



**MARUDHAR KESARI JAIN COLLEGE FOR WOMEN
(AUTONOMOUS)**

Vaniyambadi – 635 751

PG & Research Department of Biotechnology

for

Post graduate Programme

Master of Science in Biotechnology

From the Academic Year 2026 - 2027

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1. Preamble

The emergence of Biotechnology has made a contemporary advancement in the discipline of Science, embarking the venture of revolution for the enhancement of life and nature. This multidisciplinary subject has placed its foothold in different sectors like Pharmaceuticals, Food Industries, Textile Industries, Agriculture, Environment, Vaccine development to name a few, thereby opening a broad arena to widen job opportunities. The accelerated growth in newer hazards and the pressing need to address these issues has necessitated the requisite for radical strategies and pioneering research personnel to handle it with careful consideration. Cutting-edge technologies in Biotechnology therefore offer the hope to face emerging challenges with insightful approaches. With the advent of Biotechnology, there have been several astonishing inventions both in medicine and environment that has propelled it as one of the frontline subject of the 21st century at its prima facie. As a result the demand for subject experts has seen an inclined growth in all fields of science and technology. Encompassing different streams of science, Biotechnology contemplates to integrate industry and research for a constructive growth of the nation. Therefore an education that warrants both theoretical and practical expertise becomes an indispensable element to satiate the global requisite of an intellectually skilled person.

The Department of Biotechnology began its journey in the year 2007 with Bachelor's degree in a vision to empower students with adequate knowledge and skills on advancements in the field of science through Biotechnological concepts and principles. It then introduced its Post-Graduation program in the year 2014 and thereafter added the M.Phil and Pd.D research programs in the year 2018 and 2019 respectfully. The Department is endowed with highly skilled faculty members who work towards teaching, guiding and motivating the students to become successful career oriented personnel. The Department has taken up several collaborative activities with industries and research centers to provide the students with a real-time experience of a work environment. The Department has a never failed to produce University Rank Holders and also holds a commendable record in Placement. The Department is further enriched with sophisticated laboratory that is furnished with high-end instruments and equipment to deliver in-depth practical sessions for the students.

In adherence to the current needs and expectations of the industries, the curriculum and syllabi for Biotechnology were framed meticulously such that upon completion of the program, the learner will acquire commendable knowledge and skills to meet the expectancy of the industrial, educational and research sectors. The program is envisaged to impart deeper insights into radical and empowering technologies and concepts that refurbish scientific endeavors. It also seeks to mold and develop logical reasoning and solution providing potentiality to the learners so as to become equally competent with their peers by increasing the credentials of their knowledge. The program also perpetuates the support of laying the path for building a self-sustaining ability and independency to stand out as a remarkable personality in this scientific era. The program of Biotechnology cultivates the sense of responsibility for the well-being of all life and instigates the curiosity into seeking opportunities to become a part of an impactful society. Biotechnology embodies such an ardent principality that makes this stream of science an unrelinquishable asset for the sustenance and betterment of life

PROGRAMME OUTCOMES (PO)

Programme	M.Sc., Biotechnology
Programme Code	PS05
Duration	2 years [PG]
Programme Outcomes	<p>PO1: Disciplinary knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an postgraduate Programme of study.</p> <p>PO2: Communication Skills: Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically and present complex information in a clear and concise manner to different groups</p> <p>PO3: Critical thinking: Capability to apply analytic thought to a body of knowledge; analyses and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.</p> <p>PO4: Problem solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.</p> <p>PO5: Analytical reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples and addressing opposing viewpoints.</p> <p>PO6: Research-related skills: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesizing and articulating; Ability to recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation.</p> <p>PO7: Cooperation / Teamwork: Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.</p> <p>PO8: Scientific reasoning: Ability to analyse, interpret and draw conclusions from quantitative/ qualitative data and critically evaluate ideas, evidence, and experiences from an open-minded and reasoned perspective.</p>

<p>Programme Specific Outcomes:</p>	<p>PSO1– Placement: To prepare the students who will demonstrate respectful engagement with others’ ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.</p> <p>PSO2-Entrepreneur: To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skills that will facilitate startups and high potential organizations.</p> <p>PSO3 –Research and Development: Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards Growth and development.</p>
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Eligibility for Admission:

Candidate for admission to the first year of M.Sc., Biotechnology, Department of Biotechnology shall be required to have passed the UG with any Life Science with 55% marks of a recognized Indian University or any other University

Methods of Evaluation and Assessment

Methods of Evaluation		
Internal Evaluation		25 Marks
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or Overview	
Application (K3)	Suggest idea/concept with examples, suggest formulae, solve problems, Observe ,Explain	
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate Between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Course Code	Course Category	Title of the Course	Ins. Hrs/ Week	Credit	Marks		Total
					CIA	ESE	
Semester – I							
26PBTC11	Core – 1	Cell & Molecular Biology	6	5	25	75	100
26PBTC12	Core – 2	Biochemistry	6	5	25	75	100
26PBTC13P	Core – 3	Cell & Molecular biology & Biochemistry – Practical	5	4	25	75	100
26PBTE11/ 26PBTE12	DCE – 1	1. Biodiversity & Bioprospecting 2. Bioinstrumentation	5	3	25	75	100
26PBTE13/ 26PBTE14	DCE – 2	1. Cryobiology 2. Pharmaceutical Biotechnology	4	3	25	75	100
26PBTA11	AECC -1	Molecular Therapeutics	2	2	25	75	100
26PCHR11	HR	Human Rights	2	2	25	75	100
			30	22	150	450	600
Semester – II							
26PBTC21	Core – 4	Microbiology	6	5	25	75	100
26PBTC22	Core – 5	Immunology	6	5	25	75	100
26PBTC23P	Core – 6	Microbiology & Immunology Practical	5	4	25	75	100
26PBTE21/ 26PBTE22	DCE – 3	1. Nanobiotechnology 2. Environmental Biotechnology	5	3	25	75	100
26PBTE23/ 26PBTE24	DCE – 4	1. Forensic Science 2. Food Biotechnology	5	3	25	75	100
26PBTS21	SEC-1	Clinical Trials and Management	3	2	25	75	100
			30	22	150	450	600
Semester – III							
26PBTC31	Core – 7	Plant & Animal Biotechnology	6	5	25	75	100
26PBTC32	Core – 8	Research Methodology	6	5	25	75	100
26PBTC33P	Core – 9	Lab in Plant & Animal Biotechnology	6	4	25	75	100
26PBTE31/ 26PBTE32	DCE – 5	1. Enzyme Technology 2. Biostatistics	6	3	25	75	100
26PBTS31	SEC – 2	Vermiculture & Sericulture	3	2	25	75	100
26PBTIK31	IKS*	IKS in Integrative Medicine	3		25	75	100
26PBTIN31	Internship			2	25	75	100
			30	21	175	525	700
Semester – IV							
26PBTC41	Core –10	Bioinformatics	6	5	25	75	100
26PBTC42	Core – 11	Recombinant DNA Technology	6	5	25	75	100
26PBTC43P	Core – 12	Bioethics, Biosafety & IPR	4	3	25	75	100
26PBTC44P	Core – 13	Project	6	6	25	75	100
26PBTE41/ 26PBTE42	DCE – 6	1. Regulatory & Affairs & Industrial Standards 2. Stem Cell Biology & Regenerative Medicine	4	3	25	75	100

26PBTP41	PEC	BioEntrepreneurship in Biotechnology (Herbal Products)	2	2	25	75	100
26PBTL41	SLC	Medical Coding With AI	2	2	25	75	100
	MOOC	NPTEL (Online)					100
			30	26	175	525	800
			120	91	650	1950	2700

Students must complete at least one online course (MOOC) from platforms like SWAYAM, NPTEL, within the third semester. Additionally, engaging in a specified Self-learning Course is mandatory to qualify for the degree, and successful participation will be acknowledged with an extra credit of 2*.

CC: Core Course

DCE: Discipline Centric Elective

SEC: Skill Enhancement Course

PEC: Professional Enhancement Course

SLC: Self Learning Course
Course)

IKS: Indian Knowledge System (Non- Credit

AECC: Ability Enhancement Compulsory Course

FIRST YEAR – SEMESTER -I

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTC11	Cell & Molecular Biology	5	1	0	5	6	25	75	100
Core-1	Core Course				Theory				
Learning Objectives									
LO1	To understand the basics of cell organization								
LO2	To understand the cell cycle and cell signalling								
LO3	To learn the nucleus structure and organization								
LO4	To understand the process of transcription								
LO5	To know the mechanism on protein synthesis and transport								
Unit	Content								Hours
1	Cells: Basic properties of cells-Cellular Dimension-Size of cells and their composition. Cell origin and Evolution –Prokaryotic cell and Eukaryotic cell-Cell organelles- Structure and function of cell organelles- Cell membrane, Nucleus, Chromatin, Golgi apparatus, Endoplasmic reticulum, Ribosomes, Lysosome, Mitochondria, Peroxisome, Cytoskeleton, Microbodies, centrosome and centrioles								18
2	Molecular basis of eukaryotic cell – Cell cycle – regulation – check points. Cell division- mitosis and meiosis, Cell signalling- Cell Adhesion, Cell Junctions - Extracellular matrix, Programmed cell death – Stages of cell signalling – Receptors in signalling pathways– Signal transduction pathways-overview								18
3	Chromosome-structure and function, Nucleic Acids: Structure and Properties of DNA. Types of DNA. Structure and Properties of RNA – Types of RNA – Functions of RNA. DNA and RNA as Genetic Material, Non-coding RNA. Central Dogma of the Cell – Basic concepts of Gene. Regulatory regions- UTR, Promoter, Operator, Repetitive elements in DNA								18
4	Transcription – mechanism in Prokaryotes and Eukaryotes. Post transcriptional modifications- Regulation of Transcription Initiation, Elongation. Reverse transcription. Non coding regions of DNA&RNA. Operon-Lac, Trp								18
5	Genetic code - Mechanism of translation- post translational modification in RER – synthesis, Significance of each post translational modification, sorting and trafficking of proteins- site of synthesis of membrane and organelle protein – transport of membrane protein across ER. Transport of protein to Mitochondria, nucleus, chloroplast, and peroxisomes – Golgi and post golgi sorting and processing – Receptor mediated endocytosis								18
TOTAL :								90	
CO	Course Outcomes								Knowledge Level
	The Students will able to								
1	Understand about cell structure and organization.								K1, K2, K3
2	Analyze cell communication and cellular mechanisms.								K1, K2, K3, K4
3	Analyze the role of DNA in cellular functions								K1, K2, K3

4	Understand transcription and analyze the role of RNA in cellular function	K1, K2, K3, K4
5	To understand protein synthesis and evaluate its post-translational modifications.	K1, K2, K3, K5

Textbooks:

1	Paul A, 2001, Text Book of Cell and Molecular Biology Second edition
2	T.Fleming. 2002. Cell interactions: A practical approach Second edition
3	Prakash S. Lohar , 2009. Cell and Molecular Biology
4	David E.Sadva., 2009. Cell biology organelles structure and function, CBS publishers and distributors, New Delhi.
5	Luiz Carlos Uchoa, Janqueira, Jose, Carneiro. 2005. Basic Histology Text and Atlas. McGraw-Hill Professional

Reference Books:

1	Karp, G., 2009, Cell and Molecular Biology, Sixth edition, John Wiley & Sons, New York.
2	Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, 2007., Molecular Biology of the Cell, Fifth edition. Garland Science
3	Geoffrey. M.Cooper, Robert.E.Hausman.2007.The Cell-A Molecular Approach, Fourth edition. Sinauer Associates

Web Resources:

1	nptel.ac.in/courses/102104052
2.	https://www.mustafaaltinisik.org.uk/s-molecularcellbiology.pdf
3	https://archive.nptel.ac.in//content/storage2/courses/102106025/Mod%201/Lec-1.pdf

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2	3	3	3	3	2
CO2	3	3	3	2	3	2	3	3	3	3	2
CO3	3	2	2	2	3	2	3	3	3	3	2
CO4	3	3	2	2	3	2	3	3	3	3	2
CO5	3	3	3	2	3	2	3	3	3	3	2
Total	15	13	12	10	15	10	15	15	15	15	10
Average	3	2.6	2.4	2	3	2	3	3	3	3	2

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTC12	Biochemistry	5	1	0	5	6	25	75	100
Core 2	Core Course	Theory							
Learning Objectives									
LO1	To understand the basics of Biochemistry								
LO2	To illustrate the concepts of carbohydrates								
LO3	To Describe the basics of lipid biochemistry								
LO4	To understand the basis of Proteins.								
LO5	To Analyze the structure and function of nucleic acids and amino acids								
Unit	Content								Hours
1	Introduction & scope of Biochemistry; Classification of biomolecules; Water – structure & properties (polarity, solvent properties); Acid–base concepts, buffers, pH, pKa; Henderson–Hasselbalch equation; Noncovalent interactions – hydrogen bonding, hydrophobic, electrostatic, Van der Waals forces; Thermodynamics – laws (I, II, III), entropy, enthalpy, Gibbs free energy (bioenergetics basics)								18
2	Carbohydrates – nomenclature, classification, structure & properties; Metabolism – glycolysis, gluconeogenesis, glycogenesis, glycogenolysis, pentose phosphate pathway, citric acid cycle; Cori cycle; glyoxylate cycle; regulation of carbohydrate metabolism.								18
3	Lipids – nomenclature, classification, structure & properties of fatty acids; Lipid metabolism – fatty acid biosynthesis; synthesis of triglycerides, phospholipids, glycolipids; Cholesterol biosynthesis; bile acids & salts; Fatty acid oxidation – β -oxidation, α -oxidation; oxidation of unsaturated & odd-chain fatty acids; Ketone bodies (formation and utilization)								18
4	Proteins & Amino acids – nomenclature, classification, structure & properties; Protein structure (primary, secondary, tertiary, quaternary); Metabolism – biosynthesis of amino acids; Protein degradation; Nitrogen metabolism (urea cycle); Carbon skeleton of amino acids								18
5	Nucleic acids – nomenclature, classification, structure & properties; Biosynthesis – de novo & salvage pathways of purines & pyrimidines; Catabolism of purines & Pyrimidine. Synthetic analogues of nitrogenous bases (antimetabolites); inborn errors of metabolism (e.g., gout, PKU); Electron transport chain & oxidative phosphorylation (ATP generation, inhibitors, uncouplers)								18
Total								90	
CO	Course Outcomes								Knowledge Level
	The students will able to								
1	Understand the basic concepts of biochemistry.								K1, K2, K3
2	Gain knowledge of carbohydrate chemistry and functions.								K1, K2, K3, K4

3	Understand lipid biochemistry and its biological roles.	K1, K2, K3
4	Develop knowledge of proteins, amino acids, and their importance.	K1, K2, K3, K4
5	Analyze the structure and function of nucleic acids and amino acids.	K1, K2, K3, K4

Textbooks:

1	Sathyanarayana.U and U.Chakrapani., 2011. Biochemistry. Books and Allied private limited, Kolkata.
2	Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Jacqui M. Matthews, 2011. Schaum.s Outline of Biochemistry, Third Edition (Schaum.s Outline Series), McGraw-Hill

Reference Books:

1	Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, 2010. Biochemistry, Seventh Edition, W. H. Freeman.
2	Albert Lehninger, David L. Nelson Voet Donald, Judith G.Voet and Charlotte W.Pratt., 2008. Principles of Biochemistry. John Wiley and sons, Inc., New Jersey.
3	Michael M. Cox, 2008. Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman publishers.
4	Cambell, M.K. and Farrell, S.O. (2018) Biochemistry, Ninth Edition, Cengage Learning
5	Voet, D., Voet, J.G. and Pratt, C.W. (2018) Principles of Biochemistry, John Wiley & Sons. Inc, New York.

Web Resources:

1	https://recnotes.com/wp-content/uploads/2020/11/Biochemistry-U-Satyanaryan-4th-Edition.pdf
2	Biochemistry Book PDF Polysaccharide Carbohydrates

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	3	2	2	2	2	2	3	3	3	2
CO2	3	3	2	2	2	2	2	3	3	3	2
CO3	3	2	3	3	2	2	2	3	3	3	2
CO4	3	3	3	3	3	2	2	3	3	3	2
CO5	3	3	3	3	3	2	3	3	3	3	2
Total	14	14	13	13	12	10	11	15	15	15	10
Average	2.8	2.8	2.6	2.6	2.4	2	2.2	3	3	3	2

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTC13P	Core -3 Cell & Molecular Biology & Biochemistry- Practical	0	0	5	4	5	25	75	100
Core 3	Core Course	Practical							
Learning Objectives									
LO1	To separate and identify cell organelles using separation techniques.								
LO2	To study stages of cell cycle.								
LO3	To quantify biomolecules using different methods.								
LO4	To separate biomolecules using chromatographic techniques.								
LO5	Use electrophoretic techniques to separate DNA.								
Unit	Content	Hours							
1	Identification of cell organelles by differential centrifugation Histochemical staining to localize proteins/ carbohydrate	15							
2	Study of Mitosis Stages Study of Meiosis Stages.	15							
3	Estimation of RNA by orcinol method Estimation of DNA by diphenylamine method Estimation of protein by Lowry's Method Estimation of Carbohydrate by Anthrone method	15							
4	Separation of amino acids by Paper Chromatograph Separation of Sugar by Paper Chromatograph Separation of sugars by thin layer Chromatograph	15							
5	Isolation of DNA from Plant Isolation of DNA from Bacteria Agarose Gel Electrophoresis	15							
Total							75		
CO	Course Outcomes The students will able to	Knowledge Level							
1	Apply differential centrifugation to identify cell organelles.	K1, K2, K3							
2	Identify the stages of mitosis and meiosis.	K1, K2, K3, K4							
3	Apply standard biochemical methods to quantitatively estimate RNA, DNA, Protein & Carbohydrate.	K1, K2, K3							
4	Demonstrate chromatographic techniques to separate amino acids and sugars.	K1, K2, K3, K4							

5	Perform DNA isolation from plant and bacteria	K1, K2, K3, K4
Textbooks:		
1	Experimental Procedures in Lifescience - Dr.S.Rajan& Mrs. R. Selvi Christy, Anjana Book House	
2	Analytical Techniques in Biochemistry and Molecular Biology; Rajan Katoch; 2011; ISBN:9781441997852	
3	Cell and Molecular Biology Lab Manual. 14 June 2011 by Cristina C Thompson & David a Thompson	
4	Practical Guide Of Cell Biology & Molecular Genetics 6 February 2023 by Dr. Kanak Saxena	
5	A Cell Biology Lab Manual Spiral-bound –2022 by Joseph Francis	
Reference Books:		
1	Cell and Molecular Biology: A Lab Manual.30 October 2013 by K. V. Chaitanya	
2	Practical Handbook of Biochemistry: Lab Manual. 17 April 2020 by Deepak Shrivastava (Author)	
3	Lab Manual of Biochemistry. 12 April 2020 by Deepika Bairagee (Author)	
Web Resources:		
1	CELL AND MOLECULAR BIOLOGY: A Lab Manual - CHAITANYA, K. V. - Google Books	
2	https://sscollegejehanabad.org/study-material/412608884Mitosis%20in%20Onion%20Root%20Tip%20Cells%20and%20Mitotic%20Index.pdf	
3	https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf	

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	2	3	2	3	3	3
CO2	3	3	3	2	3	1	2	2	3	3	3
CO3	3	2	3	3	2	2	2	2	3	3	3
CO4	3	2	2	3	2	1	1	2	3	3	3
CO5	3	2	2	2	3	3	2	2	3	3	3
Total	15	12	12	12	13	9	10	10	15	15	15
Average	3	2.4	2.4	2.4	2.5	1.8	2	2	3	3	3

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTE11	DCE-1 Biodiversity and Bioprospecting	4	1	0	3	5	25	75	100
DCE-1	Elective Course	Theory							

Learning Objectives

LO1	To understand the importance and values of biodiversity in sustaining life.
LO2	To study biodiversity conservation, biotechnology applications, Red List, and biodiversity laws.
LO3	To Comprehend Bioprospecting Concepts
LO4	To Apply Knowledge of Bioprospecting
LO5	To Evaluate Ethical and Legal Issues.

Unit	Contents	Hours
1	Biodiversity- Definition and levels of biodiversity, Importance and values of biodiversity, India as a mega biodiversity nation, Biodiversity hotspots (India & world), Ecosystem structure and functioning (Food Chain, Food Web, Ecological pyramids), Threats (Habitat Loss, Climate Change, Invasive species, Overexploitation).	15
2	Conservation of Biodiversity – In-situ and Ex-situ (biosphere reserves, national parks, wildlife sanctuaries, seed/gene banks); Role of biotechnology (tissue culture, cryopreservation, DNA barcoding); IUCN Red List (categories & criteria); Biodiversity laws (CBD, Biological Diversity Act 2002, National Biodiversity Authority).	15
3	Introduction to Bioprospecting – Definition; Types (chemical, genetic, microbial); Sources (plants, animals, microorganisms, marine resources); Role of traditional knowledge (ethnobotany, indigenous knowledge systems)	15
4	Applications of Bioprospecting – Drug discovery (anticancer, antimicrobial examples); Industrial (enzymes, biofuels, biopolymers); Agricultural (biopesticides, biofertilizers); Microalgae & microbial bioprospecting; Biotechnology tools (genomics, proteomics, metabolomics, high-throughput screening)	15
5	Ethical, Legal & Economic Issues – Biopiracy (Neem, Turmeric, Basmati case studies); IPR (patents, copyrights, trademarks); Access & Benefit Sharing (Nagoya Protocol); Sustainable use (conservation vs commercialization)	15
	Total	75

CO	Course Outcomes Students will be able to	Knowledge Level
1	Understand biodiversity concepts, levels, importance, distribution, and threats.	K1, K2, K3
2	Compare in-situ and ex-situ conservation strategies and their significance.	K1, K2, K3, K4
3	Illustrate bioprospecting concepts, types, and sources (plants, microbes, marine).	K1, K2, K3
4	Apply bioprospecting in medicine, agriculture, and industry.	K1, K2, K3, K4
5	Analyze ethical, legal, and economic issues (biopiracy, IPR, benefit sharing).	K1, K2, K3, K4

Textbooks	
1	Krishnamurthy, K. V. (2003). Textbook of biodiversity. Science Publishers.
2	Basak, A. (2018). Environmental studies. Pearson Education India.
3	Das, A., et al. (2025). Biodiversity and bioprospecting <i>for sustainable resource use</i> . K.D. Publications.
4	Hill, D., et al. (2004). Handbook of biodiversity methods: Survey, evaluation and monitoring. Cambridge University Press.
5	Jeffries, M. J. (2006). <i>Biodiversity and conservation</i> . Routledge.
Reference Books	
1	Upadhyay, S. K., & Singh, S. P. (2021). Bioprospecting of plant biodiversity for industrial molecules. <i>Wiley</i> .
2	Arunachalam, K., et al. (2023). Bioprospecting of tropical medicinal plants. <i>Springer</i> .
3	Shukla, G., et al. (2025). Bioprospecting of ethnomedicinal plant resources. <i>Routledge</i> .
4	Singh, J., et al. (2018). Microbial bioprospecting for sustainable development. <i>Springer</i> .
Web Resources	
1	Bioprospecting – Biodiversity and conservation
2	https://www.academia.edu/113687840/BIOPROSPECTING_FOR_BIODIVERSITY
3	Fundamental Aspects of Bio Prospecting

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	2	2	1	3	3	3
CO2	3	3	3	3	2	2	2	2	3	3	3
CO3	3	2	3	3	2	2	2	2	3	3	3
CO4	3	3	3	2	2	2	2	1	3	3	3
CO5	3	2	2	3	2	2	2	2	3	3	3
Total	15	12	14	14	10	10	10	8	15	15	15
Average	3	2.4	2.8	2.8	2	2	2	1.6	3	3	3

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTE12	DEC-1 Bioinstrumentation	4	1	0	3	5	25	75	100
DCE-1	Elective Course	Theory							

Learning Objectives

LO1	To understand the concepts of Chromatography and electrophoresis	
LO2	To understand the principles of GC-MS	
LO3	To understand the concepts and working principles of Microscopy	
LO4	To understand the working mechanism Spectroscopy	
LO5	To understand the basic principle of radio isotopic techniques	
Unit	Contents	No. of Hours
1	Chromatography-types, HPLC – History, Scope, Overview, Principle and Application, Parts and mechanism of HPLC – Mobile Phase, Solvent Delivery Pump, Injector, Column, Detector and Data System with LC-MS, HPTLC, Electrophoresis-AGE, PAGE, SDS-PAGE, 2D-PAGE, capillary	15
2	GCMS – History, Scope, Overview, Principle and Application, Parts and mechanism of GCMS – Carrier Gas, Pneumatic Controller, Injector, Oven, Column, Interface, Ion Source, Mass Analyzer, Detector, Vacuum System and Control Electronics; MALDI TOF	15
3	Microscopic techniques, Principles and applications, compound, light, stereo, phase contrast, fluorescent, atomic force microscopy, confocal, flow cytometry, SEM –, Scope, Overview, Principle and Application, Parts and mechanism of SEM; TEM – Scope, Overview, Principle and Application, Parts and Mechanism of TEM	15
4	Spectroscopic techniques-theory and application. Part and mechanism of UV-visible spectroscopy, fluorescence spectroscopy, Mass spectroscopy, IR, NMR, AAS, X-ray spectroscopy, Raman spectroscopy	15
5	Radioisotopic techniques – Introduction to radioisotopes; Biological applications (tracer techniques, labeling); Radioactive decay – types (alpha, beta, gamma); Autoradiography; Radiation safety measures & detection methods (Geiger counter, scintillation counter); Health effects of radiation	15
	TOTAL	75

Course Outcomes

CO	Course Outcomes The students will able to	Knowledge Level
1	Understand the principle and working mechanism of HPLC	K1, K2, K3
2	Analyse the principle and working mechanism of GCMS	K1, K2, K3, K4
3	Understand the principle and working mechanism of SEM	K1, K2, K3
4	Apply the principle and working mechanism of TEM	K1, K2, K3, K4
5	Illustrate the principle and working mechanism of NMR	K1, K2, K3, K4

Textbooks

1	HPLC: A Practical Guide; 2007; Toshihiko T Hanai, ISBN:9781847551078
2	A Beginners' Guide to Scanning Electron Microscopy; 2018; Anwar Ul-Hamid; ISBN:9783319984827
3	A Practical Guide to Transmission Electron Microscopy: Fundamentals; Zhiping Luo; 2016; ISBN-13: 978-1-60650-703-2
4	Nuclear Magnetic Resonance Spectroscopy: An Introduction to Principles, Applications, and Experimental Methods; Joseph B. Lambert, Eugene P. Mazzola, Clark D. Ridge; 2018; SBN:9781119295280

Reference Books

1	Bioinstrumentation; L. VEERAKUMARI; 2019; MJP Publisher
2	Bioinstrumentation; 2016; M. J. Reilly; ISBN:9788123929132
3	Principles of Bioinstrumentation; Richard Normann; 1988; ISBN:9780471605140
4	Introduction to Bioinstrumentation: With Biological, Environmental, and Medical Applications; Clifford D. Ferris; 1979; ISBN:9780896030039
5	Analytical Techniques in Biosciences From Basics to Applications; Azhar Rasul, Chukwuebuka Egbuna, Jonathan C. Ifemeje, Kingsley C. Patrick-Iwuanyanwu, Muhammad Ajmal Shah; 2021; ISBN:9780128227992

Web Reference

1	HPLC: Principle, Instrumentation, Steps, Types, Uses, Diagram
2	Gas Chromatography-Mass Spectrometry (GC-MS)

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	3	3	2	3	3	2	3	3	3	3
CO2	2	3	3	2	3	3	2	3	3	3	3
CO3	2	3	3	2	3	3	2	3	3	3	3
CO4	2	3	3	2	3	3	2	3	3	3	3
CO5	2	3	3	2	3	3	2	3	3	3	3
Total	10	15	15	10	15	15	10	15	15	15	15
Average	2	3	3	2	3	3	2	3	3	3	3

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTE13	DCE 2- Cryobiology	3	1	0	3	4	25	75	100
DCE-2	Elective Course	Theory							
Learning Objectives									
LO1	To understand cryobiology principles, cryopreservation, and glass transition.								
LO2	To study liquid nitrogen, cryoprotectants, and vitrification.								
LO3	To learn cold adaptation mechanisms, hibernation, and thermoregulation.								
LO4	To understand cold injuries and hypothermia applications.								
LO5	To explore cryobiology applications in medicine and biotechnology.								
Unit	Content								Hours
1	Introduction to Cryobiology, cryopreservation - natural cryopreservation, temperature, risks, slow, permeable freezing, vitrification, uses freezable tissues, equipment, limitations.								12
2	Liquid nitrogen – uses, safety, production; glass transition- introduction, transition temperature T _g , kauzmann’s paradox, the glass transition, specific materials, silica, polymers, mechanism of vitrification, electronic structures; ex-situ conservation; cryoprotectants; cryostasis; neuropreservation.								12
3	Cryopreservation in nature – antifreeze protein, antifreeze, psychrophile, insect winter ecology, cryogenic treatment, cryogenic seal, cryogenic fuel, energy storage, crystal, cryotank, absolute zero, target temperature management.								12
4	Hibernation, heterothermy, hibernaculum; Hypothermia; Cold injuries – chilblains, frostbite, trench foot; Thermoregulation (homeostasis mechanisms, brown adipose tissue role); clinical hypothermia and therapeutic applications								12
5	Application of Cryobiology - cloning, molecular cloning, organ transplantation, sperm bank, semen extender, in-vitro fertilization, embryo transfer, cryosurgery, cryoablation.								12
	Total								60
CO	Course Outcomes								Knowledge Level
	The students will able to								
1	Understand cryobiology and cryopreservation concepts.								K1, K2, K3
2	Gain knowledge of liquid nitrogen, cryoprotectants, and vitrification.								K1, K2, K3, K4
3	Understand cold adaptations and thermoregulation.								K1, K2, K3
4	Recognize cold injuries and clinical hypothermia uses.								K1, K2, K3, K4
5	Apply cryobiology in medical and biotechnological fields.								K1, K2, K3, K4

Textbooks:	
1	Fundamentals of Cryobiology: Physical Phenomena and Mathematical Models – Alexander I. Zhmakin
2	Cryobiology: Concepts and Applications – Marianne Wilde
3	Cryobiology: An Introduction – Michael Cedric
Reference Books:	
1	Cryobiology: Fertility Cryopreservation – Cambridge University Press
2	Cryopreservation: Concepts and Applications – Marianne Wilde
3	Colby Gunn, A comprehensive introduction to Cryobiology, 2017 library press publishing, New York.
Web Resources:	
1	Cryobiology - Cherie Winner - Google Books
2	Current_Frontiers_in_Cryobiology.pdf

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	2	3	3	3	3
CO2	3	3	3	3	3	2	3	3	3	3	2
CO3	3	3	3	3	3	2	3	3	3	3	2
CO4	3	2	3	3	3	2	3	3	3	3	2
CO5	3	2	3	3	3	2	3	3	3	3	2
Total	15	13	15	15	15	10	14	15	15	15	11
Average	3	2.6	3	3	3	2	2.8	3	3	3	2.2

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTE14	DCE -2 Pharmaceutical Biotechnology	3	1	0	3	4	25	75	100
DCE-2	Elective Course	Theory							

Learning Objectives

LO1	To Understand the basic concepts in pharmacology								
LO2	To Understand the importance of biotechnological techniques in pharmaceuticals								
LO3	To Understand the stages in drug development process								
LO4	To Understand clinical aspects of drug action								
LO5	To Understand types and criteria in drug formulation								
Unit	Contents								No. of Hours
1	Introduction to pharmacology, Application of Biotechnology in pharmacology, Pharmacology and Ethnopharmacology: Scope, Applications and Importance; Sources and classification of drugs, Pharmacokinetics- Absorption, Distribution, Metabolism and Excretion (ADME), Pharmacodynamics- Mechanism of drug action								12
2	Biotechnology in pharmaceuticals- Vaccine research and development, Preparation of bacterial vaccines, toxoids, viral vaccine and antitoxins, Hybridoma technology - Production, Purification and Applications; Application of rDNA technology and genetic engineering in the production of vaccines, hormones and antibiotics.								12
I3	Drug development and process- Genomics and proteomics in drug discovery, Pharmacogenetics and pharmacogenomics, Gene expression, Drug targets, Synthetic drugs, Plant Chemicals in modern pharmacology, Drug improvement by structure modification and bio-transformation, Preclinical studies, Criteria for pharmacological evaluation of drugs; Toxicity studies- mutagenicity, carcinogenicity, computational drug design.								12
4	Clinical Pharmacology- Drug therapy, Mechanism of drug action, Therapeutic efficacy, Therapeutic index, tolerance, dosage forms and routes of drug administration, factors affecting drug action; Adverse Drug reactions and drug poisoning-classification and causes of ADR; principle clinical manifestations and treatment of ADR. poisoning; antidotes.								12
5	Formulation of drugs – Drug dosage forms; Classification; Manufacturing of dosage forms; Solid forms – tablets, capsules, powders, granules (coating, disintegration, dissolution); Tablet design (excipients, binders, lubricants); Organoleptic properties; Liquid forms – emulsions, suspensions								12
	Total								60

Course outcome		
CO	Course Outcomes	Knowledge Level
	The students will able to	
1	Perceive the fundamentals in pharmacology	K1, K2, K3
2	Gain insights into biotechnological applications in pharmaceutical industries	K1, K2, K3, K4
3	Acquire knowledge on the critical aspects in drug designing	K1, K2, K3
4	Comprehend clinical factors employed in designing novel drugs	K1, K2, K3, K4
5	Obtain theoretical knowledge in formulating different dosage forms of drugs	K1, K2, K3, K4

Textbooks	
1	Gray Walsh, Pharmaceutical Biotechnology-Concepts and Applications, 2007, Wiley Publications, Pages 465
2	Amritesh C. Shukla, Gitishree Das, Jayanta Kumar Patra, Advances in Pharmaceutical Biotechnology Recent Progress and Future Applications, 2021, Springer Nature Singapore, Page count: 478
3	Saurabh Bhatia, Saif Hameed, Zeeshan Fatima, Introduction to Pharmaceutical Biotechnology, Basic Techniques and Concepts, 2024, IOP Publishing Limited, Pages 488
Reference Books	
1	Ana Catarina Silva, Hugo Almeida, José Manuel Sousa Lobo, João Nuno Moreira, Current Applications of Pharmaceutical Biotechnology, Springer International Publishing, 2020, Pages – 400
2	Daan J. A. Crommelin, Robert D. Sindelar, Pharmaceutical Biotechnology Fundamentals and Applications, Second Edition, Taylor & Francis Publication, 2002, Pages- 425

Web Resources

1	https://bcrti.co.in/digitallibrary/includeFolder/noticeFolder/211109023348114.pdf
2	Pharmacogenetics and Pharmacogenomics: Drug Response and Genetic Polymorphisms Study Guide Quizlet
3	Aspects of Pharmacotherapy, Clinical Pharmacology and Drug Development

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	3	3	2	3	1	1
CO2	3	2	2	1	3	2	2	2	2	2	2
CO3	3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	2	1	2	2	2	2	2	2	2
CO5	3	3	3	3	3	3	3	2	2	2	2
Total	15	14	11	8	14	13	13	11	11	9	9

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTA11	Molecular Therapeutics	2	0	0	2	2	25	75	100
AECC-1	Allied Course	Theory & Problem							
Learning Objectives									
LO1	To understand biomedical ethics, biosafety, and animal research guidelines.								
LO2	To study biostatistics and research analysis methods.								
LO3	To learn molecular therapeutics and gene technologies.								
LO4	To understand drug targets and disease mechanisms.								
LO5	To explore biotherapy and immunotherapy approaches.								
Unit	Content								Hours
1	Ethics in Biomedical Research (ICMR guidelines, informed consent, human vs animal ethics); Biosafety & Biocontainment (BSL-1 to BSL-4, risk groups); Animal models in metabolic & infectious diseases; Animal models in molecular therapeutics; Animal handling & experimentation (CPCSEA guidelines); Research inference & statistical procedures; Biostatistics (descriptive & inferential statistics, hypothesis testing, p-value)								6
2	Basics of Molecular Therapeutics; Fundamentals of Gene Therapy (vectors – viral & non-viral); Gene editing (CRISPR-Cas9 basics); Gene regulation & gene silencing (RNAi, siRNA); Nutrigenomics; Stem cells (types, potency); Nuclear reprogramming; Vaccines & vaccinology (types – live, attenuated, subunit, mRNA vaccines)								6
3	Identification of drug targets; Screening of inhibitors/modulators (high-throughput screening); Molecular mechanisms of pathogenesis; Biotherapy/bioimmunotherapy; Cellular therapy (CAR-T cell basics); Antibody therapeutics (monoclonal antibodies); Cytokine therapy								6
4	Biology of diseases – viral, bacterial, fungal, protozoan; Biotherapy for diseases (antiviral, antibacterial, antifungal strategies); host–pathogen interaction; immunotherapy approaches; Biotherapy of cancer (checkpoint inhibitors basics)								6
5	Cancer stem cells; Recombinant protein therapeutics (insulin, growth factors); Opioid peptide biotherapy.								6
Total								30	
CO	Course Outcomes								Knowledge Level
	The students will able to								
1	Understand ethics, biosafety, and animal research protocols.								K1, K2, K3
2	Apply biostatistics in research analysis.								K1, K2, K3, K4
3	Understand gene therapy and molecular therapeutics.								K1, K2, K3
4	Identify drug targets and disease mechanisms.								K1, K2, K3, K4
5	Apply biotherapy and immunotherapy concepts.								K1, K2, K3, K4

Textbooks:	
1	Gene and Cell Therapy: Biology and Applications-Editor: Giridhara R. Jayandharan
2	Stem Cell Biology and Gene Therapy- Editors: Peter J. Quesenberry et al.
Reference Books:	
1	Molecular Biology of the Cell – Bruce Alberts
2	Lehninger Principles of Biochemistry – Nelson & Cox
3	Basic Immunology – Abbas & Lichtman
4	Biostatistics: A Foundation for Analysis in the Health Sciences – Daniel
5	Advanced Textbook on Gene Transfer, Gene Therapy And Genetic Pharmacology:Principles, Delivery And Pharmacological And Biomedical Applications Of Nucleotide-Based Therapies (Second Edition) Publisher : World Scientific Europe Ltd
Web Resources:	
1	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g
2	https://www.intechopen.com/books/4754

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	3	3	2	3	3	3
CO2	3	3	3	2	2	3	3	2	3	3	3
CO3	3	3	3	2	1	2	3	2	3	3	3
CO4	3	2	2	2	3	2	3	2	3	3	3
CO5	3	3	3	2	2	3	3	2	3	3	3
Total	15	14	14	10	9	13	15	10	15	15	15
Average	3	2.8	2.8	2	1.8	2.6	3	2	3	3	3

3 – Strong, 2- Medium, 1- Low

SECOND SEMESTER

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTC21	Core – 4 Microbiology	5	1	0	5	6	25	75	100
Core 4	Core Course	Theory							
Learning Objectives									
LO1	To understand microbial history, taxonomy, and diversity.								
LO2	To study microbial growth, metabolism, and culture techniques.								
LO3	To learn host–microbe interactions and epidemiology.								
LO4	To understand major microbial diseases and their control.								
LO5	To explore agricultural and environmental microbiology applications.								
Unit	Content							Hours	
1	History & Microbial Taxonomy – Major discoveries (Antonie van Leeuwenhoek, Louis Pasteur, Robert Koch, Carl Woese); Microbial taxonomy – Bacteria, viruses, fungi, algae, protozoa (classification criteria –phenotypic & genotypic, 16S rRNA); Role of bacteria in ecosystems; Applications of microbial diversity (industrial, medical, environmental); Microbial growth – growth curve, factors affecting growth; Microbial metabolism – methanogenesis, acetogenesis, aerobic vs anaerobic metabolism; auxotrophs							18	
2	Microbial culture, identification & control – Growth media (defined, complex, selective, differential);Culturing techniques – streaking method; Pure culture techniques – serial dilution & plating; Identification of bacteria – biochemical tests (IMViC); Microscopy – principles & applications of bright field, fluorescence, phase contrast, SEM; Microbial growth control – Physical methods (heat, filtration, low temperature, high pressure, osmotic pressure, radiation); Chemical methods (disinfectants, antiseptics, antibiotics)							18	
3	Host–microbe interaction & Epidemiology – Human microbiome (skin, GIT, oral cavity, lung); Symbiotic relationships – mutualism, commensalism, parasitism, endophytic association; host immunity basics (innate vs adaptive); Epidemiology – causes, types & transmission of epidemic, endemic & pandemic diseases (R0 concept, modes of transmission)							18	
4	Microbial diseases – General characteristics, pathogenesis, laboratory diagnosis & control; Diseases: Leprosy, COVID-19, Yellow fever, Influenza, AIDS, Ebola, Zika virus, Smallpox, Dengue, Chikungunya, Filariasis, Candidiasis, superficial mycosis (classification into bacterial, viral, fungal, parasitic diseases)							18	
5	Agricultural & Environmental Microbiology – Biological nitrogen fixation (free-living & symbiotic; Rhizobium mechanism); Biofertilizers – types & applications; Rhizosphere effect; Biogeochemical cycles – carbon, nitrogen, sulphur, phosphorus; Methanogenic bacteria; Extremophiles – thermophiles, acidophiles, halophiles, alkalophiles (biotechnological applications of extremophiles)							18	
Total							90		
CO	Course Outcomes							Knowledge Level	
1	Understand microbial taxonomy, diversity, and historical discoveries.							K1,K2, K3	
2	Apply knowledge of microbial growth, culture, and identification methods.							K1, K2, K3	
3	Understand host–microbe interactions and disease transmission.							K1,K3,K4	
4	Identify major microbial diseases and control measures.							K1, K2, K3	
5	Understand microbial roles in agriculture and environment.							K1,K3, K4,K5	

Textbooks:	
1	Joanne Willey, Linda Sherwood, Christopher J. Woolverton, (2017). Microbiology, (10 th edition), McGraw-Hill Education, ISBN: 978-1259281594.
2	Maheshwari DK, Dubey RC 2013. A Textbook of Microbiology. 4 th Edn S Chand Publishing India.
3	Benson HJ. (1999). Microbiological Applications: A Laboratory manual in General Microbiology, 7 th Edition, McGraw Hill.
Reference Books:	
1	Prescott's Microbiology by Joanne Willey, Kathleen Sandman, and Dorothy Wood
2	Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, and Michael A. Pfaller
3	Textbook of Diagnostic Microbiology by Connie R. Mahon, Donald C. Lehman, and George Manuselis
4	Environmental Microbiology by Ian L. Pepper, Charles P. Gerba, and Terry J. Gentry
Web Resources:	
1	https://www.britannica.com/science/microbiology
2	https://www.ncbi.nlm.nih.gov/books/NBK560448/

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	3	3	3	3	2
CO2	3	3	3	3	3	2	3	3	3	3	2
CO3	3	2	3	3	3	2	3	3	3	3	2
CO4	3	2	3	3	3	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3	3	3	3
Total	15	12	15	15	15	12	15	15	15	15	12
Average	3	2.4	3	3	3	2.4	3	3	3	3	2.4

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTC22	Core – 5 Immunology	5	1	0	5	6	25	75	100
Core - 5	Core Course	Theory							
Learning Objectives									
LO1	To Understand the history and scope of immunology.								
LO2	To Identify the different cells of the immune system and their functions.								
LO3	To Understand hypersensitivity and allergic reactions in the immune system.								
LO4	To Understand tumor immunology including tumor antigens and immune responses to cancer.								
LO5	To identify the different types of vaccines such as inactivated, attenuated, and recombinant vaccines.								
Unit	Content								Hours
1	History And Scope of Immunology. Types Of Immunity: Passive, Active and Acquired Immunity. Humoral, Cell Mediated Immunity. Cells and Organs of Immune Response and Their Functions. Antigens Types, Haptens, Epitopes and Factors Influencing Antigenicity. Antibodies Structure Types, Properties and Functions of Immunoglobulins								18
2	Cells Of Immune System. T-Cells, B-Cells, Antigen Presenting Cells, Cell Mediated Subset of T Cells Helper and Suppressor Cells, Natural Killer Cells. Lymphoid Organs (Primary and Secondary) MHC Molecules, Antigen Presentation, B Cell and T Cell Activation, Cytokines Complement System. Structure, Components, Properties and Functions								18
3	Antigen Antibody Reactions: In Vitro Tests- Precipitation, Immune-Electrophoresis. Labeled Antibody (RIA ELISA And Immuno – Fluroscnt Techniques) Hypersensitivity and Allergic Reactions Blood Cell Components, ABO Blood Grouping RH Typing. Application Of Immunological Techniques: Hybridoma Technology: Fusion of Myeloma Cells with Lymphocytes, Production of Monoclonal Antibodies and Their Applications. Human Monoclonals Catalytic Antibodies and Plantibodies								18
4	Hyper Sensitivity Reactions, Auto Immuno Disorders, Deficiencies (Primary and Secondary) And Immuno Tolerance. Tumor Immunology: Tumor Antigens, Immune Responses and Therapy, Tissue and Organ Transplant.								18
5	Immunity To Bacteria, Viruses and Parasites Vaccines and Immunization: Passive and Active Immunization Types of Vaccines – Inactivated, Attenuated and Recombinant Vaccines – Peptide and DNA Vaccines, Synthetic Vaccines, Epitope Mapping.								18
Total								90	
CO	Course Outcomes								Knowledge Level
	The students will able to								
1	Acquire knowledge on types and structure of immune systems and diversity of antibody								K2, K3
2	Elucidate cytokine and compliment-based activation and regulation of immune mechanisms								K2, K3,
3	Understand antigen–antibody reactions, immunological techniques, blood grouping, hypersensitivity, and monoclonal antibody production and applications.								K3,K4
4	Perceive knowledge on Immunodeficiency’s								K1, K2, K3,
5	Understand immune responses to pathogens and gain knowledge of vaccines, immunization methods, and vaccine development approaches.								K3, K4,K5

Textbooks:	
1	Kuby Immunology. W. H. Freeman & Co. Fourth edition, 2000
2	Immunology by Ivan Roitt, Jonathan Brostoff, and David Male. Mosby, London. 6th edition, 2001
3	Roitt's Essential Immunology – <i>Peter J. Delves et al</i>
4	Fundamental Immunology – <i>William E. Paul</i>
5	Immunology – <i>Richard Coico & Geoffrey Sunshine</i>
Reference Books:	
1	Fundamental Immunology, Paul. 7th Edition, Wolters Kluwer, Lippincott Williams and Wilkins publication
Web Resources:	
1	kuby-immunology-6th-edition.pdf
2	Immunology – Swayam https://onlinecourses.swayam2.ac.in/cec19_bt14/preview

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	2	3	3	2	2	3
CO2	3	2	2	2	3	3	3	1	3	3	2
CO3	2	3	3	1	2	3	2	2	3	1	3
CO4	2	2	3	3	3	1	1	2	1	3	3
CO5	3	3	3	3	2	2	2	3	3	1	2
Total	13	12	14	11	13	11	11	11	12	10	13
Average	2.6	2.4	2.8	2.2	2.6	2.2	2.2	2.2	2.4	2	2.6

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTC23P	Microbiology & Immunology Practical	0	0	5	4	5	25	75	100
Core 6	Core Course	Practical							
Learning Objectives									
LO1	To understand isolation and enumeration of bacteria from different sources.								
LO2	To study Gram staining and microbial morphology.								
LO3	To learn biochemical and physiological characterization of bacteria.								
LO4	To understand blood grouping and cell counting.								
LO5	To gain knowledge of immunological diagnostic techniques.								
Unit	Content							Hours	
1	Isolation and Enumeration of bacteria from soil, water, air, plant surface. Isolation of bacteria from root nodules.							15	
2	Gram staining and morphological characterization of microbes Determination of growth curve of bacteria – E.coli Biochemical characterization - catalase, oxidase, urease, coagulase, Starch Hydrolysis test, Lipid Hydrolysis test, Test for H ₂ S production or TSI agar test Antibiotic sensitivity test							15	
3	Preparation and application of liquid, solid and semi solid media Determination of microorganisms using direct count and viable Count techniques.							15	
4	Separation of Serum and Plasma, Blood grouping, WBC counting, RBC counting, WIDAL Slide test, ASO test, RPR test							15	
5	Single Radial Immunodiffusion, Double Immunodiffusion, ELISA, Western Blotting demonstration							15	
Total							75		
CO	Course Outcomes							Knowledge Level	
1	Demonstrate the ability to isolate and enumerate various microorganisms from different environmental sources.							K1,K2, K3	
2	Perform biochemical characterization and morphological identification of bacteria.							K1, K2, K3,	
3	Demonstrate proficiency of microbial growth characteristics for accurate microbiological investigations.							K1,K3,K4	
4	Demonstrate the blood grouping and serological test							K1, K2, K3,	
5	Demonstrate immunodiffusion technique, ELISA & Western blotting test.							K1,K3, K4,K5	

Text Book

1	Microbiology: A Laboratory Manual by James G. Cappuccino and Natalie R.Sherman
2	Bergeys Manual of Determinative Bacteriology by John G. Holt
Reference Books:	
1	Laboratory Manual in General Microbiology by J. W. D. and E. T. K.
2	AmitaJ, Jyotsna AandVimalaV(2018). Microbiology Practical Manual.(1s;'t Edition). Elsevier India
3	Wilmore Webley. (2016). ImmunologyLab Manual, LAD CustomPublishing
4	Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd Edition.
Web Resources:	
1	https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf
2	Immunology – Swayam https://onlinecourses.swayam2.ac.in/cec19_bt14/preview

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	2	3	3	3	3	2
CO2	3	3	3	2	3	2	3	3	3	3	2
CO3	3	3	3	3	2	3	1	3	3	3	3
CO4	3	2	2	2	3	2	1	3	3	3	2
CO5	3	3	2	2	2	3	2	3	2	2	2
Total	15	13	13	11	13	12	10	15	14	14	11
Average	3	2.6	2.6	2.2	2.6	2.4	2	3	2.8	2.8	2.2

3–Strong, 2-Medium,1-Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTE21	DCE-3 Nanobiotechnology	3	2	0	3	5	25	75	100
DCE-3	Elective Course	Theory							
Learning Objectives									
LO1	To understand the basic concepts and historical development of nanotechnology .								
LO2	To Classify different nano biomaterials such as polymer, ceramic, metal, and carbon-based materials								
LO3	To explain the applications of nanomaterials in medicine, dentistry, food, cosmetics, textiles, and environmental remediation.								
LO4	To analyze the use of specialized nanomaterials in imaging and therapy								
LO5	To Evaluate the toxicological aspects, biological interactions, and safety concerns of nanomaterials.								
Unit	Content								Hours
1	Introduction to Nanotechnology – Scientific revolution; Feynman’s vision; Classification of nanobiomaterials; Types of nanomaterials – nanoparticles, nanotubes, nanowires, nanofibers; Size-dependent variation in properties (surface area to volume ratio, quantum effects); Nature’s nanophenomena (lotus effect, gecko adhesion)								15
2	Preparation of nanomaterials – Top-down & bottom-up approaches; Biosynthesis (green synthesis using microbes/plants); Nanobiomaterials – polymer, ceramic, metal-based; Carbon-based nanomaterials (graphene, fullerenes, CNTs); DNA & protein-based nanostructures; Quantum dots; Magnetic nanoparticles; Nanofibers; Hydrogels, films & scaffolds (tissue engineering applications)								15
3	Applications – Bone substitutes & dentistry; Food & cosmetic applications (nanoencapsulation, preservatives); Biosensors & bioremediation; Antimicrobial coatings (medical implants, paints); Textile industry (smart fabrics, nano-finishing)								15
4	Nanomaterials in diagnosis & therapy; Drug delivery implications; Nanocarriers (liposomes, dendrimers, nanoparticles); Drug release mechanisms (controlled, sustained release); Targeted drug delivery; Nanotechnology in cancer therapy & diagnosis (theranostics); Magnetic nanoparticles for imaging & hyperthermia (MRI contrast agents)								15
5	Nanotoxicology; Portals of entry (inhalation, ingestion, dermal); Biototoxicity of nanoparticles; Nanoparticles in mammalian systems & health effects; Biological response & cellular interaction of implants/scaffolds; Risk assessment & safety regulation (OECD guidelines, regulatory aspects)								15
	Total								75
CO	Course Outcomes								Knowledge Level
	The Students will able to								
1	Understand the nanotechnology fundamentals, types and classification of nanomaterials.								K1, K2, K3

2	Understand the preparation methods of nanomaterials and the design and applications of diverse nanobiomaterials	K1,K2, K3,
3	Learn the applications of nanomaterials in healthcare, food, cosmetics, biosensing, bioremediation, antimicrobial coatings, and textile industries.	K1,K3,K4
4	Understand the role of nanomaterials in diagnosis and therapy.	K1, K2, K3,
5	Evaluate nanotoxicology, including nanoparticle entry routes, biological interactions, health risks, and safety assessment and regulation in biomedical applications.	K1,K3, K4,K5

Textbooks:	
1	Chad A. Mirkin and Christof M. Niemeyer, 2007. Nanobiotechnology II: More Concepts and Applications, Wiley-VCH.
2	Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag (2004)
3	Rai, Mahendra, and Clemens Posten (2013). Green.biosynthesis.of.nanoparticles; Mechanisms.and.applications?CABI, ISBN: 9781780642246.
Reference Books:	
1	D.Voet&J.G.Voet (2010), Biochemistry, John Wiley & Sons, New York.
2	David S. Goodsell, "Bionanotechnology", John Wiley & Sons Inc., publications, 2004.
3	Guozhong Cao (2004). Nanostructures and Nanomaterials, synthesis, properties and applications, Imperial College Press, ISBN: 978-1860944802.
4	C.M.Niemeyer, C.A. Mirkin (2007). <i>Nanobiotechnology</i> , WILEY-VCH Verlag GmbH & Co. KG, Weinheim, ISBN: 9783527306589.
WebResources:	
1	nano-hands-on-activities_en.pdf
2	https://web.pdx.edu/~pmoeck/phy381/intro-nanotech.pdf

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CLO1	3	2	2	2	2	2	2	2	3	3	3
CLO2	3	3	2	2	2	3	2	2	3	3	3
CLO3	3	3	3	3	2	3	2	2	3	3	3
CLO4	3	2	3	1	1	2	2	2	3	2	3
CLO5	3	3	3	2	3	3	2	2	3	3	3
TOTAL	15	13	13	10	10	13	10	10	15	15	15
AVERAGE	3	2.6	2.1	1.8	2	2.6	2	2	3	3	3

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTE22	DCE – 3 Environmental Biotechnology	3	2	0	3	5	25	75	100
DCE-3	Elective Course	Theory							
Learning Objectives									
LO1	To understand basic environmental concepts, pollution types, and control measures.								
LO2	To study environmental laws, agencies, and conservation strategies.								
LO3	To learn wastewater treatment processes and microbial roles in waste management.								
LO4	To understand bioreactors, biofilms, and reactor design principles.								
LO5	To gain knowledge of toxicity assessment, bioremediation, and solid waste management.								
Unit	Content								Hours
1	Environment: Basic concepts and issues; Environmental management and Conservation, Environmental Laws & Agencies involved in conservation. Environmental Pollution: Types of pollution & its control strategies -Air pollution, Soil pollution, Water pollution, Oil pollution & Climate change global environmental issues.								15
2	Biofilm Kinetics: Completely mixed biofilm reactor-Soluble microbial products and inert biomass-Biofilm Applications in Wastewater Treatment. Reactor types:- batch reactor - continuous-flow stirred-tank reactor- Plug-flow reactor. Engineering design of reactors- Reactors in series								15
3	Waste water management, source of waste water, Waste water treatment-physical, chemical and biological treatment. Microbiology of Waste water; Aerobic and anaerobic process, BOD and COD.								15
4	Toxicity: Types and Test for evaluating Toxicity. Biosensors, Biomonitoring of toxic materials .Biomagnification, Biomining and Biofuels								15
5	Bioremediation; <i>In-situ and Ex-situ</i> Bioremediation of contaminated soils and waste land; Microbiology of degradation of Xenobiotics in environment; Pesticides, Surfactants, Degradative plasmids. Solid waste: Composting, Vermiculture and methane production. Landfill Management & Leachate Treatment								15
Total:								75	
CO	Course Outcomes								Knowledge Level
	The Students will able to								
1	Understand environmental issues, pollution types, and conservation methods.								K1, K2, K3
2	Gain knowledge of environmental laws and regulatory agencies.								K1, K2, K3, K4
3	Explain wastewater treatment processes including BOD, COD, and microbial roles								K1, K2, K3
4	Understand biofilm kinetics and different types of bioreactors.								K1, K2, K3, K4

5	Apply knowledge of bioremediation, toxicity testing, and solid waste management techniques.	K1, K2, K3, K4
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Textbooks:	
1	Environmental Biotechnology, Hans-Joachim Jördening & Josef Winter
2	Environmental Microbiology and Biotechnology: Biovalorization of Solid Wastes and Wastewater Treatment, Anoop Singh, Shaili Srivastava, Dheeraj Rathore, Deepak Pant
Reference Books:	
1	Gareth M. Evans, Gareth G. Evans, Judy Furlong 2011
2	Environmental biotechnology: theory and application John Wiley & Sons, Ltd. West Sussex, UK
3	M. Moo-Young, W.A. Anderson, A.M. Chakrabarty, 2010. Environmental Biotechnology: Principles and Applications. Springer.
4	M. H. Fulekar, 2010 Environmental Biotechnology, by Science Publishers Department of Life Sciences, University of Mumbai, India,
5	Stanley E. Manahan, 2009. Environmental Chemistry, Ninth Edition, CRC Press.
Web Resources:	
1	lbewww.epfl.ch/LBE/Default_E.htm
2	http://lbe.epfl.ch

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	3	2	2	1	1
CO2	2	3	3	2	2	1	1	1	3	2	2
CO3	3	3	2	3	2	2	2	1	3	3	2
CO4	2	3	2	3	2	2	2	2	2	3	2
CO5	2	2	3	2	3	3	3	3	3	3	3
Total	12	13	11	11	10	10	11	9	13	12	10
Average	2.4	2.6	2.2	2.2	2.0	2.0	2.2	1.8	2.6	2.4	2.0

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTE23	DCE-4 Forensic Science	3	2	0	3	5	25	75	100
DCE-4	Elective Course	Theory							
Learning Objectives									
LO1	To understand the basic concepts and scope of forensic science.								
LO2	To Identify different types of crime scenes and evidence.								
LO3	To Understand methods of evidence collection and preservation.								
LO4	To Understand forensic techniques used in biological and chemical analysis.								
LO5	To understand the basics of forensic ballistics and firearms examination.								
Unit	Contents								Hours
I	Introduction to Forensic Science - Definition, scope, and importance of forensic science, History and development of forensic science, Branches of forensic science, Role of forensic scientists in crime investigation, Basic principles (Locard's Exchange Principle)								15
II	Crime Scene Investigation- Types of crime scenes, Crime scene management and documentation, Collection, preservation, and transportation of evidence, Chain of custody, Role of forensic experts at crime scene								15
III	Physical and Biological Evidence - Types of physical evidence (fingerprints, footprints, tool marks), Biological evidence (blood, hair, saliva, semen), Blood stain pattern analysis, DNA profiling and its applications								15
IV	Forensic Chemistry and Toxicology- Analysis of drugs, poisons, and narcotics, Alcohol and toxic substance detection, Forensic chemistry techniques (chromatography, spectroscopy), Toxicological analysis in crime investigation								15
V	Forensic Ballistics and Questioned Documents - Firearms and ammunition Ballistic examination, Types of questioned documents, Handwriting analysis and forgery detection, Cyber forensics (basic introduction).								15
	TOTAL								75

CO	Course Outcomes The students will able to	Knowledge Level
1	Understand the fundamentals, scope, and principles of forensic science.	K1, K2, K3
2	Gain knowledge of crime scene investigation and proper evidence handling procedures.	K1, K2, K3, K4
3	Identify and analyze various types of physical and biological evidence.	K1, K2, K3
4	Apply concepts of forensic chemistry and toxicology in crime investigation.	K1, K2, K3, K4
5	Evaluate forensic evidence such as ballistics and questioned documents in legal contexts.	K1, K2, K3, K4

Textbooks

1	Saferstein, R. (2017). <i>Criminalistics: An introduction to forensic science</i> (11th ed.). Pearson.
2	Sharma, B. R. (2011). <i>Forensic science in criminal investigation and trials</i> (5th ed.). Universal Law Publishing.
3	Shrivastava, P., Lorente, J. A., Srivastava, A., Badiye, A., & Kapoor, N. (Eds.). (2023). <i>Textbook of forensic science</i> . Springer.
4	Fraser, J. (2010). <i>Forensic science: A very short introduction</i> . Oxford University Press.
5	Houck, M. M. (Ed.). (2016). <i>Encyclopedia of forensic sciences</i> (3rd ed.). Elsevier.

Reference Books

1	Houck, M. M., & Siegel, J. A. (2015). <i>Fundamentals of forensic science</i> (3rd ed.). Academic Press.
2	James, S. H., & Nordby, J. J. (2005). <i>Forensic science: An introduction to scientific and investigative techniques</i> . CRC Press
3	White, P. C. (2010). <i>Crime scene to court: The essentials of forensic science</i> . Royal Society of Chemistry.

Web Resources

1	Introduction to Forensic Science Basics PDF Forensic Science Pathology
2	Introduction to Forensic Science PPT
3	https://www.fbi.gov/

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	3	2	2	3	3	3
CO2	3	3	3	3	3	3	2	2	3	3	3
CO3	3	2	3	3	3	3	2	2	3	3	3
CO4	3	3	3	3	3	3	2	2	3	3	3
CO5	3	2	3	3	3	3	2	2	3	3	3
Total	15	12	15	15	15	15	10	10	15	15	15
Average	3	2.4	3	3	3	3	2	2	3	3	3

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PBTE24	DCE 4 Food Biotechnology	5	0	0	3	5	25	75	100
DCE-4	Elective Course	Theory							
Learning Objectives									
LO1	To understand the basics and applications of food biotechnology.								
LO2	To study GM foods, biosafety, ethics, and regulatory aspects.								
LO3	To learn food quality analysis and safety regulations.								
LO4	To understand microbial production of food products and enzymes.								
LO5	To explore advanced applications like probiotics, nutrigenomics, and biosensors.								
Unit	Content								Hours
1	INTRODUCTION OF FOOD BIOTECHNOLOGY- Food Biotechnology: Introduction & Applications; Methods for the microbiological examination of water and foods; Control of Microbiological quality and safety; Food borne illnesses and diseases; Microbial cultures for food fermentation, their maintenance, strain development.								15
2	GENETICALLY MODIFIED FOOD-GM foods: Introduction and controversies related to GMOs. Ethical issues concerning GM foods; testing for GMOs; current guidelines for the production, release and movement of GMOs; labelling and traceability; trade related aspects; biosafety; risk assessment and risk management. Public perception of GM foods. IPR. GMO Act–2004. New products and processes in various food commodities including plant and animal products.								15
3	FOOD QUALITY AND ITS REGULATIONS- Analysis of food, major ingredients present in different product, Food additives colour, flavour, vitamins, Microbial safety of food products, Chemical safety of food products, heavy metal, fungal toxins, pesticide and herbicide contamination.								15
4	PRODUCTION OF FOOD PRODUCTS- Production of organic acids (vinegar, lactic acid), alcoholic beverages (beer, wine, and distilled alcoholic beverages such as whiskey, rum, vodka), glycerol; Propagation of baker's yeasts. Microbial production of vitamins (B2 and B12), antibiotics (penicillin, streptomycin, tetracycline); Enzymatic production of glucose, fructose, starch, SCP and mushrooms.								15
5	APPLICATIONS OF FOOD BIOTECHNOLOGY- Starter cultures–types, designing and development, micro encapsulation and packaging, scopes and challenge; Development and formulation of novel products such as probiotic foods. Nutrigenomics-concept, working, significance and relevance. Biosensors and novel tools and their application in food science & Technology.								15
								TOTAL	75
CO	Course Outcomes								Knowledge Level
	The students will able to								
1	Understand principles and applications of food biotechnology.								K2, K3
2	Gain knowledge of GM foods, biosafety, and regulatory frameworks.								K2, K3,
3	Analyze food quality, safety, and contamination issues.								K3,K4
4	Understand microbial production of food products and industrial applications.								K1, K2, K3,
5	Apply knowledge of probiotics, nutrigenomics, and biosensors in food science.								K3, K4,K5

Textbooks:	
1	B. Srilakshmi, Food science, New Age Publishers,2002.
2	James M. Jay, Modern Food Micro-Biology, (2000), 6th edition, An Aspen Publication, Maryland, USA.
3	Coles R, McDowell D and Kirwan MJ, Food Packaging Technology, CRC Press, 2003.
4	Lee, B. H. Fundamentals of Food Biotechnology.VCH. 2006.
Reference Books:	
1	G.F.G. Lopez & G.V.B. Canovas, Food Science and Food Biotechnology (2003), CRCPress, Florida, USA.
2	Ranganna S, Handbook of Analysis and Quality Control for Fruits and Vegetable Products (1986), 2nd ed. TMH Education Pvt. Ltd.
3	GokogluN.Novel natural food preservatives and applications in seafood preservation: a review.(2019), Journal of Science Food and Agriculture, Voulme 99, Issue 5, Page number 2068-2077.
Web Resources:	
1	Food Biotechnology Journal Taylor & Francis Online
2	Food Science and Technology - Course

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	2	2	2	3	2	2
CO2	3	3	2	3	2	3	3	3	2	3	3
CO3	3	3	3	2	2	2	3	2	3	2	3
CO4	3	2	3	2	3	2	2	2	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3
Total	15	14	13	12	13	12	13	13	13	13	14
Average	3.0	2.8	2.6	2.4	2.6	2.4	2.6	2.6	2.6	2.6	2.8

3 – Strong, 2- Medium, 1- Low

Department of Biotechnology		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CI A	ESE	Total
Course Code	Title of the Course								
26PBTS21	Clinical Trials and Management	2	1	0	2	3	25	75	100
SEC-1	Skill Enhancement Course	Theory							
Learning Objectives									
LO1	To understand drug, biologics, and device development processes.								
LO2	To learn GCP guidelines, ethics, and regulatory requirements.								
LO3	To study clinical trial design and management.								
LO4	To understand clinical data management and documentation.								
LO5	To explore global clinical trials and international guidelines								
Unit	Content								Hours
1	Developing New Drugs, Biologics & Devices – Drug development process; Pre-clinical studies (in vitro, in vivo); Clinical trials – Phase I–IV; Application for market approval (IND, NDA/BLA basics); Development of medical devices (classification & regulatory pathway); Post-marketing surveillance (pharmacovigilance, Phase IV studies)								9
2	Good Clinical Practice (GCP) & Regulatory Guidelines – Principal investigator responsibilities; Sponsor responsibilities; investigator–sponsor roles; Regulatory guidelines (ICH-GCP, FDA, CDSCO); Informed consent; Institutional Review Boards (IRB/IEC); Monitoring, audits & inspections (compliance and documentation)								9
3	Protocol, Feasibility & Study Activities – Components of a protocol; Study organization; Objectives/endpoints; Study design (randomized, double-blind, placebo-controlled); Statistical aspects (sample size, power); Subject data & record retention; Monitoring; Study phases – start-up, maintenance, completion & close-out								9
4	Managing Clinical Trial Data – Guidelines & regulations (data integrity, ALCOA principles); Site responsibilities; Source document verification (SDV); Confidentiality; Endpoint adjudication; electronic data capture (EDC), clinical data management systems (CDMS)								9
5	Global Health & International Trials – International clinical trials; Ethnic & racial differences; Ethical issues & cultural sensitivities; Importance of global trials; Diseases (HIV/AIDS, malaria, tuberculosis, polio); International regulations (WHO, ICH guidelines); Future directions (global collaborations, pandemic trials)								9
TOTAL :								45	

CO	Course Outcomes The students will able to	Knowledge Level
1	Understand drug, biologics, and device development pathways.	K1, K2, K3
2	Apply GCP guidelines and ethical principles in clinical trials.	K1, K2, K3, K4
3	Design and manage clinical trial protocols.	K1, K2, K3
4	Ensure proper clinical data management and compliance.	K1, K2, K3, K4
5	Understand global clinical research and regulations.	K1, K2, K3, K4

Textbooks:	
1	Liu, M.B. and Davis, K., Clinical trials manual from the Duke Clinical Research Institute: lessons from a horse named Jim., John Wiley & Sons, Ltd., 2nd Edition, 2010.
2	Gallin, J.I. and Ognibene, F.P. Johnson.L. Principles and Practice of Clinical Research, Academic Press., 4th Edition, 2017
Reference Books:	
1	Principles and Practice of Clinical Trials , <i>Editors: Steven Piantadosi, Curtis L. Meinert, Publisher: Springer</i>
2	Quick Guide to Good Clinical Practice, Author: Cingi Muluk Principles of Good Clinical Practice, Author: Michael J. McGraw, Publisher: Pharmaceutical Press
3	<i>Essential Guide to Good Clinical Practice</i> by Dr. Jagadeesh Manjunath, Publisher: Cliniminds or associated academic press (regional editions vary)
4	Handbook of SOPs for Good Clinical Practice, <i>Author: Celine Clive</i>
Web Resources:	
1	https://www.ich.org/
2	https://clinicalstudies.in/

Mapping Programme Outcomes and Programme Specific Outcomes with Course Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	3	3	3	3	3	3
CO2	3	3	3	2	2	3	3	3	3	3	3
CO3	3	3	3	2	1	2	3	3	3	3	3
CO4	3	2	2	2	3	2	3	3	3	3	3
CO5	3	3	3	2	3	3	3	3	3	3	2
Total	15	14	14	10	10	13	15	15	15	15	14
Average	3	2.8	2.8	2	2	2.6	3	3	3	3	2.8

3 – Strong, 2- Medium, 1- Low