3. T.D.H. Bugg, Introduction to enzymes and coenzyme chemistry. Wiley-Blackwell, London, 3rd Ed., 2012. 4. J. M Berg, L Stryer, J. L Tymoczko, G. J Gatto, Biochemistry, W.H Freeman and Co. Ltd., New York, NY, 9th Ed., 2019. 5. N. Price and L. Stevens, Fundamentals of Enzymology. Oxford University Press, New York, 3rd Ed., 1999.

Title of the Course	Analytical Techniques in Biochemistry -II
Course Code	CHB-5005
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 Courses	
Course Objectives:	• To introduce various electro-analytical, imaging and spectral characterization techniques for analysis. • To evaluate the utility of various analytical techniques as a qualitative and quantitative tool. • To understand and apply techniques and instruments used in the determination of macromolecular structures. • To understand and explore the use of tracer techniques for studying metabolic pathways and related biochemical processes.	
Course Outcomes:	Students will be able to:	Mapped to PSO
	CO 1. explain the principles of various electro-analytical, imaging and spectral characterization techniques.	PSO2

	CO 2. differentiate between various analytical techniques based on their theory and sensitivity achieved.		PSO2	
	CO 3. choose between various techniques of structure elucidation based on the information desired and interpret the data obtained to a fair level.		PSO2, PSO3, PSO4, PSO5	
	CO 4. apply the knowledge of various techniques for designing experiments in research and development.		PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Biosensors and its application:** a. Introduction and principles of biosensors. b. Components of biosensors: biorecognition elements (enzymes, antibodies, DNA, Molecular imprinted polymers), transducers, signal detection platform c. Types of biosensors: potentiometry, conductometry, coulometry and voltammetry. d. Applications: clinical and environmental analysis.	**7**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
	1.2 Radioisotope techniques a. Nature of radioactivity and its detection, measurement of radioactivity, Disintegration kinetics. b. Radio-activity counters and radioanalysis – GM Counter, Scintillation Counter, Isotope dilution analysis. c. Theory and application of Autoradiography and radiorespirometry. d. Tracer techniques for metabolic pathways. e. Safety measures in handling radioisotopes. f. Non-radioactive detection methods:	**7**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Module 2:	**2.1 Optical methods of analysis: Theory, instrumentation and applications** a. Nephelometry. b. Turbidimetry. c. UV-visible spectrophotometry. d. Fluorometric analysis.	**14**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6

	e. Flame emission photometry f. Atomic absorption spectrophotometry g. Flowcytometry.			
Module 3:	**3.1 Microscopy and Bioimaging** a. Imaging living cells and tissues and measuring cellular dynamics. b. Theory of microscopy, basic aspects of compound microscope. c. Light microscopy: Theory, instrumentation and applications of bright field, dark field, phase-contrast, inverted microscopy. d. Principle and application of fluorescence microscopy, confocal scanning microscopy, epifluorescence and immuno-fluorescence microscopy. e. Electron microscopy: Theory, instrumentation and applications of scanning electron microscopy (SEM) and transmission electron microscopy (TEM). f. Atomic force microscopy (AFM): Theory, instrumentation and applications. g. Optical tweezers: Introduction and applications.	**11**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Module 4:	**4.1 Techniques for structure determination of biomolecules: Principle, theory, instrumentation, data interpretation and applications** a. FTIR, NMR, ESR b. Single crystal X-ray diffraction, c. Optical rotatory dispersion and circular dichroism.	**14**	CO1, CO2, CO3, CO4	K1,K2, K3, K4, K5
	4.2 Mass Spectrometry for biomolecules a. Principle, components, working and applications of mass spectrometer. b. Different types of ionization methods used in mass spectrometer (CI, EI, ESI, FAB). c. Different types of mass analysers used in mass spectrometers (magnetic sector, ion trap, quadrupole), MALDI-MS, MALDI-TOF-MS, ICP-MS. d. Structural information by tandem mass spectrometry.	**7**	CO1, CO2, CO3, 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. K. Wilson, J. Walker, Principles and Techniques of Practical Biochemistry; Cambridge University Press, England, 7th Ed., 2010. 2. D. A. Skoog, D. M. West, F. J. Hollar, S. R. Crouch, Fundamentals of Analytical Chemistry, Cengage learning, USA, 9th Ed., 2014. 3. W. Kemp, Organic Spectroscopy, Palgrave Macmillan, New York, 1991.
References/ Readings:	1. de Hoffmann, E.; Stroobant, V.; Mass Spectrometry: Principles and Applications; John Wiley & Sons Ltd; England, 3rd Ed., 2007. 2. Parakhia, M. V.; Tomar, R. S.; Patel, S.; Golakiya, B. A.; Molecular Biology and Biotechnology: Microbial Methods; New India, 1st Ed., 2010. 3. R.M. Silverstein, F. X. Webster, D.Kiemle, D. Bryce, S. Samant, V. S. Nadkarni, Spectrometric Identification of Organic compounds, An Indian Adaptation John Wiley & Sons Inc., New Delhi, India, 8th Ed., 2022. 4. R. F. Egerton, Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, Springer, Switzerland 2nd Ed., 2016. 5. G. D. Christian, P. K. Dasgupta, K. A. Schug, Analytical Chemistry, John Wiley & Sons, United States of America, 7th Ed., 2013. 6. D. J. Homes, H. Peck, Analytical Biochemistry, Pearson Education Limited, England, 3rd Ed., 1998. 7. A. S. Douglas, F. J. Holler, S. R. Crouch, Principles of Instrumental Analysis, Cengage India Pvt. Ltd., Noida, Uttar Pradesh, India, 7th Ed., 2016. 8. R. A. Day & A.L. Underwood, Quantitative Analysis, Pearson Education India, 6th Ed., 2015. 9. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental methods of Analysis, HCBS Publishing, India, 7th Ed., 2004.

Title of the Course	Concepts in Immunology
Course Code	CHB-5006
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 Courses	
Course Objectives:	• To provide an insight into the components of the immune system, their development, their functions and their mechanisms of action. • To understand the role of the immune system in eliciting immune response. • To develop knowledge on the role of immune system in human health and disease conditions. • To create understanding of vaccine development and diagnostic strategies involving the immune system.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. describe the organization and functions of immune cells and organs, and analyze the structural and functional aspects of antigens and antibodies.	PSO1
	CO 2. apply the principles of innate and adaptive immunity to explain defense	PSO1, PSO4

	mechanisms against pathogens.			
	CO 3. analyze the genetic basis of antibody diversity, and evaluate immune regulatory mechanisms and their roles in human health and disease conditions.		PSO1, PSO4, PSO5	
	CO 4. evaluate and develop vaccine strategies for health and apply appropriate immunological techniques for experimental and diagnostic approaches.		PSO1, PSO2, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Cells and organs of immune system; concepts of antigens and antibodies** **1.1 Cells of the immune systems** a. Hematopoiesis; Lymphocytes and Antigen presenting cells (APCs). b. T cells: Maturation; Activation and Proliferation; T cells subsets and their functions; T cell receptor; Structure and organization. c. B cells: Maturation, Activation and Proliferation; Functions; T cell receptor, Structure and Organization.	**6**	CO1	K1, K2
	1.2 Organs of the immune system: Primary and secondary lymphoid organs: Structure and function.	**3**	CO1	K1, K2
	1.3 Antigens and Antibodies a. Antigens: Chemical complexity and molecular property of Antigens; Immunogens; Haptens; Epitopes; Antigenicity and Immunogenicity. b. Antibodies: i. Structure and function of various classes of immunoglobulins. ii. Antigenic determinants on immunoglobulins. iii. Monoclonal and Polyclonal antibodies: their production by hybridoma technology and clinical uses.	**6**	CO1	K1, K2, K3
Module 2:	**2. Immune Response** **2.1 Innate immune response**	**7**	CO2	K1, K2, K3

	a. Mechanical barriers to infection. b. Physiological factors contributing to innate immunity. c. Inflammatory response: Mechanism and mediators involved. d. Phagocytic system: Activation of macrophages and mechanism of phagocytosis. e. Complement system: Components; Properties; function; Activation of complement pathways (Classical, Alternative and lectin pathways); Consequences of complement activation; Complement fixation test.			
	2.2 Adaptive immune response a. Cell-mediated and Humoral immunity: primary and secondary immune response. b. Major Histocompatibility Complex: Molecular organization of MHC molecules (H-2, HLA); Structure of MHC molecules; Class I MHC-peptide and Class II MHC-Peptide interactions; self MHC restriction of T cells; Gene organisation and concept of MHC polymorphism; MHC expression and its regulation. c. Antigen processing and presentation pathways: Cytosolic and Endocytic pathways.	**8**	CO2	K1, K2, K3, K4
Module 3:	**3. Immunogenetics and Clinical Immunology** **3.1 Immunogenetics** a. Theories of antibody formation. b. Generation of antibody diversity. c. Class switching among constant-region genes.	**5**	CO3	K1, K2, K3, K4
	3.2 Clinical immunology a. Cytokines: properties; Receptors and Functions. b. Immunological tolerance. c. Hypersensitivity reactions: Classification and mechanisms. d. Autoimmunity: Pathogenesis; Classification (Organ-specific autoimmune disease and Systemic Autoimmune diseases). e. Immunodeficiencies: Primary and secondary immunodeficiencies. f. Transplantation immunology: Definition; Immunologic Basis of Graft Rejection;	**10**	CO3	K1, K2, K3, K4, K5

	Allograft rejection; Clinical features of graft rejection; Graft v/s host reaction; Immune tolerance to allograft; Immunosuppressive therapy for prevention of graft rejection.			
Module 4:	**4. Vaccines and Immunological techniques** **4.1 Concepts of vaccines** a. Whole-organism vaccines; recombinant vaccines; DNA and RNA vaccines; synthetic peptide and multivalent subunit vaccines.	**5**	CO4	K1,K2, K3 K4, K5
	4.2 Immunotechniques a. Antigen–antibody (Ag-Ab) reactions: General features of Ag-Ab reactions, Stages of Ag-Ab reactions (primary and secondary). b. Principles and techniques: in vitro precipitation; agglutination; immunofluorescence; ELISA; RIA; immunoelectrophoresis; immunodiffusion; Avidin-Biotin complex (ABC) method; Western blotting; Immunohistochemistry; flow cytometry	**10**	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. S. Stranford, J. Owen, J. Punt, J. Patricia, Kuby Immunology, Macmillan Learning, New York, 8th Ed., 2023. 2. P. J. Delves, S. J. Martin, D.R. Burton, I. M. Roitt, Roitt's Essential Immunology; Wiley Blackwell, Sussex; 13th Ed., 2017.			
References/ Readings:	1. A. Abbas, A. Lichtman, S. Pillai, Cellular and Molecular Immunology, Elsevier, Saunders, 8th Ed., 2014. 2. S. C. Parija, Textbook of Microbiology and Immunology; Elsevier; India, 2nd Ed. 2012. 3. F. C. Hay, O. M. R. Westwood, Practical Immunology; Cold spring Harbour, New York, 4th Ed., 2002.			

Title of the Course	Clinical Biochemistry
Course Code	CHB-5007
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 Courses	
Course Objectives:	• To introduce to safety measures and precautions in clinical laboratories. • To introduce knowledge on clinical investigations and analyses of clinical samples. • To understand the biochemistry of metabolic diseases/disorders of the human body. • To provide insights on biochemistry of ageing.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO1. explain the principles, safety measures, and biochemical basis of blood and serum analysis for clinical diagnosis.	PSO1, PSO2
	CO2. apply biochemical testing methods and interpretation principles to assess liver, kidney, thyroid, gastric, and pancreatic functions in clinical contexts.	PSO1, PSO2, PSO3

	CO3. analyze biochemical pathways and molecular mechanisms underlying metabolic disorders and inborn errors of metabolism to interpret their clinical manifestations.		PSO1, PSO4, PSO5	
	CO4. evaluate and integrate biochemical principles and ageing-related molecular changes to assess disease risk and potential interventions.		PSO1, PSO 3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Analysis of Clinical sample** **1.1 Blood sample** a. Collection and safety measures involved. b. Composition and function: Composition of blood, RBCs, Erythropoiesis, Hemoglobin, gas transport by hemoglobin, Blood buffer system (Henderson–Hasselbalch equation), acid-base balance and imbalance. c. Analysis: i. Hematological parameters: Hemoglobin, total cell count (TC), differential cell count (DC), erythrocyte sedimentation rate (ESR), bleeding time, clotting time. ii. Biochemical parameters: Glucose (fasting, postprandial, oral glucose tolerance test), lipid profile (total cholesterol, HDL, LDL, triglycerides), urea, blood gases (oxygen, carbon dioxide levels), pH.	8	CO1	K1, K2, K3
	1.2 Serum sample a. Collection methods and safety measures. b. Analysis: i. Proteins, albumin/globulin ratio ii. Bilirubin; creatinine; uric acid; electrolytes; iii. Enzymes of clinical and diagnostic importance: Enzymes as markers in the diagnosis of diseases; clinical significance of cholinesterase, alkaline and acid phosphatase (ALP and ACP), lactate dehydrogenase (LDH), creatine phosphokinase (CPK), aspartate aminotransferase (AST/SGOT), alanine	7	CO1	K1, K2, K3

	aminotransferase (ALT/SGPT).			
Module 2:	**2. Clinical Laboratory diagnosis** **2.1 Liver function tests (LFTs)** a. Functions of the liver and liver profile in health and disease b. Bilirubin metabolism and its clinical significance c. Classification of LFTs and interpretation in diagnosis of liver diseases.	5	CO2	K1, K2, K3, K4
	2.2 Renal function test (RFTs) a. Urine: Composition of urine, collection and safety measures b. Kidney physiology: Urine formation, glomerular and tubular functions, water electrolyte balance. c. Analysis of urine: Physical, chemical and microscopic examination; interpretation of RFT results.	5	CO2	K1, K2, K3, K4
	2.3 Thyroid, Gastric and Pancreatic Function tests a. Thyroid function tests: serum free and total T3 & T4 and serum TSH) b. Gastric function tests: gastric analysis, hypo/achlorhydria and hyperacidity c. Tests to assess pancreatic function in disease.	5	CO2	K1, K2, K3, K4
Module 3:	**3. Metabolic disorders** **3.1 Disorders in metabolism** a. Carbohydrates: Regulation of blood glucose, insulin and diabetes mellitus (classification, stages and diagnosis); Hypoglycaemia; Diabetic ketoacidosis. b. Lipids: Hyperlipidaemias, clinical significance of cholesterol, hypercholesteremia, c. Heart: Cardiovascular disease (Atherosclerosis and Coronary artery disease), hypertension d. Proteins: Kwashiorkor, Marasmus Protein misfolding, Creutzfeldt-Jakob disease, mad cow disease, encephalopathy e. Blood Anaemia: Iron deficiency anemia, Megaloblastic anemia, Pernicious anemia, Sickle cell disease, hemolytic anemia	8	CO3	K1, K2, K3, K4

	f. Liver: Jaundice, cirrhosis g. Kidney: Diabetes insipidus, Renal calculi.			
	3.2 Inborn errors of metabolism a. Carbohydrate: Lactose intolerance, galactosemia, Glycogen storage disease. b. Lipids: Lysosomal storage disorders: Tay-Sach'sdisease; Gaucher's disease; Niemann Pick disease; Fabry's disease. c. Amino acids: Phenylketonuria, Albinism d. Purine/pyrimidine: Lesch-Nyhan Syndrome, Gout. e. Blood: Thalassemia f. Thyroid hormone: hyperthyroidism and hypothyroidism g. Skin: Xeroderma Pigmentosum	7	CO3	K1, K2, K3, K4
Module 4:	**4. Early Diagnostic Screening and Biochemistry of Ageing** **4.1 Early Diagnostic Screening** a. Prenatal diagnosis of diseases: Nuchal Translucency scan, Double marker blood, Non-invasive prenatal testing (NIPT). b. Newborn screening: Amniocentesis and chorionic villus sampling (CVS). c. Amniotic fluid and fetal blood examination. d. Acetylcholinesterase and other tests on amniotic fluid. e. Karyotyping, chromosomal abnormalities by cytogenetics.	8	CO4	K1, K2, K4 K4, K5
	4.2 Biochemistry of ageing a. Physiological and biochemical changes in ageing b. Biomarkers of ageing c. Ageing theories: Programmed theories and Error theories d. Epigenetics. e. Plasticity and regeneration. f. Anti-ageing approaches: stem cells and regeneration therapy.	7	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. M. Vasudevan, S. Sreekumari, K. Vaidyanathan, Textbook of Biochemistry for Medical students, Jaypee brothers Medical publishers; New Delhi, 6th Ed., 2011. 2. C. Smith, A. D. Mark, M. Lieberman, Marks' Basic Medical Biochemistry: A Clinical Approach; Lippincott's William and Wilkins, USA, 2nd Ed., 2004.
References/ Readings:	1. M. N. Chattergee, R. Shinde, R.; Textbook of Medical Biochemistry, Jaypee brothers Medical publishers Ltd., New Delhi, 8th Ed., 2012. 2. A. Gaw, R. A. Cowan, M. J. Murphy, D. S. J. O'Relly, R. Srivastava, Clinical Biochemistry, Elsevier; Canada, 5th Ed., 2013.

Discipline Specific Elective (DSE) Courses

Title of the Course	Biochemistry Practical – III
Course Code	CHB-5203
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 Courses	
Course Objectives:	• To develop practical skills in enzyme analysis including assays, kinetics and data interpretation. • To apply advanced analytical methods for biochemical sample analysis. • To perform antigen-antibody interactions for immunodiagnostics. • To analyze clinical samples for diagnosing metabolic and organ disorders.	
Course Outcomes:	The students will be able to:	**Mapped to PSO**
	CO1. isolate enzymes from living cells, purify and understand their substrate interactions and kinetics.	PSO1, PSO2, PSO3, PSO5
	CO2. develop methods for estimation of biomolecules and interpret spectral data to elucidate their structures.	PSO1, PSO2, PSO3, PSO4, PSO5

	CO3. analyse the antigen and antibody interactions for diagnosis of diseases and disorders.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 4. assess clinical samples and interpret biochemical data for diagnosis and treatment of diseases.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Concepts in Biochemistry (ANY SIX)** a. Screening of microbes for production of enzymes (amylases and cellulases). b. Assay of enzyme activity, rate of reaction of amylase c. Optimization of parameters for enzyme activity, amylase d. Determination of specific activity of enzyme, amylase e. Purification of enzyme by salting-out using ammonium sulphate. f. Dialysis of the precipitated enzyme. g. Purification of enzyme by Gel filtration. h. Determination of fold purification, percentage recovery of protein. i. Molecular weight determination of the enzyme by SDS PAGE. j. Determination of Km, Vmax.	30	CO1	K1, K2, K3, K4, K5
Module 2:	**2. Analytical Techniques in Biochemistry (ANY SIX)** a. Visualization of bacterial/fungal cells by Light microscopy and Phase contrast microscopy. b. Verification of Beer lambert law using BSA (Bovine serum albumin). c. Qualitative analysis of amino acids by ninhydrin/ Xanthoproteic/ isatin, Ehrlich's/ Hopkins-Cole/ lead sulphide/ sodium nitroprusside tests (Any three). d. Determination of extinction coefficient of Tryptophan/ Tyrosine (Any one). e. Demonstration of LC-MS and interpretation of data. f. Analysis of tryptophan/ tyrosine/ proline/ small organic molecules using IR	30	CO2	K1, K2, K3, K4, K5

	spectroscopy. g. Demonstration of NMR and interpretation of data. h. Elucidation of structure of cellular metabolites (e.g. polyphenols, coumarins, alkaloids, etc.) using IR, NMR and Mass profiles.			
Module 3:	**3. Concepts in Immunology** a. Agglutination assays. i. Determination of ABO and Rh blood group. ii. Latex bead agglutination: Rheumatoid Arthritis factor determination. b. Immunodiffusion assays. i. Single Immunodiffusion: Mancini technique. ii. Double Immunodiffusion: Ag-Ab pattern and Antibody titration: Ouchterlony procedure. c. Widal test: Slide and tube method. d. Rapid tests. i. Malarial antigens Pv/Pf. ii. Dengue IgM and IgG antibodies. e. ELISA: Dot-ELISA method. f. Immunoelectrophoresis: Counter Current Immunoelectrophoresis technique. g. Differential leukocyte count: Wright's and Giemsa's staining	30	CO3	K1, K2, K3, K4, K5
Module 4:	**4. Clinical Biochemistry (ANY SIX)** a. Analysis of blood i. Estimation of Haemoglobin (Hb) content of blood by copper sulphate method and Sahli's method. ii. Estimation of total cell (TC) counts of blood sample. b. Estimation of blood glucose by glucose oxidase method or Folin-Wu method. c. Estimation of blood cholesterol level by Liberman Burchard reaction.	30	CO4	K1, K2, K3, K4, K5

	d. Estimation of serum bilirubin level by Malloy and Evelyn method e. Analysis of urine: i. Physical examination: assessment of volume, appearance, odour, color, pH and specific gravity ii. Microscopic examination: assessment of crystals, casts, cells in urine sample. Chemical examination of urine: i. Estimation of glucose in urine sample by Benedict's method. ii. Estimation of albumin content in urine sample by Sulfosalicylic acid method. f. Estimation of blood urea by Diacetyl-monoxime method. g. Estimation of serum creatinine by Jaffe's method.			
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. K. Wilson, J. Walker; Principles and Techniques of Practical Biochemistry; Cambridge University Press; New York, 7th Ed., 2010. 2. S. K. Sawhney, R. Singh; Introductory Practical Biochemistry; Narosa Publishing House; New Delhi, India, 2nd Ed., 2005.			
References/ Readings:	1. S. Mohanty, Practical clinical Biochemistry, Jaypee Brothers Medical Publishers, New Delhi, India, 1st Ed., 2013. 2. J. Kenkel, Analytical Chemistry for Technicians, Lewis publishers, USA, 3rd Ed., 2002. 3. G. Damodaran, Practical Biochemistry, Jaypee Brothers Medical Publishers, New Delhi, India, 2nd Ed., 2011. 4. H. Prescott, Laboratory exercise in Microbiology, MacGraw-Hill Companies, New York, USA, 5th Ed, 2002. 5. W. Kemp, Organic Spectroscopy, Palgrave Macmillan, New York, 1991.			

Title of the Course	Biochemistry Practical – IV
Course Code	CHB-5204
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 Courses	
Course Objectives:	• To develop practical skills in enzyme analysis including assays, kinetics and data interpretation. • To apply advanced analytical methods for biochemical sample analysis. • To perform antigen-antibody interactions for immunodiagnostics. • To analyze clinical samples for diagnosing metabolic and organ disorders.	
Course Outcomes:	The students will be able to	**Mapped to PSO**
	CO 1. isolate enzymes from living cells, purify and understand their substrate interactions and kinetics.	PSO1, PSO2, PSO3, PSO5

	CO 2. develop methods for estimation of biomolecules and interpret spectral data to elucidate their structures.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 3. analyse the antigen and antibody interactions for diagnosis of diseases and disorders.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 4. examine clinical samples and interpret biochemical data for diagnosis and treatment of diseases.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Concepts in Biochemistry (ANY SIX)** a. Screening of microbes for production of enzymes tannases, proteases b. Assay of enzyme activity, rate of reaction of cellulases/ Xylanases c. Optimization of parameters for enzyme activity of cellulases/ Xylanases d. Determination of specific activity of enzyme of cellulases/ Xylanases e. Purification of enzyme by salting-out using ammonium sulphate. f. Dialysis of the precipitated enzyme. g. Purification of enzyme by Gel filtration. h. Determination of fold purification, percentage recovery of protein. i. Molecular weight determination of the enzyme by SDS PAGE. j. Determination of Km, Vmax.	**30**	CO1	K1, K2, K3, K4, K5
Module 2:	**2. Analytical Techniques in Biochemistry (ANY SIX)** a. Identification of morphology of microorganisms using monochrome staining techniques. b. Identification of morphological features of fungal species using light microscopy.	**30**	CO2	K1, K2, K3, K4, K5

	c. Determination of extinction coefficient of Arginine/ Cysteine (Any one). d. GC Analysis of essential oils like lemon grass/ lavender/ clove/ sandalwood oils (Any two). e. Analysis of nucleic acids using IR spectroscopy. f. Structure elucidation of plant polyphenols using NMR spectroscopy. g. Elucidation of structure of cellular metabolites (e.g. flavanoids, quinones, carotenoids, etc.) using combined IR, NMR and Mass profiles.			
Module 3:	**3. Concepts in Immunology (ANY SIX)** a. Agglutination assays. i. Coomb's test. ii. Latex bead agglutination: C-reactive protein determination. b. Immunodiffusion assays. i. Single Immunodiffusion: Oudin procedure. ii. Double Immunodiffusion: Oakley–Fulthrope procedure. c. VDRL test d. Rapid tests. i. COVID-19 rapid antigen tests. ii. HBsAg rapid test. e. ELISA: Antibody sandwich ELISA method. f. Immunoelectrophoresis: Rocket Immunoelectrophoresis technique. g. Differential leukocyte count: Leishman's staining	**30**	CO3	K1, K2, K3, K4, K5
Module 4:	**4. Clinical Biochemistry (ANY SIX)** a. Analysis of blood:	**30**	CO4	K1, K2, K3, K4, K5

	i. Estimation of Haemoglobin (Hb) content of blood by Cyanmethemoglobin method and Alkaline hematin method. ii. Estimation of clotting time of blood by Lee and White method. b. Estimation of blood glucose by o-Toluidine method. c. Estimation of blood cholesterol level by Cholesterol Oxidase Method. d. Estimation of serum alanine transaminase (SGPT) and aspartate transaminase (SGOT) by Reitman and Frankel method. e. Chemical examination of urine: i. Evaluation of chloride, calcium, sulphates, phosphorus, ammonia, urea and uric acid in urine. ii. Evaluation of ketone bodies in urine sample. f. Estimation of blood urea by Alkaline hypobromite method. g. Estimation of serum uric acid by Caraway method.			
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. K. Wilson, J. Walker; Principles and Techniques of Practical Biochemistry; Cambridge University Press; New York, 7th Ed., 2010. 2. S. K. Sawhney, R. Singh; Introductory Practical Biochemistry; Narosa Publishing House; New Delhi, India, 2nd Ed., 2005.			
References/ Readings:	1. S. Mohanty, Practical clinical Biochemistry, Jaypee Brothers Medical Publishers, New Delhi, India, 1st Ed., 2013. 2. J. Kenkel, Analytical Chemistry for Technicians, Lewis publishers, USA, 3rd Ed., 2002. 3. G. Damodaran, Practical Biochemistry, Jaypee Brothers Medical Publishers, New Delhi, India, 2nd Ed., 2011. 4. H. Prescott, Laboratory exercise in Microbiology, MacGraw-Hill Companies, New York, USA, 5th Ed, 2002. 5. W. Kemp, Organic Spectroscopy, Palgrave Macmillan, New York, 1991.			