

M Sc BIOTECHNOLOGY

LOCF SYLLABUS 2025



Department of Biotechnology

School of Biological Sciences
St. Joseph's College (Autonomous)

SCHOOLS OF EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS) POSTGRADUATE COURSES

St. Joseph's College (Autonomous), an esteemed institution in the realm of higher education in India, has embarked on a journey to uphold and perpetuate academic excellence. One of the pivotal initiatives in this pursuit is the establishment of five Schools of Excellence commencing from the academic year 2014-15. These schools are strategically designed to confront and surpass the challenges of the 21st century.

Each School amalgamates correlated disciplines under a unified umbrella, fostering synergy and coherence. This integrated approach fosters the optimal utilization of both human expertise and infrastructure. Moreover, it facilitates academic fluidity and augments employability by nurturing a dynamic environment conducive to learning and innovation. Importantly, while promoting collaboration and interdisciplinary study, the Schools of Excellence also uphold the individual identity, autonomy, and distinctiveness of every department within.

The overarching objectives of these five schools are as follows:

1. **Optimal Resource Utilization:** Ensuring the efficient use of both human and material resources to foster academic flexibility and attain excellence across disciplines.
2. **Horizontal Mobility for Students:** Providing students with the freedom to choose courses aligning with their interests and facilitating credit transfers, thereby enhancing their academic mobility and enriching their learning experience.
3. **Credit-Transfer Across Disciplines (CTAD):** The existing curricular structure, compliant with regulations from entities such as TANSCHÉ and other higher educational institutions, facilitates seamless credit transfers across diverse disciplines. This underscores the adaptability and uniqueness of the choice-based credit system.
4. **Promotion of Human Excellence:** Nurturing excellence in specialized areas through focused attention and resources, thus empowering individuals to excel in their respective fields.
5. **Emphasis on Internships and Projects:** Encouraging students to engage in internships and projects, serving as stepping stones toward research endeavors, thereby fostering a culture of inquiry and innovation.
6. **Addressing Stakeholder Needs:** The multi-disciplinary nature of the School System is tailored to meet the requirements of various stakeholders, particularly employers, by equipping students with versatile skills and competencies essential for success in the contemporary professional landscape.

In essence, the Schools of Excellence at St. Joseph's College (Autonomous) epitomize a holistic approach towards education, aiming not only to impart knowledge but also to cultivate critical thinking, creativity, and adaptability – qualities indispensable for thriving in the dynamic global arena of the 21st century.

Credit system

The credit system at St. Joseph's College (Autonomous) assigns weightage to courses based on the hours allocated to each course. Typically, one credit is equivalent to one hour of instruction per week. However, credits are awarded regardless of actual teaching hours to ensure consistency and adherence to guidelines.

The credits and hours allotted to each course within a programme are detailed in the Programme Pattern table. While the table provides a framework, there may be some flexibility due to practical sessions, field visits, tutorials, and the nature of project work.

For postgraduate (PG) courses, students are required to accumulate a minimum of 92 credits, as stipulated in the programme pattern table. The total minimum number of courses offered by the department is outlined in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)

OBE is an educational approach that revolves around clearly defined goals or outcomes for every aspect of the educational system. The primary aim is for each student to successfully achieve these predetermined outcomes by the culmination of their educational journey. Unlike traditional methods, OBE does not

prescribe a singular teaching style or assessment format. Instead, classes, activities, and evaluations are structured to support students in attaining the specified outcomes effectively.

In OBE, the emphasis lies on measurable outcomes, allowing educational institutions to establish their own set of objectives tailored to their unique context and priorities. The overarching objective of OBE is to establish a direct link between education and employability, ensuring that students acquire the necessary skills and competencies sought after by employers.

OBE fosters a student-centric approach to teaching and learning, where the delivery of courses and assessments are meticulously planned to align with the predetermined objectives and outcomes. It places significant emphasis on evaluating student performance at various levels to gauge their progress and proficiency in meeting the desired outcomes.

Here are some key aspects of Outcome-Based Education:

Course: A course refers to a theory, practical, or a combination of both that is done within a semester.

Course Outcomes (COs): These are statements that delineate the significant and essential learning outcomes that learners should have achieved and can reliably demonstrate by the conclusion of a course. Typically, three or more course outcomes are specified for each course, depending on its importance.

Programme: This term pertains to the specialization or discipline of a degree programme.

Programme Outcomes (POs): POs are statements that articulate what students are expected to be capable of by the time they graduate. These outcomes are closely aligned with Graduate Attributes.

Programme Specific Outcomes (PSOs): PSOs outline the specific skills and abilities that students should possess upon graduation within a particular discipline or specialization.

Programme Educational Objectives (PEOs): PEOs encapsulate the expected accomplishments of graduates in their careers, particularly highlighting what they are expected to achieve and perform during the initial years postgraduation.

LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

The Learning Outcomes-Centric Framework (LOCF) places the learning outcomes at the forefront of curriculum design and execution. It underscores the importance of ensuring that these outcomes are clear, measurable, and relevant. LOCF orchestrates teaching methodologies, evaluations, and activities in direct correlation with these outcomes. Furthermore, LOCF adopts a backward design approach, focusing on defining precise and attainable learning objectives. The goal is to create a cohesive framework where every educational element is in harmony with these outcomes.

Assessment practices within LOCF are intricately linked to the established learning objectives. Evaluations are crafted to gauge students' achievement of these outcomes accurately. Emphasis is often placed on employing authentic assessment methods, allowing students to showcase their learning in real-life scenarios. Additionally, LOCF frameworks emphasize flexibility and adaptability, enabling educators to tailor curriculum and instructional approaches to suit the diverse needs of students while ensuring alignment with the defined learning outcomes.

Some important terminologies

Core Courses (CC): These are compulsory courses that students must undertake as essential components of their curriculum, providing fundamental knowledge within their primary discipline. Including core courses is essential to maintain a standardized academic programme, ensuring recognition and consistency across institutions.

Discipline Specific Elective Courses (ES): Elective courses are offered within the main discipline or subject of study. They allow students to select specialized or advanced options from a range of courses, offering in-depth exposure to their chosen area of study. Typically, ES are more applied in nature and provide a deeper understanding of specific topics.

Research Methodology/IPR(RM): It is a two-credit course offered in the third semester as a common program across disciplines within the school. It is designed to acquaint postgraduate learners with the research foundations and legal frameworks vital for innovation and entrepreneurship in technology and business.

Open Elective Courses (OE): These elective courses are chosen from disciplines unrelated to the student's main area of study, aiming to broaden their exposure and knowledge base. As per the Choice Based Credit System (CBCS) policy, students may opt for open elective courses offered by other disciplines within the college, enhancing the diversity of their learning experience.

Ability Enhancement Course (AEC): AE is designed to enhance skills and proficiencies related to the student's main discipline. It aims to provide practical training and hands-on experience, contributing to the overall development of students pursuing academic programmes.

Skill Enhancement Course (SEC): SE focus on developing specific skills or proficiencies relevant to students' academic pursuits. While it is open to students from any discipline, SE is particularly beneficial for those within the related academic programme.

Self-Learning (SL): A two-credit course designed to foster students' ability for independent and self-directed learning. There are Three Self-Learning Courses:

- 'Global Citizenship Education' a common online course offered to all PG students in Semester I on JosTEL.
- Compulsory MOOC on NPTEL-SWAYAM in Semester I or II
- A Department-Specific Self-Learning Course in Semester III on JosTEL

Comprehensive Examination (CE): These examinations cover detailed syllabi comprising select units from courses offered throughout the programme. They are designed to assess crucial knowledge and content that may not have been covered extensively in regular coursework.

Extra Credit Courses: To support students in acquiring knowledge and skills through online platforms such as Massive Open Online Courses (MOOCs), additional credits are granted upon verification of course completion. These extra credits can be availed across three semesters (2 - 4). In line with UGC guidelines, students are encouraged to enhance their learning by enrolling in MOOCs offered by portals like SWAYAM, NPTEL, and others. Additionally, certificate courses provided by the college are also considered for these extra credits.

Outreach Programme (OR): It is a compulsory course to create a sense of social concern among all the students and to inspire them to dedicated service to the needy.

Course Coding

The following code system (10 alphanumeric characters) is adopted for Postgraduate courses:

25	UXX	0	XX	00/X
Year of Revision	PG Department Code	Semester Number	Course Specific Initials	Running Number/with Choice

Course Specific Initials

CC - Core Course

CP - Core Practical

ES - Discipline Specific Elective

AE - Ability Enhancement Course

SL - Self-Learning

OE – Open Elective

PW - Project and Viva Voce

CE - Comprehensive Examination

OR - Outreach Programme

EVALUATION PATTERN (PG)

Continuous Internal Assessment

Sl No	Component	Marks Allotted
1	Mid Semester Test	30
2	End Semester Test	30
3	*Two Components (15 + 20)	35
4	Library Referencing	5
Total		100

Passing minimum: 50 marks

* The first component is a compulsory online test (JosTEL platform) for 15 marks comprising 7 questions (1 mark) at K1 level and 4 questions (2 marks) at K2 level; The second component is decided by the course in-charge in accordance with the prescribed K levels.

Question Paper Blueprint for Mid and End Semester Tests

Duration: 2 Hours			Maximum Marks: 60						
Section			K levels						Marks
			K1	K2	K3	K4	K5	K6	
A (compulsory)			7						$7 \times 1 = 7$
B (compulsory)				5					$5 \times 3 = 15$
C (either...or type)					3				$3 \times 6 = 18$
D (2 out of 3)	Mid Sem					1(2)	1*		$2 \times 10 = 20$
	End Sem						1(2)	1*	
Total									60

* Compulsory

Question Paper Blueprint for Semester Examination

Duration: 3 Hours				Maximum Marks: 100			
Section	K levels						Marks
	K1	K2	K3	K4	K5	K6	
A (compulsory)	10						$10 \times 1 = 10$
B (compulsory)		10					$10 \times 3 = 30$
C (either...or type)			5				$5 \times 6 = 30$
D (3 out of 5)				1(2)	1(2)	1*	$3 \times 10 = 30$
Total							100

* Compulsory

Evaluation Pattern for One/Two-credit Courses

Title of the Course	CIA	Semester Examination	Final
• Ability Enhancement Course	20 + 10 + 20 = 50	50 (Department)	100
• Self - Learning Course (Dept. Specific) • Comprehensive Examination	25 + 25 = 50	50 (CoE)	100
• Internship • Self - Learning Course (Common) • Self - Learning Online Course (NPTEL / SWAYAM)	100	-	100
• Skill Enhancement Course: Soft Skills	100	-	100
• Project Work and Viva Voce	100	100	100

Grading System

The marks obtained in the CIA and semester for each course will be graded as per the scheme provided in Table - 1.

From the second semester onwards, the total performance within a semester and the continuous performance starting from the first semester are indicated by Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA), respectively. These two are calculated by the following formulae:

$$SGPA \text{ and } CGPA = \frac{\sum_{i=1}^n C_i Gp_i}{\sum_{i=1}^n C_i}$$

$$WAM = \frac{\sum_{i=1}^n C_i M_i}{\sum_{i=1}^n C_i}$$

Where,

C_i - credit earned for the Course i

Gp_i - Grade Point obtained for the Course i

M_i - Marks obtained for the Course i

n - Number of Courses **passed** in that semester

WAM - Weighted Average Marks

Table - 1: Grading of the Courses for PG

Mark Range	Grade Point	Corresponding Grade
90 and above	10	O
80 and above and below 90	9	A+
70 and above and below 80	8	A
60 and above and below 70	7	B+
50 and above and below 60	6	B
Below 50	0	RA

Table - 2: Grading of the Final Performance for PG

CGPA	Grade	Performance
9.00 and above	O	Outstanding*
8.00 to 8.99	A+	Excellent*
7.00 to 7.99	A	Very Good
6.00 to 6.99	B+	Good
5.00 to 5.99	B	Above Average
Below 5.00	RA	Re-appear

**The Candidates who have passed in the first appearance and within the prescribed duration of the PG programme are eligible. If the Candidates Grade is O/A+ with more than one attempt, the performance is considered “Very Good”.*

Vision

Forming globally competent, committed, compassionate and holistic persons, to be men and women for others, promoting a just society.

Mission

- Fostering learning environment to students of diverse background, developing their inherent skills and competencies through reflection, creation of knowledge and service.
- Nurturing comprehensive learning and best practices through innovative and value- driven pedagogy.
- Contributing significantly to Higher Education through Teaching, Learning, Research and Extension.

Programme Educational Objectives (PEOs)

1. Graduates will be able to accomplish professional standards in the global environment.
2. Graduates will be able to uphold integrity and human values.
3. Graduates will be able to appreciate and promote pluralism and multiculturalism in working environment.

Programme Outcomes (POs)

1. Graduates will be able to apply assimilated knowledge to evolve tangible solution to emerging problems.
2. Graduates will be able to analyze and interpret data to create and design new knowledge.
3. Graduates will be able to engage in innovative and socially relevant research and effectively communicate the findings.
4. Graduates will become ethically committed professional and entrepreneurs upholding human values.
5. Graduates imbued with ethical values and social concern will be able to understand and appreciate cultural diversity, social harmony and ensure sustainable environment.

Programme Specific Outcomes (PSOs)

1. Graduates will acquire knowledge in the domain of Biotechnology with respect to emerging concepts and techniques.
2. Graduates will be able to identify, understand, design, perform experiments and apply the acquired skills in solving complex biotechnology problems using modern tools and techniques.
3. Graduates will be able to understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.
4. Graduates will be fostered for R & D activities, entrepreneurship, and effectively communicate the novel findings to the scientific community.
5. Graduates will apply bioethical principles and related norms towards next-generation product/technique development.

M. Sc. Biotechnology				
Programme Structure				
Semester	Specification	No. of Courses	Hours	Credits
1 – 4	Core Course	11	59	51
1 - 4	Core Practical	5	25	10
1, 3 & 4	Discipline Specific Elective	3	12	9
1 – 2	Open Elective	2	8	4
1	Ability Enhancement Course	1	2	1
1 – 3	Self-Learning	3	-	4
2	Skill Enhancement Course	1	4	2
3	Research Methodology	1	4	2
4	Project	1	6	3
4	Comprehensive Examination	1	-	2
2 – 4	Outreach Programme (SHEPHERD)	-	-	4
1 – 4	Extra Credit Course	4	-	12
	Total	33	120	92 (12)

M Sc BIO TECHNOLOGY PROGRAMME PATTERN								
Course Details						Scheme of Exams		
Sem.	Course Code	Course Type	Title of the Course	Hours	Credits	CIA	SE	FINAL
1	25PBT1CC01	CC Major	Core Course - 1: Biochemistry	5	5	100	100	100
	25PBT1CC02		Core Course - 2: Molecular Cell Biology	5	4	100	100	100
	25PBT1CC03		Core Course - 3: Bioinstrumentation	5	4	100	100	100
	25PBT1CP01		Core Practical - 1: Biochemistry, Molecular Cell Biology and Bioinstrumentation	5	2	100	100	100
	25PBT1ES01A	DSE	Discipline Specific Elective - 1: Biostatistics	4	3	100	100	100
	25PBT1ES01B		Discipline Specific Elective - 1: Cell Signaling					
	25PBT1AE01	AEC	Ability Enhancement Course: Entrepreneurship Skills for Biotechnology	2	1	100	-	100
	25PBT1OE01	OE	Open Elective - 1 (WS): Medical Biotechnology	4	2	100	100	100
	25PGC1SL01	SL	Global Citizenship Education (Online)	-	1	100	-	100
	-	-	Extra Credit Course	-	(3)			
Total				30	22 (3)			
2	25PBT2CC04	CC Major	Core Course - 4: Microbiology	6	5	100	100	100
	25PBT2CC05		Core Course - 5: Immunology	6	5	100	100	100
	25PBT2CC06		Core Course - 6: Recombinant DNA Technology (Internship Embedded Course)	5	4	100	100	100
	25PBT2CP02		Core Practical - 2: Recombinant DNA Technology and Immunology	5	2	100	100	100
	25PBT2OE02	OE	Open Elective - 2 (BS): Food Technology	4	2	100	100	100
	25PSS2SE01	SEC	Skill Enhancement Course: Soft Skills	4	2	100	-	100
	25PBT2SL02	SL	Online Courses: NPTEL / SWAYAM	-	2	-	100	100
	-	-	Extra Credit Course	-	(3)			
Total				30	22 (3)			
3	25PBT3CC07	CC Major	Core Course - 7: Bioinformatics	6	5	100	100	100
	25PBT3CC08		Core Course - 8: Industrial Biotechnology	6	5	100	100	100
	25PBT3CC09		Core Course - 9: Genomics and Proteomics	5	4	100	100	100
	25PBT3CP03		Core Practical - 3: Bioinformatics and Industrial Biotechnology	5	2	100	100	100
	25PBT3ES02A	DSE	Discipline Specific Elective - 2: Synthetic Biology	4	3	100	100	100
	25PBT3ES02B		Discipline Specific Elective - 2: Developmental Biology					
	25SBS3RM01	RM	Intellectual Property Rights	4	2	100	100	100
	25PBT3SL03	SL	Self Learning: Fundamentals of Genetics*	-	1	50	50	50
	-	-	Extra Credit Course	-	(3)			
Total				30	22 (3)			
4	25PBT4CC10	CC Major	Core Course - 10: Bio nanotechnology	5	5	100	100	100
	25PBT4CC11		Core Course - 11: Plant and Animal Biotechnology	5	5	100	100	100
	25PBT4CP04		Core Practical - 4: Bio nanotechnology	5	2	100	100	100
	25PBT4CP05		Core Practical - 5: Plant and Animal Biotechnology	5	2	100	100	100
	25PBT4ES03A	DSE	Discipline Specific Elective - 3: Food Biotechnology	4	3	100	100	100
	25PBT4ES03B		Discipline Specific Elective - 3: Research Methodology, Biosafety and Bioethics					
	25PBT4PW01	PW	Project	6	3	100	100	100
	25PBT4CE01	CE	Comprehensive Examination*	-	2	50	50	50
	-	-	Extra Credit Course	-	(3)			
Total				30	22 (3)			
2-4	25PCW4OR01	OR	Outreach Programme	-	4			
1-4	Total			120	92 (12)			

*For Grade Calculation: Marks obtained out of 50 will be converted into 100 in the mark statements.

Open Elective - 1 (WS): 1st Semester

School	Course Code	Title of the Course
SBS		
Botany	25PBO1OE01	Medicinal Botany
Biochemistry	25PBI1OE01	Biochemistry of Natural Products
Biotechnology	25PBT1OE01	Medical Biotechnology

Open Elective – 2 (BS): 2nd Semester
Offered to students from other Schools

School	Course Code	Title of the Course
SBS		
Botany	25PBO2OE02	Sustainable Horticulture and Urban Landscaping
Biochemistry	25PBI2OE02	First Aid Management
Biotechnology	25PBT2OE02	Food Technology
SCS		
Artificial Intelligence and Machine Learning	25PAI2OE02	Cyber Security
Computer Science	25PCA2OE02A	Web Design
	25PCA2OE02B	Cyber Security
Information Technology	25PCS2OE02	Recent Trends in Computing
Data Science	25PDS2OE02	Discrete Mathematics
Mathematics	25PMA2OE02	Operations Research
Visual Communication	25PVC2OE02	Women and Media
SLAC		
English	25PEN2OE02	English for Digital Media
History	25PHS2OE02	Public Administration
Tamil	25PTA2OE02	விளம்பரக்கலை (Art of advertising)
SMS		
Commerce	25PCO2OE02	Basics of Tally Prime
Commerce Computer Application	25PCC2OE02	Behavioural Dynamics and Psychology
Counselling Psychology	25PCP2OE02	Artificial Intelligence in Psychology
Economics	25PEC2OE02	Managerial Economics
Human Resource Management	25PHR2OE02	Counselling and Guidance
SPS		
Chemistry	25PCH2OE02	Chemistry of Health and Nutrition
Electronics	25PEL2OE02	Computer Hardware and Networks
Physics	25PPH2OE02A	Physics for Competitive Exams
	25PPH2OE02B	Nanoscience

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	25PBT1CC01	Core Course 1: Biochemistry	5	5

Course Objectives

- To understand the basics of Henderson Hasselbalch equation, carbohydrates and enzymes.
- To provide the basic knowledge about lipid metabolism and its related significance.
- To enlighten on bio-energetics and biological oxidation pathways.
- To update the knowledge on amino acids and proteins.
- To assess and appraise the role of nucleic acids.

UNIT I: Electrochemistry and Carbohydrates

(15 Hours)

pH, pKa. acid, base. Buffers - Henderson- Hasselbalch equation, biological buffer system. Water, Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms: glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway. Introduction to Enzymes: Nomenclature and classification, Mechanisms of enzyme substrate binding: Lock & Key model, Induced fit model. Mechanism of enzyme catalysis: Lysozyme

UNIT II: Lipids

(15 Hours)

Nomenclature, classification, structure, chemical and physical properties of lipids. Metabolisms: biosynthesis of fatty acids, triglycerides, phospholipids, glycolipids. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, sphingolipids and steroids.

UNIT III: Bioenergetics

(15 Hours)

Concept of energy, Principle of thermodynamics, Relationship between standard free energy and Equilibrium constant, ATP as universal unit of free energy in biological systems. Biological oxidation: Electron transport chain, oxidative phosphorylation, glycolysis, citric acid cycle, Cori cycle, glyoxylate pathway. Oxidation of fatty acids- mitochondria and peroxisomes, α and β -oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies. Photosynthesis, urea cycle, hormonal regulation of fatty acids.

UNIT IV: Proteins

(15 Hours)

Amino acids and Protein: Nomenclature, Classification, structure, chemical and physical properties of amino acids and proteins. Metabolisms: Biosynthesis of amino acids. Degradation of proteins, nitrogen metabolisms and carbon skeleton of amino acids.

UNIT V: Nucleic Acids

(15 Hours)

Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. *De novo* and salvage synthesis of purines, pyrimidine bases, nucleosides and nucleotides. Catabolism of purines and pyrimidines bases.

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment Methodology	Quiz, Seminar, Assignments and Group Discussion

Books for Study:

1. Nelson. *et al.* (2021). *Lehninger Principles of Biochemistry*, (8th Ed.) Macmillan Learning.
2. Stryer, L. (2015). *Biochemistry*, (7th Ed.). W. H. Freeman & Co.
3. Murray, R. K., Granner, B. K., Mayes. P. A. & Rodwell, V. W. (2012). *Harper's Biochemistry*, (29th Ed.). Prentice Hall International.

Books for Reference:

1. Kuchel, P., Easterbrook-Smith, S., Gysbers, V., & Matthew, J. M. (2011). *Schaums Outline of Biochemistry*, (3rd Ed.). McGraw-Hill.
2. Sathyanarayana, U. & Chakrapani. U. (2011). *Biochemistry*, Books and Allied private limited.
3. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2010). *Biochemistry*, (6th Ed.). W. H. Freeman.

Websites and eLearning Sources:

1. https://web.mit.edu/blossoms/videos/lessons/atp_fuel_life/
2. <https://oercommons.org/courseware/lesson/93659/overview>

3. <https://www.ncbi.nlm.nih.gov/books/NBK482303/>
4. https://www.lipidmaps.org/resources/lipidweb/lipidweb_html/lipids/simple/tag2/index.htm

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K-Level)
	On successful completion of this course, students will be able to	
CO1	Identify the structure and function of monosaccharides, polysaccharides and enzymes.	K1
CO2	Provide basic knowledge about lipid metabolism and its related significance.	K2
CO3	Illustrate the synthesis of biomolecules, its role in metabolic pathways and regulation.	K3
CO4	Infer the concept of energy and about the principles of thermodynamics.	K4
CO5	Assess the amino acids structures, chemical properties and their organization into proteins.	K5
CO6	Rewrite the importance and role of nucleic acids.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
1	25PBT1CC01		Core Course - 1: Biochemistry							5	5
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	3	2	2	2	2	2.1
CO2	3	3	3	2	3	2	3	2	3	2	2.6
CO3	3	3	2	2	2	2	2	3	2	3	2.4
CO4	3	1	2	2	3	2	3	3	2	2	2.3
CO5	3	2	2	2	3	2	3	2	3	2	2.4
CO6	2	2	3	1	2	1	2	2	2	1	1.8
Mean Overall Score											2.27 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	25PBT1CC02	Core Course - 2: Molecular Cell Biology	5	4

Course Objectives
To understand the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular recognition.
To identify the structures and purposes of basic components in prokaryotic and eukaryotic cells & their molecular mechanisms.
To demonstrate the mechanisms of nuclear envelope and its functions.
To evaluate the basic knowledge in the components of main signaling pathways and their functional properties.
To plan the appropriate diagnostic method for the detection of cancer.

UNIT I: Introduction to Cell Biology (15 Hours)

Basic properties of cells - Cellular dimension - Size of cells and their composition - Cell origin and Evolution (Endosymbiotic theory). Organelles of the eukaryotic cell and its functions; Bio membranes - structural organization, transport across membrane (Passive, Active and Bulk transport); Cell - Cell adhesion - Cell junctions (Tight junctions, Gap junctions, Desmosomes, Adherens); Extra cellular matrix (ECM)-components.

UNIT II: Genome Organization and Protein sorting (15 Hours)

Genome organization in Eukaryotes, DNA Replication, Transcription, Translation and Post Translational Modification. Synthesis, Sorting and trafficking of proteins: site of synthesis of organelle and membrane proteins - transport of secretory and membrane proteins across Endoplasmic Reticulum (ER) - post-translational modification in RER - transport to mitochondria, nucleus, chloroplast and peroxisome - protein glycosylation - mechanism and regulation of vesicular transport - Golgi and post- Golgi sorting and processing - receptor mediated endocytosis.

UNIT III: Nucleus (15 Hours)

Nuclear envelope - Nuclear pore complexes-nuclear matrix - organization of chromatin - supercoiling, linking number, twist - nucleosome and high order of folding and organization of chromosome (Solenoid and Zigzag model)-Global structure of chromosome - (Lamp brush and Polytene chromosomes).

UNIT IV: Cell Signaling (15 Hours)

Molecular basis of eukaryotic cell cycle, Regulation and cell cycle check points; Programmed cell death (Apoptosis); Cell-Cell signaling - signaling molecules, types of signaling, Signal transduction pathways (GPCR-cAMP, IP3, RTK, MAP Kinase, JAK-STAT, Wnt).

UNIT V: Cancer Biology (15 Hours)

Cancer Biology: Multistage cancer development Mitogens, carcinogens, oncogenes and proto- oncogenes, tumor suppressor genes - *Rb*, *p53*, Apoptosis and significance of apoptosis.

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment Methodology	Quiz, Seminars, Assignments and MCQs

Books for Study:

1. Watson, J. D. *et al.* (2006). *Molecular Biology of the gene*, (5th Ed.). Pearson Education Inc. (Unit 1 and Unit 2)
2. Cooper, J. M. & Hausman, R. E. (2000). *The cell: A Molecular Approach*, (4th Ed.). ASM Press. (Unit 3 and Unit 4)
3. Stickberger, M. W. *et al.* (2008). *Genetics*, (3rd Ed). Macmillan and Company. (Unit 5)

Books for Reference:

1. Freifelder, D. (2008). *Molecular Biology*, (2nd Ed.). Narosa Publications.
2. Alberts, B. *et al.* (2015). *Molecular Biology of Cell*, (6th Ed.). Taylor and Francis Group, Garland Science.
3. Karp, G. (2008). *Cell and Molecular Biology*, (5th Ed.). John Wiley and Sons.

4. Paul, A. (2011). *Textbook of Cell and Molecular Biology*. Books and Allied Ltd.

Websites and eLearning Sources:

1. <https://www.ncbi.nlm.nih.gov/books/NBK26857/>
2. https://mcb.berkeley.edu/courses/mcb110spring/nogales/mcb110_s2008_4signaling.pdf
3. https://pmc.ncbi.nlm.nih.gov/articles/PMC8481752/pdf/10.1177_10732748211038735.pdf
4. <https://www.khanacademy.org/science/biology/cell-signaling/mechanisms-of-cell-signaling/a/intracellular-signal-transduction>
5. <https://www.youtube.com/watch?v=2iyAaXsfuWQ>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K-Level)
	On successful completion of this course, students will be able to	
CO1	Identify the major organelles within a cell and their associated functions.	K1
CO2	Interpret and analyze data related to cellular and molecular processes.	K2
CO3	Apply knowledge of cell and molecular biology to solve practical problems or scenarios.	K3
CO4	Analyze and evaluate different cellular and molecular processes.	K4
CO5	Assess the validity and reliability of scientific research in the field of cell and molecular biology.	K5
CO6	Develop new hypotheses or theories based on existing knowledge in the field.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
1	25PBT1CC02		Core Course - 2: Molecular Cell Biology							5	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	1	2	3	3	1	3	2	2	2.1
CO2	3	3	2	3	3	2	2	3	3	2	2.6
CO3	3	2	2	3	2	2	3	3	2	2	2.4
CO4	3	2	2	2	2	2	3	3	2	2	2.3
CO5	3	2	2	4	3	2	3	2	3	2	2.4
CO6	2	2	3	1	2	1	2	1	2	1	1.8
Mean Overall Score											2.28 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	25PBT1CC03	Core Course - 3: Bioinstrumentation	5	4

Course Objectives
To introduce principle and applications of various types of microscopic techniques.
To impart understanding on different separation and purification techniques and its applications.
To provide knowledge on various electrophoretic techniques and its applications in separation of biomolecules.
To elucidate the theory and applications of various spectroscopic techniques in characterization of the biomolecules.
To acquaint with principle and applications of different radio-isotopic techniques in revealing biochemical reactions.

UNIT I: Microscopic Techniques (15 Hours)

Principles and Applications: Compound, Light, Stereo, Phase Contrast, Fluorescent Microscopy, Scanning and Transmission Electron Microscopy, Atomic Force Microscopy, Confocal Microscopy, FRET.

UNIT II: Centrifugation (15 Hours)

Principle and Applications of various types of centrifugations, Sedimentation Coefficient, Svedberg unit, RCF, Density Gradient Centrifugation. Chromatography Techniques: Principle and Application of Paper Chromatography, TLC, Gel Filtration chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC.

UNIT III: Electrophoretic Techniques (15 Hours)

Principle and Application of Agarose Gel Electrophoresis, 2D- gel Electrophoresis, PAGE- NATIVE & SDS-PAGE, Iso-electric Focusing, High resolution Electrophoresis, Immuno Electrophoresis (Immunofixation EP), ELISA, RIA, Southern, Northern and Western Blotting. Electro blotting, PCR and RT-PCR, Microarray (DNA, Proteins).

UNIT IV: Spectroscopic Techniques (15 Hours)

Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, IR Spectroscopy NMR, ESR, Atomic Absorption Spectroscopy, X- ray Diffraction, Laser Spectroscopy and Raman Spectroscopy.

UNIT V: Radio-isotopic Techniques (15 Hours)

Introduction to Radioisotopes, Uses and their Biological Applications, Radioactive Decay Types and Measurement, Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Autoradiography, RIA.

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment Methodology	Quiz, Seminars, Assignments and MCQs

Books for Study:

1. Braun, R. D. (2016). *Introduction to Instrumental Analysis*, (2nd Ed.). McGraw-Hill.
2. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology*, (7th Ed.). Cambridge University Press.
3. Farrell, S. O., & Ranallo, R. T. (2000). *Experiments in Biochemistry: A Hands-on Approach*. Brooks Cole.
4. Fulekar, M. H., & Pandey, B. (2019). *Bioinstrumentation*. Wiley.
5. Upadhyay., Upadhyay., & Nath. (2016). *Biophysical Chemistry Principles and Techniques*, (4th Ed.). Himalaya Publ.

Books for Reference:

1. Nelson, D. L., & Cox, M. M. (2008). *Lehninger Principles of Biochemistry*, (5th Ed.). W. H. Freeman.
2. Metzler, D. E. (2001). *The Chemical Reactions of Living Cells*. Academic Press.
3. Stryer, L. (1999). *Biochemistry*, (4th Ed.). W. H. Freeman & Company.

4. Veerakumari, L. (2006). *Bioinstrumentation*, (Kindle edition). MJP Publisher.
5. Jeffrey, M., & Backer. *et al.* (1996). *Biotechnology: A Laboratory Course*. Academic Press.
6. Holcapek, M., & Byrdwell, Wm. C. (2017). *Handbook of Advanced Chromatography*, (1st Ed.). Elsevier.

Websites and eLearning Sources:

1. <https://microbenotes.com/fluorescence-microscope-principle-instrumentation-applications-advantages-limitations/>
2. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000004BY/P000090/M024969/ET/1510726608Centrifugationtext.pdf
3. <https://www.youtube.com/watch?v=AKGPrRtSu04>
4. <https://www.technologynetworks.com/analysis/articles/atomic-absorption-spectroscopy-principles-and-applications-356829>
5. https://en.wikipedia.org/wiki/Geiger_counter

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K-Level)
	On successful completion of this course, students will be able to	
CO1	Name the appropriate analytical technique that are used to identify and characterize a particular biological system.	K1
CO2	Describe the working principles of different analytical techniques used in characterization of the biomolecules.	K2
CO3	Interpret infer the analytical data and conclude the characteristics of the biological system under study.	K3
CO4	Differentiate the various types of a particular analytical techniques and thus choose the appropriate technique for the study of interest.	K4
CO5	Evaluate the application of a particular analytical technique in elucidating the properties of biomolecules.	K5
CO6	Create strategies to understand the various biochemical aspects of the biological system.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
1	25PBT1CC03		Core Course - 3: Bioinstrumentation							5	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	3	2	2	2	2	2.2
CO2	2	3	3	2	3	2	3	2	3	2	2.5
CO3	3	2	2	2	2	2	2	3	2	3	2.3
CO4	3	2	2	2	2	3	3	3	2	2	2.4
CO5	3	2	2	2	3	2	3	2	3	2	2.4
CO6	2	2	3	2	2	2	2	2	2	1	2
Mean Overall Score											2.3 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	25PBT1CP01	Core Practical - 1: Biochemistry, Molecular Cell Biology and Bioinstrumentation	5	2

Course Objectives

To illustrate the basic biochemistry procedures.
To isolate & analyze DNA, RNA & proteins from both prokaryotic and eukaryotic cells.
To critically analyze isolated biomolecules.
To evaluate the quality and purity of DNA, RNA & Proteins.
To study the inner contents of cells through staining.

(A) Biochemistry

1. Basic calculations in Biochemistry - Normality, Molarity, Molality percent solutions (v/v, w/v).
2. Calibration of pH meter
3. Transition interval of commonly used pH indicators
4. Preparation of biological buffer - phosphate buffer
5. (a) Extraction of Proteins from biological materials
(b) Protein separation methods -Ammonium sulphate Precipitation,
(c) Membrane Dialysis,
(d) SDS PAGE
6. Urea-SDS PAGE for separation of low molecular weight proteins
7. Estimation of Proteins by Lowry's method
8. Estimation of Proteins by Biuret method
9. Estimation of Proteins by Bradford method
10. Estimation of RNA by orcinol method
11. Estimation of DNA by diphenylamine method
12. Estimation of Carbohydrate by Anthrone method
13. Purity check of DNA & RNA by UV Spectrometry - A260/280
14. Separation of amino acids by Paper Chromatography
15. Separation of sugars by Paper Chromatography
16. Separation of amino acids by Thin Layer Chromatography

(B) Molecular Cell Biology

1. Isolation of DNA from bacteria
2. Isolation of DNA from plants
3. Isolation of DNA from animal tissue
4. Isolation of DNA from blood
4. Plasmid DNA isolation.
5. Agarose gel electrophoresis of DNA
6. Transfer of DNA from gel - Southern Blotting
7. Isolation of RNA
8. Glyoxal denatured Agarose gel electrophoresis of RNA
9. Formaldehyde denatured Agarose gel electrophoresis of RNA
10. Urea denatured Agarose gel electrophoresis of RNA
11. Transfer of RNA from gel - Northern Blotting
12. Restriction digestion of DNA
13. Radiation induced genetic damage assessment
14. Chemical induced genetic damage.

(C) Bioinstrumentation

1. Validating Lambert – Beer's law using KMnO₄. Demonstration
2. Absorption spectra of proteins/pigment
3. Paper chromatography
4. Column chromatography
5. Thin layer chromatography

Teaching Methodology	Demonstration of practical methodologies and hands on training experience.
Assessment Methodology	Result submission and Viva

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K-Level)
	On successful completion of this course, students will be able to	
CO1	Recall the basic principles of molecular biology techniques	K1
CO2	Explain the basic operating procedure in handling different chromatographic techniques	K2
CO3	Apply and separate the proteins by its molecular weight	K3
CO4	Investigate cell morphology by staining techniques	K4
CO5	Evaluate the concentration of DNA/RNA and design a protocol for the isolation of plasmid DNA, Genomic DNA and RNA respectively	K5
CO6	Design a protocol to inspect various aspects of enzymology	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
1	25PBT1CP01		Core Practical - 1: Biochemistry, Molecular Cell Biology and Bioinstrumentation							5	2
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	3	2	2	3	2	2.2
CO2	2	3	2	3	3	2	3	2	2	2	2.4
CO3	3	3	2	2	2	2	3	2	3	2	2.4
CO4	3	3	3	2	2	2	3	2	3	2	2.5
CO5	3	2	2	2	2	2	3	2	2	3	2.3
CO6	3	2	2	3	1	2	3	1	2	1	2
Mean Overall Score											2.30 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	25PBT1ES01A	Discipline Specific Elective - 1: Biostatistics	4	3

Course Objectives
To understand the major methods of collection & presentation of data.
To provide basic knowledge about correlation and regression and its use in determining the relationship between two quantitative variables.
To enlighten the students about the methods of setting hypothesis and calculation of errors.
To update the knowledge on Tests of significance for large and small samples.
To introduce students about the use of statistical analysis packages in analyzing the biological data.

UNIT I: Introduction to Statistics (12 Hours)

Statistics - Scope -collection, classification, tabulation of Statistical Data - Diagrammatic representation graphs - graph drawing - plotted curve -Sampling method and standard errors -random sampling - use of random numbers -expectation of sample estimates - means - confidence limits - standard errors - variance. Measures of central tendency - measures of dispersion - skewness, kurtosis.

UNIT II: Correlation, Regression & Probability (12 Hours)

Correlation and regression - correlation table - coefficient of correlation - Z transformation – regression relation between regression and correlation. Probability - Markov chains applications – Probability distributions - Binomial (Gaussian distribution) and negative binomial, compound and multinomial.

UNIT III: Normal Distribution & Basis of Statistical Inference (12 Hours)

Normal distribution - graphic representation - frequency curve and its characteristics - measures of central value, dispersion, coefficient of variation and methods of computation - Basis of Statistical Inference - Sampling Distribution - Standard error - Testing of hypothesis - Null Hypothesis -Type I and Type II errors.

UNIT IV: Tests of Significance for large and small samples (12 Hours)

Tests of significance for large and small samples based on Normal, t, z distributions with regard to mean, variance, proportions and correlation coefficient - chi-square test of goodness of fit - contingency tables - chi-square test for independence of two attributes - Fisher and Behrens 'd' test - 2×2 table - testing heterogeneity - RxC table - chi-square test in genetic experiments - partition chi-square.

UNIT V: Data Entry and Statistical Analysis Package (12 Hours)

Tests of significance -t tests - F tests - Analysis of variance - one way classification – Two way classification, CRD, RBD, LSD. Spreadsheets - Data entry - mathematical functions - statistical function Graphics display - printing spreadsheets - use as a database word processes - databases - statistical analysis packages

Teaching Methodology	Black board and chalk, PPT and Softwares.
Assessment Methodology	Quiz, Assignments, MCQs, Seminars

Books for Study:

1. Daniel, W. W., & Cross, C. L. (2014). *Biostatistics: Basic Concepts and Methodology for the Health Sciences*, (10th Ed.). Wiley Press.
2. Rosner, B. (2010), *Fundamentals of Biostatistics*, (7th Ed.). Cengage Learning, Inc.
3. Rastogi, V. B. (2011). *Fundamentals of Biostatistics*. Ane books Pvt Ltd.

Books for Reference:

1. Warren, J., Gregory, E., & Grant, R. (2004), *Statistical Methods in Bioinformatics*, (1st Ed.). Springer.
2. Milton, J. S. (1992). *Statistical Methods in the Biological and Health Science*, (2nd Ed.). Mc Graw-Hill.
3. Sundar Rao, P. S. S., Jesudian, G., & Richard, J. (1987). *An Introduction to Biostatistics*, (2nd Ed.). Prestographik.
4. Zar, J. H. (1984). *Biostatistical Methods*, (2nd Ed.). Prentice Hall.

Websites and eLearning Sources:

1. <https://statistics.laerd.com/statistical-guides/measures-central-tendency-mean-mode-median.php>
2. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000023MA/P001409/M022426/ET/1504675331Module8-Q1.pdf
3. [https://www.mlsu.ac.in/econtents/4385_UNIT-1%20\(LECTURE%204\).pdf](https://www.mlsu.ac.in/econtents/4385_UNIT-1%20(LECTURE%204).pdf)
4. <https://rlacollege.edu.in/pdf/Statistics/Anova.pdf>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Define different statistical parameters and classify the data.	K1
CO2	Demonstrate proficiency in analysing data using various methods.	K2
CO3	Apply the appropriate statistical method to establish a relationship between two variables.	K3
CO4	Interpret the results obtained using various statistical tools and conclude.	K4
CO5	Determine the accuracy and precision of the experimental method.	K5
CO6	Create a model for a particular biological phenomenon based on the statistical analysis.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
1	25PBT1ES01A		Discipline Specific Elective - 1: Biostatistics							4	3
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	3	2	2	2	2	2.1
CO2	2	3	2	2	3	2	3	2	3	2	2.4
CO3	3	3	2	2	2	2	3	3	2	3	2.5
CO4	3	2	2	2	2	3	3	2	2	2	2.3
CO5	3	2	2	2	2	2	3	2	3	2	2.3
CO6	2	1	3	2	2	2	2	2	2	1	1.9
Mean Overall Score											2.25 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	25PBT1ES01B	Discipline Specific Elective - 1: Cell Signaling	4	3

Course Objectives
To introduce the fundamental concepts of Cell Signaling and its types.
To provide basic knowledge about the different transport systems, receptors and effectors involved in signaling.
To explain the different types of transducers, effectors and G-proteins and their significance in signaling.
To emphasize the role of impaired signaling mechanisms in cancer risk.
To inculcate the knowledge on the significance of cell signaling in prokaryotes and plants during different types of stress.

UNIT I: Extra Cellular Matrix (ECM) and Cell Surface (12 Hours)

Molecules in the ECM in plant and animals. Transport across cell membrane, Ficks Law. Types of transport - simple, passive, facilitated. Active transport, primary and secondary active transport system. Ionophores, gated channels (Voltage and Ligand). Cell communication and type of signaling molecules. Types of receptors and their structure. GPCR, inhibitory and stimulatory and type of down-stream effectors and signal termination. Monomeric G- proteins their role. Drugs targeting signaling molecules.

UNIT II: Cell Signaling (12 Hours)

Various types cell signaling (Autocrine, paracrine, juxtracrine and endocrine). Cell signaling molecules: Hormones and growth factors, neurotransmitters, peptide hormones, steroid hormones, eicosanoids, vitamins and gases. Cell signaling cascades: Role of MAPK pathway in signaling. Cell signaling in neurons - long term potentiation, long term depression. Cell signaling in immune system. Cross talk between signaling pathways. JAK- STAT pathway, NF-kappa B signaling.

UNIT III: Signal Transduction and Protein Kinases (12 Hours)

Concept of transducers, effectors, GTP binding proteins - Gi, Gs, Gp, Gq, ras; adenylate cyclase, guanylate cyclase, phosphor - diesterases, Protein kinase (PK) A, C and G, Calmodulin dependent PK, tyrosine kinase, stress activated PK, ribosomal S6 kinase; angiogenesis, PKs associated with cell survival and death processes.

UNIT IV: Signal Transduction and Cancer (12 Hours)

Discovery of oncogenes, proto-oncogenes. Modes of action of oncogenes - G proteins - Ras. Growth factors - Erb, Sis. Transcription factors - Fos, Jun, AP1, V-erbA. Discovery of tumor suppressor genes. RB and retinoblastoma, APC and colon cancer. Modes of action of TS genes - p110, p16, p21, Phosphatase and tensin homolog (pTEN). p53 and cancer risk. Selected examples - c-Myc and leukemia. BRCA and breast cancer.

UNIT V: Signal Transduction in Bacteria and Plants (12 Hours)

Introduction of signaling components in bacteria, Chemotaxis, Protein kinases in bacteria, His-kinases: structure and role, Plant signaling system an over view, Stress signaling in plants (biotic), Stress signaling in plants (abiotic). Plant hormones and their mechanism of action. Signaling in yeast: STAT pathway in yeast

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment Methodology	Quiz, Assignments, MCQs, Seminars

Books for Study:

1. Friedman, M., & Friedman, B. (2004). *Cell Communication: Understanding How Information is Stored and Used in Cells*. Ingram International Inc.
2. Hancock, J.T. (2005). *Cell Signaling*. Oxford University Press.

Books for Reference:

1. Cooper, G.M., & Hausman, R.E. (2009). *The Cell and Molecular Approach* (5th Ed.). ASM Press and Sinauer Associates Inc.
2. Gomperts, B.D., Kramer, I.M., & Tatham, P.E.R. (2009). *Signal Transduction* (2nd Ed.). Academic Press.
3. Helmreich, E.J.M. (2001). *The Biochemistry of Cell Signaling*. Oxford University Press.

Websites and eLearning Sources:

1. <https://www.ncbi.nlm.nih.gov/books/NBK9924/>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4382731/pdf/cshperspectmed-SIG-a006098.pdf>
3. <https://www.shivajicollege.ac.in/sPanel/uploads/econtent/54b093be805f91c972734a3a212db90a.pdf>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Write about signal transduction pathway in bacteria and plants system.	K1
CO2	Exhibit the knowledge in the regulation of target cell responsiveness.	K2
CO3	Classify the intracellular signaling cascades and their impact on cellular activities.	K3
CO4	Analyze the cytoskeleton rearrangements, motility and changes in gene expression.	K4
CO5	Organize and evaluate the basic knowledge in the components of the main signaling pathways and their functional properties.	K5
CO6	Compile the interplay between various signaling mechanisms in maintaining the homeostasis of the cell.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
1	25PBT1ES01B		Discipline Specific Elective - 1: Cell Signaling							4	3
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	3	2	2	2	2	2.3
CO2	3	2	2	2	2	3	3	3	2	1	2.3
CO3	3	3	2	2	2	2	3	2	2	2	2.3
CO4	2	3	3	2	2	3	3	2	2	2	2.4
CO5	3	3	3	2	2	2	3	2	3	2	2.5
CO6	3	3	3	2	2	2	3	2	2	2	2.4
Mean Overall Score											2.37 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	25PBT1AE01	Ability Enhancement Course: Entrepreneurship Skills for Biotechnology	2	1

Course Objectives

- To critically analyze and evaluate different aspects of biotechnology entrepreneurship.
- To assess and evaluate the success and viability of biotechnology entrepreneurship.
- To generate original ideas and solutions in the field of biotechnology entrepreneurship.
- To critically analyze and evaluate different aspects of biotechnology entrepreneurship.
- To assess and evaluate the success and viability of biotechnology entrepreneurship.

UNIT I: Entrepreneurship & Horticulture - 1

(6 Hours)

Meaning, Needs and Importance of Entrepreneurship, Fundamentals of horticulture, Ornamental horticulture.

UNIT II: Horticulture - 2

(6 Hours)

Commercial floriculture, Processing of horticulture crops, Horticulture business management.

UNIT III: Mushroom Cultivation

(6 Hours)

Mushrooms - Morphology, Classification, edibility and poisonous properties. Culturing conditions for tropical and temperate climates.

UNIT IV: Apiculture - 1

(6 Hours)

Introduction and Importance of apiculture. Different species of honey bees. Beekeeping equipment. Collection and preservation of bee pasture.

UNIT V: Apiculture - 2

(6 Hours)

Seasonal management. Familiarization with bee enemies and diseases and their control. Handling of bee colonies and manipulation for honey production

Teaching Methodology	Demonstration of practical methodologies and hands on training experience
Assessment Methodology	Quiz, Assignments, MCQs, Seminars

Books for Study:

1. Jaiswal, A. G. (2019). *Practical Hand Book of Apiculture*. Lulu Publications.
2. Bird, C. (2014). *The Fundamentals of Horticulture*. Royal Horticulture Society.

Books for Reference:

1. Rahman, A. (2017). *Apiculture in India*. ICAR.
2. Lynch, T. (2018). *Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at Home*, (3rd Ed.). Quarry Books.
3. Vashney, G. K. (2019). *Fundamentals of Entrepreneurship*. Sahitya Bhawan Publications.

Websites and eLearning Sources:

1. <https://plutuseducation.com/blog/need-of-entrepreneurship/>
2. <https://agrimoon.com/wp-content/uploads/Processing-of-Horticultural-Crops.pdf>
3. https://agritech.tnau.ac.in/farm_enterprises/fe_api_careandmanagement.html

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Explore and figure out the ideal environmental conditions required for mushroom cultivation in tropical and temperate climates	K4
CO2	Summarize the concept of bee pasture and its significance in honey bee nutrition	K5
CO3	Develop strategies to start a biotech business using the learnt entrepreneurial skills	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
1	25PBT1AE01		Ability Enhancement Course: Entrepreneurship Skills for Biotechnology							2	1
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	3	3	2	2	3	3	2	2	2.5
CO2	2	3	3	2	2	2	3	3	2	2	2.4
CO3	2	2	3	2	2	2	2	3	3	2	2.3
Mean Overall Score											2.4 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	25PBT1OE01	Open Elective - 1 (WS): Medical Biotechnology	4	2

Course Objectives

To familiarize the students about the scope of medical biotechnology and applications of molecular techniques in clinical diagnosis.

To introduce about different stages and strategies of drug selection, development and marketing.

To educate the students about the bulk drug manufacturing principles, different therapeutic categories and types of drug interactions.

To explain the causes of cancer biology and different types of cancers and diet for cancer.

To design a treatment and diagnostic strategies for cancer.

UNIT I: Introduction to Medical Biotechnology (12 Hours)

Scope for Medical Biotechnology, History of Medical Biotechnology, Molecular interactions: Protein-drug, protein-protein, protein-DNA, enzymes diagnostics, nucleic acid-based diagnostics, PCR based diagnostics.

UNIT II: Drug Discovery (12 Hours)

Clinical Research in Drug Discovery, New Drug Application and Approval - Pharmaceutical Industry - Global and Indian Perspective - Clinical Trial market. Selection of drugs - Threats behind self-medication - Monitoring the prescribed drug advised, Clinical data management, Ethical issue in clinical studies.

UNIT III: Pharmaceutical Product Manufacturing and their Control (12 Hours)

Bulk drug manufacturers, Type of reactions in bulk drug manufacture and processes. Special requirement for bulk drug manufacture. Control: Therapeutic categories such as vitamins, laxatives, analgesics, non-steroidal contraceptives, Antibiotics, biologicals, hormones. Herbal-Drug and Herb-Food Interactions: General introduction to interaction and classification. Study of following drugs and their possible side effects & interactions: Ginkgo biloba, Ginseng, Garlic & Pepper.

UNIT IV: Fundamentals of Cancer Biology (12 Hours)

Regulation of Cell cycle, Mutations that cause changes in signal molecules, tumor suppressor genes, Modulation of cell cycle in cancer, Different forms of cancers, Diet and cancer. Carcinogenesis and types.

UNIT V: Oncogenes and Treatment for Cancer: (12 Hours)

Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth factor and Growth factor receptors that are Oncogenes. Different forms of therapy, Chemotherapy, Radiation Therapy, Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection.

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment Methodology	Quiz, Assignments, MCQs, Seminars

Books for Study:

1. Lodish, H., et al. (2007). *Molecular Cell Biology* (6th Ed.). W.H. Freeman Publishers.
2. McKinnell, R.G., Parchment, R.E., Perantoni, A.O., Pierce, G. Barry, & Damjanov, I. (2006).
3. *The Biological Basis of Cancer* (4th Ed.). Cambridge University Press.
4. Weinberg, R.A. (2013). *The Biology of Cancer* (2nd Ed.). W.W. Norton & Company.
5. Watson, J.D., et al. (2007). *Molecular Biology of the Gene* (6th Ed.). Pearson Education Inc.

Books for Reference:

1. Hulley, S. (2011), *Outlines & Highlights for Designing Clinical Research: An Epidemiologic Approach*, Academic Internet Publishers. (Unit II)
2. Wood, D. & Smith, D. (2012), *Research in Clinical Practice*, Springer Publications.
3. Robert J. Levine (2010), *Ethics and Regulation of Clinical Research*: (2th Ed.), Yale University Press. (Unit II).

Websites and eLearning Sources:

1. <https://www.fda.gov/patients/learn-about-drug-and-device-approvals/drug-development-process>

2. <https://www.ncbi.nlm.nih.gov/books/NBK9840/>
3. https://www.researchgate.net/publication/371165300_FUNDAMENTALS_OF_CANCER_BIOLOGY/link/6476c8246a3c4c6efbf43d42/download

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Recall the knowledge in the fast-emerging medical biotechnology, cancer biology and the innovative processes that ensures the success of such endeavors.	K1
CO2	Understand how the various drivers of medical biotechnology interact with one another and shape the business & finance of this industry and impact the growth of medical biotechnology companies.	K2
CO3	Apply the knowledge to develop the creative thinking and explore the ideas of new vision of medical biotechnology and cancer biology.	K3
CO4	Analyze the basics of medical genetics and their underlying mechanisms, one can be aware of the ways to avoid them and also know the implications of the drugs and their effects.	K4
CO5	Plan the appropriate diagnostic method for the detection of cancer.	K5
CO6	Develop a technique to diagnose, elucidate mechanism and treat different types of cancers at an early stage.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
1	25PBT1OE01	Open Elective - 1 (WS): Medical Biotechnology								4	2
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	3	2	1	3	3	2	2	2	2.3
CO2	3	2	3	3	2	2	3	2	2	2	2.4
CO3	3	3	3	2	2	3	3	1	2	2	2.4
CO4	2	3	3	2	1	3	3	2	3	2	2.4
CO5	3	2	3	2	3	2	3	3	2	1	2.4
CO6	3	3	2	3	2	3	2	3	2	1	2.4
Mean Overall Score											2.38 (High)

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PGC1SL01	Global Citizenship Education	Online	1

Course Objectives
To develop an understanding of global governance structures, rights and responsibilities.
To recognize and respect differences, multiple identities and diversity.
To examine beliefs and perceptions about social justice, equality and civic engagement.
To develop attitudes of care and empathy for others and the environment.
To develop global competence and ethical considerations by enhancing communication and collaboration skills across cultures

UNIT I: Introduction to Global Citizenship

01. Historical and Philosophical Foundations of Global Citizenship
02. Rights and Responsibilities of Global Citizenship
03. Key Organizations and Movements Promoting Global Citizenship

UNIT II: Globalization and Its Impact on Society

04. Globalization and Its Key Drivers
05. Positive and Negative Impacts of Globalization
06. Role of Education in Fostering a Global Perspective

UNIT III: Human Rights, Social Justice, Equality and Diversity

07. Key Human Rights Treaties, Frameworks and Declarations
08. Advocacy, Activism, and Movements for Social Justice and Equality
09. Global Challenges to Human Rights, Equality and Diversity

UNIT IV: Sustainable Development and Environmental Responsibility

10. The Sustainable Development Goals and Their Relevance to Global Citizenship
11. Climate Change, Environmental Degradation and Sustainable Development
12. Strategies for Promoting Environmental Responsibility

UNIT V: Building Global Competence and Engagement

13. Effective Communication and Collaboration Across Cultures
14. Volunteering and Community Engagement in Global Initiatives
15. Ethical Considerations in Global Citizenship

Teaching Methodology	Recorded Lectures/Videos, Reading Materials, PPTs, Case Studies, Collaborative Projects, Quizzes and Polls
Assessment Methods	Seminars, Assignments, MCQs, Reflection Essays, Group Project Presentations, Problem-Solving Scenarios

Books for Study:

1. Clapham, A. (2007). *Human rights: A very short introduction*. Oxford University Press.
2. Desai, A. (2018). *Global citizenship and cultural diplomacy: India's role in a changing world*. Routledge India.
3. Gould, J. A. (2012). *The ethics of global citizenship*. Routledge.
4. Held, D., et al. (2022). *Globalization and its impact on the developing world*. Cambridge University Press.
5. Sen, A. (2009). *The idea of justice*. Penguin Books India.

Books for Reference:

1. Ghosh, A. (2007). *The global impact of Indian civilization*. HarperCollins India.
2. Kreckler, E. (2008). *The global citizen: A guide to creating an international life and career*. Career Press.
3. Kumar, R. (2017). *Sustainable development and environmental justice in India*. Oxford University Press.
4. Nair, K. G. (2014). *Human rights: A socio-political perspective*. Orient Blackswan.

5. Patel, V. (2015). *Social justice and equality in India: Theories and practices*. Oxford University Press.
6. Pillai, V. (2016). *Globalization and its impact on Indian society*. SAGE Publications India.

Websites and eLearning Sources:

1. <https://www.unesco.org/en/global-citizenship-peace-education/need-know>
2. TEDxCincinnati: Global Citizenship in the Classroom: Jenny Buccos at TEDxCincinnati
<https://www.youtube.com/watch?v=6jjLHmyBs7o>
3. Social justice -- is it still relevant in the 21st century? | Charles L. Robbins | TEDxSBU
<https://www.youtube.com/watch?v=Wtroop739uU>
4. Are We the Last Generation — or the First Sustainable One? | Hannah Ritchie | TED
<https://www.youtube.com/watch?v=Kl3VVrggKz4>
5. Diversity, Equity & Inclusion. Learning how to get it right | Asif Sadiq | TEDxCroydon
<https://www.youtube.com/watch?v=HR4wz1b54hw>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K-Level)
	On successful completion of this course, students will be able to	
CO1	Recall the historical, philosophical and practical foundations of global citizenship.	K1
CO2	Explain the key drivers of globalization and the role of education in fostering a global perspective.	K2
CO3	Apply human rights frameworks, social justice principles, and advocacy strategies to real-world challenges.	K3
CO4	Analyze the relevance of the Sustainable Development Goals in addressing climate change and environmental degradation.	K4
CO5	Develop strategies for fostering global competence by enhancing communication and collaboration skills across cultures.	K5
CO6	Critically evaluate the effectiveness of current global strategies and policies in addressing social justice and environmental sustainability.	K6

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	25PBT2CC04	Core Course - 4: Microbiology	6	5

Course Objectives
To understand the prokaryotes with special concentration on the structure, metabolism and genetics of bacteria.
To understand the importance of microbes in agriculture.
To understand the scope and importance of industrial microorganisms.
To enrich the proper understanding of disease-causing microbes.
To learn the utilization of towards for the better sustenance of environment.

UNIT I: General Microbiology (18 Hours)

Introduction and scope of microbiology. Brief study of structure and organization of major groups of microorganisms - Archaeobacteria, Cyanobacteria, Eubacteria, Fungi, Algae, Protozoa and Viruses. Microbial Taxonomy: Diversity and distribution of microbes. Control of microorganisms - physical, chemical and chemotherapeutic agents. Preservation of microorganisms. GLP for handling highly infectious disease samples and documentation. Personal safety and laboratory safety.

UNIT II: Agricultural Microbiology (18 Hours)

Bio-fertilizers and Biopesticides in agriculture: Principles of crop inoculation with microbial agents, Jeevamrit, Ghanjeemrit, Beejamrit, microbial inoculants and production, carriers for inoculants: types and characteristics, strain selection of bacteria, ITK based microbial formulation (Neemastra, Brahmastra, Dasparni ark, agniastrect), cyanobacteria and microalgae for bio fertilizer production, phosphate solubilizing microorganisms, AM fungi, Plant Growth Promoting Rhizobacteria (PGPR), biocontrol agents. Bacterial and mycopesticides.

UNIT III: Industrial Microbiology (18 Hours)

Microbial growth: Kinetics of growth. Effect of temperature, pH, osmotic pressure and radiation on microbial growth. Selection of industrially useful microbes. Fermenters and fermentation technology. Industrial production of alcohol, vinegar, lactic acid, antibiotics, enzymes and amino acids. Microbiology of food - sources of contamination - food spoilage - food preservation methods.

UNIT IV: Clinical Microbiology (18 Hours)

Epidemic, endemic, pandemic and sporadic diseases. Pathogenicity, virulence and infection. Epidemiology of infectious diseases. Bacterial diseases of human (Typhoid, Cholera, Syphilis), Fungal diseases of human (superficial, cutaneous, subcutaneous and systemic mycoses). Viral diseases of human (SARS, MERS, COVID - 19, AIDS, Hepatitis and Polio). Mycoplasmal, Chlamydial, Rickettsial and protozoan diseases of human. Mycotoxins

UNIT V: Applied Microbiology (18 Hours)

Role of microbes in the manufacture of antibiotics and vaccines. Microbes as foods - SCP production. Role of microbes in bio-gas production, petroleum industry, mining, microbial fuel cells, biodegradation and bioremediation. Microbial degradation of lignin, cellulose and pesticides. Microbial immobilization. Microbes in biological warfare.

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment Methodology	Assignment, Seminar, Posters, Group discussion, class Tests

Books for Study:

1. Pelczar, M.J., Chan, E.C.S., & Kreig, N.R. (2002). *Microbiology* (5th Ed.). Tata McGraw-Hill. (Units I and IV).
2. Willey, J., Sherwood, L., Woolverton, C.J. (2016). *Prescott's Microbiology* (10th Ed.). McGraw- Hill Education. (Unit III).
3. Tortora, G.J., Funke, B.R., & Case, C.L. (2013). *Microbiology: An Introduction* (11th Ed.). Pearson Publishers. (Unit V).

Books for Reference:

1. Murray, P.R., Rosenthal, K.S., & Pfaller, M.A. (2015). *Medical Microbiology*. Elsevier.
2. Baltz, R.H., Davies, J.E., & Demain, A.L. (2010). *Manual of Industrial Microbiology and Biotechnology* (3rd Ed.). ASM Press. (Unit II).
3. Alcamo, I. E. (2001). *Fundamentals of Microbiology* (6th Ed.). Benjamin Cummings Publishing Company, Inc.

Websites and eLearning Sources:

1. <https://www.ncbi.nlm.nih.gov/books/NBK8174/>
2. <https://ncert.nic.in/ncerts/l/kebo102.pdf>
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7823516/>
4. <https://libird.org/wp-content/uploads/2022/04/Organic-Fertilizer-English.pdf>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Identify the microbial organisms and their relevance in different infectious diseases.	K1
CO2	Understand the basic microbial structure and similarities and differences among various groups of microorganisms such as bacteria / archaea / cyanobacteria / fungi / protozoans.	K2
CO3	Apply bioprocess techniques for the production of organic acids, alcohols, wine and vinegar with the help of different microbes.	K3
CO4	Categorize microorganisms in varied fields of agricultural like bio fertilizers and biocontrol.	K4
CO5	Assess the bioprospecting of microbes for the production of vaccines, antibiotics and foods.	K5
CO6	Build a relationship between microbes, their products and its interactions with the ecosystem.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
2	25PBT2CC04		Core Course - 4: Microbiology							6	5
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	3	3	3	2	2	2.4
CO2	2	2	3	3	1	2	3	2	2	2	2.4
CO3	3	3	3	2	2	2	3	2	1	3	2.4
CO4	3	3	2	2	1	2	3	2	3	3	2.4
CO5	3	3	3	2	1	3	2	2	2	2	2.3
CO6	3	2	3	2	2	3	2	3	2	1	2.3
Mean Overall Score											2.36 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	25PBT2CC05	Core Course - 5: Immunology	6	5

Course Objectives
To define and learn the basic concepts and terminologies of immunology.
To illustrate the different classes of immune system and biomolecules pivotal to elicit the immune responses.
To instruct the students about the importance of understanding the immunochemical interactions.
To evaluate the clinical relevance of levels of immunoglobulins to different immunological disorders and infectious diseases.
To create strategies to overcome the immunological disorders and diagnostic tools.

UNIT I: Basics of immunology

(18 Hours)

Terminology - antigen, immunogen, hapten, antigenicity, immunogenicity, immunoglobulin, antibody, epitope, paratope, super antigen, allergen, tolerogen etc. Organs of immune system, tissues of immune system, cells of immune system & mediators of immune system. Active, passive and combined immunity. Vaccines – Live and attenuated, killed or inactivated, recombinant DNA, subunit and conjugate, anti-idotypic vaccines - production & applications. Role and properties of adjuvants & ISCOMs.

UNIT II: Immunoglobulin

(18 Hours)

Theories of antibody formation. Structure and Functional domains, classes, Organization and expression of Immunoglobulin Light and Heavy chain genes. B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation. Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies, catalytic antibodies and generation of immunoglobulin gene libraries.

UNIT III: Major Histocompatibility Complex (MHC)

(18 Hours)

General organization and inheritance of MHC; MHC Haplotypes. The organization of MHC class I and class II genes; structure of MHC Class -I and Class-II molecules; peptide binding of MHC molecules. Complement system alternate and classical pathways. HLA typing. Transplantation - Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy. Cell Mediated Immunity, Humoral immunity, Antigen Presenting Cell.

UNIT IV: Antigen-antibody Interactions

(18 Hours)

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, Immunofluorescence, Flow cytometry and Immuno Electron Microscopy; Biosensor assays for assessing ligand - receptor interaction, CMI techniques - Lympho- proliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis.

UNIT V: Clinical Immunology

(18 Hours)

Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity - Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Tumor immunology - Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency - Primary immune deficiencies, Acquired or secondary immune deficiencies.

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment Methodology	Assignment, Seminar, Posters, Group discussion, Class Tests

Books for Study:

1. Kuby, R.A., & Goldsby et al. (2002). *Osborne Immunology* (6th Ed.). Freeman & Co. (Units I, II, and III)
2. Delves, P.J., Martin, S.J., & Burton, D.R. (2016). *Roitt's Essential Immunology* (13th Ed.)
3. Blackwell Scientific Publisher. (Units IV and V)
4. Ian R.T. (2010). *Immunology and Introduction* (4th Ed.). Saunders College Publishing
5. Coico, R., & Sunshine, G. (2009). *Immunology: A Short Course* (6th Ed.). Wiley-Blackwell Publishers

Books for Reference:

1. Weir, D.M., & Steward, J. (1993). *Immunology* (7th Ed.). ELBS
2. Janeway, C. A. Jr., Travers, P., Walport, M., & Mark, J.S. (2008). *Immunology: The Immune System in Health and Disease*. (7th Ed.). Garland Science.
3. Hudson, L., & Hay, F.C. (1989). *Practical Immunology*. Blackwell Publishers.

Websites and eLearning Sources:

1. <https://ugcmoocs.inflibnet.ac.in/assets/uploads/1/44/1179/et/L27200220090902024141.pdf>
2. <https://www.bio-rad-antibodies.com/immunoglobulins-classes-subclasses.html>
3. <https://www.sciencedirect.com/science/article/pii/B9780123852458000133#s0265>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Define the various biomolecules involved in immune responses and basics of immunology.	K1
CO2	Understand the function of the major components of the immune system in health and disease.	K2
CO3	Apply the principles of cellular ontogeny and the gene rearrangement to understand the novel and complex immune system.	K3
CO4	Identify and categorize the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases.	K4
CO5	Inspect and create immunological techniques for better understanding of immune disorders.	K5
CO6	Develop a model to understand a particular immune disorder, diagnosis and treatment.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
2	25PBT2CC05	Core Course - 5: Immunology								6	5
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	3	2	3	2	2	2.3
CO2	2	3	2	1	1	3	3	3	2	2	2.2
CO3	3	2	2	2	2	3	3	2	2	2	2.3
CO4	3	3	3	2	2	3	3	2	1	2	2.4
CO5	3	3	3	3	1	3	3	3	2	1	2.5
CO6	3	3	2	3	2	3	3	3	2	2	2.6
Mean Overall Score											2.38 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	25PBT2CC06	Core Course - 6: Recombinant DNA Technology (Internship Embedded Course)	5	4

Course Objectives

To know the basics of recombinant DNA technology.
To provide basic knowledge about cloning and expression vectors.
To enlighten the students on gene transfer methods and screening techniques.
To update the knowledge on the basics of DNA fingerprinting technique and its applications.
To assess and appraise the applications of different molecular techniques for the betterment of the society.

UNIT I: Introduction to Recombinant DNA Technology (15 Hours)

Enzymes in Molecular Biology - Restriction endonuclease, Ligases, Reverse transcriptase, Nucleases, Polymerase, Alkaline phosphatase, Terminal transferase, T4 polynucleotide kinase; Linkers, Adaptors, Homopolymers. Vectors in gene cloning - Plasmids (pBR322, pUC), Bacteriophages (Phage λ , M13), Cosmids, Phagemids, Shuttle vector, Expression vector

UNIT II: Expression Cassette & Viral Vectors (15 Hours)

Promoters (Constitutive, Inducible, Tissue specific), Terminators, Reporters, Markers (Antibiotic resistant, Herbicide resistant, Antimetabolite); Yeast plasmid vector, Viral vectors (Adenovirus, Adeno associated virus, Baculovirus, Retrovirus, Cauliflower mosaic virus, Tobacco mosaic virus, Potato virus X), Transposons (Ac-Ds, P) Artificial chromosome (BAC, YAC, HAC), Shuttle vector, Expression vector. Chromatin immune precipitation, DNA - protein interactions, electro- mobility shift assay and methyl interference assay

UNIT III: Gene transfer Methods (15 Hours)

Physical methods: Microinjection, Particle bombardment, Magnet assisted transfection and Liposome mediated transfer); Chemical methods (PEG mediated, DEAE Dextran mediated and CaPO₄ mediated gene transfer); Biological methods (Agrobacterium, Bactofection and Viral transduction mediated gene transfer). Expression systems - Prokaryotes (Bacteria) and Eukaryotes (Yeast, Mammalian and Insect cell lines).

UNIT IV: Screening & Selection methods (15 Hours)

Insertional inactivation, Blue-White selection, Colony- In situ hybridization, In vitro selection, In vitro translation, Radioactive antibody test, Immunological techniques, DNA labelling, dot blot hybridization. DNA bar coding, marker assisted selection and QTL mapping. Trait related markers, screening and validation, gene introgression and pyramiding.

UNIT V: Molecular Techniques (15 Hours)

DNA sequencing - Maxam - Gilbert, Sanger methods, short gun sequencing and Automated DNA sequencing. PCR technology - concept, types, primer design, analysis of products and applications. Chromosome jumping, chromosome walking. Site - directed mutagenesis. RFLP, RAPD, AFLP, DNA Finger printing, DNA Foot printing, Microarray (DNA & Non-DNA). Libraries - Genomic library; C- DNA library & its types; BAC library; YAC library; Methyl filtration libraries; COT fractionation-based libraries. Applications of genetic engineering in medicine, agriculture, veterinary and industry.

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment Methodology	Assignment, Seminar, Posters, Group discussion, class Tests

Books for Study:

1. Glick, R., Pasternak, J.J., & Pattern, C.L. (2009). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (4th Ed.). ASM Press.
2. Primrose, S.B., & Twyman, R. (2006). *Principles of Gene Manipulation and Genomics*. (7th Ed.). Blackwell Scientific Publications.
3. Alberts, B., Johnson, A., Lewis, J., Roberts, K., & Walter, P. (2007). *Molecular Biology of the Cell*. (5th Ed.). Garland & Co.

Books for Reference:

1. Brown, T.A. (2020). *Gene Cloning and DNA Analysis - An Introduction* (8th Ed.). Wiley Blackwell Publications Co. Ltd
2. Winnacker, E.L. (2002). *From Genes to Clones - Introduction to Gene Technology* (Unit V). VCR Pub.,
3. Lodish, H. (2007). *Molecular Cell Biology* (6th Ed.). W.H. Freeman & Co.

Websites and eLearning Sources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2570007/pdf/12079_2008_Article_26.pdf
2. <https://www.ncbi.nlm.nih.gov/books/NBK217998/>
3. http://www.cs.helsinki.fi/bioinformatiikka/mbi/courses/09_10/itb/Lectures_1509_and_1709.pdf

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Describe underlying principles of genetic engineering that forms the basis of rDNA technology	K1
CO2	Understand the methodologies, the applications and related issues of rDNA technology.	K2
CO3	Apply research methodologies for genetic engineering techniques.	K3
CO4	Analyze the specificity and suitability of vectors for cloning genes and their expressions.	K4
CO5	Evaluate the benefits and drawbacks of biotechnological products and techniques.	K5
CO6	Create a strategy to address the societal needs like bioremediation, resistant crops, molecular diagnostic techniques, vaccine production, etc.,	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
2	25PBT2CC06		Core Course - 6: Recombinant DNA Technology (Internship Embedded Course)							5	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	3	2	2	3	3	2	2	1	2.3
CO2	3	3	3	2	1	3	3	3	2	1	2.4
CO3	3	3	3	2	2	2	3	2	2	2	2.4
CO4	2	3	3	3	3	2	2	2	3	1	2.4
CO5	3	3	2	2	1	2	3	3	1	2	2.2
CO6	2	3	2	2	2	2	3	3	1	2	2.2
Mean Overall Score											2.32 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	25PBT2CP02	Core Practical - 2: Recombinant DNA Technology and Immunology	5	2

Course Objectives

To demonstrate the various techniques needed for the isolation of nucleic acids from different organisms.

To understand the techniques essential to transform the DNA into host cells and analysis of it.

To analyze the techniques for the identification of disease-causing microbes.

To understand the isolation of pure culture from different sources and techniques associated with it.

To understand the identification of bacteria through staining and biochemical methods.

(A) Recombinant DNA Technology

1. Agarose gel electrophoresis.
2. Isolation of genomic and plasmid DNA from bacteria.
3. Isolation of total RNA from plant tissue.
4. Isolation of genomic DNA from Plant tissue.
5. Restriction digestion.
6. Ligation of DNA.
7. Transformation of bacteria by Calcium chloride method.
8. Blue-White screening method.
9. GFP cloning.
10. Gel elution of DNA.
11. DNA fingerprinting.
12. Bacterial gene expression.

(B) Immunology

1. Collection of body fluids and blood.
2. Separation of serum and plasma.
3. Precipitation - Agar Gel Diffusion, Counter current Immuno-electrophoresis, Single Radial Immunodiffusion, Rocket electrophoresis.
4. Agglutination - blood grouping, latex agglutination, heme-agglutination, WIDAL, VDRL.
5. Labelled assays - ELISA and Immunoblot.
6. Total count, Differential count (RBC & WBC).
7. Blood typing.
8. Isolation of DNA from leukocytes.

Teaching Methodology	Demonstration of practical methodologies and hands on training experience.
Assessment Methodology	Model practical exam, viva

Course Outcomes

CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Know-how on versatile techniques in recombinant DNA technology.	K1
CO2	Explain the role on antigen antibody interactions in various immune-techniques.	K2
CO3	Perform the various types of Immunological techniques.	K3
CO4	Examine and formulate the strategy to isolate single colonies and identify them.	K4
CO5	Appraise the biochemical characterization techniques and identify the pure microbial culture.	K5
CO6	Design and conduct experiments involving genetic manipulation.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
2	25PBT2CP02		Core Practical - 2: Recombinant DNA Technology and Immunology							5	2
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	3	1	2	3	2	2	3	1	2.2
CO2	2	3	2	2	1	2	3	3	2	1	2.1
CO3	2	3	2	3	2	3	3	2	3	1	2.4
CO4	2	2	2	2	2	3	3	3	2	1	2.2
CO5	3	3	3	3	3	2	3	2	2	2	2.6
CO6	3	3	3	3	1	2	3	2	3	1	2.4
Mean Overall Score											2.32 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	25PBT2OE02	Open Elective - 2 (BS): Food Technology	4	2

Course Objectives

- To acquire understanding on the chemical nature and association of microbes with food.
- To explain the principles and different methods used in food processing and preservation.
- To classify different methodologies and approaches involved in the production of different food products.
- To evaluate and identify a food science issue or problem.
- To create critical thinking and problem-solving skills to address current challenges in the food industry.

UNIT I: Food Nutrition

(12 Hours)

Food groups classification; Composition and nutritive value of cereals, millets and pulses; milk and animal products (meat, poultry and fish products). Constituent of food – contribution to texture, flavour and organoleptic properties of food;

UNIT II: Food Microbiology

(12 Hours)

Sources and activity of microorganisms associated with food; food fermentation; food chemicals; food additives – intentional and non-intentional and their functions. Food borne diseases – infections and intoxications, Food spoilage – causes.

UNIT III: Food Processing

(12 Hours)

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.

UNIT IV: Food Preservation

(12 Hours)

Use of high temperatures – sterilization, pasteurization, blanching, canning – concept, procedure & application; Low temperature storage– Factors affecting quality of frozen foods; irradiation preservation of foods,

UNIT V: Manufacture of Food Products

(12 Hours)

Bread and baked goods, dairy products – milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; confectionery, beverages.

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment Methodology	Assignment, Seminar, Posters, Group discussion, JOSTEL

Books for Study:

1. P. J. Fellows.2009. Food processing technology. Principles and practice. (Ed: 3). Woodhead Publishing Series in Food Science, Technology and Nutrition.
2. Sivasankar B. 2002. Food processing and preservation, Prentice Hall, New Delhi. (Unit III and Unit IV)
3. Ahluwalia, Vikas. 2007. Food processing. Paragon International Publishers

Books for Reference:

1. James G. Brennan. 2006. Food processing handbook, 2ndEdition. Wiley Publishers.
2. Desrosier, N.W. 2006.The Technology of Food Preservation, CBS Publishers and Distributors, New Delhi.
3. Janet D. Ward. 2013. Principles of Food Science. 4th Edition. Goodheart-Willcox.

Website and eLearning Source:

1. <https://www.ifst.org/lovefoodlovescience/resources/fats-and-oils-emulsification>
2. <https://www.fao.org/4/y5979e/y5979e03.htm>
3. <https://openknowledge.fao.org/server/api/core/bitstreams/917c7229-ee7d-405d-8f1f-4387eb603448/content>
4. <https://www.fao.org/4/y4355e/y4355e04.htm>

Course Outcomes		
CO No.	CO-Statements	Cognitive Level (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Gain knowledge on food groups, composition, nutritive value and the relationship between constituents of foods and its organoleptic properties.	K1
CO2	Outline the basics of the beneficial and harmful effects of microorganisms in food industries.	K2
CO3	Teach the significance of raw material characteristics and various physical conversion operations.	K3
CO4	Explain the concepts of low and high temperature storage techniques used in food preservation and its effect on quality of the food.	K4
CO5	Evaluate the significance of each step in the manufacture of various food products.	K5
CO6	Develop a cost-effective manufacturing strategy for the production of the essential food products.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
2	25PBT2OE02		Open Elective - 2 (BS): Food Technology							4	2
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	1	3	3	2	2	3	3	2	2	2.3
CO2	2	3	2	2	2	2	3	3	2	2	2.3
CO3	2	2	3	2	2	2	2	2	2	2	2.1
CO4	2	2	2	3	2	2	2	2	3	3	2.3
CO5	2	3	3	2	2	2	2	2	3	3	2.4
CO6	2	3	2	2	2	2	3	3	3	1	2.3
Mean Overall Score											2.28 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	25PSS2SE01	Skill Enhancement Course: Soft Skills	4	2

Course Objectives
To provide a focused training on soft skills for students in colleges for better job prospects
To communicate effectively and professionally
To help the students take active part in group dynamics
To familiarize students with numeracy skills for quick problem solving
To make the students appraise themselves and assess others

UNIT I: Effective Communication & Professional Communication (12 Hours)

Definition of communication, Barriers of Communication, Non-verbal Communication; Effective Communication - Conversation Techniques, Good manners and Etiquettes; Speech Preparations & Presentations; Professional Communication.

UNIT II: Resume Writing & Interview Skills (12 Hours)

Resume Writing: What is a résumé? Types of résumés, - Chronological, Functional and Mixed Resume, Purpose and Structure of a Resume, Model Resume.

Interview Skills: Types of Interviews, Preparation for an interview, Attire, Body Language, Common interview questions, Mock interviews & Practicum

UNIT III: Group Discussion & Personal effectiveness (12 Hours)

Basics of Group Discussion, Parameters of GD, Topics for Practice, Mock GD & Practicum & Team Building.

Personal Effectiveness: Self Discovery; Goal Setting with questionnaires & Exercises

UNIT IV: Numerical Ability (12 Hours)

Introducing concepts Average, Percentage; Profit and Loss, Simple Interest, Compound Interest; Time and Work, Pipes and Cisterns.

UNIT V: Test of Reasoning (12 Hours)

Introducing Verbal Reasoning: Series Completion, Analogy; Data Sufficiency, Assertion and Reasoning; and Logical Deduction. Non-Verbal Reasoning: Series; and Classification

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT.
Assessment Methodology	Assignment, Seminar, Group discussion

Book for Study:

1. Melchias G., Balaiah, J. & Joy, J. L. (Eds). (2018). *Winner in the Making: A Primer on soft Skills*. Trichy, India: St. Joseph's College.

Books for Reference:

1. Aggarwal, R. S. (2010). *A Modern Approach to Verbal and Non-Verbal Reasoning*. S. Chand.
2. Covey, S. (2004). *7 Habits of Highly effective people*. Free Press.
3. Gerard, E. (1994). *The Skilled Helper* (5th Ed.). Brooks/Cole.
4. Khera, S. (2003). *You Can Win*. Macmillan Books.
5. Murphy, R. (1998). *Essential English Grammar*, (2nd Ed.). Cambridge University Press.
6. Sankaran, K., & Kumar, M. (2010). *Group Discussion and Public Speaking* (5th Ed.). M.I. Publications.
7. Trishna, K. S. (2012). *How to do well in GDs & Interviews?* (3rd Ed.). Pearson Education.
8. Yate, M. (2005). *Hiring the Best: A Manager's Guide to Effective Interviewing and Recruiting*

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, students will be able to	
CO1	Recall various soft skill sets	K1
CO2	Understand personal effectiveness in any managerial positions	K2
CO3	Apply verbal and non-verbal reasoning skills to solve problems	K3
CO4	Differentiate problems at work and home; and design solutions to maintain work-life balance	K4
CO5	Assess growth and sustainability and infuse creativity in employment that increases professional productivity	K5
CO6	Construct plans and strategies to work for better human society	K6

Relationship Matrix											
Semester	Course Code			Title of the Course					Hours	Credits	
2	25PSS2SE01			Skill Enhancement Course: Soft Skills					4	2	
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	2	3	2	3	2	3	2.7
CO2	3	3	3	2	3	3	3	3	3	3	2.9
CO3	3	2	2	3	3	3	3	3	3	3	2.8
CO4	3	3	2	2	3	3	3	3	3	3	2.8
CO5	3	3	3	2	2	3	3	3	3	3	2.8
CO6	3	3	3	2	2	3	3	3	3	3	2.8
Mean Overall Score											2.8 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	25PBT3CC07	Core Course - 7: Bioinformatics	6	5

Course Objectives

- To get introduced to the basic concepts of Bioinformatics and its significance in biological data analysis.
- To describe the history, scope, importance and role of internet in bioinformatics.
- To explain about the methods to characterize and manage the different types of biological data.
- To classify different types of biological databases.
- To introduce the basics of sequence alignment and analysis.

UNIT I: Introduction to Bioinformatics

(18 Hours)

History of Bioinformatics; Role of Bioinformatics in biological sciences; Scope of Bioinformatics; Types of biological databases; Data mining and its techniques; Data warehousing. Application of Bioinformatics- gene prediction in prokaryotes and eukaryotes; other applications in the areas of health, food and medicine.

UNIT II: Databases

(18 Hours)

Nucleic acid databases - Genbank, NCBI, EMBL, DDBJ; Primary protein databases - PIR, SWISSPROT, TrEMBL; Secondary protein databases - PROSITE, PROFILES, PRINTS, Pfam; Structural classification databases - SCOP, CATH; Literature databases - PubMed, Medline; Bibliographic databases - OMIM, PubMed.

UNIT III: Sequence Analysis

(18 Hours)

Sequence Annotation - Principles and tools; Sequence retrieval system - Entrez, SRS; Sequence submission tool - BANKIT, SEQUIN, WEBIN, SAKURA. Molecular phylogeny - Concepts of tree - rooted and unrooted trees; Clustering and Phenetic method, Cladistic method, Molecular Clocks; Steps in constructing phylogenetic analysis; Softwares used for phylogeny construction, Bootstrapping strategies. Molecular viewers - Rasmol and Spdb viewer.

UNIT IV: Sequence Alignment

(18 Hours)

Concepts in alignment, similarity and homology; Local & Global; Pairwise & Multiple; Tools for sequence alignment - BLAST, FASTA, Clustal W; Substitution matrices; Scoring matrices - PAM& BLOSUM; Dot plot; EST Clustering and analyses, Codon bias detection.

UNIT V: Genomics & Proteomics

(18 Hours)

Concepts in Genomics and Proteomics, Genome annotation, Homology modelling. AI in Drug Discovery, Applications of Metabolomics & Transcriptomics; Concept of system biology. Docking Analysis (Auto dock, iGEMDOCK).

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT
Assessment Methodology	Assignment, Seminar, Group discussion

Books for Study:

- Arthur, M. L. (2009). *Introduction to Bioinformatics*, (3rd Ed.). Oxford university press.
- Attwood, T. K., & Parrysmith, D. J. (2001). *Introduction to Bioinformatics*. Pearson Education Pvt. Ltd. (Unit I, Unit II)

Books for Reference:

- Andreas, D. B., & B. F. Francis Ouellette. (2005). *Bioinformatics - A Practical guide to the analysis of Genes and Proteins*, (3rd Ed.). John Wiley & Sons, Inc., Publications. (Unit III and Unit IV).
- David, W. M. (2004). *Bioinformatics: sequence and Genome analysis*, (2nd Ed.). Cold Spring Harbor Laboratory Press, Cold Spring Harbor. (Unit V).
- Rastogi, S.C., Menderatta, M., & Rastogi, P. (2004). *Bioinformatics - concepts, skills and applications*. CBS Publishers & Distributors.

Websites and eLearning Sources:

- <https://mgcub.ac.in/pdf/material/20200406015739416c3962e5.pdf>
- <https://microbenotes.com/nucleotide-sequences-database/>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Acquire knowledge of competence in use of bioinformatical methods central to conduction of molecular biological research projects.	K1
CO2	Illustrate the exploration of proteins and solve biological problems including analysis of sequences, database searches, sequence comparison, protein structural analysis and phylogenetics.	K2
CO3	Predict the sequence variation in mutation and differential expression of genes.	K3
CO4	Explain the understanding of bioinformatics tools in annotation of genome and construct novel pipeline to sequence & structural analysis.	K4
CO5	Assess the ethical concerns regarding the use of bioinformatics software's and tools.	K5
CO6	Formulate independent research and data-driven problem-solving	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
3	25PBT3CC07		Core Course - 7: Bioinformatics							6	5
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	3	2	2	3	2	2	1	2	2.2
CO2	3	3	2	2	3	3	2	2	2	2	2.4
CO3	2	3	1	2	2	2	3	2	3	3	2.4
CO4	2	3	2	3	3	2	3	3	2	1	2.4
CO5	2	2	2	3	3	2	2	2	3	3	2.4
CO6	2	3	2	2	3	2	3	2	3	2	2.4
Mean Overall Score											2.36 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	25PBT3CC08	Core Course - 8: Industrial Biotechnology	6	5

Course Objectives
To outline the basis of Bioprocess Engineering
To relate reactors in fermentation
To differentiate fermentation processes
To assess scale up and scale down
To compile the output of fermentation processes

UNIT I: Introduction to Fermentation Technology (18 Hours)

Interaction between chemical engineering, Microbiology and Biochemistry. History of fermentation. Introduction to fermentation processes, Media formulation and optimization. Basic concepts- batch, Continuous and fed batch culture, selection methods for industrially important microorganisms. Strain improvement, preservation, and properties of industrial strains. Immobilization: different matrices, whole cell and enzyme immobilization.

UNIT II: Fermenters (18 Hours)

Design & Types: Gaden's Fermentation classification, Design and operation of Fermenters, Basic concepts for selection of a bioreactor, Impellers, baffles and sparger, sterilization. Types of reactor- tube reactor- continuous flow stir type reactor - airlift reactor- jet loop reactor, packed bed reactor, Fluidized bed reactor.

UNIT III: Bioprocess Control and Monitoring Variables (18 Hours)

O₂ requirement and uptake, Foam and antifoams, their effect on oxygen transfer, factors affecting K_{La}. Flow measurement and control, control system - manual and automatic. Application and the role of computers in bioprocess. Fermentation economics.

UNIT IV: Down-Stream Processing (18 Hours)

Introduction, recovery of microbial cells, precipitation, filtration-theory of filtration, batch and continuous filters. Centrifugation. Cell disruption - physical and chemical methods. Extraction liquid-liquid extraction and aqueous-two phase extraction. Chromatography, membrane processes, drying and crystallization.

UNIT V: Industrial Production Strategies (18 Hours)

Production strategies for industrial products: (Lactic acid and Ethanol), therapeutics (Insulin and Interferon), antibiotics (Cephalosporin), Microbial enzymes (Chitinase, Glucose Oxidase, Lipase), Exopolysaccharides (Pullulan). Use of fungi in industry including food industry, Agriculture and environmental applications: fuel cells, Biofertilizers, Bioremediation and Biological control. Animal cell culture technology to produce recombinant vaccines.

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT
Assessment Methodology	Assignment, Seminar, Group discussion

Books for Study:

1. Stanbury, P. F. (1999). *Principles of Fermentation Technology*. Butterworth-Heinemann. (Unit I, Unit II, Unit III and Unit IV).
2. El-Mansi, E. M. T. (2007). *Fermentation Microbiology & Biotechnology*. CRC / Taylor & Francis. (Unit V).

Books for Reference:

1. Bailey, J., & D. F. Ollis. (2017). *Biochemical Engineering Fundamentals*. (2nd Ed.). McGraw- Hill.
2. Cinar, A. (2003). *Batch Fermentation - Modeling, Monitoring and Control*. Marcel Dekker.

Websites and eLearning Sources:

1. <https://microbenotes.com/design-of-a-fermenter/>
2. [https://www.deshbandhucollege.ac.in/pdf/resources/1587179880_BT\(H\)-VI_Industrial_and_Environmetal_Microbiology-I.pdf](https://www.deshbandhucollege.ac.in/pdf/resources/1587179880_BT(H)-VI_Industrial_and_Environmetal_Microbiology-I.pdf)
3. <https://www.mdpi.com/2075-1729/11/6/557>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Acquire knowledge on the basic principles of fermentation and technologies used in the development of fermented food products.	K1
CO2	Predict the microbial growth kinetics, different types of fermentation, selection of microorganisms for industrial application and production of different fermented food products.	K2
CO3	Illustrate on the production of biologically derived products, including biopharmaceuticals, enzymes, and biofuels.	K3
CO4	Analyze the importance of ethics in fermentation technology in the selective production of commercial products.	K4
CO5	Evaluate the outcomes of fermentation methods when employing specific group of microorganisms in correlation with the substrate and synthesis new ideas in the utilization of alternative microorganisms for the improvement in product yield.	K5
CO6	Recognize, describe, create and learn the characteristics of important food borne pathogens including various methods for their isolation, detection and identification.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
3	25PBT3CC08	Core Course - 8: Industrial Biotechnology								6	5
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	3	2	2	2	2	2.1
CO2	3	3	3	2	3	2	3	2	3	2	2.6
CO3	3	3	2	2	2	2	3	3	2	3	2.5
CO4	3	3	2	2	3	2	3	3	2	2	2.5
CO5	3	2	2	2	3	2	3	3	3	2	2.5
CO6	2	3	2	2	2	2	2	2	2	2	2.1
Mean Overall Score											2.38 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	25PBT3CC09	Core Course - 9: Genomics and Proteomics	5	4

Course Objectives
To define the field of genomics and its significance in biological research and medicine.
To explain the principles of genomics, including genome structure and organization.
To analyze and interpret genomic data generated through next-generation sequencing.
Explain the relationship between genomics and proteomics in the study of biological systems.
Discuss methods for studying protein-protein interactions and constructing protein interaction networks.

UNIT I: Concept of Genome Organization and Minimal Cell Genome (15 Hours)

Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, in situ hybridization. Chromosome walking and characterization of chromosomes, gene function - forward and reverse genetics, gene ethics.

UNIT II: Comparative Genomics (15 Hours)

Sequencing strategies and automation: (Sanger's method) advanced methods (Automated DNA sequencing and Pyrosequencing), Human Genome Project. Introduction to the CoGe system for Comparative Genomics.

UNIT III: Functional Genomics (15 Hours)

Genetic interaction mapping, Transcriptome profiling: (Microarray, ChIP, SAGE), RNAi - Studying gene function through protein-protein interaction (Phage display and yeast two hybrid), Loss of function techniques (mutagenesis and RNAi). Functional annotation of genes. Metagenomics: Prospecting for novel genes from metagenomes and their biotechnological applications.

UNIT IV: Proteomics (15 Hours)

Protein sequencing, Protein expression analysis by 2-DE, 2D MALDI- TOF MS, LC- MS/MS, Quantitative proteomics. Tandem Mass spectrometry, Peptide mass fingerprinting. Mining the proteome, Protein expression profiling, Protein tags; protein arrays and antibody arrays.

UNIT V: Introduction to Metabolomics (15 Hours)

Metabolome, Metabolomics, Metabolite profiling, Metabolome fingerprinting, Role of Biomarker in metabolomics, Metabolome projects of plant and human, Future prospective of metabolomics.

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT
Assessment Methodology	Assignment, Seminar, Group discussion

Books for Study:

1. Daniel, L. H., & Elizabeth, W. J. (2009). *Genetics*, (7th Ed.). Jones and Barlett Publishers Inc. Subury. (Unit I).
2. Watson, J. D. (2006). *Molecular Biology of the Gene*, (5th Ed.). Pearson Education INC.

Books for Reference:

1. Lindon, J., Nicholson, J., & Holmes, E. (2006). *The Handbook of Metabonomics and Metabolomics*, (1st Ed.). Elsevier Science. (Unit V)
2. Brown, T. A. (2007). *Genomes 3*. Garland Science Publishing. (Unit II and Unit III)
3. Cullis, C. A. (2004). *Plant Genomics and Proteomics*. John Wiley & Sons, Inc., Hoboken. (Unit III and Unit IV).

Websites and eLearning Sources:

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5710109/pdf/cshperspect-STH-a023861.pdf>
2. <https://www.nature.com/scitable/knowledge/library/comparative-genomics-13239404/>
3. <https://www.technologynetworks.com/proteomics/articles/proteomics-principles-techniques-and-applications-343804>
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4850886/pdf/ClishMCS000588.pdf>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Classify the complexity of genome/ proteome structural and functional organization.	K1
CO2	Discern the crucial concepts and techniques applied in genomics, transcriptomics and proteomics.	K2
CO3	Apply structural and functional genomics approaches on newly sequenced genome for functional characterization of genes	K3
CO4	Design the experiments using various techniques of genome sequencing as well as organization of biological data.	K4
CO5	Evaluate the role of genomics and proteomics in identifying disease-related genes and biomarkers.	K5
CO6	Create experimental designs for solving experimental problems in Genomics and proteomics fields.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
3	25PBT3CC09	Core Course - 9: Genomics and Proteomics								5	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	2	1	3	3	3	1	1	2.1
CO2	3	3	2	1	2	3	3	3	2	2	2.3
CO3	3	3	3	1	1	3	3	3	3	1	2.4
CO4	3	3	3	1	1	2	2	2	3	3	2.3
CO5	3	3	3	2	2	3	3	2	1	3	2.5
CO6	2	3	3	2	1	2	3	3	1	1	2.1
Mean Overall Score											2.28 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	25PBT3CP03	Core Practical - 3: Bioinformatics and Industrial Biotechnology	5	2

Course Objectives

To perform DNA and protein sequence alignment, including pairwise and multiple sequence alignments.
To explore protein structure prediction and molecular modeling techniques.
To develop critical thinking and problem-solving skills in bioinformatics.
To produce and purify enzymes for industrial applications.
To analyze enzyme activity, kinetics, and stability.

(A) Bioinformatics

1. Primer designing
2. Sequence analysis: Pairwise alignment (BLAST).
3. Sequence analysis: Multiple alignment (Clustal W).
4. Six Frame Translation.
5. Phylogenetic analysis.
6. Molecular visualization using Rasmol.

(B) Industrial Biotechnology

1. Preparation of enzyme immobilized columns for biotransformation -e.g. yeast cells immobilized in calcium alginate beads.
2. Microbial Production of amino acids.
3. Screening and isolation of Antibiotic producing organisms from soil.
4. Isolation and screening of Enzyme producing microorganisms from soil.
5. Alcohol fermentation by Yeast.

Teaching Methodology	Demonstration of practical methodologies and hands on training experience.
Assessment Methodology	Model practical exam, viva

Course Outcomes

CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Relate the principle of management and controls on the microbial processes in industrial settings.	K1
CO2	Discuss and evaluate the ethical concerns regarding the use of bioinformatics.	K2
CO3	Apply the knowledge and skills in the accomplishment of biological tasks such as DNA analysis using graph algorithms, clustering, trees and statistical analysis of biological data.	K3
CO4	Analyze and execute the latest software's and tools in bioinformatics and biostatistics to solve biological problems.	K4
CO5	Evaluate the application of different types of Bioreactors including immobilization reactor system and its kinetics.	K5
CO6	Construct skills to handle biological sequence and structural data	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
3	25PBT3CP03	Core Practical - 3: Bioinformatics and Industrial Biotechnology								5	2
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
C01	2	2	2	2	2	3	2	2	3	2	2.2
C02	2	3	2	3	3	2	3	2	2	2	2.4
C03	3	3	2	2	2	2	3	2	3	2	2.4
C04	3	3	3	2	2	2	3	2	3	2	2.5
C05	3	2	2	2	2	2	3	2	2	3	2.3
C06	2	3	2	2	3	2	2	2	2	2	2.2
Mean Overall Score											2.33 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	25PBT3ES02A	Discipline Specific Elective - 2: Synthetic Biology	4	3

Course Objectives

- To define the field of synthetic biology and its key principles
- To apply critical thinking skills to address real-world challenges in synthetic biology.
- To explain the principles of metabolic engineering for improving metabolic pathways.
- To analyze case studies and propose ethical solutions.
- To explain the role of synthetic biology in addressing real-world challenges.

UNIT I: Fundamentals of Synthetic Biology

(12 Hours)

Introduction to engineering and design, designing and constructing of biological modules, biological systems, and biological machines. Synthetic biology toolkit. Genetic circuits, oscillators and logic gates, synchronized oscillators.

UNIT II: DNA Synthesis

(12 Hours)

BioBricks, gene assembly, gene design - synthetic genomes, new genetic polymers, XNA and CST for selection, orthogonality, refactoring translation, DNA based bio- circuits

UNIT III: Elements of Synthetic Biology

(12 Hours)

Gene shuffling for large scale pathway assembly and engineering; Choices for microbial hosts for industrial applications- bacteria, yeast, insect. Gene Editing Technologies- CRISPR and Zinc Finger Nuclease (ZFN) methods.

UNIT IV: Synthetic Cell

(12 Hours)

The notion of the minimal cell, minimal RNA, minimal genome. Approaches to the minimal cell: Complex biochemical reactions in vesicles, Protein expression in vesicles. Novel chassis and hosts. Craig Venter synthetic cell.

UNIT V: Commercial Applications of Synthetic Biology

(12 Hours)

Biosensors, Designed nucleic acid and proteins, Biomedicine, Biomaterials, Biofuels and Bioremediation; Global events & competitions- iGEM, synbiobeta. Synbiosafe: Biosafety and biocontainment. Ethical aspects of synthetic biology. Patenting, Responsible Innovation and the Ethical, Legal and Social aspects of Synthetic Biology.

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT
Assessment Methodology	Assignment, Seminar, Group discussion

Books for Study:

1. Kuldell., et al. (2015). *Biobuilder - Synthetic Biology in Lab*. Octal Publishing. (Units I and II).
2. Baldwin., et al. (2016). *Synthetic Biology - A Primer*. Imperial College Press. (Unit III).
3. Luisi, P. (2006). *The Emergence of Life: From Chemical Origins to Synthetic Biology*. Cambridge University Press, New York. (Units IV and V).
4. Monica,A.A., Swabna, V., & Edward, A. (2023). *The Blueprint of Life - A Road Map to Synthetic Biology*. (1st Ed.). Alpha International Publication, India.

Books for Reference:

1. Davidson, E. (2006). *The Regulatory Genome: Gene Regulatory Networks in Development and Evolution*. Academic Press.
2. Covert, M.W. (2014). *Fundamentals of Systems Biology: From Synthetic Circuits to Whole-Cell Models*. CRC Press.
3. Konopka, A.K. (2006). *Systems Biology: Principles, Methods, and Concepts*. CRC Press.

Websites and eLearning Sources:

1. https://www.researchgate.net/publication/353835946_Synthetic_biotechnology_and_its_application/link/61147b0a169a1a0103f52ea4/download

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Describe synthetic biology modules and genetic circuits	K1
CO2	Explain the methodologies for Bio bricks, gene assembly and gene design.	K2
CO3	Apply research ideology in gene editing techniques.	K3
CO4	Compare and contrast of biological cell and synthetic cell.	K4
CO5	Evaluate the ethical, legal and social impact of synthetic biology	K5
CO6	Construct and evaluate the minimal genome approaches.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
3	25PBT3ES02A	Discipline Specific Elective - 2: Synthetic Biology								4	3
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	1	2	3	2	3	3	2.2
CO2	2	2	2	2	2	2	2	3	3	3	2.3
CO3	3	1	2	3	1	3	2	2	3	3	2.3
CO4	3	3	3	2	2	3	3	2	2	2	2.5
CO5	2	3	2	2	2	3	3	2	2	2	2.3
CO6	2	3	2	3	1	3	3	3	3	1	2.4
Mean Overall Score											2.33 (High)

Semester	Course Code	Title of the Course	Hours	Credits
3	25PBT3ES02B	Discipline Specific Elective - 2: Developmental Biology	4	3

Course Objectives

To understand the concept and procedure of Developmental Biology.
To know the development process of humans.
To identify the genetic disorders in human development.
To know the concepts of cellular competence, induction, specification, commitment and differentiation in embryonic development.
To analyse the benefits of developmental biology in modern science.

UNIT I: Basic Concepts of Development

(12 Hours)

Morphogenesis and organogenesis in animals (Human). Embryonic fields, potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting.

UNIT II: Fertilization, Development and Sex Determination in Humans

(12 Hours)

Gametogenesis - Sperm & Egg formation; ultrastructure of sperm and ovum, egg types, egg membrane. Fertilization, cleavage, Morula, Implantation, blastulation, gastrulation, formation of germ layers, axis formation -anterior and posterior. Sex determination - chromosomes and environment.

UNIT III: Organogenesis – I and Organogenesis - II

(12 Hours)

Organogenesis: Central nervous system and the epidermis - Formation of neural tube, Differentiation of the neural tube, tissue architecture of the central nervous system, origin of cutaneous structures. Neural crest cells and axonal specificity - Specification, Trunk Neural Crest, Pattern generation in the nervous system. Plant meristem organization and differentiation - Organization of shoot apical meristem (SAM); Organization of root apical meristem (RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixes.

UNIT IV: Organogenesis - III

(12 Hours)

Paraxial and intermediate mesoderm - Somites formation, Osteogenesis, Urogenital system. Lateral plate mesoderm and endoderm - Heart formation, digestive tube and its derivatives.

UNIT V: Implications of Developmental Biology

(12 Hours)

Medical implications of developmental biology - genetic disorders in human development, environmental assaults on human development, Future therapies and Developmental biology, Environmental regulation of animal development - Environment as a part of normal development, Polyphenisms and plasticity.

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT
Assessment Methodology	Assignment, Seminar, Group discussion

Books for Study:

1. Gilbert S.F. 2010. Developmental Biology, (Ed: 9) Sinauer Associates Inc. Pub., Sunderland, Massachusetts. (Unit I, II, III, IV and V)

Books for References:

1. Alberts B *et al.*, 2002. Molecular Biology of the Cell, (Ed: 3). Garland Science, New York.
2. Lodish, H *et al.*, 2000. Molecular Cell Biology. (Ed: 4). W.H. Freeman, New York.

Websites and eLearning Sources:

1. <https://www.ncbi.nlm.nih.gov/books/NBK543707/?term=developmental%20biology>
2. <https://www.ncbi.nlm.nih.gov/books/NBK224374/?term=developmental%20biology>
3. <https://www.ncbi.nlm.nih.gov/books/NBK9983/>

Course Outcomes		
CO. No.	CO-Statements	Cognitive Levels (K-Level)
	On successful completion of this course, the students will be able to	
CO1	Recall the concepts in developmental biology morphogenesis and organogenesis.	K1
CO2	Outline the concepts of cellular competence, induction, specification, commitment and differentiation in embryonic development.	K2
CO3	Classify the genetic disorders in human development.	K3
CO4	Analyze developmental biology related to cell fate specification and patterning.	K4
CO5	Assess the early development process of humans.	K5
CO6	Design experimental approaches to study developmental processes and their medical implications.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
3	25PBT3ES02B	Discipline Specific Elective - 2: Developmental Biology								4	3
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	1	1	1	3	2	2	2	2	1.8
CO2	3	3	3	2	2	2	3	2	2	3	2.5
CO3	2	2	2	2	2	3	3	3	2	2	2.3
CO4	2	2	2	2	1	3	3	2	2	3	2.2
CO5	2	2	2	2	2	3	2	2	2	3	2.2
CO6	2	3	3	2	1	2	3	3	1	1	2.1
Mean Overall Score											2.2 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	25SBS3RM01	Intellectual Property Rights	4	2

Course Objectives
To understand the concept and procedure of IPR.
To know the status of IPR in India.
To evaluate the difference between patent, copy right and trademark.
To analyse the benefits of patent, copy right and trademark.
To prepare applications for patent, copy right and GI.

UNIT I: Intellectual Property Rights (12 Hours)

Introduction, Concept and Theories, Kinds of Intellectual Property Rights, Importance of Intellectual Property Rights, Advantages and Disadvantages of IPR. International Regime Relating to IPR - TRIPS, WIPO, WTO, GATTs. IPR in India genesis and development.

UNIT II: Patent (12 Hours)

Introduction, Patent acts and its amendments. Patentable and Non patentable inventions. Process and product patent, double patent, patent of addition. Patent application process - Searching a patent, Drafting of a patent, filling of a patent, Types of patent applications-national, regional and international, patent document, Patent Databases: specification and claims. Infringement.

UNIT III: Copy Right (12 Hours)

Concepts and principles. Historical background and development of copyright law - Copy right act, Berne Convention, Universal Copyright Convention, WIPO Phonograms and Performances treaty. Conditions for grant of copyright. Copyright in Literary, Dramatic and musical works, sound recording, cinematograph films and computer programme. Right of Broadcasting and performers. Copyright Board - Power and functioning.

UNIT IV: Trademark (12 Hours)

Introduction, examples of well-known trademark. Historical development of the concept of trademark and trademark law-National and International. Classification of Trademarks, Procedure for registration of trademark. Infringement of trademark and case studies.

UNIT V: Geographical Indication (12 Hours)

Introduction, types. GI laws. Indian GI act. Traditional knowledge and IPR. Public health and Intellectual Property Rights - case study. New plant varieties protection laws - need and benefits. Patenting of microorganism. IPR and Climate change. Patents and Biotechnology.

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT
Assessment Methodology	Assignment, Seminar, Group discussion

Books for Study:

1. Venkataraman, M. (2015). *An introduction to Intellectual property rights*. Create space Independent Pub. North Charleston.

Books for Reference:

1. Gopalakrishnan, N. S., & Agitha, T.G. (2009). *Principles of Intellectual Property*. Eastern Book Company.
2. Ramakrishna, B. & Kumar, A. H.S. (2017). *Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers*. Notion Press.
3. Boyle, J., & Jenkins, J. (2018). *Intellectual Property: Law & the Information Society-Cases and Materials*. Create space Independent Pub. North Charleston.
4. Reddy, D. S. V. (2019). *Intellectual Property Rights - Law and Practice*. Asia Law House.

Websites and eLearning Sources:

1. <https://ipindia.gov.in/>
2. <https://www.annauniv.edu/ipr/files/downloadable/Overview%20of%20IPR.pdf>
3. <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC110356/>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Understand the concept and procedure of IPR.	K1
CO2	Know the status of IPR in India.	K2
CO3	Evaluate the difference between patent, copy right and trademark.	K3
CO4	Analyse the benefits of patent, copy right and trademark.	K4
CO5	Prepare applications for patent, copy right and GI.	K5
CO6	Know the plant varieties protection laws.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
3	25SBS3RM01		Intellectual Property Rights							4	2
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	2	1	2	2	2	2	2	2.2
CO2	2	3	2	2	1	2	2	2	2	3	2.1
CO3	2	2	3	2	2	2	2	2	2	3	2.2
CO4	2	2	2	3	2	2	2	2	2	3	2.2
CO5	2	2	2	2	3	1	2	2	2	2	2.2
CO6	2	3	2	2	1	2	2	2	2	3	2.2
Mean Overall Score											2.22 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	25PBT3SL03	Self - Learning: Fundamentals of Genetics	-	1

Course Objectives

- To understand the principles of Mendelian and Cytoplasmic inheritance.
- To deliver basic knowledge on linkage analysis and gene mapping techniques.
- To explain the principles of pedigree analysis, molecular cytogenetics and epigenetics.
- To evaluate the relationship between environmental factors and gene expression.
- To assess and appraise the role of genetic equilibrium, polymorphism and various other factors that alter the allelic frequencies.

UNIT I: Introduction to Genetics

History of Genetics - Mendelism - basic principles. Extensions of Mendelism, penetrance and expressivity of genes. Non - Mendelian inheritance - cytoplasmic inheritance.

UNIT II: Linkage and Genetic Mapping

Linkage and genetic mapping Linkage and Crossing over - Stern's hypothesis, Creighton and McClintock's experiments, single cross over, multiple cross over, two-point cross, three-point cross, map distances, gene order, interference and co-efficient of coincidence. Haploid mapping (Neurospora).

UNIT III: Human Genetics and Molecular Cytogenetics

Inheritance of traits in humans; pedigree analysis, determination of human genetic diseases by pedigree analysis, genetic mapping in human pedigrees. Molecular cytogenetics, molecular genetics-DNA markers - VNTR, STR and microsatellite. Quantitative genetics - Polygenic inheritance, QTL, effect of environmental factors and artificial selection on polygenic inheritance.

UNIT IV: Population Genetics and Gene Interactions

Population genetics Gene pool, allele and genotype frequency. Hardy Weinberg law and its applications, estimation of Allele and Genotype frequency of dominant genes, co- dominant genes, sex-linked genes and multiple alleles. Interaction of genes: incomplete dominance, co-dominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes; Pleiotropy, genome imprinting, inheritance and lethal genes. Environment and gene expression: penetrance and expressivity; temperature, light, phenocopies,

UNIT V: Evolutionary Genetics and Genetic Variations

Genetic equilibrium, genetic polymorphism. Factors that alter allelic frequencies; Mutation Genetic drift - Bottle neck effect and Founder effect, migration, selection, non- random mating, inbreeding coefficient.

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT
Assessment Methodology	Assignment, Seminar, Group discussion

Books for Study:

- Gardner, E.J., Simmons, M.J., & Snustad, D.P. (2008). *Principles of Genetics* (8th Ed.) Wiley India. (Units I, II, and III).
- Snustad, D.P., & Simmons, M.J. (2009). *Principles of Genetics* (5th Ed.). John Wiley and Sons, Inc.
- Hartl, D.L. (2000). *A Primer of Population Genetics* (3rd Ed.). Sinauer Associates Inc. (Units IV and V).

Books for Reference:

- Klug, W.S., Cummings, M.R., & Spencer, C.A. (2009). *Concepts of Genetics* (11th Ed.). Benjamin Cummings
- Russell, P.J. (2009). *Genetics: A Molecular Approach* (3rd Ed.). Benjamin Cummings.
- Glick, B.R., & Pasternak, J.J. (2003). *Molecular Biotechnology - 3: Principles and Applications of Recombinant DNA*. ASM Press, Washington. (Unit III).
- Gardner, A., Howell, R.T., & Davies, T. (2008). *Human Genetics*. Published by Vinod Vasishtha for Viva Books Private Limited.

Website and eLearning Source:

1. [https://www.bergenfield.org/cms/lib6/NJ01001228/Centricity/Domain/78/Padilla/Biology Fundamentals of Genetics\(A\).pdf](https://www.bergenfield.org/cms/lib6/NJ01001228/Centricity/Domain/78/Padilla/Biology%20Fundamentals%20of%20Genetics(A).pdf)

Course Outcomes		
CO No.	CO-Statements	Cognitive Level (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Critical thinking about how traits are inherited and to use this understanding in analyses.	K1
CO2	Outline the basics of cytogenetics, extra-chromosomal inheritance, linkage and cytoplasmic inheritance.	K2
CO3	Classify the genetic basis of heredity, Mendelian and non- Mendelian modes of inheritance.	K3
CO4	Explain the concepts of gene & allele frequencies, analyze and apply the Hardy-Weinberg equilibrium for population genetics.	K4
CO5	Evaluate conclusions that are based on genetic data.	K5
CO6	Build a genetic model for the inheritance of a particular trait.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
3	25PBT3SL03		Self - Learning: Fundamentals of Genetics							-	1
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	3	2	3	2	2	2.3
CO2	3	3	2	2	1	2	3	2	2	2	2.2
CO3	3	2	2	3	2	2	3	3	1	1	2.2
CO4	3	3	3	1	2	2	3	3	2	2	2.4
CO5	2	3	2	2	2	2	3	2	2	2	2.4
CO6	3	3	2	2	2	2	3	3	3	1	2.4
Mean Overall Score											2.32 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	25PBT4CC10	Core Course - 10: Bio nanotechnology	5	5

Course Objectives
To define the field of bio nanotechnology and its applications in biology, medicine, and materials science.
To explain the principles of integrating biology and nanotechnology.
To introduce nanoscale materials, structures, and properties.
To explain the advantages and challenges of using nanoparticles in medicine.
To analyze the role of nanoscale tools in understanding biological processes.

UNIT I: Introduction to Nanotechnology and Bionanotechnology (15 Hours)

Introduction to nanotechnology – concept and evolution – recent advancements in nanotechnology. Green nanotechnology – sustainable synthesis approaches. Nanochemistry – Classification of nanomaterials – Nanostructures and dynamics of biocompatible materials – fullerenes – nanoparticles – nanotubes – colloidal gold – quantum dots – nanostructures. Nanophysics – quantum dot – quantum wire – quantum point contact – nanocrystals.

UNIT II: Nanoparticles in Diagnostics (15 Hours)

Biosensors – Gold nanoparticles – Synthesis – surface plasmon resonance (SPR) – Mie theory – Graphene-based (GR) – coupling GR and AuNPs. Carbon Nanotube-based biosensor (CNT) – single-walled and multi-walled CNTs. ZnO nanostructures as biosensors – fluorescence – photoluminescence – SPR – SERS – Quenching – conjugation and surface functionalization. CRISPR-based nanosensors for gene detection. Biomedical imaging – Fluorescence, MRI, CT, US, PET, and SPECT.

UNIT III: Nanoparticles in Agriculture (15 Hours)

Nanotechnology in pesticides and fertilizers – control of plant pests – nanoinsecticidal – antimicrobial activity – nanofungicides – antiviral. Nanotechnology in the food industry – Food process – food packaging and labeling – Nanomaterials for soil remediation – Fate of nanomaterials in soil – in plants. Recycling of Agricultural Waste.

UNIT IV: Therapeutic Applications of Nanoparticles (15 Hours)

Natural and synthetic polymer nanoparticles - poly (lactic-co-glycolic acid) (PLGA), chitosan - Liposomes and solid lipid nanoparticles (SLNP) -Hydrogel Nanohydrogel -- Drug laden nanocarriers - Factors influencing the biodistribution of drug-laden nanocarriers. Targeted drug delivery - Passive targeting - Active targeting - Different administration routes of nanocarriers - Transdermal, Blood-brain barrier, Oral route administration, inhalation route and intravenous delivery. Nanotoxicity.

UNIT V: Theragnostics / Theranostic Applications of Nanoparticles (15 Hours)

Definition - multi-functional nanoparticles - lipid-polymer hybrid nanoparticles - mesoporous silica nanoparticles – Nanoinformatics. AI and Machine Learning in nanomedicine and theranostics. DNA origami - Protein-based nanoparticles. Nanorobots and Nanomachines in biological applications.

Teaching Methodology	PPT, Chalk and Talk & Animation videos.
Assessment methodologies	Quizzes, Assignments, MCQ's, Seminars

Books for Study:

1. Christof, M. N., & Chad, A. M. (2004). *Nanobiotechnology: Concepts, Applications and Perspectives*, (1st Ed.). Wiley-VCH. (Unit I).
2. Logo the tid is, S. (2012). *Nanomedicine and Nanobiotechnology*, (12th Ed.). Springer. (Unit II).

Books for Reference:

1. Boisseau, P., & Lahmani, M. (2009). *Nanoscience: Nanobiotechnology and Nanobiology*. Springer. (Unit IV and Unit V).
2. Hakeem., K.R., & Pirzadah, T. B. (2020). *Nanobiotechnology in Agriculture. An Approach towards Sustainability*, (1st Ed.). Springer. (Unit III).

Websites and eLearning Sources:

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8745391/pdf/ijms-23-00131.pdf>
2. <https://www.sciencedirect.com/science/article/pii/S2405844021026426>
3. <https://pubmed.ncbi.nlm.nih.gov/30976948/>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Gain knowledge on synthesis, applications and environmental impact of different types of nanoparticles.	K1
CO2	Apply their acquired knowledge of nature and properties of nanoparticles in the areas of diagnostics, agriculture and therapeutics for the empowerment of mankind.	K2
CO3	Classify the chemical and physical properties of each nanoparticles.	K3
CO4	Evaluate the societal & ethical implications in the advancement of nanotechnology.	K4
CO5	Examine the applications of nanotechnology in the food industry, such as food processing, packaging, and labeling, and its effects on food safety and quality.	K5
CO6	Create ideas on the construction of novel nanoparticles with functional side chains and surface functionalization to accomplished particular task.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
4	25PBT4CC10	Core Course - 10: Bio nanotechnology								5	5
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	3	2	3	2	2	2.3
CO2	3	2	3	2	2	2	3	2	2	2	2.3
CO3	2	3	2	1	1	2	3	2	2	2	2
CO4	2	3	2	3	3	1	3	3	3	3	2.6
CO5	2	2	3	2	2	2	3	3	3	2	2.4
CO6	2	3	1	1	1	3	3	2	2	2	2
Mean Overall Score											2.26 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	25PBT4CC11	Core Course - 11: Plant and Animal Biotechnology	5	5

Course Objectives

To define plant and animal biotechnology and its significance in agriculture, medicine, and conservation.
To introduce genetic modification techniques for plants, such as transformation and gene editing.
To introduce genetic engineering techniques in animals, including transgenesis and genome editing.
To explore applications of animal biotechnology in biomedicine and agriculture.
To explore ethical concerns related to plant and animal biotechnology.

UNIT I: Establishment of Plant Tissue Culture

(15 Hours)

Culture media (types of media), explants and its preparation, Types of culture (callus, suspension, Meristem, Embryo, Protoplast and Root cultures), Regeneration of plants (Organogenesis and Somatic embryogenesis), Haploid plant production (androgenesis and gynogenesis). Isolation and fusion of Protoplast, Artificial seeds, Hardening of plants, Cryopreservation and Germplasm storage. Applications of plant tissue culture in Agriculture and Forestry.

UNIT II: Introduction of Genetic Engineering of Plants

(15 Hours)

Vector (Viral vectors, *Ti* & *Ri* plasmids) and Gene transfer methods (Electroporation, Particle bombardment, Microinjection). Chloroplast transformation. Transgenic plants - Biotic stress resistance (Pest, Viral, Bacterial & Fungal), Abiotic stress tolerance (Herbicide, Salt, Drought), Crop improvement (*Flavr Savr* tomato, Golden rice, Amino acid enrichment, preventing discolouration, Improving flower pigmentation, Male sterility). Applications of Genome editing tools in plant improvement.

UNIT III: Transgenic Plant as Bioreactors

(15 Hours)

Plantibodies, Therapeutic proteins and Edible vaccines. Introduction to animal tissue culture - culture media. Primary cell culture. Development and maintenance of cell lines. Infinite and finite cell lines, Suspension culture, Embryo culture, Organ and Histotypic cultures.

UNIT IV: Animal Cell Culture

(15 Hours)

Planning and layout of cell culture laboratories, Equipment used, Media preparation, Sources of contamination. Cell synchronization. Cryobiology. Applications of animal cell culture. Gene therapy - method, gene delivery systems and applications. Production and applications of monoclonal antibodies.

UNIT V: Animal Cell Culture Techniques

(15 Hours)

Methods of animal cloning (Somatic nuclear transfer, Chromatin transfer, Embryo splitting) and its pros & cons. Methods of production of transgenic animals (Transfection, Retroviral vector, Microinjection, Embryonic stem cells, YAC, Gene targeting) and its applications (Human disease models, Gene knockout mice, Transgenic cattle, sheep, fish, chickens). Transgenic animals as bioreactors - Therapeutic proteins, Vaccines, Recombinant Insulin.

Teaching Methodology	PPT, Chalk and Talk & Animation videos.
Assessment methodologies	Quizzes, Assignments, MCQ's, Seminars

Books for Study:

- Slater, A, *et al.* (2008). *Plant Biotechnology - The genetic manipulation of plants*, (2nd Ed.). Oxford University press. (Unit II and Unit III).
- Verma, A., & Singh, A. (2013). *Animal Biotechnology: Models in discovery and translation*, (1st Ed.). Academic Press.
- Freshney, R. I. (2010). *Culture of Animal cells: Manual of Basic technique and specialized applications*, (6th Ed.). John Wiley Publications. (Unit IV).

Books for Reference:

- Abdin, M. Z., Kiran, U., Kamaluddin, M., & Ali, A. (2017). *Plant Biotechnology: Principles and Applications*. Springer Singapore
- John, M. D. (2011). *Animal Cell Culture: Essential Methods*. Wiley & Sons Ltd. (Unit V).

- Gamborg, O. L., & Philips, G. C. (1995). *Plant Cell, Tissue and organ culture - Fundamental methods*. Narosa Publishing House. (Unit I).

Websites and eLearning Sources:

- <https://www.ncbi.nlm.nih.gov/books/NBK215771/>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7325846/pdf/main.pdf>
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10169938/pdf/43141_2023_Article_50.pdf

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Describe the basic idea on plant and animal culture techniques.	K1
CO2	Outline the mechanism of genetic engineering technology in the production of transgenic plants.	K2
CO3	Experiment with the various plant tissue culture media for the plant regeneration.	K3
CO4	Compare and interrogate with new ideas in techniques in plant and animal biotechnology & interpret them to solve complex problems.	K4
CO5	Inspect the production of artificial seeds and hardening of plants.	K5
CO6	Explore the applications of transgenic animals in modeling human diseases, gene knockout studies, and their role as bioreactors for producing therapeutic proteins, vaccines, and recombinant insulin.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
4	25PBT4CC11	Core Course - 11: Plant and Animal Biotechnology								5	5
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	1	1	3	2	2	2	3	2.2
CO2	2	3	3	1	1	2	3	3	2	2	2.2
CO3	2	3	3	2	2	2	3	3	1	2	2.3
CO4	3	1	1	3	3	3	2	2	3	3	2.2
CO5	1	2	3	3	3	1	2	2	3	3	2.3
CO6	3	2	3	1	1	2	3	3	2	2	2.2
Mean Overall Score											2.23 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	25PBT4CP04	Core Practical - 4: Bio nanotechnology	5	2

Course Objectives
To understand the properties and characteristics of nanomaterials.
To learn about the different types of nanomaterials used in bio-nanotechnology.
To learn techniques for synthesizing nanoparticles, such as metal nanoparticles
To optimize nanoparticle synthesis methods.
To analyze nanoparticle size, shape, and surface properties by characterization methods.

1. Synthesis of Gold nanoparticles using traditional Chemical reduction method.
2. Synthesis of Silver nanoparticles using traditional Chemical reduction method.
3. Synthesis of Gold nanoparticles using medicinal plant extract.
4. Synthesis of Silver nanoparticles using medicinal plant extract.
5. Characterization of gold nanoparticles using UV-visible spectrophotometer, SEM, DLS and FTIR.
6. Characterization of silver nanoparticles using UV-visible spectrophotometer, SEM, DLS and FTIR.
7. Determine the antibacterial activity using synthesized nanoparticles.

Teaching Methodology	Demonstration of practical methodologies and hands on training experience.
Assessment Methodology	Model practical exam, viva

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Understand the microbiology of food, food-borne diseases and food spoilage	K1
CO2	Demonstrate knowledge of the regulatory frameworks and ethical principles relevant to food science and biotechnology.	K2
CO3	Apply the technical, scientific communication and interpretive skills.	K3
CO4	Analyze problems in food biotechnology, by selecting and applying practical techniques with technical competence in laboratory experiments.	K4
CO5	Evaluate the applications of various concepts & techniques of food biotechnology to facilitate biotechnological advancement and innovations.	K5
CO6	Explore antibacterial activity tests using the synthesized gold and silver nanoparticles, and interpret the results to assess their effectiveness against bacterial strains.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
4	25PBT4CP04	Core Practical - 4: Bio nanotechnology								5	2
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	1	1	1	3	3	2	1	1	1.8
CO2	3	2	3	3	3	2	2	3	3	3	2.7
CO3	3	2	3	3	3	1	2	2	2	1	2.2
CO4	2	2	3	2	2	2	3	3	3	3	2.5
CO5	3	2	3	1	1	1	2	3	2	2	2.0
CO6	3	2	1	1	1	3	2	3	1	1	1.8
Mean Overall Score											2.12 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	25PBT4CP05	Core Practical - 5: Plant and Animal Biotechnology	5	2

Course Objectives

To understand and follow safety protocols in laboratory settings for working with plants and animals.
To develop basic laboratory skills, including aseptic techniques, pipetting, and sterile culture maintenance.
To learn to initiate and maintain plant tissue cultures.
To learn techniques for animal cell culture, including cell line maintenance and subculture.
To explore applications of animal biotechnology in biomedicine and agriculture.

(A) Plant Biotechnology

1. Organizing Plant Tissue Culture Laboratory
2. Preparation of Tissue Culture Media
3. Callus Induction
4. Shoot tip culture
5. Embryo/Endosperm Culture
6. Somatic Embryogenesis

(B) Animal Biotechnology

1. Preparation of culture media and sterilization
2. MTT Assay
3. Live cell counting
4. Determine the total RBC count from given sample using haemocytometer.
5. Isolation of DNA from blood samples.
6. Isolation of DNA from animal tissues.

Teaching Methodology	Demonstration of practical methodologies and hands on training experience.
Assessment Methodology	Model practical exam, viva

Course Outcomes

CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Understand the complex processes that occur in the plants and animals.	K1
CO2	Explain the basics of physiological and molecular processes that occur in plants & animals.	K2
CO3	Perform bioassay to analyze the cell cytotoxicity.	K3
CO4	Understand the processes involved in the planning, conduct and execution of plant & animal biotechnology experiments.	K4
CO5	Develop skills in the animal cell culture techniques.	K5
CO6	Accurately determine the total red blood cell (RBC) count from provided blood samples using a hemocytometer.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
4	25PBT4CP05	Core Practical - 5: Plant and Animal Biotechnology								5	2
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	1	1	2	3	3	2	1	1	2.0
CO2	2	3	3	1	1	1	3	2	1	1	1.8
CO3	3	3	3	2	2	3	3	3	1	1	2.4
CO4	3	2	3	3	3	3	3	1	3	3	2.7
CO5	3	3	3	2	1	3	3	2	1	1	2.3
CO6	2	3	3	1	1	1	3	2	1	1	1.8
Mean Overall Score											2.12 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	25PBT4ES03A	Discipline Specific Elective - 3: Food Biotechnology	4	3

Course Objectives

To define the field of food biotechnology and its role in the food industry.
To examine the use of biotechnology in ensuring food safety, such as pathogen detection and control.
To discuss the role of biotechnology in reducing foodborne illnesses.
To explore the use of microorganisms in food fermentation processes.
To formulate innovative food products considering taste, texture, appearance, and nutritional content.

UNIT I: Introduction to Food Biotechnology and Food Chemistry (12 Hours)

Biotechnology in relation to the food industry, classes of food, Characteristics of food - Nutritional value and sensory characteristics, Food chemistry - Carbohydrates, amino acids, proteins, lipids, vitamins, micro-elements. Functional foods and their health benefits. Herbal based foods, Nutraceuticals, probiotics, antioxidants, organic acids.

UNIT II: Spoilage of Foods (12 Hours)

Mechanisms and types of spoilage, Intrinsic and extrinsic factors affecting spoilage: water activity, pH, temperature, redox potential etc., major spoilage micro-organisms and their growth conditions. Spoilage of vegetables, fruits, meat, poultry, beverage and other food products.

UNIT III: Food microbiology and Food Borne Diseases (12 Hours)

Bacteria, yeasts and molds - sources, types and some important species involved in food processing and preservation; fermented foods and food chemicals. Classification - food infections - bacterial and other types; food poisoning and intoxication - bacterial and non-bacterial.

UNIT IV: Introduction to Food Processing (12 Hours)

Preliminary food processing methods - need and types, Raw material preparation: Cleaning, sorting, grading, peeling etc. Principles and methods of food preservation - Low temperature techniques: Refrigeration, Freezing and freeze drying, High temperature techniques: Blanching, HTST pasteurization, canning, UHT treatment, dehydration, drying, extrusion cooking, Irradiation techniques: UV light, microwave processing, gamma rays, cooking, use of additives, modified atmosphere packaging and storage. Smart packaging and nanotechnology-based food preservation techniques.

UNIT V: Enzymes used in Food Industry (12 Hours)

Microbial production of enzymes (proteases, amylases, invertases, pectinase, and xylanase), applications, Microbial production of organic acids, and production of novel sweeteners. Fermentation biotechnology of Indian traditional Foods. Advancements in enzyme technology for food processing.

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment methodologies	Quizzes, Assignments, MCQ's, Seminars, Poster Presentations

Books for Study:

- Shetty, K., Paliyath, G., Pometto, A., & Levin, R. E. (2005). *Food Biotechnology*, (2nd Ed.). CRC Press. (Unit V).
- Fellows, P.J. (2005). *Food Processing Technology: Principle and Practice*, (2nd Ed.). CRC Press. (Unit IV).
- Green, P.J. (2018). *Introduction to Food Biotechnology*. CRC Press. (Unit I and Unit II).

Books for Reference:

- Ray, B., & Bhunia, A. (2013). *Fundamental Food Microbiology*, (5th Ed.). CRC Press (Unit III).
- Shetty, K. (2006). *Food Biotechnology*. Taylor & Francis Group, LLC. (Unit III and Unit V).
- Belitz, W. G., & Schieberle, P. (2009). *Food Chemistry, Springer-Verlag Berlin Heidelberg*, (4th Ed.). (Unit I)
- Nielsen, S. (2009). *Food Analysis, Purdue University West Lafayette*. IN. (Unit I).

Websites and eLearning Sources:

1. https://fri.wisc.edu/files/Briefs_File/2017-07-18_0857_FRI_Brief_Microbial_Food_Spoilage_7_07.pdf
2. <https://www.cdc.gov/foodsafety/foodborne-germs.html>
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5956270/pdf/FTB-56-016.pdf>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Understand the positive role of microorganisms and enzymes.	K1
CO2	Explain the chemistry and nutritional value of food.	K2
CO3	Apply the knowledge in food production, processing, and preservation	K3
CO4	Analyze the microbiology of food borne diseases and make use of the knowledge in Protecting the human community.	K4
CO5	Plan and assess the strategies of food biotechnological industries and come out with new research findings with social concern.	K5
CO6	Explore the concepts of enzyme immobilization and microbial production of organic acids and novel sweeteners.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
4	25PBT4ES03A	Discipline Specific Elective - 3: Food Biotechnology								4	3
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	1	1	3	3	2	2	1	2.1
CO2	1	2	2	2	2	3	2	2	2	1	1.9
CO3	3	3	3	3	3	2	3	3	3	2	2.8
CO4	1	2	3	3	3	1	2	3	3	3	2.4
CO5	3	2	3	3	3	3	2	1	3	3	2.6
CO6	2	3	3	3	3	2	3	3	3	2	2.7
Mean Overall Score											2.41 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	25PBT4ES03B	Discipline Specific Elective - 3: Research Methodology, Biosafety and Bioethics	4	3

Course Objectives

- To understand the fundamentals of research, including its objectives, motivation, and various types.
- To develop knowledge on research design, hypothesis formulation, and different research methodologies.
- To gain skills in scientific writing, ethical research practices, and the use of research-related software.
- To explore the ethical aspects of GMOs, biosafety, and their environmental and societal impacts.
- To evaluate bioethical concerns in biomedical research, intellectual property rights (IPR), and biopiracy.

UNIT I: Introduction to Research

(12 Hours)

Objectives, Motivation to perform research. Types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature- review and its consolidation; Library research; field research; laboratory research.

UNIT II: Research Design

(12 Hours)

Research Question & Investigation Question, Hypothesis, Qualities of a good Hypothesis, Features of a good research design, Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

UNIT III: Scientific Writing and Research Ethics

(12 Hours)

Layout of a Research Paper, Journals in Life Science, Impact factor of Journals, Ethical issues related to publishing: Plagiarism and Self Plagiarism. Methods to search required information effectively, Reference Software such as Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Softwares for detection of Plagiarism.

UNIT IV: Bioethics and GMOs

(12 Hours)

Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-radio isotopic procedure; Benefits of transgenics to human health, society and the environment.

UNIT V: Bioethics in Biomedical Research

(12 Hours)

Nature, Concept and Relevance of Bioethics, Legal, Social, Moral and Economic Impacts of the Products and Techniques in Biotechnology, Ethical issues in Healthcare. Biopiracy and Bioethics: Application of IPR regime to Biological Resources and Biopiracy, Access to Biological Resources, Benefit Sharing and Informed Consent, Independent Ethics Committee, Constitution of institutional ethics committee, Conflicts of Interest.

Teaching Methodology	PPT, Chalk and Talk & Animation videos
Assessment methodologies	Quizzes, Assignments, MCQ's, Seminars, Poster Presentations

Books for Study:

1. Kothari, C.R., & Garg, G. (2019). Research Methodology: Methods and Techniques (4th ed.). New Age International Publishers.
2. Day, R.A., & Gastel, B. (2016). How to Write and Publish a Scientific Paper (8th ed.). Cambridge University Press.
3. Beauchamp, T.L., & Childress, J.F. (2019). Principles of Biomedical Ethics (8th ed.). Oxford University Press.
4. Krimsky, S., & Wrubel, R.P. (2018). Agricultural Biotechnology & the Environment: Science, Policy, & Social Issues. University of Illinois Press.
5. Resnik, D.B. (2021). The Ethics of Science: An Introduction (2nd ed.). Routledge.

Books for Reference:

1. Creswell, J.W., & Creswell, J.D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). SAGE Publications.
2. Saxena, A. (2020). Bioethics and Biosafety (1st ed.). Wiley India Pvt. Ltd.

- Shan, Y., & Zhang, B. (2019). Ethics and Integrity in Health and Life Sciences Research. Springer.

Websites and eLearning Sources:

- <https://www.youtube.com/watch?v=ztl6q59OV6c>
- <https://www.youtube.com/watch?v=GT1tECz4XdA>
- <https://www.youtube.com/watch?v=2q0NIWcTq1Y>
- <https://www.youtube.com/watch?v=7TmcXYp8xu4>
- <https://www.youtube.com/watch?v=FJr3-u8Db1M>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	Recall fundamental concepts of research, scientific writing, and bioethics.	K1
CO2	Explain research methods, hypothesis formation, and ethical issues in publishing and biotechnology.	K2
CO3	Utilize research tools like Zotero/Mendeley, plagiarism detection software, and reference management systems.	K3
CO4	Assess the ethical implications of GMOs, research misconduct, and conflicts of interest in biomedical research.	K4
CO5	Critically evaluate research publications, bioethical regulations, and the impact of IPR on biological resources.	K5
CO6	Develop a research proposal, scientific report, or ethical guidelines for biotechnology applications.	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
4	25PBT4ES03B		Discipline Specific Elective - 3: Research Methodology, Biosafety and Bioethics							4	3
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	1	1	3	3	3	1	3	2.3
CO2	2	2	3	2	3	2	1	1	2	3	2.1
CO3	3	3	3	3	3	2	3	3	3	2	2.8
CO4	3	2	3	1	1	1	1	3	2	3	2.0
CO5	3	3	2	3	2	3	3	3	2	3	2.7
CO6	2	2	3	3	2	3	2	1	2	3	2.1
Mean Overall Score										2.28 (High)	