M Sc BIOTECHNOLOGY

LOCF SYLLABUS 2023

Department of Biotechnology

School of Biological Sciences

St. Joseph's College (Autonomous)

Tiruchirappalli - 620002, Tamil Nadu, India

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 TANSCHE 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 110 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.*

Common Core (CC): *A common core course is a shared educational element encompassing fundamental topics across disciplines within a school. It promotes interdisciplinary comprehension and collaboration among students by providing a foundational understanding of key subjects essential for academic and professional success across diverse fields of study.*

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.*

Generic Elective Courses (EG): *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 generic elective courses offered by other disciplines within the college, enhancing the diversity of their learning experience.*

Ability Enhancement Course (AE): *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 (SE): *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-paced Learning (SP): *This course promotes independent learning habits among students and they have to undergo the course outside the regular class hours within a specified timeframe.*

Comprehensive Examinations (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 five semesters (2 - 6). 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:

23	**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 - Elective
AE - Ability Enhancement Course
SP - Self-paced Learning
EG - Generic Elective
PW - Project and Viva Voce
CE - Comprehensive Examination
OR - Outreach Programme
IS – Internship

EVALUATION PATTERN

Continuous Internal Assessment

Sl No	Component	Marks Alloted
1	Mid Semester Test	30
2	End Semester Test	30
3	*Three Components (15 + 10 + 10)	35
4	Library Referencing (30 hours)	5
	Total	**100**

Passing minimum: 50 marks

* *The first component is a compulsory online test (JosTEL platform) comprising 15 multiple choice questions (10 questions at K1 level and 5 questions at K2 level); The second and the third components are decided by the course in-charge.*

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)*	*For courses with K5 as the highest cognitive level, one K4 and one K5 question is compulsory. (Note: two questions on K4 and one question on K5)*				1	1*		$2 \times 10 = 20$
	For courses with K6 as the highest cognitive level: ***Mid Sem:*** *two questions on K4 and one question on K5;* ***End Sem:*** *two questions on K5 and one question on K6)*				Mid Sem			
						End Sem		
					1	1	1*	
							Total	**60**

***** *Compulsory*

Question Paper Blueprint for Semester Examination

Duration: 3 Hours						**Maximum Marks: 100**
UNIT	**Section A** *(Compulsory)*	**Section B** *(Compulsory)*	**Section C** *(Either…or type)*	**Section D** *(3 out of 5)*		
	K1	**K2**	**K3**	**K4**	**K5**	**K6**
UNIT I	2	2	2	2*	2*	1*
UNIT II	2	2	2			
UNIT III	2	2	2			
UNIT IV	2	2	2			
UNIT V	2	2	2			
Marks	**10 × 1 = 10**	**10 × 3 = 30**	**5 × 6 = 30**	**3 × 10 = 30**		

** For courses with K6 as the highest cognitive level wherein one question each on K4, K5 and K6 is compulsory.*
(Note: two questions each on K4 and K5 and one question on K6)

Evaluation Pattern for One/Two-credit Courses

Title of the Course	CIA	Semester Examination	Total Marks
• Ability Enhancement Course	20 + 10 + 20 = 50	50 *(A member from the Department other than the course instructors)*	100
• Self-paced Learning • Comprehensive Examination	25 + 25 = 50	50 *(CoE)*	100
• Internship	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:

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

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

Where,

Ci - credit earned for the Course i

Gpi - Grade Point obtained for the Course i

Mi - 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 imbibed with ethical values and social concern will be able to understand and appreciate cultural diversity, social harmony and ensure sustainable environment.

Programme Specific Objectives (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.

PROGRAMME STRUCTURE				
Semester	**Specification**	**Number of Courses**	**Hours**	**Credits**
1 - 4	Core Course	10	51	49
1 - 4	Core Practical	5	24	20
1, 2, 4	Elective	4	20	14
1	Ability Enhancement Course	1	2	1
2	Self-paced Learning	1	-	2
2	Skill Enhancement Course	1	4	3
2, 3	Generic Elective	2	8	6
3	Common Core	1	5	4
2 - 4	Extra Credit Course	3	-	(9)
4	Project Work and Viva Voce	1	6	5
4	Comprehensive Examination	1	-	2
2 - 4	Outreach Programme (SHEPHERD)	-	-	4
	Total	**30**	**120**	**110(9)**

M Sc BIOTECHNOLOGY							
Course Details					Scheme of Exams		
Sem	**Course Code**	**Title of the Course**	**Hours**	**Credits**	**CIA**	**SE**	**Final**
1	23PBT1CC01	**Core Course - 1**: Biochemistry	6	6	100	100	100
	23PBT1CC02	**Core Course - 2**: Molecular Cell Biology	6	6	100	100	100
	23PBT1CP01	**Core Practical - 1**: Biochemistry, Molecular Genetics and Molecular Cell Biology	6	4	100	100	100
	23PBT1ES01	**Elective - 1**: Bioinstrumentation	5	3	100	100	100
	23PBT1ES02	**Elective - 2**: Biostatistics	5	3	100	100	100
	23PBT1AE01	**Ability Enhancement Course:** Entrepreneurship skills for Biotechnology	2	1	100	-	100
		Total	**30**	**23**			
2	23PBT2CC03	**Core Course - 3**: Recombinant DNA Technology	4	4	100	100	100
	23PBT2CC04	**Core Course - 4**: Immunology	4	4	100	100	100
	23PBT2CC05	**Core Course - 5**: Microbiology	4	3	100	100	100
	23PBT2CP02	**Core Practical - 2:** Recombinant DNA Technology, Immunology and Microbiology	5	4	100	100	100
	23PBT2SP01	**Self-paced Learning:** Fundamentals of Genetics*	-	2	50	50	50
	23PBT2ES03A	**Elective - 3**: Synthetic Biology	5	4	100	100	100
	23PBT2ES03B	**Elective - 3**: Cell Signaling					
	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3	100	-	100
	23PBT2EG01	**Generic Elective – 1:** Refer ANNEXURE 1	4	3	100	100	100
	-	Extra Credit courses (MOOC/Certificate Course) - 1	-	(3)			
		Total	**30**	**27(3)**			
3	23PBT3CC06	**Core Course - 6**: Bioinformatics	6	6	100	100	100
	23PBT3CC07	**Core Course - 7**: Industrial Biotechnology	5	5	100	100	100
	23PBT3CC08	**Core Course - 8**: Genomics and Proteomics	5	5	100	100	100
	23PBT3CP03	**Core Practical - 3**: Bioinformatics and Industrial Biotechnology	5	5	100	100	100
	23SBS3CC01	**Common Core**: Intellectual Property Rights	5	4	100	100	100
	23PBT3EG02	**Generic Elective - 2 :** Refer ANNEXURE 2	4	3	100	100	100
	-	Extra Credit courses (MOOC/Certificate Course) - 2	-	**(3)**			
		Total	**30**	**28(3)**			
4	23PBT4CC09	**Core Course - 9**: Bionanotechnology	6	5	100	100	100
	23PBT4CC10	**Core Course - 10:** Plant and Animal Biotechnology	5	5	100	100	100
	23PBT4CP04	**Core Practical - 4**: Bionanotechnology	4	3	100	100	100
	23PBT4CP05	**Core Practical - 5**: Plant and Animal Biotechnology	4	4	100	100	100
	23PBT4ES04A	**Elective - 4**: Environmental Biotechnology	5	4	100	100	100
	23PBT4ES04B	**Elective - 4**: Food Biotechnology					
	23PBT4PW01	Project Work and Viva Voce	6	5	100	100	100
	23PBT4CE01	Comprehensive Examination*	-	2	50	50	50
	-	Extra Credit courses (MOOC/Certificate Course) - 3	-	**(3)**			
		Total	**30**	**28(3)**			
2 - 4	23PCW4OR01	Outreach Programme (SHEPHERD)	-	**4**			
1 - 4		**Total (2 Years)**	**120**	**110(9)**			

*- for grade calculation 50 marks are converted into 100 in the mark statements

Passed by	***Board of Studies held on 18.12.2023***
Approved by	***48th Academic Council Meeting held on 27.03.2024***

ANNEXURE 1
Generic Elective - 1 (WS)*

Course Details		
School	**Course Code**	**Title of the Course**
SBS	23PBI2EG01	Biochemistry of Natural Products
	23PBO2EG01	Medicinal Botany

**Offered to students from other Departments within School*

ANNEXURE 2
Generic Elective - 1 (BS)*

Course Details		
School	**Course Code**	**Title of the Course**
SCS	23PCA3EG02	Web Design
	23PCS3EG02	Advances in Computer Science
	23PDS3EG02	Information Security and Ethics
	23PMA3EG02	Operations Research
SLAC	23PEN3EG02	English for Effective Communication
SMS	23PCO3EG02	Basics of TallyPrime
	23PCC3EG02	Dynamics of Human Behaviour in Business
	23PCP3EG02	Social Psychology
	23PEC3EG02	Managerial Economics
	23PHR3EG02	Counselling and Guidance
SPS	23PCH3EG02	Health Science
	23PEL3EG02	Computer Hardware and Networks
	23PPH3EG02A	Physics for Competitive Exams
	23PPH3EG02B	Nanoscience

**Offered to students from other Schools*

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PBT1CC01	**Core Course 1:** Biochemistry	6	6

Course Objectives
To understand the basics of pH and related principles and carbohydrates.
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 **(18 Hours)**

pH, pK. acid, base. Buffers - Henderson- Haselbach equation, biological buffer system - Phosphate buffer system, protein buffer system, bicarbonate buffer system, amino acid buffer system and Hb buffer system. Water, Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms: glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway.

UNIT II: Lipids **(18 Hours)**

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

UNIT III: Bioenergetics **(18 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 ß-oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies. Photosynthesis, urea cycle, hormonal regulation of fatty acids.

UNIT IV: Proteins **(18 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 **(18 Hours)**

Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. In 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

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

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
CO1	identify the structure of fundamental monosaccharides and polysaccharides.	**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 polypeptides.	**K5**
CO6	explain the importance and role of nucleic acids.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
1	**23PBT1CC01**			**Core Course 1:** Biochemistry					**6**		**6**
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	23PBT1CC02	**Core Course - 2**: Molecular Cell Biology	6	6

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 **(18 Hours)**

Basic properties of cells - Cellular dimension - Size of cells and their composition - Cell origin and Evolution (Endosymbiotic theory) - Microscopy - Light Microscopy, Electron Microscopy, Application of Electron Microscopy in cell biology, Phase Contrast Microscopy, Fluorescence Microscopy, Flow Cytometry and FRET .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 **(18 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 secretary 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 **(18 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 **(18 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 **(18 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

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

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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	**23PBT1CC02**			**Core Course - 2**: Molecular Cell Biology					**6**		**6**
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	23PBT1CP01	**Core Practical - 1**: Biochemistry, Molecular Genetics and Molecular Cell Biology	6	4

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 - Practical

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 Genetics - Practical

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) Molecular Cell Biology - Practical

1. Introduction to Microtome and types
2. Microtomy - Fixation of tissue
3. Microtomy - Embedding
4. Microtomy - Sectioning of tissue
5. H&E Staining of tissues
6. Histochemical staining to localize proteins
7. Histochemical staining to localize carbohydrates
8. Histochemical staining to localize lipids.
9. Subcellular fractionation and marker enzyme detection (mitochondria).
10. Giant chromosome studies in Chironomous Larvae.
11. Meiotic study in flower buds and cockroach or grasshopper.
12. Preparation of tissue culture medium and membrane filtration
13. Preparation of single cell suspension from spleen and thymus;
14. Cell counting and cell viability;

Teaching Methodology	Demonstration of practical methodologies and hands on training experience.

Course Outcomes		
CO No.	**CO-Statements** On Successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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	**23PBT1CP01**	**Core Practical - 1**: Biochemistry, Molecular Genetics and Molecular Cell Biology							**6**		**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	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	23PBT1ES01	**Elective - 1:** Bioinstrumentation	5	3

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	Chalk and Talk, PPT and Animation Videos

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. Jefrey, 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.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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	**23PBT1ES01**			**Elective - 1:** Bioinstrumentation					**5**		**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	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	23PBT1ES02	**Elective - 2:** Biostatistics	5	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 analysing the biological data.

UNIT I: Introduction to Statistics **(15 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 **(15 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 **(15 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 **(15 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 **(15 Hours)**

Tests of significance -t tests - F tests - Analysis of variance - one way classification - Twoway 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.

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.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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	**23PBT1ES02**			**Elective - 2:** Biostatistics					**5**		**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	23PBT1AE01	**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.

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.

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.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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	**23PBT1AE01**			**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
2	23PBT2CC03	**Core Course - 3:** Recombinant DNA Technology	4	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 **(12 Hours)**

Enzymes in Molecular Biology - Restriction endonuclease, Ligases, Reverse transcriptase, Nucleases, Polymerase, Alkaline phosphatase, Terminal transferase, T4 polynucleotide kinase; Linkers, Adaptors, Homopolymers. Chromatin immune precipitation, DNA - protein interactions, electro- mobility shift assay and methyl interference assay.

UNIT II: Expression Cassette & Viral Vectors **(12 Hours)**

Promoters (Constitutive, Inducible, Tissue specific), Terminators, Reporters, Markers (Antibiotic resistant, Herbicide resistant, Antimetabolite); Vectors in gene cloning - Plasmids (pBR322, pUC), Bacteriophages (Phage λ, M13), Cosmids, Phagemids, Yeast plasmid vector, Viral vectors (Adenovirus, Adeno associated virus, Baculovirus, Herpes virus, Retrovirus, Cauliflower mosaic virus, Tobacco mosaic virus, Potato virus X), Transposons (Ac-Ds, P) Artificial chromosome (BAC, YAC, HAC), Shuttle vector, Expression vector.

UNIT III: Gene transfer Methods **(12 Hours)**

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 **(12 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 and Marker Assisted Selection (MAS), screening and validation, gene introgression and pyramiding.

UNIT V: Molecular Techniques **(12 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

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** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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	**23PBT2CC03**			**Core Course - 3:** Recombinant DNA Technology					**4**		**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	**2.3**
CO6	2	3	2	2	2	2	3	3	1	2	**2.2**
									Mean Overall Score		**2.33 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBT2CC04	**Core Course - 4:** Immunology	4	4

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 **(12 Hours)**

Terminology - antigen, immunogen, hapten, antigenecity, 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, killed, attenuated, plasma derived sub-unit, recombinant DNA, protein based, plant based, peptides, anti-idotypic and conjugate vaccines - production & applications. Role and properties of adjuvants & ISCOMs.

UNIT II: Immunoglobulin **(12 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) **(12 Hours)**

General organization and inheritance of MHC; MHC Haplotypes. The structure of MHC Class -I and Class-II molecules; organization of MHC class I and class II genes, 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 **(12 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 **(12 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

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.)

Blackwell Scientific Publisher. (Units IV and V)
3. Ian R.T. (2010). *Immunology and Introduction* (4th Ed.). Saunders College Publishing
4. 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** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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	**23PBT2CC04**	**Core Course - 4:** Immunology							**4**		**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	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	3	2	**2.6**
										Mean Overall Score	**2.38 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBT2CC05	**Core Course - 5:** Microbiology	4	3

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 **(12 Hours)**

Introduction and scope of microbiology. Brief study of structure and organization of major groups of microorganisms - Archaebacteria, 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 **(12 Hours)**

Bio-fertilizers and Biopesticides in agriculture: Principles of crop inoculation with microbial agents, microbial inoculants and production, carriers for inoculants: types and characteristics, strain selection of bacteria, cyanobacteria and microalgae for bio fertilizer production, phosphate solubilising microorganisms, AM fungi, Plant Growth Promoting Rhizobacteria (PGPR), biocontrol agents. Bacterial and mycopesticides.

UNIT III: Industrial Microbiology **(12 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 **(12 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 **(12 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

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/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
CO1	gain knowledge about 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	inspect and design 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	**23PBT2CC05**			**Core Course - 5:** Microbiology					**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	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	23PBT2CP02	**Core Practical - 2:** Recombinant DNA Technology, Immunology and Microbiology	5	4

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.

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.

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.

Microbiology

1. Sterilization techniques - physical, chemical, filtration and irradiation techniques.
2. Preparation of basal media - Solid, Liquid: Serial dilution, plating with microbial strain;
3. Isolation of single colonies.
4. Study of a compound microscope.
5. Staining methods - simple, differential, acid - fast & negative.
6. Sub-culturing of a strain using a synthetic liquid media.
7. Preservation Techniques and maintenance.
8. Study of biochemical identification of microorganisms.
9. Bacterial biofilm formation by microtiter plate assay.

Teaching Methodology	Demonstration of practical methodologies and hands on training experience.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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	interpret 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	**23PBT2CP02**	**Core Practical - 2:** Recombinant DNA Technology, Immunology and Microbiology								**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	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	**2.4**
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	**2.35 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBT2SP01	**Self-paced Learning:** Fundamentals of Genetics	-	2

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

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 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

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 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

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	PPT, Chalk and Talk & Animation videos

Books for Study

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

Books for Reference

1. Klug, W.S., Cummings, M.R., & Spencer, C.A. (2009). *Concepts of Genetics* (11th Ed.). Benjamin Cummings
2. Russell, P.J. (2009). *Genetics: A Molecular Approach* (3rd Ed.). Benjamin Cummings.
3. Glick, B.R., & Pasternak, J.J. (2003). *Molecular Biotechnology - 3: Principles and Applications of Recombinant DNA*. ASM Press, Washington. (Unit III).
4. 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

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Level (K - Level)**
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**
2	**23PBT2SP01**	**Self-paced Learning:** Fundamentals of Genetics								**-**	**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	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
2	23PBT2ES03A	**Elective - 3:** Synthetic Biology	5	4

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 **(15 Hours)**

Fundamentals of Synthetic Biology, 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 **(15 Hours)**

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

UNIT III **(15 Hours)**

Elements of synthetic biology: 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 **(15 Hours)**

Synthetic cell: 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 **(15 Hours)**

Commercial Applications - 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	PPT, Chalk and Talk & Animation videos

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
2. https://unctad.org/system/files/official-document/ditctedinf2019d12_en.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
CO1	describe synthetic biology modules and genetic circuits	**K1**
CO2	explain the methodologies for Biobricks, 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**
2	**23PBT2ES03A**	**Elective - 3:** Synthetic 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	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/Week	Credits
2	23PBT2ES03B	**Elective - 3:** Cell Signaling	5	4

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 **(15 Hours)**

Extra Cellular Matrix (ECM) and Cell Surface: 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 **(15 Hours)**

Cell signaling: Various types cell signaling (Autocrine, paracrine, juxtacrine 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 **(15 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 **(15 Hours)**

Signal Transduction and Cancer: 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 **(15 Hours)**

Signal Transduction in Bacteria and Plants: 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

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

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**
2	**23PBT2ES03B**			**Elective - 4**: Cell Signaling					**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	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
2	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3

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.

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** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
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	**23PSS2SE01**			**Skill Enhancement Course:** Soft Skills					**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	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	23PBT3CC06	**Core Course - 6:** Bioinformatics	6	6

Course Objectives
To get introduced to the basic concepts of Bioinformatics and itssignificance 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 **(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 **(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 **(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 **(18 Hours)**

Sequence alignment - concepts in alignment, 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 **(18 Hours)**

Genomics & Proteomics: Concepts in Genomics and Proteomics, Genome annotation, Homology modelling. Applications of Metabolomics & Transcriptomics; Concept of system biology. Docking Analysis.

Teaching Methodology	PPT, Chalk and Talk & Animation videos.

Books for Study

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

Books for Reference

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

Websites and eLearning Sources

1. https://mgcub.ac.in/pdf/material/20200406015739416c3962e5.pdf
2. https://microbenotes.com/nucleotide-sequences-database/
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5506686/pdf/nihms873314.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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, sequencecomparison, 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 ofgenome 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	**23PBT3CC06**		**Core Course - 6:** Bioinformatics						**6**		**6**
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	23PBT3CC07	**Core Course - 7:** Industrial Biotechnology	5	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 **(15 Hours)**

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

UNIT II **(15 Hours)**

Fermentor - 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 **(15 Hours)**

Bioprocess control and monitoring variables - O_2 requirement and uptake, Foam and antifoams, their effect on oxygen transfer, factors affecting KLa. Flow measurement and control, control system - manual and automatic. Application and the role of computers in bioprocess. Fermentationeconomics.

UNIT IV **(15 Hours)**

Down-stream processing: 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 **(15 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 technologyto produce recombinant vaccines.

Teaching Methodology	PPT, Chalk and Talk & Animation videos.

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
3. https://www.mdpi.com/2075-1729/11/6/557

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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 productionof 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 importantfood borne pathogens including various methods for their isolation, detection and identification.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
3	**23PBT3CC07**		**Core Course - 7:** Industrial 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	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	23PBT3CC08	**Core Course - 8:** Genomics and Proteomics	5	5

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 **(15 Hours)**

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

Comparative Genomics: 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 **(15 Hours)**

Functional Genomics: 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 **(15 Hours)**

Proteomics: 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 **(15 Hours)**

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

Teaching Methodology	PPT, Chalk and Talk & Animation videos

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** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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 onnewly sequenced genome for functional characterization of genes	**K3**
CO4	design the experiments using various techniques of genomesequencing 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	**23PBT3CC08**		**Core Course - 8:** Genomics and Proteomics						**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	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	23PBT3CP03	**Core Practical - 3:** Bioinformatics and Industrial Biotechnology	5	5

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.

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.

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.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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 biologicaltasks 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	**23PBT3CP03**		**Core Practical - 3:** Bioinformatics and Industrial 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	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	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	23SBS3CC01	**Common Core:** Intellectual Property Rights	5	4

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 **(15 Hours)**

Intellectual Property Rights - Introduction, Concept and Theories, Kinds of Intellectual Property Rights, Need for intellectual property right, Advantages and Disadvantages of IPR. International Regime Relating to IPR - TRIPS, WIPO, WTO, GATTS. IPR in India genesis and development.

UNIT II **(15 Hours)**

Patent - introduction, Patent acts and its amendments. Patentable and Non patentable inventions. Process and product parent, 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: specification and claims. Infringement.

UNIT III **(15 Hours)**

Copy right - 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 **(15 Hours)**

Trademark - introduction, examples of well-known trademark. Historical development of the concept of trademark and trademark law-National and International. Kinds of trademarks. Procedure for registration of trademark. Infringement of trademark.

UNIT V **(15 Hours)**

Geographical Indication - 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	PPT, videos and practical demonstration

Book 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 LawHouse.

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** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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	**23SBS3CC01**		**Common Core:** Intellectual Property Rights						**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	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
4	23PBT4CC09	**Core Course - 9:** Bionanotechnology	6	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 **(18 Hours)**

Introduction to Nanotechnology and Bionanotechnology

Introduction to nanotechnology - concept of nanotechnology - advances. 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 **(18 Hours)**

Nanoparticles in Diagnostics: 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. Biomedical imaging - Fluorescence, MRI, CT, US, PET and SPECT.

UNIT III **(18 Hours)**

Nanoparticles in Agriculture: Nanotechnology in pesticides and fertilizers - control of plant pests - nanoinsecticidal - antimicrobial activity - nanofungicides - antiviral. Nanotechnology in 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 **(18 Hours)**

Therapeutic Applications of Nanoparticles: 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 **(18 Hours)**

Theragnostics / Theranostic Applications of Nanoparticles: Definition - multi-functional nanoparticles - lipid-polymer hybrid nanoparticles - mesoporous silica nanoparticles - Nanoinformatics - DNA origami - Protein-based nanoparticles. Nanorobots and Nanomachines in biological applications.

Teaching Methodology	PPT, Chalk and Talk & Animation videos.

Books for Study

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

Books for Reference

1. Boisseau, P., & Lahmani, M. (2009). *Nanoscience: Nanobiotechnology andNanobiology. Springer*. (Unit IV and Unit V).
2. Hakeem., K.R., & Pirzadah, T. B. (2020). *Nanobiotechnology inAgriculture. 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** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
CO1	gain knowledge on synthesis, applications and environmentalimpact 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 accomplisha particular task.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
4	**23PBT4CC09**			**Core Course - 9:** Bionanotechnology					**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	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	23PBT4CC10	**Core Course - 10:** 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 **(15 Hours)**

Establishment of plant tissue culture: 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, Artificialseeds, Hardening of plants, Cryopreservation and Germplasm storage. Applications of plant tissue culture in Agriculture and Forestry.

UNIT II **(15 Hours)**

Introduction of genetic engineering of plants - 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).

UNIT III **(15 Hours)**

Transgenic plant as bioreactors - 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 **(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 antibodie

UNIT V **(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.

Books for Study

1. Slater, A, *et al*. (2008). *Plant Biotechnology - The genetic manipulation of plants*, (2nd Ed.). Oxford University press. (Unit II and Unit III).

2. Verma, A., & Singh, A. (2013). *Animal Biotechnology: Models in discoveryand translation*, (1st Ed.). Academic Press.
3. Freshney, R. I. (2010). *Culture of Animal cells: Manual of Basic technique andspecialized applications*, (6th Ed.). John Wiley Publications. (Unit IV).

Books for Reference

1. Abdin, M. Z., Kiran, U., Kamaluddin, M., & Ali, A. (2017). *Plant Biotechnology: Principles and Applications*. Springer Singapore
2. John, M. D. (2011). *Animal Cell Culture: Essential Methods*. Wiley & Sons Ltd. (UnitV).
3. Gamborg, O. L., & Philips, G. C. (1995). *Plant Cell, Tissue and organ culture - Fundamental methods*. Narosa Publishing House. (Unit I).

Websites and eLearning Sources

1. https://www.ncbi.nlm.nih.gov/books/NBK215771/
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7325846/pdf/main.pdf
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10169938/pdf/43141_2023_Article_50.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
CO1	describe the basic idea on plant and animal culture techniques.	**K1**
CO2	outline the mechanism of genetic engineering technology in theproduction of transgenic plants.	**K2**
CO3	experiment with the various plant tissue culture media for theplant 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 andhardening 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	**23PBT4CC10**	**Core Course - 10:** 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	23PBT4CP04	**Core Practical - 4:** Bionanotechnology	4	3

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.

Experiments

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.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
CO1	understand the microbiology of food, food-borne diseases andfood spoilage	**K1**
CO2	demonstrate knowledge of the regulatory frameworks and ethicalprinciples relevant to food science and biotechnology.	**K2**
CO3	apply the technical, scientific communication and interpretiveskills.	**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	**23PBT4CP04**	**Core Practical - 4:** Bionanotechnology							**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	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	23PBT4CP05	**Core Practical - 5:** Plant and Animal Biotechnology	4	4

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.

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

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.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
CO1	understand the complex processes that occur in the plants andanimals.	**K1**
CO2	explain the basics of physiological and molecular processes thatoccur in plants & animals.	**K2**
CO3	perform bioassay to analyze the cell cytotoxicity.	**K3**
CO4	understand the processes involved in the planning, conduct andexecution 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	**23PBT4CP05**		**Core Practical - 5:** Plant and Animal Biotechnology						**4**		**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	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	23PBT4ES04A	**Elective - 4:** Environmental Biotechnology	5	4

Course Objectives
To define the field of environmental biotechnology and its significance in addressing environmental challenges.
To explain the principles of biotechnology as applied to environmental issues.
To understand the principles of biodegradation and its application in treating various pollutants.
To learn about the role of microorganisms in wastewater treatment and soil remediation.
To understand the principles of converting biomass into biofuels, including ethanol and biodiesel.

UNIT I **(15 Hours)**

Environmental pollution: Classification of pollutants, Air pollution and their properties, Gaseous pollutants, water pollutants and their properties. Noise pollution, soil pollution, thermal pollution, marine pollution, solid water pollution. Bioremediation and Phytoremediation: Biofeasibility, applications of bioremediation and bioreduction.

UNIT II **(15 Hours)**

Bioadsorption and bioleaching of heavy metals: cadmium, lead, mercury, metal binding targets and organisms, bioadsorption, metal microbial interaction, biomethylation of elements (methylation of mercury and arsenic), commercial biosorbents, bioleaching, metal precipitation, advantages and disadvantages of bioleaching.

UNIT III **(15 Hours)**

Waste water treatment: biological treatment system (oxidative ponds, aerobic and anaerobic ponds, facultative ponds, aerated ponds), biological waste treatment, activatedsludge treatment, microbial pollution in activated sludge, percolating filters, waste water treatment by biofilms. Treatment scheme for dairy, distillery, tannery, sugar, fertilizers,refinery, chemical and antibiotic wastes.

UNIT IV **(15 Hours)**

Solid waste pollution and its management: Current practice of solid waste management, Treatment process for solid waste, Thermal conversion. Pyrolysis. Composting systems,vermicomposting, sewage treatment.

UNIT V **(15 Hours)**

Xenobiotics in environment: Biodegradation of hydrocarbons, substituted hydrocarbons, surfactant, pesticides, lignin, tannin, synthetic dyes, biotransformation: oxidation reactions: Cytochrome P_{450} Monooxygenase system, Alcohol and aldehyde dehydrogenases, Peroxidases. Reduction reactions: Cytochrome P_{450} and Flavin dependent reactions.Hydrolysis reactions: carboxyl esterases. Conjugation reactions: Glutathione S transferase.

Teaching Methodology	PPT, Chalk and Talk & Animation videos

Books for Study

1. Jordening, H.J., & Winter, J. (2004). *Environmental Biotechnology:Concepts and Applications*. Wiley-VCH Verlag GmbH & Co. (Unit III and V).
2. Rittmann, B. E., & McCarty, P. L. (2018). *Environmental Biotechnology: Principles and applications*. McGraw-Hill. (Unit I and Unit II).

Books for Reference

1. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (1985). *Environmental Engineering*. McGraw-Hill International. (Unit IV).

2. Grady, C. P. L. Jr., & Lim, H. C. (1980). *Biological waste water treatment: Theory and Applications*. Marcel Dekker. Inc.

Websites and eLearning Sources

1. https://www.hindawi.com/journals/ast/2021/9941979/
2. https://www.frontiersin.org/articles/10.3389/fmicb.2022.1049277/full
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9505297/pdf/metabolites-12-00818.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
CO1	understand the principles of environmental microbiology and theknowledge to ensure a sustainable environment.	**K1**
CO2	examine the ecological status and illustrate the importance ofconservation for maintaining a balanced ecosystem.	**K2**
CO3	classify the treatment technologies to clean up contaminatedenvironments and to carry out research strictly following ethics.	**K3**
CO4	categorize and assess the new technologies with innovative ideasfor effective biodegradation of organic pollutants, considering microbial and physical/chemical environments.	**K4**
CO5	examine the biotransformation of xenobiotics through oxidation reactions, reduction reactions, hydrolysis reactions, and conjugation reactions.	**K5**
CO6	design plans for effective phytoremediation of decontaminatedsoil and water, wetlands as treatment processes and preserve the biological diversity and maintain social harmony.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
4	**23PBT4ES04A**	**Elective - 4:** Environmental Biotechnology								**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	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)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PBT4ES04B	**Elective - 4:** Food Biotechnology	5	4

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 **(15 Hours)**

Introduction to Food Biotechnology and Food Chemistry 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. Herbal based foods, Nutraceuticals, probiotics, antioxidants, organic acids.

UNIT II **(15 Hours)**

Spoilage of Foods 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, beverageand other food products.

UNIT III **(15 Hours)**

Food microbiology and Food Borne Diseases 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 **(15 Hours)**

Introduction to Food Processing 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 andstorage.

UNIT V **(15 Hours)**

Enzymes used in Food Industry Microbial production of enzymes (proteases, amylases, invertases, pectinase, and xylanase), applications, Microbial production of organic acids, and production of novel sweeteners. Fermentation biotechnology of Indiantraditional Foods.

Teaching Methodology	PPT, Chalk and Talk & Animation videos.

Books for Study

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

Books for Reference

1. Ray, B., & Bhunia, A. (2013). *Fundamental Food Microbiology*, (5th Ed.). CRC Press (Unit III).
2. Shetty, K. (2006). *Food Biotechnology*. Taylor & Francis Group, LLC. (Unit III and Unit V).
3. Belitz, W. G., & Schieberle, P. (2009). *Food Chemistry, Springer-Verlag Berlin Heidelberg*, (4th Ed.). (Unit I)
4. 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** On successful completion of this course, the students will be able to	**Cognitive Levels (K - Level)**
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, andpreservation	**K3**
CO4	analyze the microbiology of food borne diseases and make useof the knowledge in Protecting the human community.	**K4**
CO5	plan and assess the strategies of food biotechnological industriesand 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	**23PBT4ES04B**		**Elective - 4:** Food Biotechnology				**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	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)**