

**DHANALAKSHMI SRINIVASAN
INSTITUTE OF RESEARCH AND TECHNOLOGY**

(Deemed to be University under section 3 of UGC Act, 1956.)
PERAMBALUR – 621 212, TAMIL NADU, INDIA.

SCHOOL OF ARTS AND SCIENCE

CURRICULUM AND SYLLABUS

M.Sc., BIOCHEMISTRY

REGULATION 2026

PROGRAMME:

Vision:

To emerge as a leading center of excellence in biochemical sciences, cultivating pioneering researchers, proficient innovators, and conscientious professionals who advance human health, environmental harmony, and societal progress through scientific discovery and application.

Mission:

- To deliver comprehensive, adaptable, and multidisciplinary postgraduate education in biochemistry that blends core scientific principles with emerging technologies, equipping graduates with strong analytical, problem-solving, and technical competencies for dynamic career opportunities and continuous professional growth.
- To promote advanced research and innovation focused on key challenges in healthcare, biotechnology, nutrition, and environmental protection, emphasizing practical solutions that benefit public health and ecological balance.
- To enhance access to quality higher education for students from rural and underprivileged backgrounds, integrating traditional knowledge with modern biochemical practices to develop relevant skills and promote self-reliant career pathways.
- To instill moral values, professional ethics, and societal awareness via hands-on learning, industry collaborations, and community-oriented projects that bridge theoretical knowledge with real-life applications.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO	PROGRAM EDUCATIONAL OBJECTIVES
PEO1	To provide graduates with a strong foundation in core and advanced biochemical concepts, laboratory techniques, and research methodologies, enabling them to pursue successful careers in academia, industry, healthcare, and research institutions.
PEO2	To develop critical thinking, analytical skills, and scientific temperament so that graduates can independently design, execute, and evaluate experiments addressing biochemical problems in health, agriculture, and environmental sectors.
PEO3	To foster ethical responsibility, effective communication, and teamwork abilities that prepare graduates to collaborate across disciplines and contribute responsibly to scientific and societal advancements.
PEO4	To encourage lifelong learning and adaptability, empowering graduates to stay updated with evolving biotechnological developments and take up entrepreneurial or higher academic pursuits in biochemistry and allied fields.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	PROGRAM SPECIFIC OUTCOMES
PSO1	Apply advanced concepts of Biochemistry, Molecular Biology, Cell Biology, Genetics, Immunology, Clinical Biochemistry, and Bioinformatics to solve scientific and societal problems.
PSO2	Demonstrate professional competence, communication skills, leadership abilities, and lifelong learning for successful careers in academia, research, industry, and entrepreneurship.

PROGRAM OUTCOMES (Pos)

PO	PROGRAM OUTCOMES
PO1	Apply advanced concepts and principles of Biochemistry and allied life sciences to understand and solve complex biological problems.
PO2	Analyze, evaluate, and solve scientific problems using logical reasoning and evidence-based approaches.
PO3	Demonstrate proficiency in advanced laboratory techniques, instrumentation, and analytical methodologies relevant to Biochemistry
PO4	Design and conduct independent research, analyse scientific data, and contribute to innovation and knowledge generation.
PO5	Utilize computational tools, bioinformatics resources, statistical methods, and emerging technologies for scientific investigations.
PO6	Interpret experimental results using appropriate statistical and computational approaches to derive meaningful conclusions.
PO7	Communicate scientific information effectively and collaborate efficiently in multidisciplinary and multicultural environments.
PO8	Practice ethical principles, biosafety, biosecurity, and professional responsibility in research and societal applications.
PO9	Apply biochemical knowledge to address issues related to health, environment, and sustainable development.
PO10	Demonstrate leadership, innovation, and entrepreneurial skills for professional growth and societal advancement.
PO11	Engage in continuous learning, adapt to emerging scientific advancements, and contribute effectively to national and global scientific communities.

SEMESTER-I

Semester	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
I	Core	Chemistry of Biomolecules	PBC26101	3	0	0	3	40	60	100
	Core	Lab in Biomolecules	PBC26102	0	0	4	2	40	60	100
	SEC	Advanced Analytical Techniques in Biochemistry	PBC26S01	2	1	0	3	40	60	100
		Lab in Analytical Techniques	PBC26S02	0	0	4	2	40	60	100
	MDC	Multi-Disciplinary Course -I	-	3	0	0	3	40	60	100
	DEC	Medical Laboratory Technology	PBC26001	4	0	0	4	40	60	100
		Cell Biology	PBC26002							
		Nutraceuticals and Functional Food	PBC26003							
	DEC	Metabolic Syndrome and Related Disorders	PBC26004	4	0	0	4	40	60	100
		Nutritional Biochemistry of Physical Activity	PBC26005							
		Biomedical Instrumentation	PBC26006							
							21			700

SEMESTER-II

Semester	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
II	Core	Advance Immunology	PBC26203	3	1	0	4	40	10	100
	Core	Enzymology	PBC26204	2	1	0	3	40	60	100
	Core	Lab in Enzymology	PBC26205	0	0	4	2	40	60	100
	SEC	Human System Biology and Physiology	PBC26S03	3	0	0	3	40	60	100
		Lab in Human System Biology	PBC26S04	0	0	4	2	40	60	100

	MDC	Multi-Disciplinary Course -II	-	3	0	0	3	40	60	100
	DEC	Ayurveda Medicine in Human Health	PBC26007	4	0	0	4	40	60	100
		Endocrinal Biochemistry	PBC26008							
		Pharmaceutical Biochemistry	PBC26009							
	DEC	Applied Biostatistics in Biochemistry	PBC26010	4	0	0	4	40	60	100
		Forensic Biochemistry and Crime Investigation	PBC26011							
		Metallochemistry	PBC26012							
							25			700

SEMESTER-III

Semester	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
III	Core	Advanced Clinical Biochemistry	PBC26306	2	1	0	3	40	60	100
	Core	Lab in Clinical Biochemistry	PBC26307	0	0	4	2	40	60	100
	Core	Molecular Biology and Genetics	PBC26308	3	0	0	3	40	60	100
	Core	Lab in Molecular Biology and Genetics	PBC26309	0	0	4	2	40	60	100
	Core	Metabolism and Regulation	PBC26310	3	1	0	4	40	60	100
	DEC	Cell Signaling and Transduction	PBC26013	4	0	0	4	40	60	100
		AI in Drug Discovery and Biochemistry	PBC26014							
		Bioethics and Animal Handling Experimentation	PBC26015							
	SEC	Skill Development Course	-	1	0	0	1			
	EE	Experiential Elective (Internship)	PBCEE01	0	0	4	2	*	*	100
							21			700

SEMESTER-IV

Semester	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
IV	Core	Computational Biology and Genomics	PBC26411	4	0	0	4	40	60	100
	Core	Research Methodology	PBC26412	3	1	0	4	40	60	100
	Core	Project	PBC26413	0	0	24	12	40	60	100
							20			400

Semester-wise Categorization of Courses

COURSE CATEGORY	Semester				No of Courses	Total Credits
	I	II	III	IV		
Core Courses (Theory & Practical)	2	3	5	3	13	48
SEC–Skill Enhancement Course	2	2	-	-	4	11
MDC–Multi Disciplinary Course	1	1	1	-	3	6
DEC–Disciplinary Elective Course	2	2	1	-	5	20
EE–Experiential Elective	-	-	1	-	1	2
Total Courses Per Semester	7	8	8	3	26 (Courses)	
Total Credits	21	25	21	20	87(Credits)	

MDC COURSE OFFERED BY THE DEPARTMENT:

S.NO	Course Code	Title of the Course
1.	PBC26901	Food Safety and Public Health
2.	PBC26902	Bioproducts and Start-up Innovations

DEC COURSE OFFERED BY THE DEPARTMENT:

S.NO	Course Code	Title of the Course
1.	PBC26001	Medical Laboratory Technology
2.	PBC26002	Cell Biology
3.	PBC26003	Nutraceuticals and Functional Food
4.	PBC26004	Metabolic Syndrome and Related Disorders
5.	PBC26005	Nutritional Biochemistry of Physical Activity
6.	PBC26006	Biomedical Instrumentation
7.	PBC26007	Ayurveda Medicine in Human Health
8.	PBC26008	Endocrinal Biochemistry
9.	PBC26009	Pharmaceutical Biochemistry
10.	PBC26010	Applied Biostatistics in Biochemistry
11.	PBC26011	Forensic Biochemistry and Crime Investigation
12.	PBC26012	Metallochemistry
13.	PBC26013	Cell Signaling and Transduction
14.	PBC26014	AI in Drug Discovery and Biochemistry
15.	PBC26015	Bioethics and Animal Handling Experimentation

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PBC26101	Chemistry of Biomolecules	Core	3	0	0	3

Pre-Requisite:

- Basic knowledge of Biology and Chemistry at the undergraduate level.
- Understanding of the structure and functions of cells and biomolecules.

Co- Requisite:

- Laboratory in Chemistry of Biomolecules.
- Analytical Techniques in Biochemistry.

Progressive Course:

- Metabolism and Metabolic Regulation.
- Advanced Molecular Biology and Biochemical Research Techniques.

Course Objectives:

1. To explain the unique physicochemical properties of water and the structure, classification, and biological functions of carbohydrates, emphasizing their roles in cellular processes and molecular recognition.
2. To examine the classification, structure, physicochemical properties, synthesis, purification, and structural organization of amino acids and proteins, and their significance in biological systems.
3. To analyze the structure, properties, and functional roles of nucleic acids and lipids, including their involvement in genetic information processing, membrane organization, and cellular signaling.
4. To assess the biochemical functions, metabolic significance, and clinical importance of vitamins and minerals in maintaining physiological and cellular homeostasis.
5. To evaluate the structure, biological roles, and applications of glycosaminoglycans, glycoconjugates, glycoproteins, and lectins, with special emphasis on carbohydrate-mediated cellular communication and recognition mechanisms.

Course Outcomes:

CO1: Recall and explain the structural, physicochemical, and functional properties of carbohydrates, including their biological significance in living systems **(K4)**.

CO2: Describe and discuss the classification, structure, synthesis, purification, and functional organization of amino acids and proteins. **(K4)**.

CO3: Apply knowledge of the structure, properties, and biological functions of nucleic acids and lipids to explain their roles in cellular processes and membrane organization. **(K4)**:

CO4: Analyze the biochemical functions, metabolic significance, and clinical importance of vitamins and minerals in maintaining cellular homeostasis and human health. **(K5)**

CO5: Evaluate the structure, biological roles, and functional significance of glycosaminoglycans, glycoconjugates, lectins, and carbohydrate-mediated molecular recognition mechanisms. **(K5)**

Unit-I	Carbohydrate	09 Hrs.
<p>Carbohydrates: Introduction Classification and properties of carbohydrates. Structure, properties and biological functions of monosaccharides, disaccharides, oligosaccharides and polysaccharides. Chemistry and biological roles of homo- and heteropolysaccharides. Glycosidic bonds and their significance. Lectin–oligosaccharide interactions and their role in cell recognition, cell adhesion, immune responses and other biochemical processes.</p>		
Unit-II	Amino acids and Proteins	09 Hrs.
<p>Amino Acids: Introduction, Classification, structure and physicochemical properties of amino acids. Chemical synthesis of peptides with emphasis on solid-phase peptide synthesis.</p> <p>Proteins: Introduction, Classification, isolation and purification of proteins. Structural organization of proteins – primary, secondary, tertiary and quaternary structures. Methods for amino acid sequence determination and characterization of proteins. Protein conformation and Ramachandran plot. Denaturation of proteins and factors affecting protein stability.</p>		
Unit-III	Nucleic Acids and Lipids	09 Hrs.
<p>Nucleic Acids: Structure and properties of nucleotides and nucleic acids. Physicochemical properties, enzymatic cleavage, nucleotide transformations, methylation, DNA sequencing and synthesis. Structure of DNA (A, B and Z forms). Types, structure and functions of RNA. Nucleotides as energy carriers, coenzyme components and secondary messengers. Nucleic acid-binding proteins.</p> <p>Lipids: Classification and biological significance of lipids. Fatty acids and their physicochemical properties. Structure and properties of prostaglandins. Storage lipids – triacylglycerols. Membrane lipids – glycerophospholipids, galactolipids, sulpholipids, sphingolipids and sterols. Structure, distribution and functions of membrane lipids. Role of lipids as signal molecules, cofactors and pigments.</p>		
Unit-IV	Vitamins and Minerals	09 Hrs.
<p>Vitamins- Fat soluble vitamins and water-soluble vitamins. Fat soluble vitamins: structure, sources and requirement, biological actions and clinical significance of vitamin A, D, E, K. Water soluble vitamins: structure, sources and requirement, biological actions and clinical significance of thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid and vitamin B12.</p> <p>Minerals- Classification, structural properties and biological role of minerals (iron, calcium, magnesium, sodium, iodine, potassium) in biochemical process.</p>		
Unit-V	Glycosaminoglycans and Glycoconjugates	09Hrs.
<p>Glycosaminoglycans - structure, location and biological role of hyaluronic acid, chondroitin sulphate, keratin sulfate, heparin sulfate, dermatan sulfate and heparin. Sialic acid – structure and significance. Proteoglycans. Glycoproteins and their biological importance. Principal sugars in human glycoproteins.</p> <p>Lectins - structure, function, applications. Major classes of glycoproteins - O-linked, N-linked, GPI linked oligosaccharides. Carbohydrates as information molecules- the sugar code. Blood group antigens and bacterial cell wall polysaccharides.</p>		

Text Book(s):

1. Nelson, D. L., & Cox, M. M. Lehninger Principles of Biochemistry (Latest Ed.). W. H. Freeman and Company. (Core Text for Metabolic & Structural foundations)
2. Voet, D., & Voet, J. G. Biochemistry (Latest Ed.). John Wiley & Sons. (Advanced text for physical chemistry & mechanisms)
3. Branden, C., & Tooze, J. Introduction to Protein Structure. Garland Science Publishing. (Dedicated reference for Unit II)

Reference Book(s):

1. Branden, C., & Tooze, J. (1999). Introduction to Protein Structure (2nd ed.). Garland Science Publishing. (The ultimate reference text for secondary structure elements, motifs, domains, and folding pathways).
2. Varki, A., Cummings, R. D., Esko, J. D., Stanley, P., et al. (Eds.). (2022). Essentials of Glycobiology (4th ed.). Cold Spring Harbor Laboratory Press. (Comprehensive reference for advanced postgraduate glycomics and sugar-code dynamics).
3. Cantor, C. R., & Schimmel, P. R. (2004). Biophysical Chemistry (Parts I, II, and III). W. H. Freeman and Company. (The gold standard reference for thermodynamic modeling of nucleic acid and protein stability).
4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., et al. (2021). Molecular Cell Biology (9th ed.). W. H. Freeman and Company. (Essential reference for membrane dynamics, lipid asymmetry, and receptor-ligand kinetics).
5. Blackburn, G. M., Gait, M. J., Loakes, D., & Williams, D. M. (Eds.). (2022). Nucleic Acids in Chemistry and Biology (4th ed.). Royal Society of Chemistry. (Advanced reference covering non-canonical structures like G-quadruplexes and RNA topological folds).

e Resources:

1. NCBI Bookshelf Free online textbooks and reference materials in biochemistry and life sciences
2. PubMed Database of biomedical and life science research articles.
3. Protein Data Bank (PDB) Repository of three-dimensional structures of proteins and nucleic acids.
4. KEGG Pathway Database Resource for biochemical pathways, metabolism, and molecular interactions.
5. SWAYAM Online courses and learning resources offered by the Government of India.

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credit
I	PBC26101			Chemistry of Biomolecules								3		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)	Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	2	1	1	-	-	-	-	-	-	3	3	1.85
CO2	3	3	3	2	2	-	-	-	-	-	-	3	3	2.15
CO3	3	3	3	2	3	1	-	-	-	-	-	3	3	2.31
CO4	3	3	2	2	2	1	-	-	1	-	-	3	3	2.15
CO5	3	3	3	3	2	1	-	-	1	-	-	3	3	2.38
Mean	3.00	3.00	2.60	2.00	2.00	0.60	0.00	0.00	0.40	0.00	0.00	3.00	3.00	2.17

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PBC26102	Lab in Biomolecules	Core	0	0	4	2

Pre-Requisite:

- Basic knowledge of biochemistry and chemical principles.

Co-Requisite:

- Biomolecules (Theory)

Progressive Course:

- Advanced Analytical Techniques in Biochemistry.
- Research Methodology and Bioinstrumentation.

Course Objectives:

1. To impart practical knowledge of analytical and physiological biochemistry techniques.
2. To develop skills in qualitative and quantitative analysis of biomolecules.
3. To familiarize students with clinical biochemical and hematological investigations.
4. To train students in the operation of analytical instruments and interpretation of experimental data.
5. To enable students to apply biochemical techniques in research and diagnostic laboratories.

Course Outcomes:

CO1: Perform qualitative analysis of major biomolecules using biochemical methods. (K4)

C02: Estimate carbohydrates, proteins, lipids, and nucleic acids using standard laboratory techniques. (K4)

C03: Analyze biochemical data and interpret the properties of biomolecules. (K4)

CO4: Perform separation and characterization techniques for biomolecules. (K5)

C05: Record, interpret, and communicate experimental findings effectively. (K5)

Practicals

30 hrs

1. Qualitative identification of carbohydrates.
2. Estimation of reducing sugar by DNS method.
3. Estimation of glucose by GOD-POD method.
4. Qualitative tests for amino acids and proteins.
5. Estimation of protein by Biuret method.
6. Estimation of protein by Lowry method.
7. Extraction and qualitative analysis of lipids.
8. Determination of acid value and saponification value of fats.
9. Isolation of DNA from biological samples.
10. Separation of biomolecules by paper/TLC chromatography.

Text Book(s):

1. Plummer, D. T. (2018). An Introduction to Practical Biochemistry, 6th Edition, McGraw-Hill Education, New Delhi.
2. Wilson, K. and Walker, J. (2022). Principles and Techniques of Biochemistry and Molecular Biology, 9th Edition, Cambridge University Press, Cambridge.
3. Sawhney, S. K. and Singh, R. (2020). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.
4. Sadasivam, S. and Manickam, A. (2020). Biochemical Methods, 4th Edition, New Age International Publishers, New Delhi.
5. Pattabiraman, T. N. (2021). Laboratory Manual in Biochemistry, All India Publishers and Distributors, Chennai.

Reference Book(s):

1. Bishop, M. L., Fody, E. P. and Schoeff, L. E. (2022). Clinical Chemistry: Principles, Techniques, and Correlations, 9th Edition, Wolters Kluwer, Philadelphia.
2. Burtis, C. A. and Bruns, D. E. (2023). Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics, 8th Edition, Elsevier, St. Louis.
3. Tietz, N. W. (2023). Textbook of Clinical Chemistry and Molecular Diagnostics, 7th Edition, Elsevier, Philadelphia.
4. Nielsen, S. S. (2023). Food Analysis Laboratory Manual, 4th Edition, Springer Nature, Cham.
5. Rodwell, V. W., Bender, D. A., Botham, K. M., Kennelly, P. J. and Weil, P. A. (2021). Harper's Illustrated Biochemistry, 32nd Edition, McGraw-Hill Education, New York.

e Resources:

1. NCBI Bookshelf <https://www.ncbi.nlm.nih.gov/books/>
2. PubMed Database <https://pubmed.ncbi.nlm.nih.gov/>
3. ExPASy Bioinformatics Resource Portal <https://www.expasy.org/>
4. Protein Data Bank (PDB) <https://www.rcsb.org/>
5. National Programme on Technology Enhanced Learning (NPTEL) – Biochemistry Courses <https://nptel.ac.in/courses>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									Hours		Credit
I	PBC26102		Lab in Biomolecules									4		2
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	2	2	1	-	-	1	-	-	-	3	2	3
CO2	3	3	3	2	2	-	-	1	-	-	-	3	3	3
CO3	2	3	3	3	2	-	-	1	1	-	-	3	3	2
CO4	3	3	3	2	2	-	-	1	-	-	-	3	3	3
CO5	2	2	2	2	1	-	-	2	1	1	-	2	3	2
Mean	2.60	2.60	2.60	2.20	1.60	0.00	0.00	1.20	0.40	0.20	0.00	2.80	2.80	2.60

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PBC26S01	Advanced Analytical Techniques in Biochemistry	Skill Enhancement Course	2	1	0	3
Pre-Requisite: <ul style="list-style-type: none"> Fundamental knowledge of biochemistry, biomolecules, and cellular organization. Basic understanding of chemical principles, laboratory techniques, and analytical measurements. 							
Co- Requisite: <ul style="list-style-type: none"> Biomolecular Chemistry and Metabolism. 							
<ul style="list-style-type: none"> Laboratory in Biomolecules and Analytical Biochemistry 							
Progressive Course: <ul style="list-style-type: none"> Proteomics, Metabolomics, and Structural Biology. Advanced Research Methodology and Bioinstrumentation. 							
Course Objectives:							
1. To introduce the basic principles of analytical techniques used in biochemistry.							
2. To provide knowledge on spectroscopic methods such as UV-Visible, fluorescence, IR, NMR, and mass spectrometry.							
3. To understand chromatographic techniques including TLC, HPLC, GC, ion-exchange, and affinity chromatography.							
4. To familiarize students with electrophoretic techniques like SDS-PAGE, agarose gel electrophoresis, and blotting methods.							
5. To develop skills in immunochemical techniques such as ELISA, RIA, immunodiffusion, and Immunoelectrophoresis.							
Course Outcomes:							
CO1: Evoke the principles, instrumentation, and applications of analytical techniques used in biochemical investigations. (K4)							
CO2: Explain the theoretical basis and operational principles of spectroscopic and chromatographic techniques employed in biomolecular analysis. (K4)							
CO3: Apply analytical and separation techniques to identify, quantify, and characterize biomolecules in biological samples. (K4)							
CO4: Analyze electrophoretic, immunological, and bioanalytical data for the investigation of biomolecular structure, function, and diagnostics. (K5)							
CO5: Analyze the applications of advanced analytical and omics technologies in biochemical research, biomarker discovery, and high-throughput biological investigations. (K5)							

Unit-I	Principles of Analytical Biochemistry	09 Hrs.
Fundamentals of analytical biochemistry. Analytical measurements and data quality – accuracy, precision, sensitivity, specificity, selectivity, reproducibility, limit of detection (LOD) and limit of quantification (LOQ). Calibration methods, standard curve preparation and validation. Beer–Lambert law and deviations. Buffer systems, pH measurement, ionic strength and buffer capacity. Sampling methods, sample preparation, extraction and preservation techniques. Statistical treatment of analytical data and quality assurance in biochemical analysis. Overview of modern biochemical instrumentation and laboratory practices.		
Unit-II	Spectroscopic Techniques	09 Hrs.
Principles, instrumentation and applications of spectroscopic methods in biomolecular research. UV–Visible spectroscopy, fluorescence spectroscopy and fluorimetry. Infrared (IR) and Fourier Transform Infrared (FTIR) spectroscopy. Circular dichroism (CD) spectroscopy and its applications in protein structure analysis. Nuclear Magnetic Resonance (NMR) spectroscopy – principles and applications in structural biology. Mass spectrometry – ionization techniques (ESI, MALDI), mass analyzers and biomolecular applications. Spectroscopic characterization of proteins, nucleic acids and metabolites.		
Unit-III	Chromatographic Techniques	09 Hrs.
Principles of chromatographic separation and resolution. Paper chromatography and thin-layer chromatography (TLC). Column chromatography, gel filtration chromatography, affinity chromatography and ion-exchange chromatography. High-Performance Liquid Chromatography (HPLC) and Ultra-Performance Liquid Chromatography (UPLC). Gas Chromatography (GC) and Gas Chromatography–Mass Spectrometry (GC–MS). Liquid Chromatography–Mass Spectrometry (LC–MS/MS). Method development, validation and applications in purification, identification and quantification of biomolecules.		
Unit-IV	Electrophoretic and Immunological Techniques	09 Hrs.
Principles and applications of electrophoretic techniques. Agarose gel electrophoresis, SDS–PAGE, Native PAGE, two-dimensional gel electrophoresis (2D-PAGE), isoelectric focusing and capillary electrophoresis. Southern, Northern and Western blotting techniques. Immunological methods – antigen–antibody interactions, ELISA, Radioimmunoassay (RIA), immunofluorescence, immunohistochemistry and flow cytometry. Applications in molecular diagnostics, biomarker discovery and clinical biochemistry.		
Unit-V	Advanced Analytical and Omics Technologies	09 Hrs.
Principles and applications of centrifugation and ultracentrifugation. Biosensors and bioanalytical devices. Surface Plasmon Resonance (SPR) and biosensing technologies. Microarray technology and next-generation analytical platforms. . Fundamentals of proteomics, metabolomics and lipidomics. Hyphenated analytical techniques and systems biology approaches. Nanobiotechnology-based analytical methods.		

Laboratory automation, robotics, artificial intelligence-assisted analytics, high-throughput screening technologies and emerging trends in biochemical research.

Text Book(s):

1. Wilson, K. & Walker, J. (2022). Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
2. Skoog, D. A., Holler, F. J. & Crouch, S. R. (2021). Principles of Instrumental Analysis, Cengage Learning.
3. Chatwal, G. R. (2020). Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
4. Plummer, D. T. (2018). An Introduction to Practical Biochemistry, McGraw-Hill Education.
5. Nigam, A. (2021). Instrumentation and Techniques in Biochemistry, Oxford Book Company.

Reference Book(s):

1. Nelson, D. L. & Cox, M. M. (2021). *Lehninger Principles of Biochemistry*, W.H. Freeman.
2. Voet, D. & Voet, J. G. (2019). *Biochemistry*, Wiley.
3. Alberts, B. et al. (2022). *Molecular Biology of the Cell*, Garland Science.
4. Lottspeich, F. & Engels, J. W. (2021). *Bioanalytics: Analytical Methods in Biochemistry*, Wiley-VCH.
5. Bishop, M. L., Fody, E. P. & Schoeff, L. E. (2022). *Clinical Chemistry*, Wolters Kluwer.

e Resources:

1. NCBI Bookshelf – <https://www.ncbi.nlm.nih.gov/books/>
2. PubMed – <https://pubmed.ncbi.nlm.nih.gov/>
3. RCSB Protein Data Bank (PDB) – <https://www.rcsb.org/>
4. ExPASy Bioinformatics Resource Portal – <https://www.expasy.org/>
5. NPTEL Biochemistry & Instrumentation Courses – <https://nptel.ac.in/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course										Hours	Credit
I	PBC26S01		Advanced Analytical Techniques in Biochemistry										3	3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	2	2	1	1	-	-	-	-	-	3	3	2.00
CO2	3	3	3	2	2	1	-	-	-	-	-	3	3	2.31
CO3	3	3	3	3	3	1	-	-	1	-	-	3	3	2.62
CO4	3	3	3	3	3	2	1	-	1	-	-	3	3	2.77
CO5	3	3	3	3	3	2	1	1	2	-	-	3	3	3.00
Mean	3.00	3.00	2.80	2.60	2.40	1.40	0.40	0.20	0.80	0.00	0.00	3.00	3.00	2.54

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PBC26S02	Lab in Analytical Techniques	Skill Enhancement Course	0	0	4	2
Pre-Requisite: <ul style="list-style-type: none"> Basic knowledge of biochemistry, chemistry, and laboratory techniques. 							
Co-Requisite: <ul style="list-style-type: none"> Analytical Techniques (Theory) 							
Progressive Course: <ul style="list-style-type: none"> Instrumental Analysis Advanced Biochemical Techniques 							
Course Objectives:							
1. To provide practical knowledge of basic and advanced analytical techniques used in biological sciences.							
2. To develop skills in handling analytical instruments and performing quantitative measurements.							
3. To understand the principles and applications of spectroscopic, chromatographic, and electrophoretic techniques.							
4. To train students in data analysis, interpretation, and validation of experimental results.							
5. To enhance technical skills required for research and diagnostic laboratory applications.							
Course Outcomes:							
CO1: Demonstrate laboratory safety practices and prepare samples for analytical investigations. (K3)							
CO2: Perform quantitative analysis using spectroscopic and colorimetric techniques. (K3)							
CO3: Separate and identify biological molecules using chromatographic and electrophoretic methods. (K3)							
CO4: Analyze and interpret experimental data obtained from analytical instruments. (K4)							
CO5: Evaluate the accuracy, precision, and reliability of analytical measurements. (K5)							
Practical's						30 hrs	
1. Calibration and operation of a UV–Visible Spectrophotometer and determination of λ_{max} of a colored compound.							
2. Preparation of a standard curve and quantitative estimation of protein using UV–Visible Spectrophotometry (Lowry/Bradford method).							
3. Estimation of sodium and potassium using a Flame Photometer using standard calibration curves.							

4. Extraction of phytochemicals from plant materials using solvent extraction techniques (maceration/Soxhlet extraction).
5. Separation of cellular components by differential centrifugation.
6. Separation and identification of amino acids by Paper Chromatography.
7. Separation of amino acids or plant pigments by Thin Layer Chromatography (TLC).
8. Separation of biomolecules using Column Chromatography.
9. Quantitative estimation of DNA/RNA using UV–Visible Spectrophotometry.
10. Integrated analytical exercise involving extraction, centrifugation, chromatographic separation, and UV–Visible spectrophotometric analysis of a biological sample.

Text Book(s):

1. Plummer, D. T. (2018). An Introduction to Practical Biochemistry, 6th Edition, McGraw-Hill Education, New Delhi.
2. Wilson, K. and Walker, J. (2022). Principles and Techniques of Biochemistry and Molecular Biology, 9th Edition, Cambridge University Press, Cambridge.
3. Sawhney, S. K. and Singh, R. (2020). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.
4. Sadasivam, S. and Manickam, A. (2020). Biochemical Methods, 4th Edition, New Age International Publishers, New Delhi.
5. Pattabiraman, T. N. (2021). Laboratory Manual in Biochemistry, All India Publishers and Distributors, Chennai.

Reference Book(s):

1. Bishop, M. L., Fody, E. P. and Schoeff, L. E. (2022). Clinical Chemistry: Principles, Techniques, and Correlations, 9th Edition, Wolters Kluwer, Philadelphia.
2. Burtis, C. A. and Bruns, D. E. (2023). Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics, 8th Edition, Elsevier, St. Louis.
3. Tietz, N. W. (2023). Textbook of Clinical Chemistry and Molecular Diagnostics, 7th Edition, Elsevier, Philadelphia.
4. Nielsen, S. S. (2023). Food Analysis Laboratory Manual, 4th Edition, Springer Nature, Cham.
5. Rodwell, V. W., Bender, D. A., Botham, K. M., Kennelly, P. J. and Weil, P. A. (2021). Harper's Illustrated Biochemistry, 32nd Edition, McGraw-Hill Education, New York.

e Resources:

6. NCBI Bookshelf <https://www.ncbi.nlm.nih.gov/books/>
7. PubMed Database <https://pubmed.ncbi.nlm.nih.gov/>
8. ExPASy Bioinformatics Resource Portal <https://www.expasy.org/>
9. Protein Data Bank (PDB) <https://www.rcsb.org/>
10. National Programme on Technology Enhanced Learning (NPTEL) – Biochemistry Courses
<https://nptel.ac.in/courses>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credit
I	PBC26S02			Lab in Biomolecules								4		2
Course Outcomes	Programme Outcomes (POs)											Programme Specific	Mean Score	
(COs)												Outcomes (PSOs)	of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1		PSO2
CO1	3	2	2	2	1	-	-	1	-	-	-	3	2	3
CO2	3	3	3	2	2	-	-	1	-	-	-	3	3	3
CO3	2	3	3	3	2	-	-	1	1	-	-	3	3	2
CO4	3	3	3	2	2	-	-	1	-	-	-	3	3	3
CO5	2	2	2	2	1	-	-	2	1	1	-	2	3	2
Mean	2.60	2.60	2.60	2.20	1.60	0.00	0.00	1.20	0.40	0.20	0.00	2.80	2.80	2.60

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PBC26001	Medical Laboratory Technology	Disciplinary Elective Course	4	0	0	4

Pre-Requisite:

- Basic knowledge of Biology, Chemistry, and Human Physiology.
- Understanding of laboratory safety practices and scientific measurement techniques.

Co- Requisite:

- Practical training in Medical Laboratory Technology and Clinical Diagnostic Techniques.
- Concurrent study of Clinical Biochemistry, Hematology, and Pathology.

Progressive Course:

- Advanced Clinical Laboratory Technology, Clinical Biochemistry, and Diagnostic Techniques.
- Specialized studies in Hematology, Histopathology, Blood Banking, Molecular Diagnostics, and Integrative Healthcare.

Course Objectives:

1. To provide fundamental knowledge of medical laboratory practices, safety, and quality control.
2. To understand principles and techniques used in clinical biochemistry, hematology, microbiology, and histopathology.
3. To develop skills in collection, handling, and analysis of clinical samples.
4. To familiarize students with diagnostic tests and interpretation of laboratory results.
5. To train students in the use of laboratory instruments and modern diagnostic techniques in healthcare.

Course Outcomes:

CO1: Analyze the principles of medical laboratory technology, laboratory safety practices, biosafety measures, specimen handling procedures, and quality control systems used in clinical laboratories. (K4)

CO2: Analyze the biochemical parameters of blood and body fluids and interpret the results of clinical biochemical investigations for the assessment of physiological and pathological conditions. (K4)

CO3: Analyze hematological parameters, blood banking procedures, coagulation profiles, and transfusion practices for the diagnosis and management of blood-related disorders (K4)

CO4: Evaluate histopathological techniques, clinical diagnostic procedures, microscopy findings, and laboratory quality assurance systems for disease diagnosis and monitoring (K5)

CO5: Evaluate the integration of Ayurveda with modern medicine, including evidence-based validation, herbal drug standardization, nutraceutical applications, and preventive healthcare strategies. (K5)

Unit-I	Fundamentals of Medical Laboratory Technology	12 Hrs.
Introduction to medical laboratory technology, laboratory organization and safety, biosafety levels, sterilization methods, infection control, laboratory instruments and glassware, sample collection, preservation, transport, and quality control in laboratory diagnosis.		
Unit-II	Clinical Biochemistry	12 Hrs.
Principles of clinical biochemistry, analysis of blood and body fluids, estimation of glucose, urea, creatinine, uric acid, bilirubin, cholesterol, and enzymes (SGOT, SGPT, ALP), liver function tests (LFT), kidney function tests (KFT), and interpretation of biochemical results.		
Unit-III	Hematology and Blood Banking	12 Hrs.
Blood composition and functions, hemoglobin estimation, RBC and WBC counting, blood grouping and cross matching, coagulation tests (BT, CT, PT, APTT), ESR, anemia classification, leukemia basics, blood bank procedures and transfusion safety.		
Unit-IV	Histopathology and Clinical Diagnostics	12 Hrs.
Tissue processing techniques, fixation, embedding, sectioning and staining (H&E staining), cytology techniques, urine and stool analysis, cerebrospinal fluid (CSF) analysis, clinical microscopy, laboratory automation and quality assurance in diagnostics.		
Unit-V	Integrative and Modern Applications	12 Hrs.
Integration of Ayurveda with modern medicine; evidence-based Ayurveda; clinical validation of herbal drugs; nutraceuticals; herbal drug standardization; role of Ayurveda in preventive healthcare and lifestyle medicine.		

Text Book(s):

1. Ramnik Sood (2020). *Medical Laboratory Technology: Methods and Interpretations*, Jaypee Brothers.
2. Mukherjee, K. L. (2019). *Medical Laboratory Technology*, McGraw Hill Education.
3. Godkar, P. B. (2021). *Textbook of Medical Laboratory Technology*, Bhalani Publishing House.
4. Dacie, J. V. & Lewis, S. M. (2020). *Practical Haematology*, Elsevier.
5. Cheesbrough, M. (2018). *District Laboratory Practice in Tropical Countries*, Cambridge University Press.

Reference Book(s):

1. Turgeon, M. L. (2021). *Clinical Hematology: Theory and Procedures*, Wolters Kluwer.
2. Bishop, M. L. et al. (2022). *Clinical Chemistry*, Wolters Kluwer.
3. Cheesbrough, M. (2019). *Medical Laboratory Manual for Tropical Countries*, Cambridge University Press.
4. Collee, J. G. et al. (2020). *Mackie & McCartney Practical Medical Microbiology*, Elsevier.
5. Henry, J. B. (2021). *Clinical Diagnosis and Management by Laboratory Methods*, Elsevier.

e Resources:

1. NCBI Bookshelf – <https://www.ncbi.nlm.nih.gov/books/>
2. PubMed – <https://pubmed.ncbi.nlm.nih.gov/>
3. WHO Laboratory Manuals – <https://www.who.int/>
4. CDC Laboratory Guidelines – <https://www.cdc.gov/>
5. Lab Tests Online – <https://labtestsonline.org/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credit
I	PBC26001			Medical Laboratory Technology								4		4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	2	2	2	1	1	2	-	-	-	3	2	1.77
CO2	3	3	3	3	2	1	-	2	1	-	-	3	3	2.08
CO3	3	3	3	3	2	1	-	2	1	-	-	3	3	2.08
CO4	3	3	3	3	2	2	1	2	1	1	-	3	3	2.31
CO5	2	3	2	3	3	2	2	2	2	1	1	3	3	2.23
Mean	2.80	3.00	2.60	2.80	2.20	1.40	0.80	2.00	1.00	0.40	0.20	3.00	2.80	2.09

Unit-I	Cell Structure and Molecular Organization	12 Hrs.
Ultrastructure of prokaryotic and eukaryotic cells, plasma membrane structure and models, membrane dynamics, transport mechanisms (passive, active and vesicular transport), cytoskeletal system (microtubules, microfilaments, intermediate filaments), cell junctions, extracellular matrix, nucleus organization, chromatin structure and genome packaging.		
Unit-II	Biomolecules and Cellular Metabolism	12 Hrs.
Structure and function of carbohydrates, proteins, lipids and nucleic acids in cellular systems, enzyme structure and kinetics, regulation of enzyme activity, bioenergetics, ATP synthesis, mitochondrial oxidative phosphorylation, glycolysis, TCA cycle, electron transport chain, overview of lipid and amino acid metabolism in cells.		
Unit-III	Cell Cycle, Division and Apoptosis	12 Hrs.
Cell cycle phases and regulation, cyclins and cyclin-dependent kinases (CDKs), cell cycle checkpoints, regulation of mitosis and meiosis, spindle assembly and chromosome segregation, DNA damage checkpoints, molecular mechanisms of apoptosis (intrinsic and extrinsic pathways), cell proliferation and differentiation control.		
Unit-IV	Cell Signaling and Communication	12 Hrs.
Cell signaling mechanisms including autocrine, paracrine and endocrine signaling, receptors (GPCRs, receptor tyrosine kinases, ion channel receptors), second messenger systems (cAMP, Ca ²⁺ , IP3/DAG), signal transduction cascades, protein phosphorylation networks, signal amplification and regulation of cellular responses.		
Unit-V	Cancer Biology and Advanced Cell Systems	12 Hrs.
Oncogenes, tumor suppressor genes (p53, Rb), molecular basis of cancer development, cell transformation, tumor progression and metastasis, angiogenesis, cancer stem cells, immune response to tumors, apoptosis dysregulation in cancer, introduction to stem cells, cell differentiation, and advanced techniques in cell biology (flow cytometry, cell imaging, and molecular markers).		

Text Book(s):

1. Alberts, B. et al. (2022). *Molecular Biology of the Cell*, Garland Science.
2. Lodish, H. et al. (2021). *Molecular Cell Biology*, W.H. Freeman.
3. Cooper, G. M. & Hausman, R. E. (2019). *The Cell: A Molecular Approach*, Sinauer.
4. Karp, G. (2020). *Cell and Molecular Biology: Concepts and Experiments*, Wiley.
5. De Robertis, E. D. P. & De Robertis Jr., E. M. (2018). *Cell and Molecular Biology*, Lippincott.

Reference Book(s):

1. Pollard, T. D. & Earnshaw, W. C. (2020). *Cell Biology*, Elsevier.
2. Bruce Alberts (2022). *Essential Cell Biology*, Garland Science.
3. Watson, J. D. et al. (2021). *Molecular Biology of the Gene*, Pearson.
4. Lewin, B. (2020). *Genes XII*, Jones & Bartlett.
5. Nelson, D. L. & Cox, M. M. (2021). *Lehninger Principles of Biochemistry*, W.H. Freeman.

e Resources:

1. NCBI Bookshelf – <https://www.ncbi.nlm.nih.gov/books/>
2. PubMed – <https://pubmed.ncbi.nlm.nih.gov/>
3. Khan Academy Biology – <https://www.khanacademy.org/science/biology>
4. Cell Image Library – <https://www.cellimagelibrary.org/>
5. NPTEL Cell Biology Courses – <https://nptel.ac.in/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									Hours		Credit
I	PBC26002		Cell Biology									4		4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	2	3	-	1	1	1	1	-	-	2	3	2.08
CO2	3	3	3	-	2	1	-	2	1	-	-	3	2	2.15
CO3	3	3	-	3	2		1	1	2	1	-	3	3	2.31
CO4	3	3	3	-	3	2	1	-	2	1	1	2	3	2.46
CO5	3	3	-	3	3	2	2	2	2	2	1	3	2	2.62
Mean	3.00	3.00	2.80	3.00	2.40	1.40	1.00	2.00	1.60	0.80	0.40	3.00	3.00	2.31

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PBC26003	Nutraceuticals and Functional Food	Disciplinary Elective Course	4	0	0	4
Pre-Requisite: <ul style="list-style-type: none"> Basic knowledge of Biochemistry, Human Physiology, and Cell Biology. Understanding of food chemistry and fundamental concepts of metabolism. 							
Co- Requisite: <ul style="list-style-type: none"> Practical exposure to Biochemical analysis and food science laboratory techniques. Concurrent study of Pharmacology, Microbiology, and Clinical Nutrition concepts. 							
Progressive Course: <ul style="list-style-type: none"> Advanced Nutraceutical Science and Functional Food Technology. Specialized studies in Clinical Nutrition, Pharmacognosy, Food Biotechnology, Drug Development, and Translational Biomedical Research 							
Course Objectives:							
1. To understand the basic concepts, scope and classification of nutraceuticals and functional foods.							
2. To study bioactive compounds, present in foods and their physiological roles.							
3. To gain knowledge on functional foods and their role in human health promotion.							
4. To understand the role of nutraceuticals in prevention and management of chronic diseases.							
5. To learn processing, safety evaluation, quality control and regulatory aspects of nutraceuticals.							
Course Outcomes:							
CO1: Analyze the concept, classification, evolution, and regulatory framework of nutraceuticals and functional foods in relation to global trends and market applications. (K4)							
CO2: Analyze the structure, chemistry, and biological roles of bioactive food components, including phytochemicals, antioxidants, probiotics, and dietary fibers in human health. (K4)							
CO3: Analyze the functional properties, bioavailability, and molecular mechanisms of functional foods in disease prevention, immune modulation, and gut health. (K4)							
CO4: Evaluate the role of nutraceuticals and functional foods in the prevention and management of chronic diseases, including their therapeutic potential and clinical evidence. (K5)							
CO5: Evaluate the development, safety, quality control, and regulatory aspects of nutraceutical formulations, including delivery systems and commercialization strategies. (K5)							

Unit-I	Fundamentals of Nutraceuticals and Functional Foods	12 Hrs.
Concept, scope and evolution of nutraceuticals and functional foods, classification of nutraceuticals (Dietary supplements, herbal nutraceuticals, engineered foods), differences between nutraceuticals, pharmaceuticals and functional foods, global trends, market potential, and regulatory overview.		
Unit-II	Bioactive Compounds in Foods	12 Hrs.
Structure, chemistry and biological role of bioactive food components including carbohydrates, proteins, peptides, lipids and essential fatty acids, phytochemicals such as polyphenols, flavonoids, carotenoids, alkaloids and terpenoids, dietary fiber, antioxidants, probiotics, prebiotics and symbiotic, mechanisms of action in human health.		
Unit-III	Functional Foods and Mechanisms of Action	12 Hrs.
Concept and classification of functional foods, natural and processed functional foods, role of fruits, vegetables, cereals and dairy-based functional foods, bioavailability and metabolism of functional components, molecular mechanisms involved in disease prevention, functional foods in immune modulation and gut health.		
Unit-IV	Nutraceuticals in Disease Prevention and Therapy	12 Hrs.
Role of nutraceuticals in management of chronic diseases such as diabetes, cardiovascular diseases, cancer, obesity, neurodegenerative and inflammatory disorders, antioxidant and anti-inflammatory nutraceuticals, herbal and Ayurvedic nutraceuticals, clinical evidence and therapeutic applications.		
Unit-V	Development, Safety and Regulatory Aspects	12 Hrs.
Extraction, formulation and delivery systems of nutraceuticals, nano-formulations and encapsulation techniques, stability and bioavailability enhancement, toxicity evaluation and safety assessment, quality control standards, regulatory frameworks (FSSAI, FDA, WHO guidelines), labeling, packaging, and commercialization aspects.		

Text Book(s):

1. Wildman, R. E. C. (2021). *Handbook of Nutraceuticals and Functional Foods*, CRC Press.
2. Gibson, G. R. & Williams, C. M. (2020). *Functional Foods: Concept to Product*, Woodhead Publishing.
3. Shahidi, F. (2021). *Nutraceuticals and Functional Foods*, Wiley.
4. Shils, M. E. et al. (2020). *Modern Nutrition in Health and Disease*, Wolters Kluwer.
5. Das, A. J. (2022). *Food Biotechnology and Nutraceuticals*, Springer.

Reference Book(s):

1. Ross, A. C. et al. (2021). *Modern Nutrition in Health and Disease*, Lippincott Williams & Wilkins.
2. Branen, A. L. et al. (2019). *Food Additives and Functional Foods*, CRC Press.
3. Hasler, C. M. (2020). *Functional Foods: Benefits and Applications*, ACS Publications.
4. Shahidi, F. & Ambigaipalan, P. (2021). *Bioactive Compounds in Foods*, Wiley.
5. Gibson, G. R. (2019). *Probiotics and Prebiotics in Human Nutrition*, CRC Press.

e Resources:

1. NCBI Bookshelf – <https://www.ncbi.nlm.nih.gov/books/>
2. PubMed – <https://pubmed.ncbi.nlm.nih.gov/>
3. FSSAI Official Portal – <https://www.fssai.gov.in/>
4. WHO Nutrition Resources – <https://www.who.int/health-topics/nutrition>
5. ScienceDirect Food Science – <https://www.sciencedirect.com/topics/food-science>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course										Hours	Credit
I	PBC26003		Nutraceuticals and Functional Food										4	4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	-	2	-	2	-	-	-	1	2	2	2	2.00
CO2	3	3	2	2	2	-	-	-	2	-	1	3	2	2.43
CO3	3	3	2	3	2	2	2	-	-	-	-	3	2	2.44
CO4	3	3	3	3	2	2	2	2	1	1	-	3	3	2.67
CO5	2	3	3	3	3	3	2	2	1	2	1	2	3	2.42
Mean	2.80	2.80	2.50	2.60	2.25	2.25	2.00	2.00	1.00	1.50	1.00	2.60	2.40	2.39

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PBC26004	Metabolic Syndrome and Related Disorders	Disciplinary Elective Course	4	0	0	4
Pre-Requisite: <ul style="list-style-type: none"> Strong foundation in Biochemistry, Human Physiology, and Cell Biology. Basic understanding of endocrine regulation, metabolism, and clinical laboratory parameters. 							
Co- Requisite: <ul style="list-style-type: none"> Practical training in Clinical Biochemistry and Diagnostic Techniques. Concurrent study of Pathophysiology, Nutrition, and Endocrinology. 							
Progressive Course: <ul style="list-style-type: none"> Advanced Clinical Biochemistry and Metabolic Disorders. Specialized studies in Endocrinology, Cardiometabolic Diseases, Nutritional Biochemistry, and Translational Medical Research. 							
Course Objectives:							
1. To understand the concept, diagnostic criteria, and major risk factors of metabolic syndrome.							
2. To explain the role of obesity, dyslipidemia, and altered lipid metabolism in metabolic disorders.							
3. To describe insulin resistance, diabetes mellitus, and their biochemical investigations and complications.							
4. To analyze the relationship between metabolic syndrome, hypertension, and cardiovascular diseases.							
5. To discuss NAFLD, PCOS, gut microbiota, and emerging preventive and therapeutic approaches in metabolic syndrome.							
Course Outcomes:							
CO1: Analyze the components, risk factors, epidemiology, and pathophysiological mechanisms of metabolic syndrome, including the roles of adipose tissue, adipokines, oxidative stress, and inflammation. (K4)							
CO2: Analyze the biochemical basis of obesity and dyslipidemia, including lipid metabolism, lipoproteins, energy balance, hormonal regulation, and their role in atherosclerosis and metabolic disorders. (K4)							
CO3: Analyze glucose homeostasis, insulin signaling, insulin resistance, and the biochemical basis, diagnosis, and complications of diabetes mellitus. (K4)							
CO4: Evaluate the physiological and biochemical mechanisms underlying hypertension and cardiovascular disorders, including RAAS, endothelial dysfunction, and biomarkers of cardiovascular risk. (K5)							
CO5: Evaluate the pathophysiology, diagnosis, and emerging therapeutic approaches for metabolic disorders such as NAFLD, PCOS, and gut microbiota–related metabolic regulation. (K5)							
Unit-I	Introduction to Metabolic Syndrome						12Hrs.

Definition and diagnostic criteria of metabolic syndrome. Epidemiology and risk factors. Components of metabolic syndrome: obesity, insulin resistance, dyslipidemia, hypertension, and hyperglycemia. Role of adipose tissue and adipokines. Oxidative stress and inflammation in metabolic syndrome.		
Unit-II	Obesity and Dyslipidemia	12 Hrs.
Classification and assessment of obesity. Energy balance and body mass index (BMI). Lipid metabolism and lipoproteins. Hypercholesterolemia and hypertriglyceridemia. Biochemical basis of atherosclerosis. Hormonal regulation of appetite and body weight. Prevention and management of obesity.		
Unit-III	Diabetes Mellitus and Insulin Resistance	12 Hrs.
Insulin synthesis and mechanism of action. Insulin resistance and glucose homeostasis. Type 1 and Type 2 diabetes mellitus. Prediabetes and impaired glucose tolerance. Glycated hemoglobin (HbA1c) and biochemical investigations for diabetes. Acute and chronic complications of diabetes. Principles of diabetes management.		
Unit-IV	Hypertension and Cardiovascular Disorders	12 Hrs.
Regulation of blood pressure. Renin–angiotensin–aldosterone system (RAAS). Causes and classification of hypertension. Metabolic syndrome and cardiovascular diseases. Endothelial dysfunction and oxidative stress. Biomarkers of cardiovascular risk. Prevention and therapeutic approaches.		
Unit-V	Non-Alcoholic Fatty Liver Disease and Emerging Concepts	12 Hrs.
Non-alcoholic fatty liver disease (NAFLD): causes, pathogenesis, and diagnosis. Polycystic ovary syndrome (PCOS) and its association with metabolic syndrome. Role of gut microbiota in metabolic disorders. Lifestyle interventions including diet and exercise. Functional foods, nutraceuticals, and recent advances in management.		

Text Book(s):

1. Devlin, T.M. (2023). Textbook of Biochemistry with Clinical Correlations. 9th Edition. Wiley, New York.
2. Rodwell, V.W., Bender, D.A., Botham, K.M., Kennelly, P.J. and Weil, P.A. (2021). Harper's Illustrated Biochemistry. 32nd Edition. McGraw-Hill Education, New York.
3. Ferrier, D.R. (2022). Lippincott Illustrated Reviews: Biochemistry. 8th Edition. Wolters Kluwer, Philadelphia.
4. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Weil, P.A. (2021). Harper's Illustrated Biochemistry. 32nd Edition. McGraw-Hill Education, New York.

Reference Book(s):

1. Reaven, G.M. and Laws, A. (2020). Insulin Resistance: The Metabolic Syndrome X. Humana Press, New Jersey.
2. Jameson, J.L., Fauci, A.S., Kasper, D.L., Hauser, S.L. and Loscalzo, J. (2022). Harrison's Principles of Internal Medicine. 21st Edition. McGraw-Hill Education.
3. James, W.P.T. (2021). Obesity and Metabolic Syndrome. Springer Nature, Switzerland.
4. Feingold, K.R., Anawalt, B., Boyce, A. et al. (2023). Endotext: Endocrinology and Metabolism. MDText.com, Inc.
5. Rifai, N., Horvath, A.R. and Wittwer, C.T. (2023). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. 7th Edition. Elsevier, Philadelphia.

e Resources:

1. National Center for Biotechnology Information (NCBI): <https://www.ncbi.nlm.nih.gov>
2. PubMed Database: <https://pubmed.ncbi.nlm.nih.gov>
3. National Institutes of Health (NIH): <https://www.nih.gov>
4. American Diabetes Association (ADA): <https://diabetesjournals.org>
5. World Health Organization (WHO): <https://www.who.int>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course										Hours		Credit
I	PBC26004		Metabolic Syndrome and Related Disorders										4		4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	3	3	3	2	1	1	2	2	1	-	3	3	2.31	
CO2	3	3	3	3	3	1	1	2	2	1	-	3	3	2.38	
CO3	3	3	3	3	3	2	1	2	2	2	-	3	3	2.54	
CO4	3	3	3	3	3	2	2	2	2	2	1	3	3	2.62	
CO5	3	3	3	3	3	2	2	2	2	2	2	3	3	2.69	
Mean	3.00	3.00	3.00	3.00	2.80	1.60	1.40	2.00	2.00	1.60	0.60	3.00	3.00	2.51	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PBC26005	Nutritional Biochemistry of Physical Activity	Disciplinary Elective Course	4	0	0	4

Pre-Requisite:

- Basic understanding of Biochemistry, Human Physiology, and Human Nutrition.
- Fundamental knowledge of metabolism and energy production pathways.

Co- Requisite:

- Practical exposure to Biochemistry and Nutrition-related laboratory techniques.
- Concurrent study of Exercise Physiology, Clinical Nutrition, and Human Physiology.

Progressive Course:

- Advanced Sports Biochemistry and Exercise Physiology.
- Specialized studies in Clinical Nutrition, Sports Medicine, Nutrigenomics, Rehabilitation Sciences, and Metabolic Health Management.

Course Objectives:

1. To understand the biochemical basis of physical activity and energy metabolism.
2. To study the role of nutrients in exercise performance and muscle function.
3. To learn exercise-induced biochemical changes and antioxidant defense mechanisms.
4. To gain knowledge of sports nutrition and ergogenic aids.
5. To understand the role of nutrition and physical activity in health and disease management.

Course Outcomes:

CO1: Analyze the principles of exercise biochemistry, skeletal muscle metabolism, and bioenergetics, including aerobic and anaerobic energy pathways during physical activity. **(K4)**

CO2: Analyze the role of macronutrients and micronutrients in exercise performance, including energy metabolism, hydration, and nutrient timing strategies in physically active individuals. **(K4)**

CO3: Analyze biochemical and hormonal responses to exercise, including oxidative stress, muscle fatigue, antioxidant defense systems, and exercise-induced metabolic adaptations. **(K4)**

CO4: Evaluate sports nutrition strategies and ergogenic aids, including dietary supplements, nutraceuticals, and their effectiveness, safety, and ethical considerations in athletic performance. **(K5)**

CO5: Evaluate the role of exercise and nutrition in health, disease prevention, and special populations, including personalized nutrition and advances in sports biochemistry. **(K5)**

Unit-I	Fundamentals of Exercise Biochemistry and Energy Metabolism	12 Hrs.
Introduction to exercise physiology and sports biochemistry. Skeletal muscle structure and function. ATP as the energy currency. Bioenergetics of exercise. Aerobic and anaerobic metabolism. Carbohydrate, lipid, and protein metabolism during physical activity. Energy expenditure and metabolic adaptations to exercise.		
Unit-II	Macronutrients and Micronutrients in Physical Activity	12 Hrs.
Nutritional requirements for physically active individuals and athletes. Role of carbohydrates, proteins, and fats in exercise performance. Glycogen metabolism and glycogen loading. Vitamins and minerals involved in energy production and muscle function. Electrolyte balance and hydration. Nutrient timing and dietary recommendations for different types of exercise.		
Unit-III	Exercise-Induced Biochemical Changes and Oxidative Stress	12 Hrs.
Biochemical responses to acute and chronic exercise. Hormonal regulation during exercise. Oxidative stress and free radical generation during physical activity. Antioxidant defense systems. Muscle fatigue and recovery mechanisms. Exercise-induced inflammation and immune responses. Biomarkers of exercise stress and performance.		
Unit-IV	Sports Nutrition and Ergogenic Aids	12 Hrs.
Principles of sports nutrition. Pre-, during-, and post-exercise nutrition. Nutritional strategies for endurance and strength training. Ergogenic aids and performance-enhancing supplements. Protein supplements, creatine, caffeine, and branched-chain amino acids. Nutraceuticals and functional foods. Safety and ethical concerns associated with dietary supplements.		
Unit-V	Nutrition in Health, Disease, and Special Populations	12 Hrs.
Role of physical activity and nutrition in obesity, diabetes mellitus, cardiovascular diseases, and metabolic syndrome. Exercise and weight management. Nutrition for children, adolescents, women, and elderly athletes. Nutritional considerations in vegetarian athletes. Personalized nutrition and nutrigenomics. Recent advances in sports nutrition and exercise biochemistry.		

Text Book(s):

1. Maughan, R.J. and Burke, L.M. (2023). **Sports Nutrition**. 3rd Edition. Wiley-Blackwell, Oxford.
2. McArdle, W.D., Katch, F.I. and Katch, V.L. (2022). **Exercise Physiology: Nutrition, Energy, and Human Performance**. 10th Edition. Wolters Kluwer, Philadelphia.
3. Nieman, D.C. and Wentz, L.M. (2020). **The Compelling Link Between Physical Activity and the Body's Defense System**. CRC Press, Boca Raton.
4. Williams, M.H. (2021). **Nutrition for Health, Fitness and Sport**. 12th Edition. McGraw-Hill Education, New York.
5. Rodwell, V.W., Bender, D.A., Botham, K.M., Kennelly, P.J. and Weil, P.A. (2021). **Harper's Illustrated Biochemistry**. 32nd Edition. McGraw-Hill Education, New York.

Reference Book(s):

1. Jeukendrup, A.E. and Gleeson, M. (2019). **Sport Nutrition: An Introduction to Energy Production and Performance**. 3rd Edition. Human Kinetics, Champaign.
2. Lanham-New, S.A., Stear, S.J., Shirreffs, S.M. and Collins, A.L. (2023). **Sport and Exercise Nutrition**. 2nd Edition. Wiley-Blackwell, Oxford.
3. Benardot, D. (2022). **Advanced Sports Nutrition**. 3rd Edition. Human Kinetics, Champaign.
4. Burke, L.M. and Deakin, V. (2021). **Clinical Sports Nutrition**. 6th Edition. McGraw-Hill Australia.
5. Powers, S.K. and Howley, E.T. (2023). **Exercise Physiology: Theory and Application to Fitness and Performance**. 12th Edition. McGraw-Hill Education, New York.

e Resources:

1. National Center for Biotechnology Information (NCBI) – <https://www.ncbi.nlm.nih.gov>
2. PubMed Database – <https://pubmed.ncbi.nlm.nih.gov>
3. American College of Sports Medicine (ACSM) – <https://www.acsm.org>
4. International Society of Sports Nutrition (ISSN) – <https://www.sportsnutritionistsociety.org>
5. World Health Organization (WHO) – <https://www.who.int>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									Hours		Credit
I	PBC26005		Nutritional Biochemistry of Physical Activity									4		4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	3	3	2	1	1	2	2	1	-	3	3	2.31
CO2	3	3	3	3	3	2	1	2	2	1	-	3	3	2.46
CO3	3	3	3	3	3	2	2	2	2	2	-	3	3	2.62
CO4	3	3	3	3	3	3	2	2	2	2	1	3	3	2.77
CO5	3	3	3	3	3	3	2	2	2	2	2	3	3	2.85
Mean	3.00	3.00	3.00	3.00	2.80	1.80	1.40	2.00	2.00	1.60	0.60	3.00	3.00	2.60

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PBC26006	Biomedical Instrumentation	Disciplinary Elective Course	4	0	0	4
Pre-Requisite: <ul style="list-style-type: none"> Basic knowledge of Human Physiology and Anatomy. Fundamentals of Physics, Electronics, and Cell Biology. 							
Co- Requisite: <ul style="list-style-type: none"> Biomedical Instrumentation Laboratory. Clinical Biochemistry and Medical Diagnostics 							
Progressive Course: <ul style="list-style-type: none"> Advanced Biomedical Instrumentation and Biomedical Signal Processing. Medical Imaging, Biosensors, Bioelectronics, and Biomedical Device Design. 							
Course Objectives:							
1. To introduce the principles and applications of biomedical instrumentation used in healthcare and clinical diagnostics.							
2. To understand the operation of physiological sensors, bioelectric recording systems, and patient monitoring devices.							
3. To familiarize students with biomedical imaging techniques, microscopy, radiation detection, and biomedical telemetry.							
4. To develop knowledge of diagnostic, therapeutic, and rehabilitation instruments used in modern medicine.							
5. To enable students to evaluate recent advances and emerging technologies in biomedical instrumentation for clinical and research applications.							
Course Outcomes:							
CO1: Explain the principles, design, and clinical applications of bioelectric recording systems, physiological transducers, and biomedical instrumentation used in healthcare. (K3)							
CO2: Apply the operating principles of physiological analyzers, biomedical sensors, telemetry systems, and therapeutic devices for clinical and research applications. (K4)							
CO3: Analyze the working mechanisms, performance, and diagnostic significance of microscopy, biomedical imaging modalities, and radiation detection techniques. (K4)							
CO4: Evaluate the accuracy, safety, efficiency, and clinical suitability of biomedical instruments for diagnosis, monitoring, and rehabilitation. (K5)							
CO5: Design and propose appropriate biomedical instrumentation solutions by integrating emerging technologies for healthcare, biomedical research, and clinical diagnostics. (K5)							

Unit-I	Bioelectric Signals and Biomedical Recording Systems	12 Hrs.
Bioelectric electrodes: ECG, EEG, EMG and microelectrodes. Biomedical recording systems: ECG, EEG, EMG and echocardiography. Cardiac assist devices: Cardiac pacemakers and defibrillators. Blood flow measurement using electromagnetic, ultrasonic, CT, NMR and laser Doppler flow meters		
Unit-II	Physiological Measurement and Biomedical Sensors	12 Hrs.
Pulmonary function analyzers: Spirometry and respiratory gas analyzers. Blood gas analysis: Blood pH, pCO ₂ and pO ₂ analyzers. Physiological transducers: Body temperature, pulse and respiration sensors. Audiometers: Basic and speech audiometers. Hemodialysis machine: Dialyzers and artificial kidney. Biomedical telemetry: Wireless telemetry, single- and multi-channel telemetry, and transmission of physiological signals through telephone lines.		
Unit-III	Biomedical Microscopy and Imaging Techniques	12 Hrs.
Light microscopy: Visualization of cells and subcellular components, resolving power and microscopy of living cells. Advanced microscopy: Phase-contrast, fluorescence and ultraviolet microscopy. Electron microscopy: Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM). Fixation and staining techniques for electron microscopy, freeze-etch and freeze-fracture methods, and image processing methods in microscopy. Endoscopy and thermography.		
Unit-IV	Medical Imaging and Radiation Detection	12 Hrs.
Medical imaging modalities including ultrasonography, radiographic and fluoroscopic techniques, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Functional MRI (fMRI) and Positron Emission Tomography (PET). Retinal imaging and imaging applications in biometric systems. Detection and measurement of radioisotopes using ionization chamber, Geiger–Müller counter, proportional counter and liquid scintillation counter. Molecular imaging of radioactive materials and radiation safety guidelines.		
Unit-V	Physiotherapy, Electrotherapy and Clinical Applications	12 Hrs.
Fundamentals of physiotherapy and electrotherapy. Electrotherapy instruments including generation, circuit diagrams, testing and demonstration. Principles of operation, clinical applications and safety considerations of electrotherapy instruments. Biomedical instrumentation in rehabilitation and patient care. Recent advances and emerging trends in biomedical instrumentation.		

Text Book(s):

1. Khandpur, R. S. *Handbook of Biomedical Instrumentation*. 4th Edition, McGraw Hill Education, 2020.
2. Cromwell, L., Weibell, F. J., & Pfeiffer, E. A. *Biomedical Instrumentation and Measurements*. 2nd Edition, Pearson Education.
3. Webster, J. G., & Eren, H. *Medical Instrumentation: Application and Design*. 5th Edition, Wiley, 2020.
4. Carr, J. J., & Brown, J. M. *Introduction to Biomedical Equipment Technology*. 4th Edition, Pearson.

Reference Book(s):

1. Bronzino, J. D., & Peterson, D. R. The Biomedical Engineering Handbook. 4th Edition, CRC Press.
2. Enderle, J. D., & Bronzino, J. D. Introduction to Biomedical Engineering. 4th Edition, Academic Press.
3. Rangayyan, R. M. Biomedical Signal Analysis. 2nd Edition, Wiley-IEEE Press.
4. Suetens, P. Fundamentals of Medical Imaging. 3rd Edition, Cambridge University Press.
5. Bushberg, J. T., et al. The Essential Physics of Medical Imaging. 4th Edition, Lippincott Williams & Wilkins.

e Resources:

1. National Programme on Technology Enhanced Learning (NPTEL): <https://nptel.ac.in>
2. SWAYAM Online Courses: <https://swayam.gov.in>
3. National Digital Library of India (NDLI): <https://ndl.iitkgp.ac.in>
4. IEEE Xplore Digital Library: <https://ieeexplore.ieee.org>
5. PubMed: <https://pubmed.ncbi.nlm.nih.gov>
6. ScienceDirect: <https://www.sciencedirect.com>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course										Hours	Credit
1	PBC26006		Biomedical Instrumentation										4	4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	2	-	-	-	-	-	-	-	-	3	2	2.6
CO2	3	3	3	2	-	-	-	-	-	-	-	3	3	2.8
CO3	3	3	3	3	2	-	-	-	-	-	-	3	3	2.9
CO4	3	3	3	3	3	2	2	-	-	-	-	3	3	2.8
CO5	3	3	3	3	3	3	2	2	2	2	2	3	3	2.6
Mean	3.0	3.0	2.8	2.2	1.6	1.0	0.8	0.4	0.4	0.4	0.4	3.0	2.8	2.7

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26203	Advanced Immunology	Core	3	1	0	4
Pre-Requisite: <ul style="list-style-type: none"> Fundamentals of Cell Biology, Human Physiology, and Biochemistry. Basic knowledge of immune system organization and function. 							
Co- Requisite: <ul style="list-style-type: none"> Molecular Biology and Genetics. Clinical Biochemistry. 							
Progressive Course: <ul style="list-style-type: none"> Immunotechnology and Vaccine Development. Clinical Immunology and Immunotherapeutics. 							
Course Objectives:							
1. To provide advanced knowledge of the cellular and molecular components of the immune system.							
2. To understand the mechanisms underlying innate and adaptive immune responses.							
3. To analyze antigen recognition, immune regulation, and host defense mechanisms against pathogens.							
4. To evaluate the immunological basis of hypersensitivity, autoimmunity, transplantation, and immunodeficiency disorders.							
5. To develop critical understanding of modern immunological techniques and emerging immunotherapies for disease diagnosis and treatment.							
Course Outcomes:							
CO1: Explain the organization, components, and functions of innate and adaptive immune systems. (K2)							
CO2: Analyze the molecular mechanisms involved in antigen recognition, immune cell activation, and immune signaling pathways. (K4)							
CO3: Evaluate immune responses against infectious agents and the regulatory mechanisms maintaining immune homeostasis. (K5)							
CO4: Assess the immunological basis of hypersensitivity, autoimmunity, transplantation, and immunodeficiency disorders. (K5)							
CO5: Assess immunological approaches employing advanced diagnostic and therapeutic strategies for disease management. (K5)							
Unit-I	Fundamentals of the Immune System						12 Hrs.
Overview of the immune system. Cells and organs of the immune system. Hematopoiesis and lymphoid organs. Innate and adaptive immunity. Characteristics and components of immune responses. Cytokines, chemokines, and							

their biological functions.		
Unit-II	Antigens, Antibodies and Antigen Processing	12 Hrs.
Properties of antigens and immunogens. Structure, classes, and functions of immunoglobulins. Antigen-antibody interactions. Major Histocompatibility Complex (MHC) and antigen presentation pathways. Processing of endogenous and exogenous antigens.		
Unit-III	Immune Cell Activation and Regulation	12 Hrs.
B-cell development, activation, and antibody production. T-cell development and activation. T-cell receptors and signaling pathways. Co-stimulatory molecules. Cytokine-mediated regulation of immune responses. Immune tolerance and immune regulation.		
Unit-IV	Immunopathology and Clinical Immunology	12 Hrs.
Hypersensitivity reactions: Types I–IV. Autoimmune diseases and mechanisms. Immunodeficiency disorders. Tumor immunology and immune surveillance. Transplantation immunology and graft rejection. Immunological markers in disease diagnosis.		
Unit-V	Advanced Immunological Techniques and Immunotherapy	12 Hrs.
Monoclonal antibodies and hybridoma technology. Flow cytometry and immunofluorescence techniques. ELISA, Western blotting, and immunodiagnostic methods. Vaccines and vaccine design. Immunotherapy, CAR-T cell therapy, immune checkpoint inhibitors, and emerging therapeutic approaches.		

1. **Text Book(s):** Murphy, K., & Weaver, C. (2022). *Janeway's immunobiology* (10th ed.). W.W. Norton & Company.
2. Owen, J. A., Punt, J., & Stranford, S. A. (2023). *Kuby immunology* (9th ed.). W.H. Freeman and Company.
3. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2023). *Roitt's essential immunology* (14th ed.). Wiley Blackwell.

Reference Book(s):

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2024). *Cellular and molecular immunology* (11th ed.). Elsevier.
2. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2023). *Roitt's essential immunology* (14th ed.). Wiley-Blackwell.
3. Male, D., Brostoff, J., Roth, D. B., & Roitt, I. (2021). *Immunology* (10th ed.). Elsevier.
4. Murphy, K., & Weaver, C. (2022). *Janeway's immunobiology* (10th ed.). W.W. Norton & Company.
5. Owen, J. A., Punt, J., & Stranford, S. A. (2023). *Kuby immunology* (9th ed.). W.H. Freeman and Company.

e Resources:

1. National Center for Biotechnology Information. (n.d.). *NCBI immunology resources*. Retrieved July 2, 2026, from [NCBI](#)
2. Nature Portfolio. (n.d.). *Nature Reviews Immunology*. Retrieved July 2, 2026, from [Nature Reviews Immunology](#)
3. American Association of Immunologists. (n.d.). *American Association of Immunologists*. Retrieved July 2, 2026, from [AAI](#)
4. British Society for Immunology. (n.d.). *British Society for Immunology*. Retrieved July 2, 2026, from [BSI](#)
5. Immunopaedia. (n.d.). *Immunopaedia: Immunology learning platform*. Retrieved July 2, 2026, from [Immunopaedia](#)

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course								Hours		Credit
II	PBC26203		Advanced Immunology								4		4
Course Outcome s (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	
CO1	3	2	1	1	-	-	-	-	-	-	3	2	1.33
CO2	3	3	2	2	1	-	-	-	-	-	3	3	1.92
CO3	3	3	3	2	2	1	-	-	-	-	3	3	2.33
CO4	3	2	3	3	2	2	1	-	-	1	3	3	2.42
CO5	3	3	3	3	3	2	2	1	1	2	3	3	2.67
Mean	3.0	2.6	2.4	2.2	1.6	1.0	0.6	0.2	0.2	0.6	3.0	2.8	2.13

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26204	Enzymology	Core	2	1	0	3

Pre-Requisite:

- Strong foundation in Biochemistry, Protein Chemistry, and Molecular Biology.
- Basic understanding of chemical kinetics and enzyme structure–function relationships.

Co- Requisite:

- Practical training in Enzymology and Protein Purification techniques.
- Concurrent study of Molecular Biology, Biotechnology, and Structural Biology concepts.

Progressive Course:

- Advanced Enzymology and Protein Engineering.
- Specialized studies in Industrial Biotechnology, Computational Biology, Drug Design, Systems Biology, and Translational Enzyme Technology.

Course Objectives:

1. To develop advanced conceptual understanding of enzyme structure–function relationships
2. To analyze enzyme catalytic mechanisms using biochemical and molecular approaches
3. To interpret steady-state and pre-steady-state enzyme kinetics.
4. To understand enzyme regulation at molecular, genetic, and metabolic levels
5. To explore enzyme engineering, immobilization, and industrial/clinical applications.

Course Outcomes:

CO1: Analyze enzyme structure, architecture, active sites, cofactors, and the structural basis of catalysis using modern biophysical techniques. **(K4)**

CO2: Analyze catalytic mechanisms of enzymes, including acid–base, covalent, metal ion catalysis, and molecular models such as induced fit and conformational selection. **(K4)**

CO3: Analyze enzyme kinetics and mechanistic behavior using steady-state and pre-steady-state approaches, including interpretation of kinetic plots and reaction systems. **(K4)**

CO4: Evaluate enzyme regulation mechanisms including allosteric control, covalent modification, feedback inhibition, and metabolic control systems in biological pathways. **(K5)**

CO5: Evaluate enzyme technology, engineering approaches, and applications in industry, medicine, biosensors, and therapeutic development. **(K5)**

Unit-I	Structural and Molecular Enzymology	15 Hrs.
Enzyme architecture; active site mapping; domain organization; protein dynamics in catalysis; enzyme specificity; cofactors and prosthetic groups; transition state stabilization; structural basis of catalysis (X-ray crystallography, NMR, cryo-EM overview).		
Unit-II	Advanced Enzyme Catalysis	15 Hrs.
Catalytic strategies: acid-base, covalent, metal ion catalysis; proximity and orientation effects; induced fit vs conformational selection; catalytic antibodies; ribozymes and abzymes; energetics of catalysis		
Unit-III	Enzyme Kinetics and Mechanistic Analysis	15 Hrs.
Steady-state kinetics; Michaelis–Menten derivation; Lineweaver–Burk, Eadie–Hofstee and Hanes plots; pre-steady-state kinetics; rapid kinetic techniques; multisubstrate reactions; enzyme cooperativity; kinetic isotope effects.		
Unit-IV	Enzyme Regulation and Control Systems	15 Hrs.
Allosteric enzymes (MWC and KNF models); feedback inhibition; covalent modification (phosphorylation, acetylation); zymogen activation; gene regulation of enzymes; metabolic control analysis; signal integration in enzymatic pathways.		
Unit-V	Enzyme Technology, Engineering & Applications	15 Hrs.
Enzyme purification methods (chromatography, electrophoresis); enzyme immobilization; recombinant enzymes; directed evolution; enzyme engineering; industrial biocatalysis; biosensors; clinical enzymes as biomarkers; therapeutic enzymes and drug design.		

Text Book(s):

1. Berg, J. M., Tymoczko, J. L. & Gatto, G. J. (2023). Biochemistry, 10th Ed. W.H. Freeman.
2. Voet, D. & Voet, J. G. (2021). Biochemistry, 5th Ed. Wiley.
3. Copeland, R. A. (2021). Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. Wiley.
4. Palmer, T. (2022). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry. CRC

Reference Book(s):

1. Fersht, A. (2021). Structure and Mechanism in Protein Science. Springer
2. Bisswanger, H. (2020). Enzyme Kinetics: Principles and Methods. Wiley-VCH.
3. Segel, I. H. (2021). Enzyme Kinetics. Wiley.
4. Cornish-Bowden, A. (2022). Fundamentals of Enzyme Kinetics. Wiley.
5. Walsh, C. (2020). Posttranslational Modification of Proteins. Roberts & Co.

e Resources:

1. NCBI Bookshelf – Enzyme Mechanisms & Kinetics <https://www.ncbi.nlm.nih.gov/books/>
2. RCSB Protein Data Bank (Structural Enzymology) <https://www.rcsb.org>
3. IUBMB Enzyme Nomenclature Database <https://iubmb.qmul.ac.uk/enzyme/>
4. Nature Reviews Chemistry – Enzyme Catalysis Articles (2020–2025) <https://www.nature.com/natrevchem>
5. ScienceDirect – Enzyme Engineering & Biocatalysis Research (2020–2025) <https://www.sciencedirect.com>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									Hours		Credit
II	PBC26204		Enzymology									3		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	3	3	2	1	1	2	1	1	-	3	3	2.23
CO2	3	3	3	3	2	1	1	2	1	1	-	3	3	2.23
CO3	3	3	3	3	3	2	1	2	2	2	-	3	3	2.54
CO4	3	3	3	3	3	2	2	2	2	2	1	3	3	2.69
CO5	3	3	3	3	3	3	2	2	2	2	2	3	3	2.85
Mean	3.00	3.00	3.00	3.00	2.60	1.80	1.40	2.00	1.60	1.20	0.40	3.00	3.00	2.51

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26205	Lab in Enzymology	Core	0	0	4	2
Pre-Requisite: <ul style="list-style-type: none"> Fundamentals of Biochemistry, including the structure and function of proteins and enzymes. Basic knowledge of laboratory techniques, solution preparation, and spectrophotometric analysis. 							
Co- Requisite: <ul style="list-style-type: none"> Enzyme Biochemistry (Theory). Analytical Techniques in Biochemistry. 							
Progressive Course: <ul style="list-style-type: none"> Clinical Enzymology and Diagnostic Biochemistry. Industrial Biochemistry and Biotechnology Applications. 							
1. To train students in enzyme extraction, purification, and quantitative analysis.							
2. To develop skills in enzyme kinetics and inhibition studies.							
3. To understand factors affecting enzyme activity through experiments.							
4. To apply spectrophotometric techniques in enzymology							
5. To develop research-oriented laboratory competence in enzymology.							
Course Outcomes:							
CO1: Analyze the activity and specific activity of enzymes using standard biochemical assays and interpret the experimental results. (K4)							
CO2: Analyze the effects of pH, temperature, and substrate concentration on enzyme activity and explain their influence on enzyme kinetics. (K4)							
CO3: Evaluate the effects of enzyme inhibitors and activators on catalytic efficiency and regulatory mechanisms. (K5)							
CO4: Evaluate enzyme purification strategies including ammonium sulphate precipitation and chromatographic techniques for obtaining purified enzyme preparations. (K5)							
CO5: Evaluate enzyme kinetic parameters such as K_m and V_{max} using Lineweaver–Burk plots and interpret their significance in enzyme catalysis. (K5)							
CO6: Evaluate advanced analytical techniques such as isoenzyme electrophoresis, SDS–PAGE, and column chromatography for enzyme characterization, separation, and purification. (K5)							
Practical's							30 hrs
1. Determination of specific activity of salivary amylase. 2. Effect of pH on the activity of salivary amylase. 3. Effect of temperature on the activity of salivary amylase. 4. Effect of substrate concentration on the activity of salivary amylase. 5. Determination of urease activity.							

6. Effect of pH on urease activity.
7. Effect of temperature on urease activity.
8. Effect of substrate concentration on urease activity.
9. Effect of inhibitor on urease activity.
10. Effect of activator on urease activity.

Demonstration Experiments

1. Enzyme purification by ammonium sulphate precipitation.
2. Determination of kinetic parameters (K_m and V_{max}) using Lineweaver–Burk plot.
3. Electrophoretic separation of isoenzymes.
4. Separation of proteins by SDS–PAGE.
5. Purification of enzymes by column chromatography.

Text Book(s):

1. Voet, D. & Voet, J. G. (2021). Biochemistry, 5th Ed.
2. Copeland, R. A. (2021). Enzymes: Practical Introduction to Structure and Mechanism.
3. Palmer, T. (2022). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry.

Reference Book(s):

1. Segel, I. H. (2021). Enzyme Kinetics. Wiley.
2. Bisswanger, H. (2020). Enzyme Kinetics: Principles and Methods.
3. Dixon, M. & Webb, E. C. (2020). Enzymes.
4. Fersht, A. (2021). Structure and Mechanism in Protein Science.
5. Copeland, R. A. (2021). Enzyme Methods and Applications.

e Resources:

1. NCBI Bookshelf – Enzyme Methods <https://www.ncbi.nlm.nih.gov/books/>
2. Protocols.io – Enzyme Assay Protocols <https://www.protocols.io>
3. RCSB Protein Data Bank – Enzyme Structures <https://www.rcsb.org>
4. Khan Academy – Enzyme Kinetics Tutorials <https://www.khanacademy.org>
5. ScienceDirect – Enzyme Technology Research <https://www.sciencedirect.com>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									Hours		Credit
II	PBC26205		Lab in Enzymology									4		2
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	3	2	1	1	1	2	1	1	1	3	3	1.92
CO2	3	3	3	3	2	1	1	2	1	1	1	3	3	2.08
CO3	3	3	3	3	2	2	1	2	1	1	1	3	3	2.15
CO4	3	3	3	3	3	2	2	2	1	1	1	3	3	2.31
CO5	3	3	3	3	3	2	2	3	1	1	1	3	3	2.38
CO6	3	3	3	3	3	2	2	3	1	1	1	3	3	2.38
Mean	3.00	3.00	3.00	2.83	2.33	1.67	1.50	2.33	1.00	1.00	1.00	3.00	3.00	2.20

Unit-I	Cell and Blood Physiology	06 Hrs.
<p>Cell: Cell organization and ultrastructure, membrane transport mechanisms including passive, active and facilitated transport, cellular signaling, homeostasis and physiological regulation. Body fluid compartments, composition of intracellular and extracellular fluids, electrolyte balance, osmotic regulation, acid–base balance and physiological buffering systems.</p> <p>Blood: Composition and physiological functions of blood, plasma proteins and hemoglobin, hemopoiesis and its regulation. Blood groups, transfusion biology, blood coagulation and fibrinolysis. Organization of the immune system, innate and adaptive immunity, antigen–antibody interactions, cytokines, and basic immunological responses.</p>		
Unit-II	Cardiovascular and Respiratory Physiology	06 Hrs.
<p>Cardiovascular System: Functional anatomy of the heart, cardiac cycle, heart sounds, conduction system, and ECG. Hemodynamics, blood circulation, regulation of blood pressure, cardiac output, and vascular physiology. Neural and hormonal regulation of cardiovascular functions. Overview of hypertension, atherosclerosis, heart failure, and cardiac arrhythmias. Respiratory System: Functional anatomy of the respiratory system, mechanics of breathing, lung volumes and capacities, gas exchange, and transport of respiratory gases. Regulation of respiration and pulmonary function tests. Ventilation-perfusion relationships and physiological adaptations to exercise and high altitude. Overview of asthma, COPD, pulmonary fibrosis, and respiratory failure.</p>		
Unit-III	Digestive and Excretory Physiology	06 Hrs.
<p>Digestive System: Functional anatomy of the gastrointestinal tract, secretion and regulation of digestive juices, digestion and absorption of carbohydrates, proteins, lipids, vitamins and minerals. Gastrointestinal motility, neural and hormonal regulation of digestion, and liver functions.</p> <p>Excretory System: Structure and functions of the kidney, nephron organization, glomerular filtration, tubular reabsorption and secretion. Formation and concentration of urine, regulation of water and electrolyte balance, acid–base regulation, and hormonal control of renal function. Overview of common renal disorders and physiological alterations.</p>		
Unit-IV	Reproduction System	06 Hrs.
<p>Spermatogenesis, oogenesis, menstrual/estrous cycles, sperm banking, Fertilization, post- fertilization changes, early embryogenesis, gastrulation Development of organs, placenta, embryo sac, seed formation, apical meristem, leaf development Metamorphosis, regeneration, IVF, embryo transfer</p>		
Unit-V	Nervous System Physiology	06 Hrs.
<p>Functional organization of the nervous system, structure and functions of neurons and neuroglial cells. Resting membrane potential, action potential, nerve impulse transmission, and synaptic transmission. Neurotransmitters and their physiological roles. Organization and functions of the central and peripheral nervous systems. Autonomic nervous system and its regulation. Sensory receptors, reflex actions, and higher functions of the brain including learning, memory, and cognition. Overview of neurological disorders and physiological alterations.</p>		

Text Book(s):

1. Guyton, A. C. & Hall, J. E. (2021). *Textbook of Medical Physiology*, 14th Edition, Elsevier.
2. Tortora, G. J. & Derrickson, B. H. (2021). *Principles of Anatomy and Physiology*, 16th Edition, Wiley.
3. Vander, A. J., Sherman, J. H. & Luciano, D. S. (2020). *Human Physiology: The Mechanisms of Body Function*, McGraw-Hill Education.
4. Widmaier, E. P., Raff, H. & Strang, K. T. (2019). *Vander's Human Physiology*, McGraw-Hill.
5. Ganong, W. F. (2021). *Review of Medical Physiology*, 26th Edition, McGraw-Hill Education.

Reference Book(s):

1. Costanzo, L. S. (2020). *Physiology*, 7th Edition, Elsevier.
2. Berne, R. M. & Levy, M. N. (2018). *Physiology*, Elsevier.
3. Silverthorn, D. U. (2019). *Human Physiology: An Integrated Approach*, Pearson.
4. Guyton & Hall (2021). *Medical Physiology Review and Workbook*, Elsevier.
5. Boron, W. F. & Boulpaep, E. L. (2022). *Medical Physiology*, Elsevier.

e Resources:

1. NCBI Bookshelf – <https://www.ncbi.nlm.nih.gov/books/>
2. OpenStax Anatomy & Physiology – <https://openstax.org/details/books/anatomy-and-physiology>
3. PubMed – <https://pubmed.ncbi.nlm.nih.gov/>
4. Khan Academy Physiology – <https://www.khanacademy.org/science/health-and-medicine>
5. NPTEL Physiology Courses – <https://nptel.ac.in/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course										Hours	Credit
II	PBC26S03		Human System Biology and Physiology										3	3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	2	2	1	-	-	1	-	-	-	3	2	1.54
CO2	3	3	3	2	1	-	-	1	-	-	-	3	2	1.69
CO3	3	3	3	2	2	-	-	1	-	-	-	3	3	1.85
CO4	2	3	3	3	2	-	-	1	1	-	-	3	3	1.92
CO5	2	3	3	3	2	-	-	2	1	1	-	3	3	2.15
CO6	2.60	3.00	2.80	2.40	1.60	0.00	0.00	1.20	0.40	0.20	0.00	3.00	2.60	1.83

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26S04	Lab in Human System Biology	Skill Enhancement Course	0	0	4	2
Pre-Requisite: <ul style="list-style-type: none"> Basic knowledge of human anatomy, physiology, cell biology, and biochemistry. Familiarity with laboratory safety practices and handling of biological samples. 							
Co- Requisite: <ul style="list-style-type: none"> Human System Biology (Theory) Advanced Cell Biology 							
Progressive Course: <ul style="list-style-type: none"> Clinical Biochemistry Molecular Diagnostics 							
Course Objectives:							
1. To provide practical exposure to the structure and functions of major human organ systems.							
2. To develop laboratory skills for the analysis of physiological and biochemical parameters.							
3. To familiarize students with standard clinical and diagnostic laboratory techniques.							
4. To correlate biochemical changes with normal physiological functions.							
5. To develop scientific observation, interpretation, and laboratory documentation skills.							
Course Outcomes:							
CO1: Demonstrate laboratory safety and perform basic experiments related to human organ systems(K3)							
CO2: Analyze physiological and biochemical parameters using standard laboratory methods (K4)							
CO3: Interpret laboratory data to understand normal human system functions and homeostasis. (K4)							
CO4: Perform basic clinical laboratory investigations and correlate results with physiological conditions. (K3)							
CO5: Prepare laboratory records, interpret experimental findings, and communicate scientific observations effectively (K6)							
							60 hrs
1. Measurement of Basic Physiological Parameters Determination of pulse rate, respiratory rate, body temperature, blood pressure, and calculation of Body Mass Index (BMI).							
2. ABO and Rh Blood Grouping Determination of ABO and Rh blood groups using the slide agglutination method.							

3. Estimation of Hemoglobin

Estimation of hemoglobin concentration using Sahli's or Cyanmethemoglobin method.

4. Determination of Packed Cell Volume (PCV)

Measurement of hematocrit using the microhematocrit method.

5. Estimation of Blood Glucose

Quantitative estimation of blood glucose by the Glucose Oxidase–Peroxidase (GOD-POD) method.

6. Complete Urine Analysis

Physical examination (colour, appearance, specific gravity, pH) and qualitative tests for glucose, protein, ketone bodies, bile salts, and bile pigments.

7. Erythrocyte Sedimentation Rate (ESR)

Determination of ESR using the Westergren or Wintrobe method

8. Exercise Physiology Test

Assessment of pulse rate and blood pressure before and after exercise and evaluation of recovery time.

9. Serum Lipid Profile Analysis

Estimation of serum total cholesterol, triglycerides, HDL, and LDL levels. Interpretation of lipid profile results in relation to cardiovascular health.

10. Interpretation of Clinical Laboratory Reports

Analysis and interpretation of normal and abnormal clinical reports, including complete blood count (CBC), lipid profile, liver function tests (LFT), kidney function tests (KFT), and electrocardiogram (ECG) case studies.

Text Book(s):

1. G.K. Pal and Pravati Pal. *Textbook of Practical Physiology*. Universities Press.
2. Mukherjee, K.L. *Medical Laboratory Technology*. Tata McGraw-Hill.
3. Henry, J.B. *Clinical Diagnosis and Management by Laboratory Methods*. Elsevier.

Reference Book(s):

1. Tietz, N.W. *Fundamentals of Clinical Chemistry and Molecular Diagnostics*. Elsevier.
2. Bishop, M.L., Fody, E.P., & Schoeff, L.E. *Clinical Chemistry: Principles, Techniques and Correlations*. Wolters Kluwer.
3. Henry, J.B. *Clinical Diagnosis and Management by Laboratory Methods*. Elsevier.
4. Guyton, A.C., & Hall, J.E. *Textbook of Medical Physiology*. Elsevier.

e Resources:

1. National Digital Library of India (NDLI)
2. SWAYAM MOOCs
3. NPTEL – Human Physiology and Clinical Biochemistry
4. PubMed (<https://pubmed.ncbi.nlm.nih.gov>)
5. National Center for Biotechnology Information (NCBI) (<https://www.ncbi.nlm.nih.gov>)

Relationship Matrix for COs, POs and PSOs

Semester	Course code	Title of the course											Hours	Credit
II	PBC26S04	Lab in Human System Biology											4	2
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	2	2	1	-	-	1	-	-	-	3	3	1.38
CO2	3	3	3	3	2	-	-	2	1	-	-	3	3	1.77
CO3	2	3	3	2	2	-	-	1	1	1	-	3	2	1.54
CO4	2	3	3	3	2	-	-	1	-	-	-	3	3	1.54
CO5	3	3	3	2	1	-	-	1	-	-	-	3	2	1.38
Mean	2.60	3.00	2.80	2.40	1.60	0.00	0.00	1.20	0.40	0.20	0.00	3.00	2.60	1.83

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26007	Ayurveda Medicine in Human Health	Disciplinary Elective Course	4	0	0	4

Pre-Requisite:

- Basic understanding of Biology, Human Physiology, and Biochemistry.
- Introductory knowledge of medicinal plants and natural products.

Co- Requisite:

- Practical exposure to herbal pharmacology or phytochemical analysis.
- Concurrent study of Clinical Biochemistry, Pharmacology, and Human Physiology concepts.

Progressive Course:

- Advanced Ayurveda Science and Integrative Medicine.
- Specialized studies in Ethnopharmacology, Clinical Research in Ayurveda, Nutraceutical Development, and Preventive Healthcare Systems.

Course Objectives:

1. To introduce fundamental principles of Ayurveda and its relevance to human health.
2. To understand Ayurvedic concepts of body constitution (Dosha, Dhatu, Mala).
3. To study medicinal plants and herbal formulations used in Ayurveda.
4. To integrate Ayurveda concepts with modern biomedical science.
5. To explore preventive and therapeutic approaches of Ayurveda in disease management.

Course Outcomes:

CO1: Analyze the fundamental principles of Ayurveda, including Panchamahabhuta theory, Tridosha concept, and Prakriti, in relation to health and disease. **(K4)**

CO2: Analyze Ayurvedic physiological concepts such as Dhatu, Mala, Agni, Srotas, and Ojas and compare them with modern physiological and immunological systems. **(K4)**

CO3: Analyze Ayurvedic pharmacology (Dravyaguna), including herbal classification, Rasayana therapy, and medicinal properties (Rasa, Guna, Virya, Vipaka) of commonly used herbs. **(K4)**

CO4: Evaluate Ayurvedic approaches to disease causation, pathology, and management of lifestyle disorders such as diabetes, hypertension, and digestive diseases, including Panchakarma principles. **(K4)**

CO5: Evaluate the integration of Ayurveda with modern medicine, including evidence-based validation, clinical applications, nutraceutical development, and preventive healthcare strategies. **(K5)**

Unit-I	Fundamentals of Ayurveda	12 Hrs.
Introduction to Ayurveda; history and philosophy; Panchamahabhuta theory; Tridosha concept (Vata, Pitta, Kapha); concept of Prakriti (body constitution); fundamental principles of health and disease.		
Unit-II	Human Physiology in Ayurveda	12 Hrs.
Concept of Dhatu (tissues), Mala (waste products), Agni (digestive fire); Srotas (body channels); homeostasis in Ayurveda; comparison with modern physiology; concept of immunity (Ojas).		

Unit-III	Ayurvedic Pharmacology (Dravyaguna)	12 Hrs.
Classification of medicinal plants; Rasayana therapy; herbal properties (Rasa, Guna, Virya, Vipaka); commonly used herbs (Ashwagandha, Tulsi, Turmeric, Neem); formulation principles.		
Unit-IV	Disease Management in Ayurveda	12 Hrs.
Concept of disease (Vyadhi); Nidana (causative factors); pathology in Ayurveda; lifestyle disorders; diabetes, hypertension, digestive disorders in Ayurvedic perspective; detoxification therapies (Panchakarma overview).		
Unit-V	Integrative and Modern Applications	12 Hrs.
Integration of Ayurveda with modern medicine; evidence-based Ayurveda; clinical validation of herbal drugs; nutraceuticals; herbal drug standardization; role of Ayurveda in preventive healthcare and lifestyle medicine.		

Text Book(s):

1. Sharma, P. V. (2021). Charaka Samhita (English Commentary), Chaukhamba Publications.
2. Dash, B. & Kashyap, L. (2020). Fundamentals of Ayurveda. Concept Publishing.
3. Singh, R. H. (2022). Ayurveda: Science of Life, Springer Nature.
4. Tripathi, B. (2021). Astanga Hridaya, Chaukhamba Sanskrit Series.
5. Patwardhan, B. (2023). Integrative Approaches in Ayurveda and Modern Medicine. Elsevier

Reference Book(s):

1. Sharma, R. K. (2020). Ayurvedic Pharmacology and Therapeutics. Chaukhamba.
2. Gupta, A. (2021). Principles of Ayurveda Medicine. Academic Press.
3. Sharma, H. (2022). Herbal Drug Technology in Ayurveda. Wiley.
4. Lad, V. (2020). Textbook of Ayurveda: Fundamental Principles. Lotus Press.
5. WHO (2021). Benchmarks for Training in Ayurveda. World Health Organization.

e Resources:

1. Ministry of AYUSH – Government of India <https://www.ayush.gov.in>
2. National Institute of Ayurveda (NIA) Resources <https://www.nia.nic.in>
3. PubMed – Ayurveda and Herbal Medicine Research <https://pubmed.ncbi.nlm.nih.gov>
4. NCBI Bookshelf – Herbal Medicine & Integrative Health <https://www.ncbi.nlm.nih.gov/books/>
5. ResearchGate – Ayurveda Clinical Studies (2020–2025) <https://www.researchgate.net>

Relationship Matrix for COs, POs and PSOs

Semester	Course code	Title of the course											Hours	Credit
II	PBC26007	Ayurveda Medicine in Human Health											4	4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	3	3	2	1	1	2	2	1	-	3	3	2.31
CO2	3	3	3	3	2	2	1	2	2	1	-	3	3	2.38
CO3	3	3	3	3	3	2	1	2	2	2	-	3	3	2.54
CO4	3	3	3	3	3	2	2	2	2	2	1	3	3	2.69
CO5	3	3	3	3	3	3	2	2	2	2	2	3	3	2.85
Mean	3.00	3.00	3.00	3.00	2.60	1.80	1.40	2.00	1.80	1.60	0.60	3.00	3.00	2.54

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26008	Endocrinal Biochemistry	Disciplinary Elective Course	4	0	0	4
Pre-Requisite: <ul style="list-style-type: none"> Strong foundation in Biochemistry, Cell Biology, and Human Physiology. Basic understanding of metabolism and molecular signaling mechanisms. 							
Co- Requisite: <ul style="list-style-type: none"> Practical training in Clinical Biochemistry and Hormone Assay techniques. Concurrent study of Physiology, Molecular Biology, and Pathophysiology. 							
Progressive Course: <ul style="list-style-type: none"> Advanced Endocrinology and Molecular Endocrinology. Specialized studies in Clinical Endocrinology, Metabolic Diseases, Neuroendocrinology, and Biomedical Diagnostics. 							
Course Objectives:							
1. To explain mechanisms of hormone action and signal transduction pathways.							
2. To explain mechanisms of hormone action and signal transduction pathways.							
3. To study endocrine glands and their physiological functions.							
4. To analyze biochemical alterations associated with endocrine disorders.							
5. To explore recent advances in endocrine biochemistry and diagnostics							
Course Outcomes:							
CO1: Analyze the organization of the endocrine system, hormone classification, synthesis, secretion, transport, and feedback regulation mechanisms in maintaining hormonal homeostasis. (K4)							
CO2: Analyze hormone action mechanisms, including receptor types and signal transduction pathways such as cAMP, cGMP, calcium-calmodulin, and protein kinase-mediated signaling. (K4)							
CO3: Analyze the biochemical functions and regulatory roles of major endocrine glands, including hypothalamus, pituitary, thyroid, parathyroid, adrenal, and pancreas. (K4)							
CO4: Evaluate the biochemical basis, clinical features, and laboratory diagnosis of endocrine disorders such as diabetes mellitus, thyroid dysfunctions, adrenal disorders, and pituitary abnormalities. (K5)							
CO5: Evaluate recent advances in endocrinal biochemistry, including molecular endocrinology, endocrine genomics, hormonal biomarkers, endocrine disruptors, and modern diagnostic techniques. (K5)							
Unit-I	Introduction to Endocrinal Biochemistry						12 Hrs.
Endocrine system organization and regulation. Classification of hormones. Hormone synthesis, secretion, transport, metabolism, and excretion. Feedback mechanisms in endocrine regulation. Hormonal homeostasis and biological rhythms							

Unit-II	Mechanism of Hormone Action	12 Hrs.
Hormone receptors: membrane-bound and intracellular receptors. Signal transduction pathways involving cAMP, cGMP, calcium-calmodulin, phosphoinositides, and protein kinases. Gene regulation by steroid and thyroid hormones		
Unit-III	Biochemistry of Major Endocrine Glands	12 Hrs.
Hypothalamus and pituitary hormones. Thyroid hormones and regulation. Parathyroid hormone, calcitonin, and calcium homeostasis. Adrenal cortex and medulla hormones. Pancreatic hormones and glucose metabolism.		
Unit-IV	Endocrine Disorders and Clinical Biochemistry	12 Hrs.
Diabetes mellitus and biochemical basis. Thyroid disorders: hypothyroidism and hyperthyroidism. Adrenal disorders: Cushing's syndrome and Addison's disease. Pituitary dysfunctions. Laboratory diagnosis and biochemical markers of endocrine diseases.		
Unit-V	Recent Advances in Endocrinal Biochemistry	12 Hrs.
Molecular endocrinology. Endocrine genetics and genomics. Hormones in obesity and metabolic syndrome. Endocrine disruptors and environmental hormones. Biomarkers, immunoassays, and emerging diagnostic techniques in endocrinology.		

Text Book(s):

1. Hadley, M.E. & Levine, J.E. *Endocrinology*, 7th Edition, Pearson Education.
2. Murray, R.K., et al. *Harper's Illustrated Biochemistry*, McGraw Hill Education.
3. Nelson, D.L. & Cox, M.M. *Lehninger Principles of Biochemistry*, W.H. Freeman.

Reference Book(s):

1. Williams Textbook of Endocrinology, 14th Edition.
2. Stryer, L. *Biochemistry*, W.H. Freeman.
3. Chatterjea, M.N. & Shinde, R. *Textbook of Medical Biochemistry*.
4. Burtis, C.A. & Bruns, D.E. *Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics*.

e Resources:

1. NCBI Bookshelf – Endocrinology Resources.
2. National Digital Library of India (NDLI).
3. SWAYAM and NPTEL Courses on Endocrinology and Biochemistry.
4. WHO and NIH Online Learning Resources.

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									Hours		Credit
II	PBC26008		Endocrinal Biochemistry									4		4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	3	3	2	1	1	2	2	1	-	3	3	2.31
CO2	3	3	3	3	2	2	1	2	2	1	-	3	3	2.38
CO3	3	3	3	3	3	2	1	2	2	2	-	3	3	2.54
CO4	3	3	3	3	3	2	2	2	2	2	1	3	3	2.69
CO5	3	3	3	3	3	3	2	2	2	2	2	3	3	2.85
Mean	3.00	3.00	3.00	3.00	2.60	1.80	1.40	2.00	1.80	1.60	0.60	3.00	3.00	2.54

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26009	Pharmaceutical Biochemistry	Disciplinary Elective Course	4	0	0	4
Pre-Requisite: <ul style="list-style-type: none"> Strong foundation in Biochemistry, Molecular Biology, and Human Physiology. Basic understanding of enzymes, metabolism, and cell signaling. 							
Co- Requisite: <ul style="list-style-type: none"> Practical training in Clinical Biochemistry and Analytical Techniques. Concurrent study of Pharmacology, Molecular Biology, and Pathophysiology. 							
Progressive Course: <ul style="list-style-type: none"> Advanced Pharmaceutical Biochemistry and Drug Design. Specialized studies in Pharmacology, Pharmacogenomics, Clinical Therapeutics, and Biomedical Drug Development. 							
Course Objectives:							
1. To understand the biochemical principles underlying drug action and metabolism.							
2. To study the absorption, distribution, metabolism, and excretion of drugs							
3. To explain the role of enzymes and receptors in pharmacological responses							
4. To evaluate biochemical mechanisms of drug toxicity and adverse effects.							
5. To explore recent advances in pharmaceutical biotechnology and drug development							
Course Outcomes:							
CO1: Explain the biochemical principles of drug discovery, drug–receptor interactions, pharmacodynamics, and pharmacokinetics in pharmaceutical sciences. (K3)							
CO2: Apply the concepts of drug absorption, distribution, metabolism, and excretion (ADME) to interpret the pharmacokinetic behavior of therapeutic agents. (K4)							
CO3: Analyze the role of metabolic enzymes, particularly the cytochrome P450 system, in drug metabolism, biotransformation, and drug–drug interactions. (K4)							
CO4: Evaluate the biochemical mechanisms underlying drug toxicity, adverse drug reactions, and therapeutic drug monitoring for safe and effective drug therapy. (K5)							
CO5: Design and propose innovative therapeutic strategies by integrating pharmacogenomics, biopharmaceuticals, nanomedicine, and personalized medicine in drug development. (K5)							
Unit-I	Introduction to Pharmaceutical Biochemistry						12 Hrs.
Scope and importance of pharmaceutical biochemistry. Drug discovery and development. Biochemical targets of drugs. Drug–receptor interactions. Principles of pharmacodynamics and pharmacokinetics.							

Unit-II	Drug Absorption, Distribution, Metabolism and Excretion (ADME)	12 Hrs.
Routes of drug administration. Factors affecting drug absorption and distribution. Plasma protein binding. Biotransformation of drugs. Phase I and Phase II metabolic reactions. Drug elimination and excretion.		
Unit-III	Enzymes and Drug Metabolism	12 Hrs.
Role of liver in drug metabolism. Cytochrome P450 enzyme system. Enzyme induction and inhibition. Prodrugs and active metabolites. Biochemical basis of drug interactions.		
Unit-IV	Drug Toxicity and Therapeutic Monitoring	12 Hrs.
Mechanisms of drug toxicity. Oxidative stress and free radical-mediated toxicity. Hepatotoxicity, nephrotoxicity, and neurotoxicity. Adverse drug reactions. Therapeutic drug monitoring and biomarkers.		
Unit-V	Recent Advances in Pharmaceutical Biochemistry	12 Hrs.
Pharmacogenomics and personalized medicine. Biopharmaceuticals and recombinant therapeutics. Monoclonal antibodies. Nanomedicine and targeted drug delivery. Emerging trends in drug design and development.		

Text Book(s):

1. Satyanarayana, U. & Chakrapani, U. *Biochemistry*, Elsevier Publications.
2. Wilson, K. & Walker, J. *Principles and Techniques of Biochemistry and Molecular Biology*.
3. Murray, R.K. et al. *Harper's Illustrated Biochemistry*, McGraw Hill Education.
4. Nelson, D.L. & Cox, M.M. *Lehninger Principles of Biochemistry*.

Reference Book(s):

1. Thomas M. Devlin. *Textbook of Biochemistry with Clinical Correlations*.
2. Katzung, B.G. *Basic and Clinical Pharmacology*.
3. Nelson, D.L. & Cox, M.M. *Lehninger Principles of Biochemistry*.
4. Tripathi, K.D. *Essentials of Medical Pharmacology*.

E Resources:

1. NCBI Bookshelf – Pharmaceutical and Clinical Biochemistry Resources.
2. National Digital Library of India (NDLI).
3. SWAYAM and NPTEL Courses on Pharmaceutical Sciences.
4. FDA and WHO Online Drug Information Portals.

Relationship Matrix for Cos, Pos and PSOs

Semester	Course code		Title of the course									Hours		Credit
II	PBC26009		Pharmaceutical Biochemistry									4		4
Course Outcomes (Cos)	Programme Outcomes (Pos)											Programme Specific Outcomes (PSOs)		Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	3	3	2	1	1	2	2	1	-	3	3	2.31
CO2	3	3	3	3	3	2	1	2	2	1	-	3	3	2.46
CO3	3	3	3	3	3	2	1	2	2	2	-	3	3	2.54
CO4	3	3	3	3	3	3	2	2	2	2	1	3	3	2.69
CO5	3	3	3	3	3	3	2	2	2	2	2	3	3	2.85
Mean	3.00	3.00	3.00	3.00	2.80	2.00	1.40	2.00	2.00	1.60	0.60	3.00	3.00	2.57

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26010	Applied Biostatistics in Biochemistry	Disciplinary Elective Course	4	0	0	4
Pre-Requisite: <ul style="list-style-type: none"> Basic knowledge of Mathematics, Biology, and Biochemistry. Understanding of scientific data collection and laboratory measurements. 							
Co- Requisite: <ul style="list-style-type: none"> Practical training in research methodology and statistical software applications. Concurrent study of Biochemistry laboratory courses and Experimental Design. 							
Progressive Course: <ul style="list-style-type: none"> Advanced Biostatistics and Bioinformatics. Specialized studies in Research Methodology, Data Science in Life Sciences, Epidemiology, Clinical Research, and Biostatistical Analysis 							
Course Objectives:							
1. To understand the basic principles, concepts and applications of biostatistics in biochemical research.							
2. To learn methods of data collection, classification, presentation and statistical analysis of biological data.							
3. To develop knowledge on probability, sampling methods, correlation and regression analysis.							
4. To familiarize students with statistical tests and their applications in biochemical experiments.							
5. To enhance the ability to interpret research data using statistical tools and software.							
Course Outcomes:							
CO1: Analyze biological data using measures of central tendency, dispersion, frequency distributions, and graphical methods for effective interpretation of biochemical data. (K4)							
CO2: Analyze probability concepts, statistical distributions, and sampling techniques to assess variability and reliability in biological and biochemical investigations. (K4)							
CO3: Analyze relationships between biological variables using correlation and regression methods and interpret their significance in biochemical research. (K4)							
CO4: Evaluate statistical hypotheses and apply appropriate statistical tests, including t-test, Chi-square test, F-test, and ANOVA, for the analysis of experimental data. (K5)							

CO5: Evaluate experimental designs and apply statistical software tools for the analysis, interpretation, and presentation of biochemical, clinical, and molecular biology research data. (K5)

Unit-I	Fundamentals of Biostatistics	12 Hrs.
Definition, scope and importance of biostatistics in biochemistry, types of biological data, collection, classification and presentation of data, variables and scales of measurement, frequency distribution, tabulation and graphical representation of data. Measures of central tendency (mean, median and mode) and measures of dispersion (range, variance, standard deviation and coefficient of variation).		
Unit-II	Probability and Statistical Distribution	12 Hrs.
Basic concepts of probability, laws of probability, probability distributions (binomial, Poisson and normal distribution), standard normal curve, sampling methods, random sampling, stratified sampling, systematic sampling, sampling errors and bias.		
Unit-III	Correlation and Regression Analysis	12 Hrs.
Concept of correlation, types of correlation, positive and negative correlation, Pearson's correlation coefficient, Spearman's rank correlation, regression analysis, linear regression, regression equation and applications in biochemical studies.		
Unit-IV	Statistical Testing and Analysis	12 Hrs.
Hypothesis testing, null and alternative hypotheses, level of significance, Type I and Type II errors, Student's t-test, Chi-square test, F-test, Analysis of Variance (ANOVA), p-value and interpretation of statistical results.		
Unit-V	Applications of Biostatistics in Biochemistry	12 Hrs.
Experimental design, controls and replicates, data analysis using statistical software, graphical presentation of data, statistical analysis of enzyme kinetics, clinical biochemical parameters, molecular biology experiments, pharmacological studies and interpretation of research data.		

Text Book(s):

1. P.N. Arora & P.K. Malhan – Biostatistics – Himalaya Publishing House.
2. Jerrold H. Zar – Biostatistical Analysis – Pearson Education.
3. S.C. Gupta & V.K. Kapoor – Fundamentals of Applied Statistics – Sultan Chand & Sons.
4. Wayne W. Daniel & Chad L. Cross – Biostatistics: A Foundation for Analysis in the Health Sciences – Wiley
5. R. Ramakrishnan – Biostatistics for Medical and Biological Sciences – Saras Publications.

Reference Book(s):

1. A. Indrayan – Medical Biostatistics – CRC Press.
2. K. Krishnaswami & S. Ranganathan – Methodology of Research in Social Sciences and Biostatistics.
3. M. Sundar Rao & J. Richard – An Introduction to Biostatistics – Prentice Hall.

4. Douglas G. Altman – Practical Statistics for Medical Research – Chapman & Hall.
5. Harvey Motulsky – Intuitive Biostatistics – Oxford University Press.

e Resources:

1. NCBI – National Centre for Biotechnology Information – <https://www.ncbi.nlm.nih.gov>
2. NPTEL – Biostatistics Courses – <https://nptel.ac.in>
3. Khan Academy – Statistics and Probability – <https://www.khanacademy.org>
4. OpenStax – Introductory Statistics – <https://openstax.org>
5. PubMed – Biomedical Research Database – <https://pubmed.ncbi.nlm.nih.gov>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									Hours		Credit
II	PBC26010		Applied Biostatistics in Biochemistry									4		4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	3	3	2	2	1	2	2	1	-	3	3	2.38
CO2	3	3	3	3	3	2	1	2	2	1	-	3	3	2.46
CO3	3	3	3	3	3	2	2	2	2	2	-	3	3	2.62
CO4	3	3	3	3	3	3	2	2	2	2	1	3	3	2.77
CO5	3	3	3	3	3	3	2	2	3	2	2	3	3	2.85
Mean	3.00	3.00	3.00	3.00	2.80	2.40	1.60	2.00	2.20	1.60	0.60	3.00	3.00	2.62

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26011	Forensic Biochemistry and Crime Investigation	Disciplinary Elective Course	4	0	0	4
Pre-Requisite: <ul style="list-style-type: none"> Basic knowledge of Biochemistry and biomolecules. Fundamental understanding of Molecular Biology and Genetics. 							
Co- Requisite: <ul style="list-style-type: none"> Analytical Techniques in Biochemistry. Molecular Biology and Genetic Engineering. 							
Progressive Course: <ul style="list-style-type: none"> Advanced Forensic Science and Forensic Toxicology. Forensic Molecular Biology and Forensic Genomics. 							
Course Objectives:							
1. To introduce the principles of forensic science and their applications in crime investigation.							
2. To understand the role of biochemistry in the analysis of biological evidence.							
3. To familiarize students with forensic techniques used in criminal investigations.							
4. To provide knowledge on forensic toxicology, DNA profiling, and modern forensic technologies.							
5. To introduce the principles of forensic science and their applications in crime investigation.							
Course Outcomes:							
CO1: Analyze crime scene investigation procedures and evaluate the collection, preservation, packaging, and interpretation of different types of forensic evidence in criminal investigations. (K4)							
CO2: Analyze biological evidence and forensic biochemical markers for the identification, comparison, and individualization of biological samples in forensic casework. (K4)							
CO3: Evaluate the applicability and reliability of DNA fingerprinting, STRs, VNTRs, PCR, and molecular forensic techniques in human identification, paternity testing, and disaster victim identification. (K5)							
CO4: Evaluate toxicological findings obtained from chemical, chromatographic, and spectroscopic analyses to interpret cases involving drugs, poisons, alcohol, pesticides, and heavy metal exposure. (K5)							
CO5: Evaluate modern forensic technologies, biometric systems, forensic genomics, and legal frameworks for their effectiveness, ethical implications, and admissibility in forensic investigations and judicial proceedings. (K5)							
Unit-I	Introduction to Forensic Science and Crime Investigation						12Hrs.
History and scope of forensic science. Principles of crime scene investigation. Collection, preservation, packaging, and transportation of forensic evidence. Types of evidence: biological, physical, chemical, and trace evidence. Chain of custody and legal considerations. Role of forensic biochemistry in criminal investigations.							
Unit-II	Biological Evidence and Forensic Biochemistry						12 Hrs.

Nature and significance of biological evidence. Identification and analysis of blood, semen, saliva, sweat, hair, nails, bones, and tissues. Blood grouping and blood stain analysis. Biochemical markers in forensic investigations. Species identification and individualization of biological samples.

Unit-III	DNA Fingerprinting and Molecular Forensics	12Hrs.
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Structure and properties of DNA. Principles and applications of DNA fingerprinting. Short Tandem Repeats (STRs), Variable Number Tandem Repeats (VNTRs), mitochondrial DNA analysis. Polymerase Chain Reaction (PCR) and electrophoretic techniques in forensic investigations. Paternity testing, missing person identification, and disaster victim identification.

Unit-IV	Forensic Toxicology and Chemical Analysis	12Hrs.
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Introduction to forensic toxicology. Analysis of alcohol, narcotics, drugs, poisons, pesticides, and heavy metals. Drug abuse and doping control. Toxicokinetics and toxicodynamics. Chromatographic and spectroscopic techniques in toxicological investigations. Interpretation of toxicological reports.

Unit-V	Modern Forensic Technologies and Legal Aspects	12 Hrs.
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Digital and cyber forensics. Forensic anthropology and odontology. Fingerprint analysis and biometric identification. Emerging technologies in forensic science: biosensors, artificial intelligence, forensic genomics, and proteomics. Expert testimony, forensic ethics, legal procedures, and admissibility of forensic evidence in courts.

Text Book(s):

1. Saferstein, R., Criminalistics: An Introduction to Forensic Science, 13th Edition, Pearson, 2023.
2. Butler, J.M., Advanced Topics in Forensic DNA Typing: Methodology, Academic Press, 2022.
3. Houck, M.M. and Siegel, J.A., Fundamentals of Forensic Science, 4th Edition, Academic Press, 2024.
4. Nanda, B.B. and Tiwari, R.K., Forensic Science in India and the World, 2022.
5. James, S.H., Nordby, J.J. and Bell, S., Forensic Science: An Introduction to Scientific and Investigative Techniques, 5th Edition, CRC Press, 2023.

Reference Book(s):

1. White, P.C., Crime Scene to Court: The Essentials of Forensic Science, Royal Society of Chemistry, 2021.
2. Mozayani, A. and Noziglia, C., The Forensic Laboratory Handbook, Humana Press, 2022.
3. Robertson, J. and Roux, C., Forensic Examination of Fibres, 3rd Edition, CRC Press, 2021.
4. Lee, H.C. and Gaensslen, R.E., Advances in Fingerprint Technology, 4th Edition, CRC Press, 2022.
5. Pillay, V.V., Textbook of Forensic Medicine and Toxicology, 20th Edition, Paras Medical Publisher, 2023.

e Resources:

1. National Forensic Sciences University (NFSU) – <https://www.nfsu.ac.in>
2. Bureau of Police Research and Development (BPR&D) – <https://bprd.nic.in>
3. National Crime Records Bureau (NCRB) – <https://www.ncrb.gov.in>
4. PubMed – <https://pubmed.ncbi.nlm.nih.gov>
5. INTERPOL Forensics – <https://www.interpol.int>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course										Hours	Credit
I	PBC26011		Forensic Biochemistry and Crime Investigation										4	4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	2	2	1	1	1	2	1	1	1	2	2	1.69
CO2	3	3	3	2	1	1	1	2	1	1	1	3	2	1.85
CO3	3	3	3	3	2	1	1	2	1	1	1	3	3	2.08
CO4	3	3	3	3	2	2	1	2	1	1	1	3	3	2.15
CO5	3	3	2	3	2	2	2	3	2	2	2	2	3	2.38
Mean	3.00	3.00	2.60	2.60	1.60	1.40	1.20	2.20	1.20	1.20	1.20	2.60	2.60	1.98

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26012	Metallochemistry	Disciplinary Elective Course	4	0	0	4

Pre-Requisite:

- Fundamentals of Inorganic Chemistry and Coordination Chemistry.

Co- Requisite:

- Laboratory Course in Inorganic Chemistry/Coordination Chemistry.

Progressive Course:

- Advanced Organometallic Chemistry.
- Bioinorganic Chemistry and Materials Chemistry.

Course Objectives:

- To understand the electronic structure, bonding, and stereochemistry of transition metal complexes.
- To explain the synthesis, properties, and reactivity of organometallic compounds.
- To study the catalytic and biological roles of metal complexes.
- To explore modern applications of metallochemistry in medicine, materials science, and nanotechnology.
- To develop the ability to interpret spectroscopic and structural data of metal complexes.

Course Outcomes:

CO1: Explain the electronic structure, bonding, and stereochemistry of coordination compounds. **(K3)**

CO2: Analyze the synthesis, structure, and reactivity of organometallic compounds. **(K4)**

CO3: Interpret the spectroscopic and magnetic properties of transition metal complexes **(K4)**.

CO4: Evaluate the catalytic and biological significance of metal complexes. **(K5)**

CO5: Design and assess applications of metallochemistry in medicine, materials science, and nanotechnology **(K5)**

Unit-I	Fundamentals of Metallochemistry	12Hrs.
Introduction to metallochemistry. Electronic configuration of transition metals. Coordination compounds and nomenclature. Crystal Field Theory (CFT) and Ligand Field Theory (LFT). Metal–ligand bonding including σ and π bonding. Stability of metal complexes. Chelation and macrocyclic effect.		
Unit-II	Organometallic Chemistry	12 Hrs.
Introduction and classification of organometallic compounds. The 18-electron rule. Metal carbonyls: synthesis, structure, bonding, and applications. Metal nitrosyls and phosphine complexes. Metal–alkene and metal–alkyne complexes. Ferrocene and other metallocenes. Organometallic reaction mechanisms		
Unit-III	Spectroscopic and Magnetic Properties	12Hrs.

Electronic spectra of transition metal complexes. Selection rules. Orgel and Tanabe–Sugano diagrams. Charge transfer spectra. Magnetic properties of transition metal complexes. ESR and Mössbauer spectroscopy. Structural characterization using IR, UV–Visible, NMR, and X-ray diffraction techniques.

Unit-IV	Bioinorganic and Catalytic Metallochemistry	12Hrs.
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Essential and trace metals in biological systems. Hemoglobin, myoglobin, and cytochromes. Metalloenzymes and metalloproteins. Metal ions in medicine. Cisplatin and other metal-based drugs. Homogeneous and heterogeneous catalysis. Industrial catalytic processes involving transition metals.

Unit-V	Advanced Applications of Metallochemistry	12 Hrs.
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Supramolecular coordination chemistry. Metal–organic frameworks (MOFs). Nanometallic materials and nanocatalysts. Metallochemistry in renewable energy including hydrogen production, fuel cells, and solar energy conversion. Environmental applications of metal complexes. Metal complexes in sensing, imaging, and diagnostics. Recent advances and future perspectives in metallochemistry.

Text Book(s):

1. Housecroft, C. E., & Sharpe, A. G. (2026). Inorganic chemistry (6th ed.). Pearson.
2. Bernhardt, P. V., & Lawrance, G. A. (2024). Introduction to coordination chemistry (2nd ed.). Wiley.
3. Crabtree, R. H. (2026). The organometallic chemistry of the transition metals (8th ed.). Wiley.
4. Pfennig, B. W. (2021). Principles of inorganic chemistry (2nd ed.). Wiley.
5. Weller, M., Overton, T., Rourke, J., & Armstrong, F. (2018). Inorganic chemistry (7th ed.). Oxford University Press.

Reference Book(s):

1. Cotton, F. A., Wilkinson, G., Murillo, C. A., & Bochmann, M. (1999). Advanced inorganic chemistry (6th ed.). John Wiley & Sons.
2. Miessler, G. L., Fischer, P. J., & Tarr, D. A. (2014). Inorganic chemistry (5th ed.). Pearson.
3. Kaim, W., & Schwederski, B. (2013). Bioinorganic chemistry: Inorganic elements in the chemistry of life (2nd ed.). Wiley.
4. Dabrowiak, J. C. (2017). Metals in medicine (2nd ed.). Wiley.
5. Huynh, H. V. (2017). The organometallic chemistry of N-heterocyclic carbenes. Wiley

e Resources:

1. American Chemical Society (ACS) Publications
2. Royal Society of Chemistry (RSC) Publishing
3. Wiley Online Library
4. SpringerLink Chemistry Collection
5. ScienceDirect (Elsevier)

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credit
II	PBC26012			Metallochemistry								4		4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	2	1	-	-	-	-	-	-	-	3	2	2.33
CO2	3	3	3	2	2	-	-	-	-	-	-	3	3	2.71
CO3	3	3	3	3	2	-	-	-	-	-	-	3	3	2.86
CO4	3	2	3	3	2	2	2	-	-	1	-	3	3	2.40
CO5	3	3	3	3	3	2	2	2	2	2	1	3	3	2.46
Mean	3.00	2.80	2.80	2.40	2.25	2.00	2.00	2.00	2.00	1.50	1.00	3.00	2.80	2.55

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PBC26901	Food Safety and Public health	Multi-Disciplinary Course-I	3	0	0	3

Pre-Requisite:

- Basic knowledge of Biology

Co- Requisite:

- Basic knowledge of Chemistry and Environmental Science.
- Interest in food safety, nutrition, and public health.

Progressive Course:

- Food Microbiology
- Food Quality Assurance and Food Processing Technology

Course Objectives:

1. Understand the principles of food safety and their importance in protecting public health.
2. Explain foodborne diseases, food contamination, and preventive measures.
3. Familiarize with food safety laws, regulations, and quality management systems.
4. Develop knowledge of food hygiene, sanitation, and safe food handling practices.
5. Analyze the role of food safety in disease prevention and sustainable public health.

Course Outcomes:

CO1: Explain advanced concepts of food safety, public health, and food safety management systems. **(K2)**

CO2: Analyze biological, chemical, and physical food hazards and their impact on food quality and public health. **(K3)**

CO3: Apply food safety principles, hygiene practices, and quality assurance systems to ensure safe food production and handling. **(K3)**

CO4: Evaluate national and international food safety regulations, risk assessment approaches, and food safety management systems for effective public health protection. **(K4)**

CO5: Design innovative strategies and integrated food safety management plans to prevent foodborne diseases and enhance public health outcomes. **(K5)**

Unit-I	Introduction to Food Safety and Public Health	12 Hrs.
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Concept and importance of food safety; relationship between food safety and public health; food chain and farm-to-fork concept; food hazards (biological, chemical, and physical hazards); food contamination and spoilage; importance of safe food handling.

Unit-II	Foodborne Diseases and Food Hygiene	12 Hrs.
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Foodborne infections and intoxications; major foodborne pathogens including *Salmonella*, *Escherichia coli*, *Listeria*, *Staphylococcus aureus*, and *Clostridium botulinum*; food poisoning and outbreaks; personal hygiene; cleaning and

sanitation practices; safe food preparation and storage.

Unit-III	Food Safety Standards and Regulations	12Hrs.
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Food Safety and Standards Act (FSSA), 2006; Food Safety and Standards Authority of India (FSSAI); Codex Alimentarius Commission; ISO 22000 Food Safety Management System; Hazard Analysis and Critical Control Points (HACCP); Good Manufacturing Practices (GMP); Good Hygienic Practices (GHP).

Unit-IV	Food Quality Assurance and Risk Management	12 Hrs.
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Food quality parameters; food quality assurance systems; food labeling and packaging; food adulteration; detection and prevention of adulteration; food safety risk assessment; food recall procedures; consumer awareness and education.

Unit-V	Food Safety, Nutrition, and Public Health	12 Hrs.
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Nutrition and food safety; food fortification; food security and public health; emerging food safety issues; antimicrobial resistance in the food chain; climate change and food safety; sustainable food safety practices; public health surveillance and future challenges.

Text Book(s):

1. Adams, M. R., & Moss, M. O. (2018). *Food Microbiology* (5th Edition). Royal Society of Chemistry.
2. Forsythe, S. J. (2020). *The Microbiology of Safe Food* (3rd Edition). Wiley-Blackwell.

Reference Book(s):

1. Marriott, N. G., Schilling, M. W., & Gravani, R. B. (2018). *Principles of Food Sanitation* (6th Edition). Springer.
2. Motarjemi, Y., & Lelieveld, H. (2014). *Food Safety Management: A Practical Guide for the Food Industry*. Academic Press.
3. Jay, J. M., Loessner, M. J., & Golden, D. A. (2005). *Modern Food Microbiology* (7th Edition). Springer.
4. World Health Organization (WHO). *Five Keys to Safer Food Manual*.
5. FSSAI. *Food Safety and Standards Regulations*. Government of India.

e Resources:

1. Food Safety and Standards Authority of India (FSSAI): <https://www.fssai.gov.in>
2. World Health Organization (WHO) – Food Safety: <https://www.who.int/health-topics/food-safety>
3. Food and Agriculture Organization (FAO): <https://www.fao.org>
4. Codex Alimentarius Commission: <https://www.fao.org/fao-who-codexalimentarius>
5. National Programme on Technology Enhanced Learning (NPTEL): <https://nptel.ac.in>
6. SWAYAM Online Courses: <https://swayam.gov.in>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course							Hours		Credit
I	PBC26901			Food Safety and Public health							3		3
Course Outcome s (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	
CO1	3	3	2	2	2	2	2	2	—	—	3	3	2.40
CO2	3	3	3	2	2	2	2	2	2	—	3	3	2.45
CO3	3	3	3	3	2	2	2	2	2	2	3	3	2.50
CO4	3	3	3	3	3	2	2	2	2	2	3	3	2.58
CO5	3	3	3	3	3	3	3	2	2	2	3	3	2.75
Mean	3.00	3.00	2.80	2.60	2.40	2.20	2.20	2.00	2.00	2.00	3.00	3.00	2.54

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PBC26902	Bioproducts and Start-up Innovations	Multi-Disciplinary Course-II				3
Pre-Requisite: <ul style="list-style-type: none"> Basic knowledge of Biochemistry, Biotechnology, and Microbiology. Understanding of biomolecules, fermentation, and biological processes. 							
Co- Requisite: <ul style="list-style-type: none"> Industrial Biotechnology and Bioprocess Technology. Bioinformatics and Analytical Techniques in Biochemistry. 							
Progressive Course: <ul style="list-style-type: none"> Biotechnology Entrepreneurship and Innovation Management. Industrial Biotechnology and Bio-based Product Development. 							
Course Objectives:							
1. To provide an understanding of bio-based products and their industrial applications.							
2. To familiarize students with entrepreneurship and start-up ecosystems in biotechnology.							
3. To explore innovative technologies for the development of sustainable bioproducts.							
4. To encourage innovation, commercialization, and intellectual property awareness							
5. To provide an understanding of bio-based products and their industrial applications.							
Course Outcomes:							
CO1: Analyze the role of bioproducts, biomass resources, and bioeconomy concepts in promoting sustainable development and circular economy practices. (K4)							
CO2: Analyze the production processes, industrial applications, quality standards, and value-added potential of various bioproducts and biotechnological innovations. (K4)							
CO3: Evaluate biotechnology entrepreneurship models, start-up ecosystems, funding opportunities, and technology transfer mechanisms for establishing sustainable bio-based enterprises. (K5)							
CO4: Evaluate intellectual property rights, regulatory requirements, commercialization strategies, and ethical considerations associated with biotechnology products and enterprises. (K5)							
CO5: Evaluate emerging biotechnological technologies and future entrepreneurial opportunities in healthcare, agriculture, food, environmental, and industrial biotechnology sectors. (K5)							
Unit-I	Introduction to Bioproducts and Bioeconomy						12Hrs.
Concept of bioeconomy and circular economy. Classification and significance of bioproducts. Biomass and renewable resources. Biofertilizers, biopesticides, biofuels, bioplastics, enzymes, probiotics, and nutraceuticals. Sustainable development and green technologies. Global and Indian bioeconomy initiatives.							

Unit-II	Bioproduct Development and Industrial Applications	12 Hrs.
Production and applications of industrial enzymes, fermented products, organic acids, amino acids, pigments, essential oils, and microbial metabolites. Functional foods and nutraceuticals. Medicinal plant-based products. Waste valorisation and value-added products from agricultural and food residues. Quality control and standardisation of bioproducts.		
Unit-III	Biotechnology Entrepreneurship and Start-up Ecosystem	12Hrs.
Fundamentals of entrepreneurship. Innovation and creativity in biotechnology. Business models and business plan development. Start-up ecosystem in India. Government schemes and funding agencies. Role of BIRAC, DBT, DST, MSME, and Start-up India. Incubation centers, accelerators, and technology transfer mechanisms.		
Unit-IV	Intellectual Property Rights and Commercialisation	12Hrs.
Patents, copyrights, trademarks, geographical indications, and industrial designs. Patent filing procedures. Biosafety and bioethics. Regulatory aspects of biotechnology products. Product validation, quality assurance, and certification. Marketing strategies and commercialization of bio-based products. Case studies of successful biotechnology enterprises.		
Unit-V	Emerging Technologies and Future Opportunities	12Hrs.
Artificial intelligence and digital biotechnology. Synthetic biology and precision fermentation. Nanobiotechnology and advanced biomaterials. Bioinformatics and data-driven innovations. Bio-based packaging and sustainable products. Future trends in biotechnology entrepreneurship. Women entrepreneurship and social innovation. Start-up opportunities in healthcare, agriculture, environment, food technology, and industrial biotechnology		

Text Book(s):

1. Satyanarayana, U., Biotechnology, 2nd Edition, Books and Allied, 2022.
2. Crueger, W. and Crueger, A., Biotechnology: A Textbook of Industrial Microbiology, 3rd Edition, Panima Publishing, 2021.
3. Shimasaki, C., Biotechnology Entrepreneurship: Starting, Managing and Leading Biotech Companies, 3rd Edition, Academic Press, 2023.
4. Ratledge, C. and Kristiansen, B., Basic Biotechnology, 4th Edition, Cambridge University Press, 2021.
5. Pandey, A., Industrial Biotechnology: Sustainable Production and Bioresource Utilization, CRC Press, 2022

Reference Book(s):

1. Hisrich, R.D., Peters, M.P. and Shepherd, D.A., *Entrepreneurship*, 12th Edition, McGraw-Hill, 2023.
2. Desai, V., *Dynamics of Entrepreneurial Development and Management*, Himalaya Publishing House, 2022.
3. Kumar, H.D., *Modern Concepts of Biotechnology*, Vikas Publishing House, 2021.
4. Singh, B.D., *Biotechnology: Expanding Horizons*, 5th Edition, Kalyani Publishers, 2023.
5. Bhattacharya, S.K., *Entrepreneurship Development and Project Management*, Oxford University Press, 2021.

e Resources:

1. Department of Biotechnology (DBT), Government of India – <https://dbtindia.gov.in>
2. Biotechnology Industry Research Assistance Council (BIRAC) – <https://birac.nic.in>
3. Start-up India – <https://www.startupindia.gov.in>
4. Ministry of MSME – <https://msme.gov.in>
5. National Innovation Foundation – <https://nif.org.in>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									Hours		Credit
II	PBC26902		Bioproducts and Start-up Innovations									3		3
Course Outcom es (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	2	2	2	1	2	2	1	1	1	3	2	1.92
CO2	3	3	3	2	2	2	2	2	1	1	1	3	3	2.15
CO3	3	3	3	3	3	3	2	2	2	2	2	2	3	2.54
CO4	3	3	2	3	3	2	2	3	2	2	2	2	3	2.46
CO5	3	3	3	3	3	3	3	3	2	2	2	2	3	2.69
Mean	3.00	3.00	2.60	2.60	2.60	2.20	2.20	2.40	1.60	1.60	1.60	2.40	2.80	2.35