M Sc BOTANY

LOCF SYLLABUS 2025

Department of Botany

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 92 credits, as stipulated in the programme pattern table. The total minimum number of courses offered by the department is outlined in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)

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

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

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

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

Here are some key aspects of Outcome-Based Education:

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

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

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

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

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

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

LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

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

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

Some important terminologies

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

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

Research Methodology/IPR(RM): *It is a two-credit course offered in the third semester as a common*

program across disciplines within the school. It is designed to acquaint postgraduate learners with the research foundations and legal frameworks vital for innovation and entrepreneurship in technology and business.

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

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

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

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

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

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

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

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

Course Coding

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

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

Course Specific Initials

CC - Core Course
CP - Core Practical
ES - Discipline Specific Elective
AE - Ability Enhancement Course
SL - Self-Learning
OE – Open Elective
PW - Project and Viva Voce
CE - Comprehensive Examination
OR - Outreach Programme
IS – Internship

EVALUATION PATTERN (PG)

Continuous Internal Assessment

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

Passing minimum: 50 marks

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

Question Paper Blueprint for Mid and End Semester Tests

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

***** *Compulsory*

Question Paper Blueprint for Semester Examination

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

***** *Compulsory*

Evaluation Pattern for One/Two-credit Courses

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

Grading System

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

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

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

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

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 Outcomes (PSOs)

1. Graduates will acquire the basic concepts to utilize them for lifelong learning, communicative skills and to imbibe ethical values to create a better world.
2. Graduates will learn about the systematics, structure and functions of plants for effective management of cultivation practices for improved plant performance.
3. Graduates will develop laboratory skills utilizing modern tools, techniques and protocols to collect and process data to design innovative scientific problems and solutions.
4. Graduates will apply the skills for the benefit of the society through teamwork and project management practices for employability and entrepreneurship.
5. Graduates will exploit the knowledge gained through various courses for sustainable environment and human welfare.

M. Sc. Botany				
Programme Structure				
Semester	**Specification**	**No. of Courses**	**Hours**	**Credits**
1 – 4	Core Course	12	60	51
1 - 4	Core Practical	8	24	10
1, 3 & 4	Discipline Specific Elective	3	12	9
1 – 2	Open Elective	2	8	4
1	Ability Enhancement Course	1	2	1
1 – 3	Self-Learning	3	-	4
2	Skill Enhancement Course	1	4	2
3	Research Methodology	1	4	2
4	Project	1	6	3
4	Comprehensive Examination	1	-	2
2 – 4	Outreach Programme (SHEPHERD)	-	-	4
1 - 4	Extra Credit Course	4	-	12
	Total	**37**	**120**	**92 (12)**

M.Sc. BOTANY PROGRAMME PATTERN								
Course Details						Scheme of Exams		
Sem.	Course Code	Course Type	Title of the Course	Hours	Credits	CIA	SE	Final
1	25PBO1CC01	CC Major	**Core Course - 1:** Plant Diversity - 1: Algae, Fungi, Bryophytes and Lichens	5	5	100	100	100
	25PBO1CC02		**Core Course - 2:** Plant Diversity - 2: Pteridophytes, Gymnosperms and Paleobotany	5	4	100	100	100
	25PBO1CC03		**Core Course - 3:** Advanced Plant Anatomy, Embryology and Morphogenesis	4	3	100	100	100
	25PBO1CP01		**Core Practical - 1:** Plant Diversity (Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms and Palaeobotany)	4	2	100	100	100
	25PBO1CP02		**Core Practical - 2:** Advanced Plant Anatomy, Embryology and Morphogenesis	2	1	100	100	100
	25PBO1ES01A	DSE	**Discipline Specific Elective - 1:** Ecology, Phytogeography and Climate Change	4	3	100	100	100
	25PBO1ES01B		**Discipline Specific Elective - 1:** Forestry and Wood Science					
	25PBO1AE01	AEC	**Ability Enhancement Course:** Landscape Designing	2	1	100	-	100
	25PBO1OE01	OE	**Open Elective - 1 (WS):** Medicinal Botany	4	2	100	100	100
	25PGC1SL01	SL	Global Citizenship Education (Online)	-	1	100	-	100
	-	-	Extra Credit Course	-	(3)			
			Total	**30**	**22 (3)**			
2	25PBO2CC04	CC Major	**Core Course - 4:** Plant Physiology	6	5	100	100	100
	25PBO2CC05		**Core Course - 5:** Biochemistry	5	4	100	100	100
	25PBO2CC06		**Core Course - 6:** Pharmacognosy (Internship Embedded Course)	5	5	100	100	100
	25PBO2CP03		**Core Practical - 3:** Plant Physiology	3	1	100	100	100
	25PBO2CP04		**Core Practical - 4:** Biochemistry	3	1	100	100	100
	25PBO2OE02	OE	**Open Elective - 2 (BS):** Sustainable Horticulture and Urban Landscaping	4	2	100	100	100
	25PSS2SE01	SEC	**Skill Enhancement Course:** Soft Skills	4	2	100	-	100
	25PBO2SL02	SL	Online Courses: NPTEL / SWAYAM	-	2	-	100	100
	-	-	Extra Credit Course	-	(3)			
			Total	**30**	**22 (3)**			
3	25PBO3CC07	CC Major	**Core Course - 7:** Plant Systematics	6	5	100	100	100
	25PBO3CC08		**Core Course - 8:** Research Methodology	5	4	100	100	100
	25PBO3CC09		**Core Course - 9:** Cell and Molecular Biology	5	4	100	100	100
	25PBO3CP05		**Core Practical - 5:** Plant Systematics	4	2	100	100	100
	25PBO3CP06		**Core Practical - 6:** Research Methodology	2	1	100	100	100
	25PBO3ES02A	DSE	**Discipline Specific Elective - 2:** Plant Pathology	4	3	100	100	100
	25PBO3ES02B		**Discipline Specific Elective - 2:** Bioinformatics and Bio nanotechnology					
	25SBS3RM01	RM	Intellectual Property Rights	4	2	100	100	100
	25PBO3SL03	SL	**Self Learning:** Evolutionary Adaptations and Plant Breeding*	-	1	50	50	50
	-	-	Extra Credit Course	-	(3)			
			Total	**30**	**22 (3)**			
4	25PBO4CC10	CC Major	**Core Course - 10:** Microbiology and Immunology	5	5	100	100	100
	25PBO4CC11		**Core Course - 11:** Genetic Engineering and Biotechnology	5	4	100	100	100
	25PBO4CC12		**Core Course - 12:** Genetics	4	3	100	100	100
	25PBO4CP07		**Core Practical - 7:** Microbiology and Immunology	3	1	100	100	100
	25PBO4CP08		**Core Practical - 8:** Genetic Engineering and Biotechnology	3	1	100	100	100
	25PBO4ES03A	DSE	**Discipline Specific Elective - 3:** Organic Farming	4	3	100	100	100
	25PBO4ES03B		**Discipline Specific Elective - 3:** Integrated Pest Management					
	25PBO4PW01	PW	Project	6	3	100	100	100
	25PBO4CE01	CE	Comprehensive Examination*	-	2	50	50	50
	-	-	Extra Credit Course	-	(3)			
			Total	**30**	**22 (3)**			
2-4	25PCW4OR01	OR	Outreach Programme	-	4			
1-4			**Total**	**120**	**92 (12)**			

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

Open Elective - 1 (WS): 1st Semester

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

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

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

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PBO1CC01	**Core Course – 1:** Plant Diversity - 1**:** Algae, Fungi, Bryophytes and Lichens	5	5

Course Objectives
To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes.
To gain knowledge about the ecological and economic importance of algae, fungi, lichens and bryophytes.
To spark interest in the evolutionary roots of plant development.
To study the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, bryophytes and microorganisms.
To expose the beneficial and harmful viewpoint.

Unit-I: **(15 Hours)**

Algae: Phycology- Introduction and brief history, Algology in India (Contributions of eminent Indian Algologists, Classification of algae (F. E. Fritsch, 1945), Types of Life cycle. General characteristics, thallus organization, occurrence, reproduction and economic importance of algae.

Unit-II: **(15 Hours)**

Chlorophyta**:** Detail study of structure, reproduction and life cycle of *Chlamydomonas*, *Volvox*, *Cladophora*, *Ulva*, *Caulerpa*, *Oedogonium* and *Spirogyra*. Phaeophyta: Detail study of structure, reproduction and life cycle of *Ectocarpus*, *Padina* and *Sargassum*. Rhodophyta: Detail study of structure, reproduction and life cycle of *Batrachospermum*, *Gracillaria* and *Polysiphonia*. Centric and Pinnate Diatoms.

Unit-III: **(15 Hours)**

Fungi: General features, occurrence and distribution, Mode of nutrition and reproduction in fungi (vegetative, a sexual and sexual), Contributions of Indian Mycologists. Classification of fungi (Ainsworth, 1973; Alexopoulos and Mims, 1979). General characters of major divisions Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Spore dispersal mechanisms, Ecological and Economic importance of fungi.

Unit-IV: **(15 Hours)**

Heterothallism; parasexuality; sex hormones in fungi; Phylogeny and inter-relationships of major groups of fungi. Fossil Fungi. Lichens - Classification of Lichens (Hale, 1969), Nature of association of phycobionts and mycobionts, structure and reproduction in *Usnea*, Economic and ecological importance of lichens. Identification of lichens using Artificial intelligence, MATLAB software, Image processing techniques.

Unit-V: **(15 Hours)**

Bryophyta: Classification (Rothmaler, 1951), general and reproductive characters of major classes, Distribution of bryophytes, Comparative study of gametophytes and sporophytes of major classes: Hepaticopsida: *Marchantia*, *Porella*, Anthocerotopsida: *Anthoceros*, *Notothyllus*, Bryopsida: *Sphagnum*, *Polytrichum*. Economic importance of bryophytes.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Singh, Pandey and Jain. (2020). *A textbook of Botany*, (5thEdition), Rastogi Publication, Meerut.
2. Vashishta, B.R. and Sinha, A.K. (2007). *Botany for Degree Students - Fungi.* S. Chand, New Delhi.

Books for Reference:

1. Hale, Jr. M. E., (1983), *Biology of Lichens*. Edward Arnold, Mayland.
2. Alexopoulus, C. J. and Mims, C. W. (1979). *Introductory Mycology*. Wiley Eastern Ltd., New York.
3. Bessey, E. A. (1979). *Morphology and Taxonomy of Fungi*. Vikas Publications, New Delhi.

Websites and eLearning Sources:

1. https://www.algaebase.org/
2. https://thealgaefoundation.org/academy.html
3. https://www.ffungi.org/en/education
4. https://www.linnean.org/learning/fabulous-fungi
5. https://www.fungiu.com/
6. https://microbenotes.com/bryophytes/
7. https://stri.si.edu/story/bryophytes
8. https://www.fs.usda.gov/wildflowers/beauty/lichens/about.shtml

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Acquire knowledge about the structure, reproduction and life cycle of Algae, Fungi, Lichen and Bryophytes.	**K1**
CO2	Learn the major classes and types of Algae, Fungi, Lichen and Bryophytes and their variations in life cycles and life history.	**K2**
CO3	Recognize the economic importance and biomedical applications of Algae, Fungi, Lichen and Bryophytes.	**K3**
CO4	Comprehend the structural organization of gametophyte and sporophyte in different classes of Bryophytes.	**K4**
CO5	Apply the ICT tools for identification of Flower plants.	**K5**
CO6	Acquire knowledge about the structure, reproduction and life cycle of Algae, Fungi, Lichen and Bryophytes.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**25PBO1CC01**	**Core Course – 1:** Plant Diversity - 1: Algae, Fungi, Bryophytes and Lichens								**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	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	1	2.0
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	2	2.2
Mean Overall Score											**2.1 (medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PBO1CC02	**Core Course – 2:** Plant Diversity - 2: Pteridophytes, Gymnosperms & Palaeobotany	5	4

Course Objectives
To understand the salient features of pteridophytes and gymnosperms
To trace the evolutionary relationship between pteridophytes and gymnosperms
To study the morphology, anatomy and reproduction of various genera mentioned in the syllabus
To acquire knowledge on fossils and fossilization process
To study evolution of plants with the help of the geological time scale.

UNIT-I **(15 Hours)**

Pteridophytes - General characters. Classification: Pteridophyte Phylogenic Group (2016). Theories of origin of vascular cryptogams. Telome concept. Sporangium development - eusporangiate and leptosporangiate type, Apogamy and Apospory. Detailed account on stelar evolution in Pteridophytes, Heterospory and seed habit.

UNIT-II **(15 Hours)**

Morphology, anatomy, reproduction and evolution of gametophytes and sporophytes of the following genera: *Psilotum, Lycopodium, Selaginella, Equisetum, Alsophila* and *Marsilea*.

UNIT-III **(15 Hours)**

Gymnosperms - General characters, Classification of gymnosperms (Sporne, 1965). Phylogeny and comparative study of Cycadopsida, Coniferopsida and Gnetopsida. Salient features of Pteridospermales, Bennettitales, Pentaxylales, Cycadales, Cordaitales, Coniferales and Gnetales. Economic importance of gymnosperms.

UNIT-IV **(15 Hours)**

A general account on distribution, morphology, anatomy, reproduction and life cycle of the following genera: Cycadopsida – *Cycas*; Coniferopsida -*Taxus*; Gnetopsida - *Gnetum*.

UNIT-V **(15 Hours)**

Palaeobotany- Geological time scale, fossilization and types of fossil, Carbon dating. Studies on fossils of India.Rajmahal hill flora and the Deccan Intertrappean flora. Detailed study of the fossil forms: Pteridohytes – *Rhynia, Lepidodendron* and *Calamites*; Gymnosperms - *Lyginopteris*, *Williamsonia* and *Cordaites*.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Sharma, O.P. (2017). *Pteridophyta*, McGraw Hill Education, New York.
2. Bhatnagar, S.P. and AlokMoitra. (2020). *Gymnosperms*, New Age International (P) Ltd., Publishers, Bengaluru.

Books for Reference:

1. Rashid, A. (2007). *An Introduction to Pteridophyte*. Vikas Publications.
2. Johri, R. M., Lata, S., & Tyagi, K. (2005). *A Text book of Gymnosperms* Dominate Publications and Distributer.
3. Vasista, P. C., Sinha, A. K., & Anilkumar. (2005). *Botany for Degree Students, Gymnosperms*. S. Chand.

Websites and eLearning Sources:

1. https://bsapubs.onlinelibrary.wiley.com/doi/10.1002/aps3.70003
2. https://pteridophytes.berkeley.edu/
3. https://www.conifers.org/zz/gymnosperms.php

4. https://library.fiveable.me/introduction-botany/unit-4/gymnosperms/study-guide/ojT5Bx5MG4UiZCDD
5. https://naturalhistory.si.edu/education/teaching-resources/paleontology
6. https://www.palaeobotany.org/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Remember the morphological/anatomical organization, life history of major types of Pteridophytes and Gymnosperms.	**K1**
CO2	Understand recent trends in general characters of Pteridophytes and Gymnosperms.	**K2**
CO3	Comprehend the economic importance of Pteridophytes, Gymnosperms and fossils.	**K3**
CO4	Trace the evolutionary / phylogenetic relationship of Pteridophytes and Gymnosperms.	**K4**
CO5	Classify fossil types and fossilization process of Pteridophytes and Gymnosperms.	**K5**
CO6	Evaluate the features studied with actual plant diversity during field visits.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**25PBO1CC02**	**Core Course – 2:** Plant Diversity - 2: Pteridophytes, Gymnosperms & Palaeobotany								**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	1	3	3	3	2	2	**2.4**
CO2	3	3	3	2	2	3	3	3	2	2	**2.5**
CO3	3	3	3	2	2	3	3	3	2	2	**2.5**
CO4	3	3	2	2	2	3	3	3	2	2	**2.5**
CO5	3	3	3	3	2	3	3	3	2	2	**2.7**
CO6	3	3	2	3	2	3	3	3	2	2	**2.6**
Mean Overall Score											**2.53 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PBO1CC03	**Core Course - 3:** Advanced Plant Anatomy, Embryology and Morphogenesis	4	3

Course Objectives
To understand fundamental concepts in plant anatomy.
To explore growth patterns integrating molecular and evolutionary perspectives.
To examine plant reproductive biology with genetic and physiological regulation.
To explore morphogenetic mechanisms including genetic and tissue differentiation.
To apply plant anatomy and embryology for crop improvement and plant regeneration.

UNIT I Shoot and Root Development & Cambium (12 Hours)

Theories of Shoot and root apical meristem organization and recent molecular insights, Quiescent center, Structural diversity and evolutionary trends of xylem and phloem, Cambium: cell division, and molecular regulation, cambium in budding, grafting, and wound healing. Protective tissues: Periderm, lenticels, trichomes and their role in stress responses.

UNIT II Comparative Anatomy & Vascular Differentiation (12 Hours)

Primary and secondary growth in root and stem (Dicot & Monocot), Hormones and transcription factors in Lateral root formation, Root-stem transition, Leaf anatomy (Dicot & Monocot) with emphasis on C3, C4, and CAM pathways, Stomatal diversity and function: Molecular studies on stomatal development, Nodal and petiole anatomy, vascularization of flowers and seedlings.

UNIT III Microsporangium, Megasporangium & Fertilization (12 Hours)

Microsporangium and microsporogenesis: Advances in pollen biology and transcriptomics, Pollen development, ultrastructure, and storage techniques for conservation, Pollen-stigma interactions, mechanisms of self-incompatibility and biotechnological approaches to overcome incompatibility, Megasporangium development, Female gametophyte formation and embryo sac nutrition, Advances in fertilization biology: Double fertilization, paternal genome activation and post-fertilization signaling.

UNIT IV Seed Development, Apomixis & Plant Propagation (12 Hours)

Endosperm types, haustoria, physiological roles, and molecular regulation of endosperm development, Embryo development in dicot and monocot: Role of gene expression and phytohormones, Polyembryony: Genetic basis and its applications, Apomixis and its significance, Apospory and its applications.

UNIT V Morphogenesis & Plant Development (12 Hours)

Morphogenesis and its relation to plant morphology and evolution, Turing's theory, Genetic, hormones and environment factors in morphogenesis, Molecular basis of morphogenesis, Cellular morphogenesis: asymmetric division in tissue differentiation, Tissue-level morphogenesis: Dedifferentiation, redifferentiation, and vascular tissue regeneration in vitro and in vivo, Plant galls as models for studying morphogenesis and host-pathogen interactions, Recent advances in synthetic morphogenesis and applications.

Teaching Methodology	PPT, videos and practical demonstration
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Charles B. Beck (2010), *An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century* (2nd Edition), Cambridge University Press.
2. William C. Dickison, (2000). *Integrative Plant Anatomy* (1st Edition), Academic Press.
3. Taylor A. Steeves, Vipen K. Sawhney, (2017). *Essentials of Developmental Plant Anatomy* (1st Edition), Oxford University Press Inc.

Books for Reference:

1. Elvira Hörandl et al., (2024). *Apomixis in Systematics, Evolution and Phylogenetics of Angiosperms: Current Developments and Prospects, Critical Reviews in Plant Sciences,* DOI: 10.1080/07352689.2024.2396259
2. Ray F. Evert, (2006). *Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function, and Development"* (3rd Edition).
3. Richard Crang, Sheila Lyons-Sobaski, and Robert Wise, (2018). *Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants"*
4. Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy, (2015). *Plant Physiology*

Websites and eLearning Sources:

1. https://oercommons.org/browse?f.keyword=plant-anatomy
2. https://vrplants.cals.ncsu.edu/pb250/
3. https://uou.ac.in/sites/default/files/slm/BSCBO-202.pdf

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Demonstrate In-depth Knowledge of Plant integrating classical theories with recent molecular insights.	**K1**
CO2	Analyze Plant Growth and Development with emphasis on physiological adaptations	**K2**
CO3	Understand Reproductive Processes in Plants	**K3**
CO4	Apply Concepts of Morphogenesis including applications in tissue engineering.	**K4**
CO5	Apply Knowledge of anatomical and embryological principles for Applied Research	**K5**
CO6	Demonstrate In-depth Knowledge of Plant integrating classical theories with recent molecular insights.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**25PBO1CC03**	**Core Course - 3:** Advanced Plant Anatomy, Embryology and Morphogenesis								**4**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	1	3	3	3	2	2	**2.4**
CO2	3	3	3	2	2	3	3	3	2	2	**2.5**
CO3	3	3	3	2	2	3	3	3	2	2	**2.5**
CO4	3	3	2	2	2	3	3	3	2	2	**2.5**
CO5	3	3	3	3	2	3	3	3	2	2	**2.7**
CO6	3	3	2	3	2	3	3	3	2	2	**2.6**
										Mean Overall Score	**2.53 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PBO1CP01	**Core Practical – 1:** Plant Diversity (Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms and Palaeobotany)	4	2

Algae:
External morphology and internal anatomy of the vegetative and reproductive structures of the following living forms: *Caulerpa*, *Ulva, Diatoms, Sargassum, Gracillaria, Padina, Batrachospermum*, *Nostoc* and *Oscillatoria*.

Fungi:
Preparation of culture media and culture of fungi in the laboratory
Study of morphological and reproductive structures of the following living forms: Plasmodiophora, Rhizopus, Pilobulus, Polyporus, Aspergillus, Penicillium, Colletotrichum and Agaricus

Study of Economically important fungi: Preparation of wine, Food recipe and value added products (Mushroom Pakoda, Mushroom Chips, and Mushroom Biscuit)

Lichen:
Usnea

Bryophytes:
Reboulia, Anthoceros, Pogonatum and *Polytrichum.*

Pteridophytes:
Psilotum, *Lycopodium*, *Selaginella*, *Equisetum*, *Alsophila* and *Marsilea*.

Gymnosperms:
Cycas, *Cupressus*, *Gnetum*.

Palaeobotany:
Rhynia, *Lepidodendron*, *Calamites*, *Lyginopteris*, *Williamsonia*, *Cordaites*. Field Trip and Report submission.

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PBO1CP02	**Core Practical – 2:** Advanced Plant Anatomy, Embryology and Morphogenesis	2	1

Practical

1. Microscopic examination of meristematic tissues (Tunica-Corpus and Histogen organization)
2. Sectioning of dicot, monocot stem and root to study vascular differentiation
3. Identification of different stomatal types in dicot and monocot leaves
4. Sectioning and microscopic examination of nodes and petioles
5. Preparation and staining of anthers to observe pollen morphotypes
6. Dissection and microscopic analysis of ovules
7. Observation of endosperm and haustorial structures in seeds of angiosperms.
8. Dissection of mature seeds to compare embryo structures
9. Examination of gall structures in understanding plant morphogenesis and host-pathogen interactions.

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PBO1ES01A	**Discipline Specific Elective – 1:** Ecology, Phytogeography and Climate Change	4	3

Course Objectives
Explain population dynamics, community ecology and ecological indicators.
Describe energy flow, resource conservation, pollution and waste management.
Identify biodiversity types, threats and conservation strategies.
Understand phytogeographical zones, plant distribution theories and GIS applications.
Examine climate change impacts, global agreements and sustainability measures.

Unit I: Ecological Principles and Population Dynamics (12 Hours)

Introduction to ecology: History, scope and key concepts. Diversity in plant life. Population dynamics; regulation of population density. Community ecology: Characteristics, structure, origin and succession trends. Ecological indicators and climax vegetation.

Unit II: Ecosystem Functioning and Environmental Challenges (12 Hours)

Ecosystem types and functional aspects: Food chain, food web and energy flow. Natural resources: Energy resources (renewable & non-renewable), soil formation, water conservation (stepwells, tank irrigation and rainwater harvesting). Pollution: types. Waste management: Solid and e-waste, recycling and eco-restoration. Ethno-forestry practices in Indian rural landscapes.

Unit III: Biodiversity and Conservation Strategies (12 Hours)

Biodiversity: Types (species, genetic and ecosystem), values, and importance. Hotspots, habitat loss, poaching and invasive species. Endangered and endemic plants of India, Red List categories (IUCN). Conservation approaches: *In situ* and *ex situ*, biotechnology-assisted conservation. Sacred Groves: community-conserved biodiversity hotspots. World conservation organizations and biodiversity laws (Biodiversity Act, 2002). Indigenous germplasm conservation strategies.

Unit IV: Phytogeography and Plant Distribution (12 Hours)

Phytogeographical zones and vegetation types of India and Tamil Nadu. Patterns of plant distribution: Continuous, discontinuous and endemism. Theories of plant distribution: Continental drift, Age and Area hypothesis. Principles of remote sensing and GIS applications in phytogeography. Impact of invasive and exotic species on native flora. Significance culturally protected forests on plant diversity.

Unit V: Climate Change and Global Policies (12 Hours)

Global warming and anthropogenic climatic consequences: climate crisis, greenhouse effect, ozone depletion and acid rain. Role of UNFCCC and IPCC. Climate agreements: Paris Agreement (2015), COP annual meetings: goals and compliance. Carbon economy: Carbon credits, carbon footprint and ESG. Environmental auditing and sustainability measures (SDGs). Indigenous climate adaptation strategies in agriculture and settlement planning.

Teaching Methodology	Chalk and talk, PPT, Field visits
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Kormondy, E.J. (2017). *Concepts of Ecology*. Prentice Hall, U.S.A. (4th edition).

Books for Reference:

1. Sharma, P.D. (2010). *Ecology and Environment*. Rastogi Publications, Meerut, India. (8th edition).
2. Eugene Odum, (2017*). Fundamentals of Ecology* (5th Ed.) Cengage, Bengaluru.
3. Sharma P.D. (2019). *Plant ecology and phytogeography,* Rastogi Publications, Meerut.
4. Alexander von Humboldt, AimeBonpl and, Stephen T. Jackson (eds.) (2013). *Essay on the Geography of Plants,* University of Chicago Press.

Websites and eLearning Sources:

1. https://libguides.southflorida.edu/oer/environmental
2. https://www.serengeti.com/
3. https://www.bdu.ac.in/cde/SLM/M.Sc.%20Botany/Botany%20I%20Year/Angiosperm%20Taxonomy%20,%20Ecology,Phytogeography/chapter5.pdf
4. https://www.ipcc.ch/assessment-report/ar6/
5. https://unfccc.int/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Understand the basic concepts of ecosystem, energy flow and climate change.	**K1**
CO2	Gain insights on recent threats to ecosystems and climate patterns	**K2**
CO3	Apply the knowledge gained on population dynamics to manage social dynamics.	**K3**
CO4	Evaluate the causes of ecosystem destruction and consequences of climate change.	**K4**
CO5	Analyze the importance of anthropocentric implication on ecosystem and climate change.	**K5**
CO6	Formulate and propose the best solution for handling complex ODE problems	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**25PBO1ES01A**	**Discipline Specific Elective – 1:** Ecology, Phytogeography and Climate Change								**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	2	2	2	2	2.2
CO2	2	3	2	2	3	3	2	2	2	2	2.3
CO3	2	3	2	2	2	2	2	2	2	2	2.1
CO4	2	2	3	2	2	2	2	2	2	3	2.2
CO5	2	2	2	3	3	2	3	2	2	2	2.3
CO6	2	2	2	2	3	2	2	2	2	2	2.1
Mean Overall Score											**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PBO1ES01B	**Discipline Specific Elective - 1:** Forestry and Wood Science	4	3

Course Objectives
Explore forest types, distribution, conservation and remote sensing applications.
Study forest products, conservation laws and societal impacts.
Learn wood properties, durability, preservation and traditional uses.
Understand wood preservation, manufacturing, and sustainable alternatives.
Study forest classification, tree growth and indigenous conservation methods.

Unit I: Forest Ecology and Conservation (12 Hours)

World and Indian forest scenario: Types, distribution, and influencing factors. Forest protection: Conservation strategies for rare and endangered species. Silviculture: Principles, practices, and the role of exotics. Remote Sensing and GIS applications in forest management. Sacred groves and community forests.

Unit II: Forest Resources, Policies and Societal Impact (12 Hours)

Major and minor forest products. Indian Forest Act (1927), Forest Conservation Act. Biodiversity Act, 2002. Role of social and community forestry. Forest industries and their role in the economy: Cottage industries, energy plantations. Renewable energy from forests. Ethnobotanical significance.

Unit III: Wood Science and Timber Technology (12 Hours)

Nature and properties of wood: Physical, chemical, mechanical and anatomical aspects. Wood durability: Factors affecting decay, defects and abnormalities. Methods of wood preservation and enhance longevity. Commercial timber species in India. Indigenous wood selection for construction and medicine. Traditional Indian craftsmanship.

Unit IV: Wood Protection, Processing and Industry Applications (12 Hours)

Impact of fungi, insects and environmental factors in timber industry. Traditional and modern methods of wood preservation techniques. Manufacturing and applications of plywood, fibre boards and particle boards. Current status and raw material supply issues in Paper and rayon industries. Wood substitution and eco-friendly materials for Sustainable alternatives.

Unit V: Silviculture, Forest Growth and Measurement Techniques (12 Hours)

Silviculture: Concept, scope, classification of forests (Indian and global). Seed dynamics in forests: Germination, dispersal and establishment. Tree Growth: Height, diameter, volume and net increment. Progress in social forestry, industrial forestry and multiple forestry. Indigenous conservation techniques in tribal communities.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Franz F. P. Kollmann, Wilfred A. Jr. Cote. (2012). *Principles of Wood Science and Technology: I Solid Wood, Springer.*
2. J. L. Bowyer, R. Shmulsky and J. G. (2007). *Haygreen. Forest Products and Wood Science: An Introduction,* Blackwell Publishing Professional.
3. De Vere Burton L., (2000), *Introduction to Forestry Science,* Delmar publishers, NY.

Books for Reference:

1. Jha, L. K. (1996). *Forestry for rural development,* APH Publishing Corporation, New Delhi.
2. Negi, S. S. (1994), *India's Forests, Forestry and Wildlife,* Indus Publishing Co., New Delhi.

Websites and eLearning Sources:

1. https://www.swst.org/wp/education/educational-materials/
2. https://forestlearning.edu.au/

3. https://iwst.icfre.gov.in/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Understand the physical, chemical and mechanical properties of commercial wood.	**K1**
CO2	Acquire knowledge on wood substitution.	**K2**
CO3	Evaluate the raw materials needed for industries.	**K3**
CO4	Protect, conserve and sustainable utilization of forests resources.	**K4**
CO5	Gain skills for careers in the forest service and wood processing industry.	**K5**
CO6	Learn the traditional utilisation of forest resources	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**25PBO1ES01B**			**Discipline Specific Elective - 1:** Forestry and Wood Science						**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	3	2	2	3	2	2	3	2	2.4
CO2	2	3	2	3	2	2	3	2	2	1	2.2
CO3	2	2	3	2	1	3	3	2	3	1	2.2
CO4	3	3	2	3	2	3	2	2	3	2	2.5
CO5	2	3	2	3	1	2	3	2	3	1	2.4
CO6	3	2	3	2	2	3	2	2	3	2	2.4
									Mean Overall Score		**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PBO1AE01	**Ability Enhancement Course:** Landscape Designing	2	1

Course Objectives
To recognize the importance of Landscape Designing.
To gain an understanding of Landscape Designing management.
To develop skills necessary to manage a wholesale Landscape Designing.
To acquire knowledge regarding theory and practice of rising plants.
To develop an interest to become an entrepreneur.

UNIT I **(6 Hours)**

Horticulture tools, implements and accessories.

UNIT II **(6 Hours)**

Landscapes: Lawn making and maintenance. Layout a model of Landscape design. Prepare a model of rockery, hanging baskets. Prepare a model of Xeriscaping.

UNIT III **(6 Hours)**

Nursery: Preparation of Nursery beds. Seed: Structure and types - Seed dormancy; Seed storage: Seed banks. Vegetative Propagation: Cutting, Layering, Grafting and Budding. Transplantation – steps and Methods. Bonsai–Training, Terrarium, Mulching and Topiary techniques.

UNIT IV **(6 Hours)**

Gardening: Designing outdoor garden – hedges, edges, fences, terrace garden and Vertical garden. Medicinal plant garden. Layout model outdoor college garden. Designing Indoor kitchen garden. Indoor design arts -waste material art and craft, Bottle art. Herbarium art.

UNIT V **(6 Hours)**

Floriculture: Flower decoration – Dry and wet decoration. Field Visit: Horticultural garden / nurseries.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Acquaah, G. (2002). *Horticulture: Principles and Practices*. Pearson Education, Singapore.
2. Bose, TK., Maiti, RG., Dhua, RS. and Das, P. (1999). *Floriculture and Landscaping*. NayaProkash, Calcutta.

Books for Reference:

1. Ashman, M. A. and Puri, G. (2002). *Essential soil science- A clear and concise introduction to soil science*. Blackwell scientific publishers, London.
2. SubbaRao, N. S. (1997). *Biofertilizers in Agriculture and Forestry*. India Book House Limited, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
3. Tolanus, S. (2006). *Soil fertility, Fertilizer and Integrated Nutrient management*. International Book Distributory Co.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	To recognize the importance of tools, implements and accessories.	**K1**
CO2	To gain an understanding of Landscapes designing.	**K2**
CO3	To develop skills necessary to manage a wholesale nursery.	**K3**
CO4	To acquire knowledge on gardening practices.	**K4**
CO5	To develop an interest to become an entrepreneur in floriculture.	**K5**
CO6	To recognize the importance of tools, implements and accessories.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
1	**25PBO1AE01**		**Ability Enhancement Course:** Landscape Designing							**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	2	2	3	2	3	3	2	2.5
CO2	2	3	2	3	2	2	3	2	3	3	2.5
CO3	2	3	2	3	2	3	2	2	3	2	2.4
CO4	3	3	3	3	2	3	2	3	2	2	2.6
CO5	2	2	3	2	3	3	2	3	2	3	2.5
CO6	3	2	3	2	2	3	2	3	3	2	2.5
Mean Overall Score											**2.5 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	25PBO1OE01	**Open Elective – 1 (WS):** Medicinal Botany	4	2

Course Objectives
To acquire the knowledge about understanding of principle and efficacy of various Indian system of medicines.
To learn the identification, pharmacological importance and processing of medicinal plants based on their classification and characterization.
To analyze the suitable conservation method for medicinal plants using modern biotechnology tools to ensure the sustainable utilization.
To evaluate the medicinal plants based drug efficacy and its various applications for different ailments.
To create new methods for identification and characterization of drug adulteration and formulations for the human welfare.

Unit I **(12 Hours)**

Key Historical events, Scope and importance of medicinal plants. Traditional medicinal systems: Siddha, Ayurvedha, Homeopathy, Chinese medicine, Unani, Naturopathy and Aromatherapy. Status of Indian medicinal plant trade, medicinal plants prohibited from export, leading companies in India in trade of medicinal plants.

Unit II **(12 Hours)**

Collection and processing of herbal raw materials for drugs preparation-Post Harvesting care, Drying, Dressing, Packing and Storage. Conservation and mass propagation of important medicinal plants through In vitro propagation methods. Role of NMPB, CDRI and CIMAP on medicinal plants conservation and research development. WHO regulation and Guidelines for quality control and trade of herbal medicine.

Unit III **(12 Hours)**

Ethno botany - concept, scope and objectives; Role of ethno botany in modern Medicine. Medico-Ethno botanical sources – Eg. Contribution of Kani Tribes. Major tribes of South India and their ethno botanical knowledge. Herbal preparation methods-bolus, capsules, compresses, creams, decoctions, extracts, infusions, herbal tea, ointments, massage oils, medicinal vinegar, poultice & plasters, powders, salves, syrups, tinctures, tonic, bathing remedies and dry extract (pills or capsules). Application of herbal formulations for the treatment of certain diseases- Jaundice, Fever, Cardiac, Infertility, Diabetics, Blood pressure, Skin care and Respiratory diseases.

Unit IV **(12 Hours)**

Patent guidelines for Phytotherapeutic compounds. Identification and utilization of the medicinal herbs in curing various ailments – *Catharanthus roseus* (Anti-cancer), *Aegle marmelos (*Cardiotonic), *Withania somnifera* (Drugs acting on nervous system), *Cardiospermum halicacabum* (Anti-rheumatic) and *Centella asiatica* (Memory booster), *Phyllanthus emblica* (Rejuvenating) and *Phyllanthus niruri* (Hepato-protective).

Unit V **(12 Hours)**

Medicinally useful plant parts - Root – *Hemidesmus indicus* and *Rawvolfia serpentina;* Rhizome – *Acorus calamus* and *Curcuma longa;* Stem – *Tinospora cordifolia* and *Santalum album*, Bark – *Terminalia arjuna* and *Saraca asoca;* Leaf – *Andrographis paniculata* and *Cynodon dactylon;* Flowers –*Crocus sativus* and *Syzygium aromaticum ;* Fruits - *Piper longum* and *Terminalia chebula;* Seeds– *Azadirachta indica* and *Trigonellafoenum -graecum.*

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Evans, (2009). *Pharmacognosy*, Elsevier Publications, Edinburgh.
2. James Green, (2000) *Herbal Medicine-Maker's Handbook*, Crossing Press, U.S.
3. Weiss, Rudolf Fritz (2000) *Herbal Medicine*, (2nd Edition) Thieme Medical Publishers
4. Kokate CK, Purokit AP and Gokahale, (2006). *Pharmacognosy*, NiraliPrakashan.

5. Somasundara, S (1997). *MaruththuvaThavaraiyal*, IlangovanPadhippagam, Palayamkottai
6. *Cultivation of Medicinal and Aromatic crops* by A.A. Farooqui and B.S. Sreeramu (2004)

Books for Reference:

1. Trivedi P C, (2006). *Medicinal Plants: Ethnobotanical Approach*, Agrobios, India.
2. Purohit and Vyas, (2008). *Medicinal Plant Cultivation*, (2nd Ed.). Agrobios, India.
3. *Quality control and evaluation of Herbal Drugs* by Pulok. K. Mukarjee (2019) Online Resources.

Websites and eLearning Sources:

1. http://www.gallowglass.org/jadwiga/herbs/preparations.html
2. http://shawnacohen.tripod.com/thetribaltraditions/id51.html
   http://www.vasundharaorissa.org/Research%20Reports/GlobalisationAndMedicinalplantsOfOrissa.pdf
3. http://www.emea.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/09/WC500003393.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Obtain the knowledge about understanding of Principle and Treatment methods of various Traditional system of medicines.	**K1**
CO2	Learn the current trade status and role of medicinal plants conservation and research development	**K2**
CO3	Study and Investigate about the kani tribes and Indian tribes' contribution in modern Medicine and Herbal preparation Methods.	**K3**
CO4	Obtain knowledge in identification and utilization of the medicinal herbs in curing various ailments from various plant parts.	**K4**
CO5	Create new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society.	**K5**
CO6	Obtain the knowledge about understanding of Principle and Treatment methods of various Traditional system of medicines.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
1	**25PBO1OE01**		**Open Elective – 1 (WS):** Medicinal Botany							**4**	**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	1	3	3	3	1	2	2	2.3
CO2	3	2	3	3	3	1	2	3	3	2	2.5
CO3	3	3	3	2	3	2	3	3	2	3	2.7
CO4	3	1	3	2	3	2	3	1	2	2	2.2
CO5	2	3	2	2	3	1	1	2	3	2	2.1
CO6	3	2	3	1	3	3	3	1	2	2	2.3
										Mean Overall Score	**2.36 (High)**

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

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

UNIT I: Introduction to Global Citizenship

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

UNIT II: Globalization and Its Impact on Society

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

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

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

UNIT IV: Sustainable Development and Environmental Responsibility

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

UNIT V: Building Global Competence and Engagement

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

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

Books for Study:

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

Books for Reference:

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

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

Websites and eLearning Sources:

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

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

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PBO2CC04	**Core Course – 4:** Plant Physiology	6	5

Course Objectives
Develop an advanced understanding of plant physiological processes, including photosynthesis, respiration, and nutrient regulation at multiple levels.
Gain research expertise in plant physiology, encompassing experimental design, data analysis, and modern research tools.
Apply plant physiology knowledge to address practical challenges in agriculture, environment, and biotechnology through critical thinking.
Enhance communication skills for effectively conveying scientific ideas in both written and oral formats to diverse audiences.
Promote ethical research practices in plant physiology with a focus on sustainability and environmental responsibility.

UNIT I **(18 Hours)**

Water and Plant cells: Water and its role in plants, diffusion and osmosis, water potential. Water balance of plants: absorption by roots, transport through the xylem, aquaporins. Transpiration – structure of stomata, role of hormones and ions in stomatal movement. Mineral nutrition: essential nutrients, deficiencies, plant disorders. Solute transport: passive and active transport, molecular basis of inter and intracellular uptake and transport. Pattern, pathway and mechanism of translocation in the phloem.

UNIT II **(18 Hours)**

Photosynthesis: The light reactions-nature of light, properties and various roles of pigments, organisation of photosynthetic apparatus and light absorbing antenna systems, molecular basis of electron transport and its coupling to ATP synthesis. The carbon reactions- The Calvin-Benson cycle, photorespiration, inorganic carbon concentrating mechanisms (The C4 carbon cycle, Crassulacean Acid Metabolism), and carbon allocation (starch and sucrose).

UNIT III **(18 Hours)**

Respiration: Glycolysis, gluconeogenesis and their regulation. Oxidation of pyruvate and the Citric Acid cycle. Pasteur effect, anaplerotic reactions, amphibolic nature of the Citric Acid cycle. Oxidative pentose phosphate pathway and its roles. Respiratory chain complexes and oxidative phosphorylation, internal and external NAD(P) Hdehydrogenase, alternative oxidase. Nonphosphorylating mechanisms and their roles. Bottom-upregulation of plant respiration. The Glyoxylate cycle and its role in germinating seeds.

UNIT IV **(18 Hours)**

Nitrogen cycle,physiology of biological and non-biological nitrogen fixation, assimilation of nitrate and ammonium-GS-GOGAT; Plant responses to light signals: the phytochromes and the blue-light responses (cryptochromes, phototropins and zeaxanthin). Biosynthesis, metabolism, transport, physiological and developmental effects of auxin, gibberellin, cytokinin, ethylene and abscisic acid.

UNIT V **(18 Hours)**

Flowering and fruit development: Floral evocation, Circadian rhythm, photoperiodism, vernalisation. Physiology of fruit development and ripening. Physiology of seed development, maturation, dormancy, germination and tropisms. Ageing and senescence-types and physiological/ biochemical changes. Abiotic stress (drought, heat and salinity): Plant responses and mechanisms of tolerance.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. William, G.H., & Norman, P.A. (2009). *Introduction to Plant Physiology* (4th Ed.). John Wiley & Sons.
2. Taiz, L., Zeiger, E., Moller, I. M., & Murphy, A. (2015). *Plant Physiology*. (6th Ed.). Sinauer Associates

Books for Reference:

1. Noggle, G.R., & Fritz, G.J. (2001). *Introductory Plant Physiology*. Prentice-Hall.
2. Devlin, R. M. (2000). *Plant Physiology*. Affiliated East West Press Pvt. Ltd.
3. Epstein, E. (2000). *Mineral Nutrition in Plants - Principles and Perspectives*, Wiley.
4. Salisbury, F. B., & Ross, C. W. (1992). *Plant Physiology* (4th Ed.). Wadsworth Publishing CO.
5. Taiz, L., Zeiger, E., Moller, I. M., & Murphy, A. (2028). *Plant Physiology and Development* (6th Ed.). OUP.

Websites and eLearning Sources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5593313/
2. https://www.nobelprize.org/prizes/chemistry/1997/boyer/25946-the-binding-change-mechanism/
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3645666/
4. https://www.frontiersin.org/articles/10.3389/fpls.2018.01771

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Recall and describe fundamental principles of plant physiology, such as photosynthesis, respiration, and nutrient uptake, demonstrating basic knowledge retention.	**K1**
CO2	Explain the intricate molecular and cellular mechanisms underlying key physiological processes in plants, showcasing a deeper understanding of plant physiology concepts.	**K2**
CO3	Apply advanced knowledge of plant physiology to design and conduct experiments, demonstrating the ability to integrate theoretical concepts into practical research.	**K3**
CO4	Analyze and interpret complex data sets related to plant physiological experiments, showcasing proficiency in data analysis and critical thinking skills.	**K4**
CO5	Communicate scientific findings effectively through well-structured written reports and articulate presentations, demonstrating advanced communication skills tailored to diverse audiences.	**K5**
CO6	Evaluate ethical considerations in plant physiology research, demonstrating an understanding of the importance of responsible conduct and sustainable practices in the field.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
2	**25PBO2CC04**		**Core Course – 4:** Plant Physiology							**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	3	3	2	2	3	3	3	2	3	**2.7**
CO2	3	3	3	2	2	3	3	3	2	2	**2.6**
CO3	3	3	3	3	3	3	3	3	2	3	**2.9**
CO4	3	3	3	2	2	3	3	3	2	2	**2.6**
CO5	3	3	3	3	3	3	3	3	3	3	**3**
CO6	3	3	3	2	2	3	3	3	2	2	**2.6**
										Mean Overall Score	**2.73 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PBO2CC05	**Core Course – 5:** Biochemistry	5	4

Course Objectives
To understand the structural and functional role of biomolecules.
To explore metabolic pathways emphasizing enzymatic regulations in health and disease.
To analyze Protein Structure and Function along with their biomedical implications.
To understand enzyme kinetics with their industrial and pharmaceutical applications.
To integrate biomolecular concepts with modern applications.

UNIT I: Carbohydrates & Their Metabolism (15 Hours)

Homoglycans: Chemical structure, properties and biological functions of starch, glycogen, cellulose, dextrin and inulin. Heteroglycans: Structure and biological roles of agar, alginic acid, glycosaminoglycans, proteoglycans, glycoproteins and pectins. Glycocalyx & Oligosaccharides: Role in cell communication and immune response. Carbohydrate metabolism and related disoreders, Carbohydrates in biotechnology and pharmaceutical industries.

UNIT II: Lipids, Biomembranes & Metabolism (15 Hours)

Types of Lipids: Triglycerides, phosphoglycerides, steroids, prostaglandins, sphingolipids, leukotrienes and lipopolysaccharides. Membrane Proteins & Receptors: Adrenaline, acetylcholine and insulin receptors—mechanisms and functions. Lipid Metabolism: β-oxidation, biosynthesis of fatty acids, cholesterol metabolism and lipid-related disorders. Lipids in nanotechnology, drug delivery and functional foods.

UNIT III: Amino Acids, Peptides & Vitamins (15 Hours)

Amino Acids: Structure, classification, and importance in protein biosynthesis. Peptides & Biologically Active Molecules: Structure, metabolism, and function of glutathione, cyclosporin, and bioactive peptides. Amino Acid Metabolism: Phenylalanine, tyrosine, glycine, cysteine, and methionine metabolism and related disorders. Vitamins: Coenzyme function, deficiency diseases and vitamin metabolism overview. Role of amino acids in nutraceuticals and peptide-based drug development.

UNIT IV: Protein Structure, Folding & Function (15 Hours)

Protein Structure: Primary Structure: Peptide bonds and sequence determination. Secondary Structure: α-helix, β-sheets, and supersecondary structures. Tertiary & Quaternary Structure: Forces stabilizing collagen, hemoglobin structure and allosteric regulation. Protein Sequencing Strategies: Chemical and enzymatic methods. Ramachandran Plot: Role in protein conformation and disease-linked misfolding. Proteins in structural, computational biology and disease modeling.

UNIT V: Enzymes, Kinetics & Industrial Applications (15 Hours)

Principles of Catalysis: Activation energy, reaction profiles, enzyme-substrate interaction. Enzyme Kinetics: Michaelis-Menten equation, Lineweaver-Burk plot, KM & Vmax determination. Enzyme Regulation: Role of pH, temperature, substrate concentration, allosteric regulation. Enzyme Inhibition: Competitive, non-competitive, and allosteric regulation; regulation of glutamine synthetase. Application of enzymes in industry and diagnostics.

Teaching Methodology	PPT, videos and practical demonstration
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. David Nelson and Michael Cox, 2021. Lehninger Principles of Biochemistry (8th Edition), W. H. Freeman Publisher.
2. Emine E. Abali, Susan D. Cline, David S. Franklin, 2025. Lippincott® Illustrated Reviews: Biochemistry (Lippincott Illustrated Reviews Series) Ninth, North American Edition, LWW Publishers.
3. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, 2015. Biochemistry (8th Edition), W. H. Freeman Publisher.
4. N.S. Punekar, 2025. ENZYMES: Catalysis, Kinetics and Mechanisms (2nd Edition). Springer.
5. Wolfgang Aehle, 2007. Enzymes in Industry: Production and Applications, 3rd Edition, Wiley-VCH

6. David Whitford, 2013. Proteins: Structure and Function, Wiley-VCH

Books for Reference:

1. David Nelson and Michael Cox, (2021). *Lehninger Principles of Biochemistry* (8th Edition), W. H. Freeman Publisher
2. Emine E. Abali, Susan D. Cline, David S. Franklin, (2025). *Lippincott® Illustrated Reviews: Biochemistry (Lippincott Illustrated Reviews Series) Ninth*, North American Edition, LWW Publishers
3. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, (2015). *Biochemistry* (8th Edition), W. H. Freeman Publisher
4. N.S. Punekar, (2025). *ENZYMES: Catalysis, Kinetics and Mechanisms* (2nd Edition). Springer
5. Wolfgang Aehle, 2007. Enzymes in Industry: Production and Applications, 3rd Edition, Wiley-VCH
6. David Whitford, (2013). *Proteins: Structure and Function*, Wiley-VCH
7. Yoon H, Shaw JL, Haigis MC, Greka A. *Lipid metabolism in sickness and in health: Emerging regulators of lipotoxicity.* Mol Cell. 2021 Sep 16;81(18):3708-3730. doi: 10.1016/j.molcel.2021.08.027.
8. Qiu, S., Cai, Y., Yao, H. et al. *Small molecule metabolites: discovery of biomarkers and therapeutic targets.* Sig Transduct Target Ther 8, 132 (2023). https://doi.org/10.1038/s41392-023-01399-3
9. Biochemistry Free for All – Oregon State University, https://biochem.oregonstate.edu/undergraduate/educational-resources

Websites and eLearning Sources:

1. Biochemistry Free for All – Oregon State University, https://biochem.oregonstate.edu/undergraduate/educational-resources

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	To demonstrate Knowledge of Biomolecular Structures and their derivatives.	**K1**
CO2	To analyze metabolic Pathways and Their Clinical Relevance	**K2**
CO3	To evaluate Protein Structure and the significance of protein misfolding in diseases.	**K3**
CO4	To Apply Enzyme Kinetics to Biological and Industrial Processes	**K4**
CO5	To Integrate Biomolecular Knowledge with Research and Industry	**K5**
CO6	To demonstrate Knowledge of Biomolecular Structures and their derivatives.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
2	**25PBO2CC05**		**Core Course – 5:** Biochemistry							**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	1	3	3	3	2	2	**2.4**
CO2	3	3	3	2	2	3	3	3	2	2	**2.5**
CO3	3	3	3	2	2	3	3	3	2	2	**2.5**
CO4	3	3	2	2	2	3	3	3	2	2	**2.5**
CO5	3	3	3	3	2	3	3	3	2	2	**2.7**
CO6	3	3	2	3	2	3	3	3	2	2	**2.6**
										Mean Overall Score	**2.53 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PBO2CC06	**Core Course - 6:** Pharmacognosy (Internship embedded course)	5	5

Course Objectives
To acquire the knowledge about understanding of Principle and Treatment methods of various Traditional system of medicines.
To learn the identification, pharmacological importance and processing of medicinal plants based on their classification and characterization.
To analyze the suitable conservation method for medicinal plants using modern biotechnology tools to ensure the sustainable utilization.
To evaluate the medicinal plants based drug efficacy and its various applications for different ailments.
To create new drug formulations using phytochemical compounds for the healthy life of society.

Unit-I **(15 Hours)**

Traditional and alternative system of medicine-Principle, practice, short history and merits of herbal medicine- Siddha, Ayurveda, Homeopathy, Chinese medicine, Unani, Naturopathy, Aromatherapy and acupuncture. Status of Indian medicinal plant trade, medicinal plants prohibited from export, leading companies in India in trade of medicinal plants.

Unit-II **(15 Hours)**

Classification of crude drugs - alphabetical, taxonomical, morphological, chemical, pharmacological (therapeutical). Medicinal plants - Mass Cultivation methods for sustainable utilization, Collection and processing of herbal raw material for drugs Preparation-Post Harvesting care, Drying, Dressing, Packing and Storage. Conservation and mass propagation of important medicinal plants through *In vitro* propagation methods.

Unit-III **(15 Hours)**

Medicinally useful plant parts: Root –*Hemidesmus indicus*, *With an iasomnifera* and *Rauvolfia serpentina*; Rhizome - *Zingiber officinalis, Acorus calamus* and *Curcuma longa*; Stem- *Tinospora cordifolia, Santalum album*; Bark – *Terminalia arjuna, Cinnamomum verum* and *Saracaasoca*; Leaf – *Adhatodavasica*, *Ocimum sanctum* and *Cynodon dactylon*; Flowers – *Crocus sativus, Syzygium aromaticum* and *Leucus aspera*; Fruits – *Phyllanthus emblica, Piper longum* and *Terminalia chebula*; Seeds – *Azadirachta indica,* Trigonella foenum-graecum and *Ricinus communis*.

Unit-IV **(15 Hours)**

Herbal preparation methods - bolus, capsules, compresses, creams, decoctions, extracts, infusions, herbal tea, ointments, massage oils, medicinal vinegar, poultice & plasters, powders, salves, syrups, tinctures, tonic, maceration and baths and bathing remedies teas and dry extract (pills or capsules). Application of herbal formulations for the treatment of certain diseases- Jaundice, Fever, Cardiac, Infertility, Diabetics, Blood pressure, Skin care and Respiratory diseases.

Unit-V **(15 Hours)**

Pharmaceutical plant products- alkaloids, glycosides, terpenoids, tannins, flavonoids, lipids, proteins. Nutraceuticals, cosmeceuticals, pharmaceuticals - fibre, sutures, surgical dressings, adaptogens, rasayana. Drug adulteration and methods of evaluation-physical, chemical and microscopic. NMPB, CDRI, CIMAP, CIPLA; Herbal drug regulations in India. WHO regulation and Guidelines for quality control and trade of herbal medicine.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Book for Study:

1. Evans, (2009). *Pharmacognosy*, Elsevier Publications, Edinburgh.

Books for Reference:

1. James Green, (2000) *Herbal Medicine-Maker's Handbook*, Crossing Press, U.S.
2. Weiss, R.F. (2000) *Herbal Medicine, (*2ndEdition) Thieme Medical Publishers
3. Kokate CK, Purokit A P and Gokahale, (2006). *Pharmacognosy*, Nirali Prakashan.
4. Somasundara, S (1997). *Maruththuva Thavaraiyal*, Ilangovan Padhippagam, Palayamkottai
5. A. A. Farooqui and B. S. Sreeramu (2004) *Cultivation of Medicinal and Aromatic crops*
6. Pulok. K. Mukarjee (2019) *Quality control and evaluation of Herbal Drugs*

Websites and eLearning Sources:

1. http://www.gallowglass.org/jadwiga/herbs/preparations.html
2. http://shawnacohen.tripod.com/thetribaltraditions/id51.htmlhttp://www.vasundharaorissa.org/Research%20Reports/GlobalisationAnd
3. http://www.emea.europa.eu/docs/en_GB/document_library/Scientific_ guideline/2009/09/WC500003393.pdf

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Acquire the knowledge about understanding of Principle and Treatment methods of various Traditional system of medicines.	**K1**
CO2	Learn the identification, pharmacological importance and processing of medicinal plants based on their classification and characterization.	**K2**
CO3	Analyze the suitable conservation method for medicinal plants using modern biotechnology tools to ensure the sustainable utilization.	**K3**
CO4	Evaluate the medicinal plants based drug efficacy and its various applications for different ailments	**K4**
CO5	Create new drug formulations using phytochemical compounds for the healthy life of society.	**K5**
CO6	Acquire the knowledge about understanding of Principle and Treatment methods of various Traditional system of medicines.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
2	**25PBO2CC06**	**Core Course – 6:** Pharmacognosy (Internship embedded course)								**5**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	1	3	3	3	1	2	2	2.3
CO2	2	2	3	1	2	1	3	3	2	3	2.2
CO3	3	3	3	2	3	2	3	3	2	3	2.7
CO4	3	1	3	2	3	2	3	1	2	2	2.2
CO5	2	3	2	2	3	1	1	2	3	2	2.1
CO6	3	2	3	1	3	3	3	1	2	2	2.3
Mean Overall Score											**2.30 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PBO2CP03	**Core Practical - 3:** Plant Physiology	3	1

Experiments

1. Determination of water potential (Shardakov's method).
2. Determination of solute potential.
3. Hill reaction.
4. Estimation of total acidity in CAM plants.
5. Apparent photosynthesis.
6. Effect of CO2 concentration on photosynthesis
7. Effect of quality of light on photosynthesis
8. Estimation of total free amino acids and proline.
9. *In vivo* assay of NR and NiR.
10. Estimation of IAA.
11. Estimation of starch by perchloric method.
12. Estimation of nitrogen (Nessler's method).
13. Determination of activity of peroxidase and lipase

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PBO2CP04	**Core Practical - 4:** Biochemistry	3	1

Practical

1. Estimation of glycogen / total polysaccharides
2. Estimation of hexosamine
3. Extraction and Estimation of Lipids.
4. Estimation of cholesterol
5. Qualitative Analysis of Amino Acids
6. Determination of total proteins (Bradford's / Lowry's)
7. Study of Enzyme Kinetics (experiments with acid phosphatase)
8. Effect of temperature on enzyme activity.
9. Effect of [S] on enzyme activity; measurement of Vmax and Km.
10. Estimation of Ascorbic acid (Calorimetric /volumetric)

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PBO2OE02	**Open Elective – 2 (BS):** Sustainable Horticulture and Urban Landscaping	4	2

Course Objectives
Understand the Fundamentals of Horticulture in sustainable agriculture and urban planning.
Develop Practical Skills in Plant Propagation
Enhance Aesthetic and Functional Gardening Skills
Apply Landscaping Principles for Green Infrastructure
Integrate Sustainable and Smart Gardening Techniques

UNIT I: Fundamentals of Horticulture (12 Hours)

Importance and scope of horticulture in sustainable agriculture and urban planning. Divisions of horticulture: Pomology, Olericulture, Floriculture, Landscaping and Post-harvest Technology. Climate, soil and nutritional needs of horticultural crops, Plant propagation methods – Cutting, Grafting, Budding and Layering.

UNIT II: Indoor and Aesthetic Gardening (12 Hours)

Selection and maintenance of indoor plants – Flowering plants, hanging baskets and air-purifying plants. Terrariums, Bonsai and Topiary. Aesthetic gardening and urban biodiversity conservation.

UNIT III: Fruit Crops and Floral Designing (12 Hours)

Induction of flowering, flower thinning, pollination, fruit setting and development in commercial fruit crops. Flower decoration techniques (Dry & Wet methods), Post-harvest handling of flowers and fruits to the enhance market value.

UNIT IV: Landscaping and Green Infrastructure (12 Hours)

Principles of landscaping – Importance in urban planning, climate adaptation and ecosystem restoration. Designing house gardens, institutional and industrial gardens. Green corridor development: Avenue planting for railway stations, highways, and urban spaces. Selection and cultivation of trees, shrubs, climbers, herbs and ground covers. Tree transplantation techniques.

UNIT V: Specialized Gardens and Smart Green Spaces (12 Hours)

Lawn development – Selection of grass species, maintenance practices. Innovative Gardening: Vertical gardens, roof/terrace gardens and water gardens for urban spaces. Smart Landscaping: Planning and designing parks, public gardens and biodiversity parks for climate resilience.

Teaching Methodology	PPT, videos and practical demonstration
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Bird, C. (Ed.). (2014). The Fundamentals of Horticulture: Theory and Practice. Cambridge: Cambridge University Press.
2. Dumroese, R. K., T. Luna, D. Thomas, editors. 2009. Nursery manual for native plants: A guide for tribal nurseries – Volume 1: Nursery management. Agricultural Handbook 730. Washington, D.C.: U.S. Department of Agriculture, Forest Service. 302 p. https://www.fs.fed.us/rm/pubs_series/wo/wo_ah730.pdf
3. A.K. Thompson, 2003. Fruits and Vegetables: Harvesting, Handling and Storage, Blackwell Publishing Ltd, https://doi.org/10.1002/9780470751060.refs
4. Ying, J., Zhang, X., Zhang, Y., & Bilan, S. (2021). Green infrastructure: systematic literature review. Economic Research-Ekonomska Istraživanja, 35(1), 343–366. https://doi.org/10.1080/1331677X.2021.1893202
5. Gary Austin, 2014. Green Infrastructure for Landscape Planning Integrating Human and Natural Systems, 1st Edition, Routledge, Taylor and Francis group
6. Chu Xiao Hui, Ge Dan, Sagr Alamri, Davood Toghraie, Greening smart cities: An investigation of the integration of urban natural resources and smart city technologies for promoting environmental

sustainability, Sustainable Cities and Society, 99, 2023, 104985, https://doi.org/10.1016/j.scs.2023.104985

Books for Reference:

1. Bird, C. (Ed.). (2014). *The Fundamentals of Horticulture: Theory and Practice*. Cambridge: Cambridge University Press.
2. Dumroese, R. K., T. Luna, D. Thomas, editors. 2009. *Nursery manual for native plants: A guide for tribal nurseries – Volume 1:* Nursery *management. Agricultural Handbook* 730. Washington, D.C.: U.S. Department of Agriculture, Forest Service. 302 p. https://www.fs.fed.us/rm/pubs_series/wo/wo_ah730.pdf
3. A.K. Thompson, (2003). *Fruits and Vegetables: Harvesting, Handling and Storage,* Blackwell Publishing Ltd, https://doi.org/10.1002/9780470751060.refs
4. Ying, J., Zhang, X., Zhang, Y., & Bilan, S. (2021). *Green infrastructure: systematic literature review*. Economic Research - EkonomskaIstraživanja, 35(1), 343–366. https://doi.org/10.1080/1331677X.2021.1893202
5. Gary Austin, (2014). *Green Infrastructure for Landscape Planning Integrating Human and Natural Systems,* (1st Edition), Routledge, Taylor and Francis group
6. Chu Xiao Hui, Ge Dan, Sagr Alamri, Davood Toghraie, Greening smart cities: An investigation of the integration of urban natural resources and smart city technologies for promoting environmental sustainability, Sustainable Cities and Society, 99, (2023), 104985, https://doi.org/10.1016/j.scs.2023.104985

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Demonstrate knowledge of horticulture and its applications in agriculture, landscaping, and environmental sustainability.	**K1**
CO2	Perform propagation techniques effectively for commercial and home gardening purposes.	**K2**
CO3	Design and maintain diverse indoor and outdoor gardens	**K3**
CO4	Create functional and aesthetic landscape designs including industrial and urban spaces.	**K4**
CO5	Apply sustainable gardening practices such as rooftop gardens, water conservation in landscaping, and biodiversity-friendly gardening.	**K5**
CO6	Reference books	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
2	**25PBO2OE02**	**Open Elective – 2 (BS):** Sustainable Horticulture and Urban Landscaping								**4**	**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	1	3	3	3	2	2	**2.4**
CO2	3	3	3	2	2	3	3	3	2	2	**2.5**
CO3	3	3	3	2	2	3	3	3	2	2	**2.5**
CO4	3	3	2	2	2	3	3	3	2	2	**2.5**
CO5	3	3	3	3	2	3	3	3	2	2	**2.7**
CO6	3	3	2	3	2	3	3	3	2	2	**2.6**
										Mean Overall Score	**2.53 (High)**

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

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

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

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

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

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

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

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

Basics of Group Discussion- Parameters of GD- Topics for Practice - Mock GD & Practicum & Team Building. *Personal Effectiveness*: Self Discovery - Goal Setting with questionnaires & Exercises.

Unit IV: Numerical Ability (12 Hours)

Introducing concepts - Average – Percentage - Profit and Loss - Simple Interest - Compound Interest - Time and Work - Pipes and Cisterns.

Unit V: Test of Reasoning (12 Hours)

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

Teaching Methodology	Chalk and talk, PPT, Mathematical models, Video presentation

Books 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

Websites and eLearning Sources:

1. https://www.indeed.com/career-advice/resumes-cover-letters/communication-skills
2. https://www.seek.com.au/career-advice/article/50-communication-skills-for-the-workplace-your-resume
3. https://southeast.iu.edu/career/files/power-phrases.pdf
4. https://dese.ade.arkansas.gov/Files/20201209124449_Professional-Communication.docx

5. https://www.dol.gov/sites/dolgov/files/ETA/publications/00-wes.pdf
6. https://www.tmu.ac.in/other_websites/cdoe.tmu.ac.in.old/study-material/28-08-2024/COMMON/SEMESTER_2/MAIN_SOFT_SKILLS.pdf
7. https://byjus.com/maths/profit-and-loss-questions/
8. https://www.indiabix.com/

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

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

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PBO3CC07	**Core Course – 7:** Plant Systematics	6	5

Course Objectives
Understand plant diversity, classification, nomenclature, and evolutionary relationships through in-depth plant systematic study.
Proficiently use modern tools for plant identification, taxonomy, and phylogenetic analysis to contribute to plant systematic.
Critically analyze and synthesize scientific literature on plant systematic, applying knowledge to evolutionary biology and botanical classification.
Develop practical skills in fieldwork, herbarium techniques, and specimen curation for collecting and preserving plant specimens.
Conduct independent research projects applying systematic principles to address real-world challenges in biodiversity conservation, ecosystem management, and plant breeding.

UNIT I **(18 Hours)**

Overview of Plant Systematics – Phenetics (artificial, natural classification) and Cladistics (Phylo genetic 35systematic): terms and concepts, taxon selection, character analysis, cladogram construction, cladogram analysis – Angiosperm Phylogeny Group classification: principles of APG system, detailed version of APG IV.

UNIT II **(18 Hours)**

Taxonomic hierarchy: principal ranks – species concept and infraspecific categories (subspecies, varieties and forms) – genus concept and infra generic categories (subgenus, section and series) – family concept and infra family categories (subfamily, tribe and subtribe).

UNIT III **(18 Hours)**

Botanical nomenclature: ICN principles; scientific names; authorship; nomenclatural types; valid publication; priority of publication; conservation of names; retention and rejection; taxonomic revision; synonyms; names of hybrids and cultivated plants.

UNIT IV **(18 Hours)**

Plant identification: field inventory; herbarium techniques, Flora (e-flora), monographs; journals; taxonomic key. Systematic evidence: morphology; anatomy; palynology; embryology; cytology; phytochemistry.

UNIT V **(18 Hours)**

Molecular systematic: Plant genomes- nuclear, chloroplast and mitochondria. Molecular markers, generating molecular data, restriction site mapping, gene sequencing, analysis of molecular data, alignment of sequences, methods of phylogeny reconstruction.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Michael, G., &Simpson. (2019). *Plant Systematics*, (3rd Ed.). Academic Press.
2. Crawford, D. J. (2003). *Plant Molecular Systematics*. Cambridge University Press.
3. Heywood, V. K., & Moore, D. M. (1984). *Current Concepts in Plant Taxonomy*. Academic Press.

Books for Reference:

1. Grant, W. F. (1984). *Plant Biosystematics.* Academic Press Inc.
2. Harborne, J. B., & Turner, B. L. (1984). *Plant Chemosystematics*. Academic Press.
3. Hillis, D. M., Moritz, C., & Mable, B. K. (1996). *Molecular Systematics.* Sinaver Associates.

Websites and eLearning Sources:

1. https://www.kew.org/read-and-watch/apg-classification-consensus
2. https://unacademy.com/content/neet-ug/study-material/biology/what-is-the-taxonomic- hierarchy/

3. https://www.iapt-taxon.org/nomen/main.php
4. https://biomed.brown.edu/Courses/BIO48/26.Systematics.HTML

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Recognize fundamental plant systematics principles and key terms.	**K1**
CO2	Explain plant taxa evolutionary relationships with depth in systematics principles and methods.	**K2**
CO3	Apply plant systematics knowledge to analyze literature critically and draw conclusions effectively.	**K3**
CO4	Demonstrate proficiency in practical plant systematics skills, including fieldwork and specimen curation.	**K4**
CO5	Execute independent plant systematics research, showcasing advanced problem-solving abilities	**K5**
CO6	Evaluate ethical considerations in plant systematics, emphasizing responsible research practices.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PBO3CC07**		**Core Course – 7:** Plant Systematics							**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	3	2	2	2	3	3	3	2	2	**2.5**
CO2	3	3	3	2	3	3	3	3	3	3	**2.9**
CO3	3	3	3	2	3	3	3	3	3	3	**2.9**
CO4	3	3	3	3	3	3	3	3	3	3	**3.0**
CO5	3	3	3	2	2	3	3	3	3	3	**2.8**
CO6	3	3	3	2	3	3	3	3	3	3	**2.9**
Mean Overall Score											**2.83 (High)**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
3	25PBO3CC08	**Core Course – 8:** Research Methodology	5	4

Course Objectives
To obtain knowledge on basic concepts in Research and in Biostatistics.
To acquire knowledge on sampling techniques, evaluate literature, collection of data and thesis writing.
To analyze the significance of data bases and Citation Index.
To acquire skill in writing research articles and formatting the papers.
To solve and statistically analyse the data of variables

UNIT-I **(15 Hours)**

Research-types, objectives and approaches. Hypothesis: definition, characteristics, types, significance. Methods of collecting data: primary and Secondary- merits and demerits, Code of research ethics. Literature collection: Books, Research articles and e-resources.

UNIT-II **(15 Hours)**

Structure of thesis & research article. Journals in Life Sciences, Impact factor of Journals, Ethical issues related to publishing, Plagiarism and Software. Manuscript for publication and proof correction. Structure and components of research proposal, National and International funding sources.

UNIT-III **(15 Hours)**

Bibliometrics: definition and relevance; Bibliometrics databases, h-index, SNIP, Page Rank, Impact Factor and evaluation. The use of biblio metrics in research: Citation Research, Science Citation Index. The Institute for Scientific Information (ISI), Thomson Reuter's Web metric and ORCID. Tailored Research and Retraction. Indian Patent Act.

UNIT-IV **(15 Hours)**

Biostatistics: Introduction. Census method, Sample-types; Sampling techniques. Classification of data; Frequency Distribution: Discrete, Continuous and Cumulative Frequency Distributions. Tabulation of data; Diagrammatic and graphical representation of data: Bar Charts: Simple, Multiple & Sub divided, Histogram, Frequency polygon, Ogive curve, Pie diagram. Measures of Central values: Mean, Median and Mode. Measures of Dispersions: Range, Mean deviation and Standard deviation.

UNIT-V **(15 Hours)**

Skewness. Probability: Binomial, Poisson and Normal distributions. Correlation: types, methods. Regression analysis, Large sample(Z), small sample testing: Test of Significance; t-test, chi-square and F test. ANOVA - one and two way, Duncan Multiple Range Test. Principles of experimental design - randomization, replication, local control, size and shape of the plot, CRD &RBD.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Kothari, C. R. (2014). *Research Methodology-Methods & Techniques*. Wishwa Prakashan.
2. Misra, R. P. (2000). *Research Methodology-A Handbook*. Concept Pub. Company.
3. Pillai & Bagavathi. (2008). *Statistics*. S. Chand & Company Ltd.

Books for Reference:

1. Gupta, S. P. (1990). *Statistical Methods*. Sultan Chand & Sons.
2. Rao, N. G. (1983). *Statistics for Agricultural Science*. Oxford & IBH.
3. Gupta, S. C. (2013). *Fundamentals of statistics*. Himalaya Publishers.

Websites and eLearning Sources:

1. https://monad.edu.in/img/media/uploads/objectives,types%20and%20features%20research.pdf
2. https://iaeme.com/MasterAdmin/Journal_uploads/IJLIS/VOLUME_7_ISSUE_3/IJLIS_07_03_002.pdf

3. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_extension_trainees/ln_biostat_hew.pdf

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Understand and comprehend the basics in research methodology and applying them in research/project work.	**K1**
CO2	Demonstrate the ability to choose methods appropriate to research objectives.	**K2**
CO3	Develop advanced critical thinking skills and Demonstrate enhanced writing skills	**K3**
CO4	Help them to select an appropriate research design	**K4**
CO5	Enable them to collect the data, edit it properly and analyse it accordingly. Thus, it will facilitate students' prosperity in higher education.	**K5**
CO6	Apply various statistic ai tools in teaching and research.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PBO3CC08**		**Core Course – 8:** Research Methodology							**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	2	3	2	**2.4**
CO2	2	3	2	3	2	3	2	3	2	1	**2.3**
CO3	2	2	3	2	1	3	3	2	3	1	**2.2**
CO4	3	3	2	3	2	3	3	2	3	2	**2.6**
CO5	2	2	3	2	1	3	2	3	2	1	**2.1**
CO6	3	2	3	2	2	3	2	2	3	2	**2.4**
									Mean Overall Score		**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PBO3CC09	**Core Course - 9:** Cell and Molecular Biology	5	4

Course Objectives
To understand the organization of cells.
To acquire knowledge on the structure and organization of various cell organelles
To learn cell cycle and methods of cell division
To apply the knowledge acquired to study the molecular mechanisms of transcription and translations.
To analyze the principles of gene regulation.

UNIT I **(15 Hours)**

Phases and control system of cell cycle, Cell cycle checkpoints - DNA damage, centrosome duplication, spindle assembly. Cyclins and Cyclin-dependent kinases, apoptosis. Cytoskeleton structure and functions: actin filaments (microfilaments), microtubules, and intermediate filaments.

UNIT II **(15 Hours)**

Cell communication: general principles, Signaling molecules and their receptors. Receptors: Cell surface receptors - ion-channel linked receptors, G-protein coupled receptors, and Tyrosine-kinase linked receptors (RTK). Cellular responses to environmental signals in plants- mechanisms of signal transduction. Programmed cell death.

UNIT III **(15 Hours)**

Transcription: RNA polymerases and their role. Transcription signals - promoters and terminators. Detailed account of transcription in *E. coli* and eukaryotes. Differences between the prokaryotic and the eukaryotic transcription, Post transcriptional modifications of mRNA (5'CAP formation, poly adenylation, splicio some assembly, splicing, editing). Organization of mRNA, RNA editing, mRNA export.

UNIT IV **(15 Hours)**

Translation: Genetic code - introduction, important features of the genetic code, exceptions to the standard code. Mechanism of translation in prokaryotes and eukaryotes. Differences between prokaryotic and eukaryotic protein synthesis. Protein sorting and translocation. Post- translational modification of proteins, Protein folding-self-assembly and role of chaperones.

UNIT V **(15 Hours)**

Gene regulation: Operon model - Inducible and repressible systems. Attenuation, positive and negative regulation. *lac*and*trp*operons of E. coli. Regulation of eukaryotic gene expression. Gene families and hormonal control in eukaryotes. RNA in gene regulation. Gene silencing: transcriptional and post transcriptional gene silencing.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Malacinski, G.M. (2015). *Essentials of Molecular Biology*. Jones and Bartlett.
2. Berk, A., Chris, Kaiser, Lodish, H., Amon, A., Ploegh, H., Bretscher, A., Krieger, M., & Kelsey, Martin, C. (2016). *Molecular Cell Biology*. WH Freeman & Co.

Books for Reference:

1. Cooper M (2000). *The Cell-a molecular biology approach*. (2nd ed). Sinauer Associates,
2. Massachusetts. Lodish et al (2004). *Molecular Cell Biology,* COH freeman & Co. New York.
3. Watson JD et al. (2004). *Molecular biology of the gene*, Pearson education, Singapore.
4. Gardner et al. (2004). *Principles of genetics*. John Wiley & Sons Inc. Singapore.
5. Veer BalaRastogi, (2016). *Principles of Molecular Biology*, Medtech publishers, New Delhi.

Websites and eLearning Sources:

1. www.khanacademy.org

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Know the stages of cell cycle	**K1**
CO2	Understand the molecular events and the cellular structures responsible involved cell cycle	**K2**
CO3	Apply the reason to comprehend the molecular mechanism	**K3**
CO4	Compare the molecular mechanism in prokaryotes with eukaryotes	**K4**
CO5	Evaluate the regulatory molecular mechanism	**K5**
CO6	Know the stages of cell cycle	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PBO3CC09**		**Core Course – 9:** Cell and Molecular 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	3	2	2	2	2	3	2	2	2	2	2.2
CO2	3	1	2	2	2	3	2	2	2	2	2.2
CO3	2	2	2	2	2	2	2	2	1	2	1.9
CO4	2	1	3	2	2	2	3	2	2	3	2.2
CO5	2	2	2	3	2	2	2	2	2	2	2.0
CO6	3	2	2	2	2	3	2	2	2	2	2.2
Mean Overall Score											**2.08 (Medium)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PBO3CP05	**Core Practical - 5:** Plant Systematics	4	2

1. Exercise in key making.
2. Binomial identification using Flora.
3. Study and submission of digital description of the following families with reference to their South Indian representatives and minimum of one member each to be described, dissected and sketched to scale (classification based on APG IV, 2016):
    - **BASAL ANGIOSPERM: Nymphaeales –**Nymphaeaceae
    - **MONOCOTS: Alismatales -** Araceae, **Commelinales-**Commelinaceae, **Poales -** Cyperaceae
    - **EUDICOTS: Ranunculales -** Menispermaceae
    - **ROSIDS: Malpighiales -** Passifloraceae, **Sapindales -** Meliaceae, **Brassicales -** Cleomaceae
    - **SUPERASTERIDS: Santalales -** Loranthaceae, **Caryophyllales -** Caryophyllaceae,Aizoaceae
    - **ASTERIDS: Solanales -** Convolvulaceae, **Lamiales -** Scrophulariaceae, Acanthaceae, Verbenaceae
4. Exercise in the important Articles of the Code.
5. Cladogram construction and analysis.
6. Submission of herbaria of any five plant species.
7. Field Visit report.

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PBO3CP06	**Core Practical – 6:** Research Methodology	2	1

1. Sampling
2. Collection of data
3. Classification of data
4. Diagrammatic representation of data
5. Measures of central value
6. Measures of dispersion
7. Test of significance
8. Bibliometrics
9. H-Index

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PBO3ES02A	**Discipline Specific Elective - 2:** Plant Pathology	4	3

Course Objectives
The goal of the course is to provide students with basic understanding of plant pathology and the etiology of specific plant diseases.
To provide comprehensive knowledge about microbes and its effect on man and environment.
To provide comparative analysis of major groups of plant pathogens.
To study the principles of fungal infections in plants.
To enhance the knowledge and skills needed for self-employment in agricultural products.

Unit-I: (12 Hours)

Concept of plant disease – definitions of disease, disease cycle and pathogenicity. General symptoms and Classification of plant diseases. History of Plant Pathology with special references to Indian work.

Unit-II: (12 Hours)

Pathogenesis- pathogens and their mode of dissemination, pre-penetration, penetration and post penetration changes. Role of Chemical Weapons (Enzymes, Toxins and Growth regulators) in disease development.

Unit-III: (12 Hours)

Effect of infection on physiology of host *viz.* photosynthesis, respiration, carbohydrate metabolism, nitrogen metabolism, phenols, shikimic acid pathway, importance of phenol oxidation in plant diseases.

Unit-IV (12 Hours)

Plant diseases: causal organisms, symptoms, disease cycle and control measures for the following diseases: White rust of Crucifers, Bacterial blight of paddy, yellow vein Mosaic of Bhindi, covered smut of Barley, Spike disease in Sandal. Integrated Disease Management (IDM) –Plant diseases control: Cultural, physical, chemical and biological methods.

Unit-V (12 Hours)

General concepts on plant immunity: morphological, structural defence mechanisms and biochemical defence mechanisms, pre-existing defence mechanisms. Phytoalexins, defence through induced synthesis of proteins and enzymes. Molecular Basis of Defence Mechanism: Signal Transduction, Recognition of the pathogen by the host, transmission of the alarm signal to the host defence providers.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Singh, R S. (2018). *Introduction to Principles of Plant Pathology*, (4thed). Scientific International, Bengaluru, India.
2. Mehrotra, RS and Aggarwal, A. (2017). *Plant Pathology*. McGraw Hill Publisher Co. Ltd., New Delhi.

Books for Reference:

1. Sharma P D. (2001). *Microbiology and plant pathology*, Rastogi publications, Meerut.
2. Rangasamy G. (1998). *Diseases of crop plants in India*. Prentice-Hall of India, New Delhi.
3. Mukherjee K G and JayantiBhasin, (1986). *Plant diseases of India*. Tata MacGraw-Hill, New Delhi.
4. HarsfallJGandCowlingEB.91979). *Plant Disease, an Advanced Treatise*. Academic Press, NY.

Websites and eLearning Sources:

1. https://www.india.gov.in/topics/agriculture/plant-protection
2. https://www.uasbangalore.edu.in/en/department-of-plant-pathology/
3. https://buat.edu.in/plant-pathology/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Acquire knowledge on pathogenesis and disease establishment in plants	**K1**
CO2	Learn the process of plant pathogenesis and disease establishment	**K2**
CO3	Recognize the effect of Microbe infection on host physiology	**K3**
CO4	Comprehend the various different types of disease control mechanism	**K4**
CO5	Familiarize the concepts in plant immunity and various defence mechanism in plants	**K5**
CO6	Acquire knowledge on pathogenesis and disease establishment in plants	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PBO3ES02A**		**Discipline Specific Elective - 2:** Plant Pathology							**4**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	3	3	3	2	2	2.3
CO2	2	3	2	2	2	3	2	2	2	3	2.3
CO3	2	2	2	2	2	3	3	2	2	2	2.5
CO4	2	2	2	2	2	3	3	3	2	2	2.2
CO5	2	2	3	2	2	2	3	3	2	2	2.3
CO6	2	2	2	2	2	3	3	3	2	2	2.3
Mean Overall Score											**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PBO3ES02B	**Discipline Specific Elective – 2:** Bioinformatics and Bio nanotechnology	4	3

Course Objectives
To Outline the basics of sequence alignment and analysis
To Classify different types of biological databases
To Study the basic elements of interface, concepts between biology and nanotechnology.
To Explain the synthesis approaches for nanomaterial and its characterization.
To Construct various types of nanomaterial for application and evaluate the impact on environment.

Unit-I **(12 Hours)**

Overview of Bioinformatics, Need for Bioinformatics technology, Data format and processing, secondary resources and applications. Role of structural bioinformatics, biological data integration system. Bioinformatics and its applications. Biological Database Retrieval System - NCBI, PUBMED, EBI, EMBL, DDBJ and Gen- Bank.

Unit-II **(12 Hours)**

Database searches for homology using BLAST and FASTA. Drug design medicine (molecular personalized, preventive), Gene therapy and design of microbes for various applications; waste cleanup, forensic studies, phylogenetic analysis; methods and software (MEGA, PhyML).

Proteomic data bases - Swiss-Prot, Uni-Prot, ExPASY and PDB. RNA data bases-Rfam and GtRNA. Phylogenetic analysis Construction of Phylogenetic tree with reference to DNA and Protein sequences. Biological importance of computerized Phylogenetic analysis.

Unit-III **(12 Hours)**

Nanotechnology – definition, origin, scope and importance. Principles: quantization effects -inverse relationship between size and reactive surface area. Properties: surface effects, the effects ofsize, shape and surface area. Advances made with plant nanobionics-bomb detection, glowing plants, augmented photosynthesis, etc. Essentials of nanostructure generation: top-down vs. Bottom up. Physical, chemical and biogenic synthesis of nanomaterials - biomimetics, green plants and microorganisms.

Unit-IV **(12 Hours)**

Detection and measurement of nanoparticles - physical characterization by UV, FTIR, SEM, FESEM, DLS, X-ray diffraction and Zeta potential. Targeted nanoparticles: active & passive targeting. Application: medicine, manufacturing & materials, delivery vehicles, cancer therapy, Nanoparticles on human health and environment, nano fertilizers and nano pesticides in suitable agriculture.

Unit-V **(12 Hours)**

Interactions between nanoparticles and living systems, interaction with cells, exposure of living systems to nanomaterials - toxicity effects. Factors influencing the interaction of nanomaterials over mammalian cells: uptake, transport abiodistribution of nanoparticles in living system, Nano based biosensors, 3D printing, Nanotechnology in synthetic biology.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Sharon, M. & Sharon, M (2012). *Bio-Nanotechnology- Concepts and Applications,* CRC Press.
2. Atkinson WI. (2011). *Nanotechnology*. Jaico Book House, New Delhi.
3. Imtiaz Alam Khan. (2005). *Elementary bioinformatics*. Pharma Book Syndicate, Hyderabad.
4. Rastogi, S.C., Mediratta, N. and Rastogi. P. (2004). *Bioinformatics, methods and applications, genomics, proteomics and drug discovery,* Prentice hall of India, Pvt. Ltd., New
5. Delhi.
6. Nalwa HS. (2005). *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology.* American Scientific Publ.

Books for Reference:

1. Barbara Panessa-Warren, (2006) *Understanding cell-nanoparticle interactions making nanoparticles more biocompatible.* Brookhaven National Laboratory
2. European Commission, SCENIHR, (2006). *Potential risks associated with engineered and adventitious products of nanotechnologies,* European Union
3. Gysell Mortimer, (2011). *The interaction of synthetic nanoparticles with biological systems PhD Thesis, School of Biomedical Sciences,* Univ. of Queensland.
4. Jain K.K. *Nanobiotechnology molecular diagnostics: Current techniques and application* (Horizon Bioscience) (2006) Taylor & Francis 1st edition.

Websites and eLearning Sources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC419715/
2. https://phys.org/news/2014-10-endless-possibilities-bio-nanotechnology.html
3. http://www.particle-works.com/applications/controlled-drug-release/Applications

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Explain the fundamentals of bioinformatics and biological database retrieval systems	**K1**
CO2	Apply sequence alignment tools and analyze their role in drug design, gene therapy, and forensic studies.	**K2**
CO3	Utilize proteomic and RNA databases for phylogenetic analysis and evolutionary studies.	**K3**
CO4	Describe nanotechnology principles, synthesis methods, and applications in plant nanobionics.	**K4**
CO5	Evaluate nanoparticle detection techniques and their role in medicine, agriculture, and drug delivery	**K5**
CO6	Analyze nanoparticle interactions with living systems and explore their applications in biosensors, 3D printing, and synthetic biology	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
3	**25PBO3ES02B**	**Discipline Specific Elective – 2:** Bioinformatics and Bio nanotechnology								**4**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	3	2	1	3	2	2	2.1
CO2	3	2	2	1	3	1	3	3	2	3	2.3
CO3	1	2	3	2	3	2	3	1	3	2	2.2
CO4	2	2	1	2	3	3	1	2	2	3	2.1
CO5	2	2	3	2	3	1	3	2	3	2	2.3
CO6	2	2	1	3	3	3	3	2	3	3	2.5
										Mean Overall Score	**2.2 (High)**

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

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

UNIT I: IPR Agencies (12 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: Patent (12 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: Copyright (12 Hours)

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

UNIT IV: Trademark (12 Hours)

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: Geographical Indication (12 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	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Venkataraman M. (2015). *An Introduction to Intellectual Property Rights*. Create space Independent Pub. North Charleston.

Books for Reference:

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

Websites and eLearning Sources:

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

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

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25SBS3RM01**		Intellectual Property Rights							**4**	**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	1	3	3	3	2	2	**2.4**
CO2	3	3	3	2	2	3	3	3	2	2	**2.5**
CO3	3	3	3	2	2	3	3	3	2	2	**2.5**
CO4	3	3	2	2	2	3	3	3	2	2	**2.5**
CO5	3	3	3	3	2	3	3	3	2	2	**2.7**
CO6	3	3	2	3	2	3	3	3	2	2	**2.6**
										Mean Overall Score	**2.53 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
3	25PBO3SL03	**Self – Learning:** Evolutionary Adaptations and Plant Breeding	-	1

Course Objectives
To evaluate Evolutionary Theories in relation to plant evolution and adaptation and their applications in Biodiversity Conservation.
To understand the Fundamentals of Plant Breeding and crop improvement.
To develop Skills in Selection and Hybridization Techniques to improve crop traits.
To analyze the Role of Genetic Variation and Evolution in Crop Improvement.
To apply molecular breeding and genome editing in modern breeding programs.

UNIT I: Evolution and Speciation

Origin of life and theories of evolution – Lamarckism and Darwinism. Types of variations – Definition, causes, and significance in evolution. Mutation and its role in speciation – Hugo De Vries' mutation theory. Evolution through ages – Human evolution and phylogenetic relationships. Evidences for evolution – Fossil records, comparative anatomy, embryology and molecular evidence.

UNIT II: Fundamentals of Plant Breeding

History and significance of plant breeding in agriculture and food security. Objectives and achievements in plant breeding. Genetic basis (selfing and crossing). Modes of reproduction in crop plants – Asexual, sexual, and apomictic reproduction (advantages and limitations). Plant Introduction – Types, procedures. Centres of origin and domestication– Vavilov's theory and its relevance.

UNIT III: Selection and Hybridization Methods

Selection Methods – Mass selection, pure-line selection, and clonal selection. Hybridization Techniques. Incompatibility and male sterility. Bulk method and pedigree method. Role of distant hybridization in crop improvement.

UNIT IV: Advanced Breeding Concepts

Inbreeding depression and heterosis – Genetic basis and applications in hybrid crop development. Steps in hybrid seed production – Single cross, double cross, and three-way cross techniques. Polyploidy and its significance – Induced polyploidy, role of autopolyploids and allopolyploids in crop improvement. Mutation breeding in crop improvement.

UNIT V: Resistance Breeding and Molecular Approaches

Backcrossing techniques, Breeding for disease resistance and drought tolerance- Rice, sugarcane, groundnut, and maize. Germplasm conservation and utilization. Limitations of conventional breeding – Need for molecular breeding approaches.

Teaching Methodology	PPT, videos and practical demonstration
Assessment Methods	Online Test, MCQ

Books for Study:

1. Chaudhari, H. K. (1995). *Elementary Principles of Plant Breeding*, (Revised Ed.).Oxford &IBH.
2. Chittaranjan, K. (2006-07). *Genome Mapping and Molecular Breeding in Plants*. Vols. I-VII. Springer.
3. Mishra, T (2023). Evolutionary Biology with Practical. Mahaveer publication. ISBN: 978-9394095991.

Books for Reference:

1. Singh, B. D. (2022). *Plant Breeding Principles and Methods,* (12th Ed.).
2. Chopra, V. L. (1994). *Plant breeding-Theory and Practice*. Oxford & IBH.
3. Acquaah, G. (2020). *Principles of Plant Genetics and Breeding*,(3rdEd.).

Websites and eLearning Sources

1. https://www.seedworld.com/the-evolution-of-plant-breeding/
2. https://evolution.berkeley.edu/evolution-101/an-introduction-to-evolution/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Explain the principles of plant breeding and genetic improvement in the context of sustainable agriculture and food security.	**K1**
CO2	Perform hybridization and selection techniques to develop high-yielding and stress-resistant crop varieties.	**K2**
CO3	Analyze the genetic basis of heterosis, polyploidy and mutations and their applications in plant breeding.	**K3**
CO4	Apply the concepts of heterosis, polyploidy and mutations in Plant Breeding.	**K4**
CO5	Utilize molecular breeding tools and biotechnological approaches for crop improvement and disease resistance.	**K5**
CO6	Interpret evolutionary processes and their impact on plant domestication and biodiversity conservation.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
3	**25PBO3SL03**		**Self – Learning:** Evolutionary Adaptations and Plant Breeding							**-**	**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	2	2	2	2	3	2	1	3	2	2	2.1
CO2	3	2	2	1	3	1	3	3	2	3	2.3
CO3	1	2	3	2	3	2	3	1	3	2	2.2
CO4	2	2	1	2	3	3	1	2	2	3	2.1
CO5	2	2	3	2	3	1	3	2	3	2	2.3
CO6	2	2	1	3	3	3	3	2	3	3	2.5
										Mean Overall Score	**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PBO4CC10	**Core Course – 10:** Microbiology and Immunology	5	5

Course Objectives
To provide students with basic understanding of Structure and organization of bacteria.
To understand the application of microbes in food and dairy microbiology.
To provide comparative analysis of major groups of microbes.
To be aware about the immune systems of human being.
To know about the antibody production and their immunological role.

Unit-I **(15 Hours)**

Scope, branches and history. Structure and organization of Bacteria, General characteristic of bacteria - Outline classification of Bergey's manual of 9th edition. Growth Curve. Factors affecting growth, Reproduction: Methods of preservation of Microbes. Actinomycetes. Brief study on Spirochetes, Rickettsias, Chlamydias and Mycoplasmas, Viruses – Structure, organization, replication. Brief account on Viroids, virusoids and prions. Culture of microorganisms: synchronous, batch and continuous culture. Chemostat and turbidostat.

Unit-II **(15 Hours)**

Food, dairy and environmental microbiology: Source of Microbial contamination of food; food poisoning and food-borne infections. Beneficial role of microbes - yoghurt, Bread, Wine, and Spoilage of fruits, vegetables, meats, poultry, eggs, and bakery products Methods of food preservation. Microbial contamination of milk, milk-borne diseases-preservation of milk and dairy products. Importance of Microbial flora of soil and their role in biogeochemical cycling.

Unit-III **(15 Hours)**

Industrial microbiology: selection of industrially useful microbes, fermentation processes, recovery of end products; production of alcohol, insulin, lactic acid and single cell protein. Common immunizations, antibiotics and other chemotherapeutic agents and their mode of action. Drug resistance in microbes.

Unit IV **(15 Hours)**

Immunology: History and scope of immunology, Innative and adaptive immunity, - organs of immune systems (primary and Secondary), types of Antigen and antibody and their reactions, Monoclonal and Polyclonal antibodies and its applications.

Unit V **(15 Hours)**

Immune system activation: T –cell and B cell activation and Differentiation, Types of hypersensitivity reactions (TYPE I –IV), Immune regulations, Immunodeficiency disorders (AIDS, SCID). Tumour Immunology, Transplantation immunology (graft types, rejections Mechanisms).

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Sullia, S. B. and Shantharam, S. 1998. General Microbiology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi **Unit-II and Unit-III**
2. Pelczar, M. J., Reid, R. D. and Chan, E. C. S. 1983. Microbiology, Tata Mc Graw Hill Publishing Co., New Delhi. **Unit I**
3. Prescott 2009 7e, Microbiology. Wm. C. Brown Publishers.
4. KubyJ, 2000, Immunology,4th edition, WH Freeman.

Books for Reference:

1. Reed, G. (1983). Prescott & Dunn's Industrial Microbiology. (4thed). AVI Publishing Co., Connecticut, USA.
2. Adams M R and Moss MO, (2008), Food Microbiology. Royal Soc. Chem., Cambridge, UK.

3. Dickinson M. (2003). Molecular Plant Pathology. BIOS Scientific Publishers, London.
4. Roittetal., (1998), *Immunology* (5thedition), Mosby International Ltd.London.UK.
5. František Baluška 2015. Signaling and Communication in Plants, Springer, New York.

Websites and eLearning Sources:

1. https://www.youtube.com/playlist?list=PL0lgiXDBo2olviMsZ6zWDeOCcej7cYx4I
2. https://www.youtube.com/watch?v=plmdIUsqCq4
3. https://www.youtube.com/watch?v=ACYSUXNSsMM
4. https://www.youtube.com/watch?app=desktop&v=MvNpSXIurPQ
5. https://www.youtube.com/playlist?list=PLc_SwOK0df2UnB3UvyDeEqVvtFEAEjLyJ

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Understand the various types of microbes in an environment and their importance.	**K1**
CO2	Demonstrate the role of microorganisms in food processing and spoilage, soil fertility and sewage disposal	**K2**
CO3	Assess role of microorganisms in industrial processing of microbial products	**K3**
CO4	Distinguish the structure and function of immune system in humans.	**K4**
CO5	Evaluate and justify the defence mechanism against infection in plants and humans.	**K5**
CO6	Understand the various types of microbes in an environment and their importance.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**25PBO4CC10**		**Core Course – 10:** Microbiology and Immunology							**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	2	2	3	3	3	2	2	2.5
CO2	2	3	2	2	2	2	2	2	2	3	2.2
CO3	3	3	3	2	2	3	3	2	2	2	2.5
CO4	3	3	3	3	1	3	3	3	3	1	2.6
CO5	2	2	2	2	3	2	2	2	2	3	2.2
CO6	3	3	2	2	2	3	3	3	2	2	2.5
									Mean Overall Score		**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PBO4CC11	**Core Course – 11:** Genetic Engineering and Biotechnology	5	4

Course Objectives
To define the principles and application of intellectual property rights.
To understand the principles of genetic engineering.
To learn the types and application of cloning vectors.
To study and analyze different types of gene transfer methods.
To design protocol for plant tissue culture.

Unit-I **(15 Hours)**

Agrobacterium mediated gene transfer and Crown gall; Hairy Root Culture. Nucleases: Exonucleases and Endonucleases, Restriction Enzymes: (Type I - V), RNases and Eukaryotic (cDNA). Methylases: CpG Methylase, Dam Methylase, Dcm Methylase; Polymerases: DNA Pol I, Klenow Fragments, Reverse Transcriptase, Taq & Pfu Polymerases. Ligases: T4 DNA Ligase, E. coli DNA Ligase, T4 RNA Ligase Topoisomerases: Type I (A, B) & Type II (A, B) End Modifying Enzymes: Terminal Transferase, T4 Polynucleotide Kinase, Alkaline Phosphatases. Linkers and Homopolymers.

Unit-II **(15 Hours)**

Features of Cloning vectors: ideal cloning vehicles: Natural vectors (E. coli and Agrobacterium based), *in vitro* vectors (pBR), sstr DNA vectors (M13) and shuttle vectors. Human Artificial Chromosomes (HACs). Expression of cloned genes - problems and solution. Cloning strategies - cDNA libraries and genomic libraries.

Unit-III **(15Hours)**

Metagenomics. Engineered microbes - bioremediation of oil spills: oil-eating super bugs (*B. megatarium*, *P. putida* &*A. borkumensis*); Bt crops, golden rice technology, plantibodies and edible vaccines. Strategies for crop improvement: engineering for resistance against herbicides and diseases. Antisense RNA technology, CRISPR and Controversy of gene editing in human Embryo- Lulu and Nana.

Unit-IV **(15 Hours)**

Technology protection systems (GURT) - terminator gene technology. Biosafety aspects of GMOs and GM foods. Principles of bio safety; potential risks; environmental impacts; safety of food and animal feed derived from G M crops; and patterns of gene flow. Issues concerning release of Bt-brinjal. Essentials of IPRs and patents.

Unit-V **(15 Hours)**

Synthetic biology-scope and importance. Artificial DNA and synthetic genome. Contribution of JC Venter. Minimal genome, expanded gene pool. Creation of synthetic and commercially available products. Potentials and applications; ethical issues of synthetic organisms.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. OldRNandPrimroseSB.2004, Principles of Gene Manipulation-Black well Sci., USA.
2. J D Watson, M Gilman, J Witkowski and M Zoller 1992. Recombinant DNA (12thEdition), WH Freeman Co., New York.

Books for Reference:

1. Presidential Commission for the Study of Bio ethical Issues, 2010. (www.bioethics.gov)
2. ETC Group, Canada, 2010.Extreme Genetic Engg-an introduction to synthetic biology.
3. Young, E and Alper, H, 2010. Synthetic Biology: A Review. Journal of Biomedicine and Biotechnology.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Understand the principles of genetic engineering.	**K1**
CO2	Learn the types and application of cloning vectors.	**K2**
CO3	Study and analyse different types of gene transfer methods.	**K3**
CO4	Design protocol for plant tissue culture.	**K4**
CO5	Compile the principles and application of Intellectual Property Rights.	**K5**
CO6	Understand the principles of genetic engineering.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
4	**25PBO4CC11**		**Core Course – 11:** Genetic Engineering and 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	2	1	3	3	3	2	2	**2.4**
CO2	3	3	3	2	2	3	3	3	2	2	**2.5**
CO3	3	3	3	2	2	3	3	3	2	2	**2.5**
CO4	3	3	2	2	2	3	3	3	2	2	**2.5**
CO5	3	3	3	3	2	3	3	3	2	2	**2.7**
CO6	3	3	2	3	2	3	3	3	2	2	**2.6**
Mean Overall Score											**2.53 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PBO4CC12	**Core Course - 12:** Genetics	4	3

Course Objectives
To acquire knowledge on objectives of Mendelian laws.
To outline the process of evolution and various theories pertaining to biological evolution.
To learn about the population genetics.
To solving problems with relevance to the principles and applications of genetics.
To acquire the basic knowledge on genomics and proteomics.

UNIT I **(12 Hours)**

Mendel and his work: Laws of inheritance. Back cross and Test cross. Gene interaction and Modified Mendelian ratios. Quantitative inheritance and multiple alleles. Problem solving in genetics.

UNIT II **(12 Hours)**

Linkage and crossing over, 3-point cross and gene mapping methods. DNA is the genetic material: Griffith's experiment, Avery et al., and Hershy and Chase experiment; RNA as genetic material - Experiment of Fraenkel and Singer.

UNIT-III **(12 Hours)**

Organization of eukaryotic and bacterial genomes- transformation, transduction (generalized and specialized), conjugation (F factor mediated, Hfr and Sexduction). Fine structure of the Gene: Cistron, muton and recon, Watson and Crick model of DNA helix, Semi-conservative replication mechanism of DNA: replication of linear and circular DNA, Replication of RNA genomes.

UNIT IV **(12 Hours)**

Molecular mechanisms of DNA repair (mismatch and proof reading, photoreactivation, excision, recombination and SOS repair). Mobile genetic elements- IS elements and transposons in maize and bacteria. Beneficial and harmful effects of mutations.

UNIT V **(12 Hours)**

Population genetics: gene frequency, gene pool, Hardy-Weinberg equilibrium. Gene frequencies-conservation and changes. Decline of human gene pool and eugenics. Genomics: Arabidopsis genome and rice genome. Gene therapy with reference to Haemo philia, Stem cells-Definition, types & sources.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Malacinski, G.M. & Freifelder, D. (2008). *Essentials of Molecular Biology*, (4th Ed.). Jones & Bartlett.
2. Verma, P. S., & Agarwal, V. K. (2003). *Genetics*. S. Chand.

Books for Reference:

1. Gardner, E. J., Simmons, M. J., Snustad, D. P. (1991). *Principles of Genetics*,(8th Ed.). John Wiley and Sons Inc.
2. Strick berger. (2005). *Genetics*, (3rdEd). Prentice Hall of India Pvt. Ltd.
3. Snustad, D. P., & Michael, J. S. (2010). *Principles of Genetics*. John Wiley & Sons

Websites and eLearning Sources:

1. https://courses.lumenlearning.com/wm-biology1/chapter/reading-laws-of-inheritance-2/
2. https://www.genome.gov/
3. https://www.ncbi.nlm.nih.gov/books/NBK9900/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Understand the principles of linkage, crossing over and the hereditary mechanisms.	**K1**
CO2	Examine the structure and functions of genetic materials.	**K2**
CO3	Explain the organization of prokaryotic and eukaryotic genomes.	**K3**
CO4	Justify and outline the mechanisms of DNA repair.	**K4**
CO5	Compose the dynamics of genetic variation and data interpretation.	**K5**
CO6	Interpret and analyse population genetics models.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**25PBO4CC12**		**Core Course - 12:** Genetics							**4**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	3	2	2	3	2	2	**2.2**
CO2	3	2	2	1	2	1	3	3	2	3	**2.2**
CO3	1	2	3	2	3	2	3	2	3	2	**2.3**
CO4	2	2	1	3	2	2	3	2	3	3	**2.3**
CO5	2	2	2	2	3	1	3	2	3	3	**2.3**
CO6	2	2	1	3	2	2	3	2	3	3	**2.3**
									Mean Overall Score		**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PBO4CP07	**Core Practical - 7:** Microbiology and Immunology	3	1

Experiments

1. Isolation and enumeration (CFU) of microorganisms in soil by serial dilution.
2. Bacterial staining: Differential staining–Grams Staining.
3. Isolation of bacteria from skin, mouth and urine.
4. Potability test of water-Most Probable Number (MPN) presumptive, confirmative and completed tests.
5. Testing quality of milk by Methylene blue reduction Test (MBRT)and phosphatase test.
6. Morphological and biochemical identification of bacteria: indole test, methyl red test, Voges-Proskaur test, Citrate utilization test, TSI agar test.
7. ABO Blood grouping
8. WIDAL-test for typhoid
9. RPR-test for syphilis
10. RF-test for rheumatoid arthritis
11. ELISA-Demo
12. Western Blotting -Demo

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
4	25PBO4CP08	**Core Practical - 8:** Genetic Engineering and Biotechnology	3	1

Genetic Engineering and Biotechnology

1. Sterilization techniques
2. Culture media Preparation
3. *In vitro* Seed germination
4. Embryo culture
5. Callus induction and differentiation
6. Micropropagation
7. Somatic embryogenesis.
8. Synthetic Seeds
9. Suspension Culture
10. Hardening methods
11. Demonstration of PAGE
12. Demonstration of AGE
13. Demonstration of Somoclonal variations study
14. Demonstration of Gene sequencing

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PBO4ES03A	**Discipline Specific Elective - 3:** Organic Farming	4	3

Course Objectives
To enable students to gain knowledge on the scope and significances of organic farming.
To impart practical insights sustainable agriculture, green manuring, recycling and composting.
To understand the physical and chemical properties of soil.
To know about the sustainable agriculture.
To know about the importance of biofertilizers in organic farming.

UNIT-I **(12 Hours)**

Scope of organic farming, Requirements for organic farming, Farm components for an organic farm. Certification and standers for organic farming (National and International) Conversion to organic farming-Process, green card systems and subsidies. Organic and conventional farming

UNIT-II **(12 Hours)**

Types of Farming, Concept of different cropping systems in relation to Organic Farming (Inter cropping), Fundamental of organic life stock farming: fish farming, poultry farming, bee keeping and Diary farming, Animal Welfare in organic farming.

UNIT-III **(12 Hours)**

Soil formation, composition and types, methods of increasing soil productivity and fertility, Cultivation of crops with organic inputs: field crops and leguminous crops. Vermicomposting production and uses, Types of earthworms and benefits, other organic farming management; Panchagavya, Fish extract, Rishi Krishi, Role of beneficial insects in soil fertility

UNIT-IV **(12 Hours)**

Organic crop production methods- sugarcane, mango, ginger, medicinal and ornamental crops. Green labels, Bio-fuel crops. Integrated Nutrient Management (INM) and Integrated Plant Nutrient Supply System (IPNS). Modern techniques of Pest Management in organic farming.

UNIT-V **(12 Hours)**

Agro forestry and role in sustainable farming, Agencies and institutions related to organic farming. Organic Food Quality and Human Health. Bio Entrepreneurship development and concept and approaches Polices and government schemes promoting organic farming.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Palaniappan, S. P., & Annadurai, K. (2007). *Organic Farming-Theory and Practice*. Scientific Publishers.
2. Lakshmi, Narasaiah, M. (2010). *Agriculture and Water Management*. Discovery publishing House.
3. D. P Singh (2017) Organic farming for sustainable agriculture, springer Publisher
4. Michal. H, Bohcool and Parizkoohatkan (2008) Organic Pest and Disease Management, FAO Publisher

Books for Reference:

1. Gupta, P. K. (2012). Vermi composting for sustainable Agriculture. Agrobios.
2. Kumar, N. (2010). Introduction to Horticulture. Oxford & Ibh Publishing Co. Pvt. Ltd.
3. H. P Garg (2022) Handbook of organic farming and Biofertilizers, Avishkar Publisher.
4. K. S. Sahayaraj (2014) Biological control of Insect pests, Springer Publisher
5. Vinod Kumar Yadav (2018) Sustainable Agriculture and Organic farming, NIPA publisher, India.

Websites and eLearning Sources:

1. https://www.dec.ny.gov/chemical/8480.html
2. https://www.fao.org/3/y5104e/y5104e05.htm
3. https://www.gasum.com/en/our-operations/biogas-production/how-is-biogas-produced/
4. https://www.legit.ng/1128248-economic-importance-earthworm-vermiculture.html

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Apply techniques for synthesizing green manure and develop strategies to increase crop yield.	**K1**
CO2	Analyze and decipher the significance of biofertilizers in soil fertility.	**K2**
CO3	Develop new strategies to enhance soil fertility, crop yields with minimum cost and sustainable utilization of various biodegradable wastes.	**K3**
CO4	Practice and maintain soil fertility and plant productivity.	**K4**
CO5	Plan a proper pest management strategy for various crops.	**K5**
CO6	Gain knowledge to develop into entrepreneurial skills.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**25PBO4ES03A**		**Discipline Specific Elective - 3:** Organic Farming							**4**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	2	3	1	2	3	**2.3**
CO2	1	2	3	2	2	3	2	3	2	2	**2.2**
CO3	1	2	3	2	2	3	3	2	2	3	**2.3**
CO4	3	2	2	3	1	3	3	1	2	3	**2.3**
CO5	2	3	2	1	3	1	2	2	3	3	**2.2**
CO6	1	2	3	2	2	3	3	2	2	3	**2.3**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PBO4ES03B	**Discipline Specific Elective - 3:** Integrated Pest Management	4	3

Course Objectives
To understand the Insect morphology and concept of Integrated Pest Management (IPM).
To familiarize students with the role of insects in agriculture and their economic importance.
Understand pest of stored grain products and their life cycles
Understanding of chemical, biological, and cultural control methods.
To apply the concepts learned to real-world pest management scenarios.

UNIT I **(12 Hours)**

Definition and principles of IPM, History and evolution of pest management Importance of insect pests in agricultural ecosystems, Classification of insect pests. Pest damage and economic thresholds, Role of beneficial insects and natural enemies in sustainable agriculture.

UNIT II **(12 Hours)**

Agricultural pests' life cycle (Aphids, Beetles), Behavior and feeding habits of key pests, Pest population dynamics, Pest Monitoring and Sampling Techniques, Recent technology in pest monitoring (remote sensing, apps), Economic Injury Level (EIL) and Economic Threshold (ET).

UNIT III **(12 Hours)**

Pests of crops: (Classification, Biology, nature of damage and control measures)- Pests of Rice: Rice Stem Borer, Brown Planthopper, pest of Sugarcane: Early Shoot Borer, Top Shoot Borer, Pests of cotton: Cotton Bollworm, Cotton Aphid, Pests of Pests of Banana: Banana: Pseudostem Weevil, Banana Rhizome Weevil. Stored Grain Pests and their Control Measures.

UNIT IV **(12 Hours)**

Physical and Mechanical Methods**:** light traps, pheromone traps, barriers, row covers Chemical Control: Types of pesticides, modes of action, Pesticide resistance, safety measures, environmental effects. Biological Control: Use of natural enemies (Predators, Parasitoids, Pathogens), advantages, and limitations. Cultural Control: Crop rotation, intercropping, field sanitation, and resistant crop varieties.

UNIT V **(12 Hours)**

Biotechnology in pest management (Genetically modified crops, CRISPR), forestry, and urban pest management strategies, Evaluation and adaptive management in IPM programs, future pest management: Challenges and innovations, Insect as food and medicine.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Dharam P. Abrol, Uma Shankar (2012) "Integrated Pest Management: Principles and Practice", CABI Publishing, United Kingdom.
2. R.P. Soundararajan (2018) "Agricultural Pest Management", New India Publishing Agency, India.
3. G.S. Dhaliwal, Ramesh Arora (2019) "Principles of Insect Pest Management", Kalyani Publishers, India.
4. A.P. Gutierrez, L.A. Falcon (2013) "Insect Pest Management", Springer, United States
5. K. Gautam (2020) "Fundamentals of Agricultural Entomology and Pest Management", Scientific Publishers, India.

Books for Reference:

1. David Dent, Richard H. Binks (2020) "*Insect Pest Management*" CABI Publishing, United Kingdom.
2. R. T. Roush, B. E. Tabashnik (2018) "*Concepts of Insect Control*", Springer, United States.
3. C. P. Srivastava (2015) "*Advances in Pest Management*", Studium Press LLC, United States.

4. C. Huffaker, R. Rabb (2019) "*Ecological Methods in Integrated Pest Management*", Wiley-Blackwell, United States.
5. George E. Heimpel, Nicholas J. Mills (2017) "*Biological Control in Pest Management*", Cambridge University Press, United Kingdom.
6. David Rees (2007) "*Stored Grain Pests and Their Management*", CSIRO Publishing, Australia.

Websites and eLearning Sources:

1. https://www.youtube.com/watch?v=VV0HrSJ6sHU
2. https://www.youtube.com/watch?v=5gZ1olhvwOA
3. https://www.youtube.com/watch?v=z7oo6njfZzE
4. https://www.youtube.com/watch?v=j5Hngi6zZj8
5. https://www.youtube.com/watch?v=g6LMw9I6rxU

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Principles and historical evolution of IPM and classify agricultural insect pests based on their economic importance	**K1**
CO2	Explain the life cycle, behavior, and population dynamics of major agricultural pests and describe modern pest monitoring techniques.	**K2**
CO3	Analyze the biology, nature of damage, and control measures of key pests affecting major crops such as rice, sugarcane, cotton, and banana.	**K3**
CO4	Evaluate different pest control methods, including physical, mechanical, chemical, biological, and cultural techniques, while assessing their environmental impact.	**K4**
CO5	Apply biotechnology-based pest management strategies (e.g., GM crops, CRISPR) and develop innovative approaches for sustainable pest control in forestry, urban environments, and future challenges.	**K5**
CO6	Assess the role of insects as food and medicine and explore emerging trends and innovations in pest management.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**25PBO4ES03B**		**Discipline Specific Elective - 3:** Integrated Pest Management							**4**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	3	2	2	3	2	2	2.2
CO2	3	2	2	1	3	1	3	3	2	3	2.3
CO3	1	2	3	2	3	2	3	2	3	2	2.3
CO4	2	2	1	2	3	3	3	2	2	3	2.3
CO5	2	2	2	2	3	1	3	2	3	2	2.2
CO6	2	2	1	3	2	2	3	2	3	3	2.3
										Mean Overall Score	**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
4	25PBO4CE01	Comprehensive Examination	-	2

Course Objectives
To acquire knowledge for attending competitive exams in biology.
To study the classification and the evolutionary significance of different plant groups.
To understand organisation, structure and function of various biomolecules.
To understand the mechanisms involved in plant physiology.
To understand components of biodiversity and ecosystem.

UNIT I:

Classification, structure and reproduction of Algae, Fungi, Lichens, Bryophytes, Pteridophytes and Gymnosperms, Ecology and Evolutionary trends. Levels of organization of tissues, organs & systems. Nodal anatomy, stomatal types; Shoot and root development; floral meristems and floral development, microsporogenesis, endosperm, embryo development and apomixis.

UNIT-II:

Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle, structure & function of cytoskeleton, signaling through G-protein coupled receptors, signal transduction pathways; DNA replication, repair and recombination, Protein synthesis and gene expression; Methods of genetic transfers - transformation, conjugation, transduction, germinal verses somatic mutants, Structural and numerical alterations of chromosomes.

UNIT III:

Light harvesting complexes; mechanisms of electron transport, CO2 fixation-C3, C4 and CAM pathways. Nitrogen metabolism, plant hormones- physiological effects, phytochromes, photoperiodism, Plant response to biotic and abiotic stress. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins), Principles of catalysis, enzyme kinetics and enzyme regulation, Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

UNIT IV:

Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants; Concept of habitat and niche, Ecosystem structure; ecosystem function; energy flow and mineral cycling, biogeographical zones of India. Rare, endangered species. Conservation strategies. Environmental pollution; global environmental change.

UNIT V:

Cells and molecules involved in innate and adaptive immunity, antigens, inflammation, hypersensitivity and autoimmunity; Microbial fermentation, Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals. Bioremediation and phytoremediation, Biosensors, RFLP, RAPD and AFLP techniques; Measures of central tendency and dispersal, Levels of significance; Regression and Correlation; t-test.

Teaching Methodology	Chalk and talk, PPT
Assessment Methods	Seminar, Snap Test, MCQ

Books for Study:

1. Pandey, P. B. (2014). College Botany 1: Including algae, fungi, lichens, bacteria, viruses,plant pathology, industrial microbiology and bryophyta. Chand Publishing.
2. Kothari, C. R. (2014). Research Methodology-Methods & Techniques. Wishwa Prakashan.

Books for Reference:

1. Berk, A., Chris, A. K., Lodish, H., Amon, H., Ploegh, H., Bretscher, A., Krieger, M., & Kelsey, Martin, C. (2016). Molecular Cell Biology. WH Freeman & Co. New York.
2. Sharma, P. D. (2010). Ecology and Environment, (8th Ed.). Rastogi Publications.

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	Recollect the classification and the evolutionary significance of different plant groups.	**K1**
CO2	Revisit the structure and functions of different organelles nucleic acids and proteins.	**K2**
CO3	Regain the knowledge on the organization of prokaryotic and eukaryotic genomes.	**K3**
CO4	Remind the biochemical processes in biological systems.	**K4**
CO5	Recapture the dynamics of genetic variation and data interpretation.	**K5**
CO6	Recall the ecosystems and population genetics models.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**25PBO4CE01**		Comprehensive Examination							**-**	**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	1	3	3	3	2	2	**2.4**
CO2	3	3	3	2	2	3	3	3	2	2	**2.5**
CO3	3	3	3	2	2	3	3	3	2	2	**2.5**
CO4	3	3	2	2	2	3	3	3	2	2	**2.5**
CO5	3	3	3	3	2	3	3	3	2	2	**2.7**
CO6	3	3	2	3	2	3	3	3	2	2	**2.6**
										Mean Overall Score	**2.53 (High)**