M Sc BOTANY

LOCF SYLLABUS 2023

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

OUTCOME-BASED EDUCATION (OBE)

OBE is an educational approach that revolves around clearly defined goals or outcomes for every aspect of the educational system. The primary aim is for each student to successfully achieve these predetermined outcomes by the culmination of their educational journey. Unlike traditional methods, OBE does not prescribe a singular teaching style or assessment format. Instead, classes, activities, and evaluations are structured to support students in attaining the specified outcomes effectively.

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

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

Here are some key aspects of Outcome-Based Education:

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

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

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

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

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

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

LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

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

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

Some important terminologies

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

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

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

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

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

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

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

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

Extra Credit Courses: *To support students in acquiring knowledge and skills through online platforms such as Massive Open Online Courses (MOOCs), additional credits are granted upon verification of course completion. These extra credits can be availed across five semesters (2 - 6). In line with UGC guidelines, students are encouraged to enhance their learning by enrolling in MOOCs offered by portals like SWAYAM, NPTEL, and others. Additionally, certificate courses provided by the college are also considered for these extra credits.*

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

Course Coding

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

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

Course Specific Initials

CC - Core Course
CP - Core Practical
ES - Elective
AE - Ability Enhancement Course
SP - Self-paced Learning
EG - Generic Elective
PW - Project and Viva Voce
CE - Comprehensive Examination
OR - Outreach Programme
IS – Internship

EVALUATION PATTERN

Continuous Internal Assessment

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

Passing minimum: 50 marks

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

Question Paper Blueprint for Mid and End Semester Tests

<table>
<tr><td colspan="3">Duration: 2 Hours</td><td colspan="4"></td><td colspan="2">Maximum Marks: 60</td></tr>
<tr><td colspan="2" rowspan="2">Section</td><td colspan="6">K levels</td><td rowspan="2">Marks</td></tr>
<tr><td>K1</td><td>K2</td><td>K3</td><td>K4</td><td>K5</td><td>K6</td></tr>
<tr><td colspan="2">A (compulsory)</td><td>7</td><td></td><td></td><td></td><td></td><td></td><td>7 × 1 = 7</td></tr>
<tr><td colspan="2">B (compulsory)</td><td></td><td>5</td><td></td><td></td><td></td><td></td><td>5 × 3 = 15</td></tr>
<tr><td colspan="2">C (either…or type)</td><td></td><td></td><td>3</td><td></td><td></td><td></td><td>3 × 6 = 18</td></tr>
<tr><td rowspan="4">D (2 out of 3)</td><td>For courses with K5 as the highest cognitive level, one K4 and one K5 question is compulsory.
(Note: two questions on K4 and one question on K5)</td><td></td><td></td><td></td><td>1</td><td>1*</td><td></td><td rowspan="4">2 × 10 = 20</td></tr>
<tr><td rowspan="3">For courses with K6 as the highest cognitive level: Mid Sem: two questions on K4 and one question on K5; End Sem: two questions on K5 and one question on K6)</td><td></td><td></td><td></td><td colspan="2">Mid Sem</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">End Sem</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>1</td><td>1*</td></tr>
<tr><td colspan="7">Total</td><td>60</td></tr>
</table>

***** *Compulsory*

Question Paper Blueprint for Semester Examination

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

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

Evaluation Pattern for One/Two-credit Courses

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

Grading System

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

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

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

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

Where,

Ci - credit earned for the Course i

Gpi - Grade Point obtained for the Course i

Mi - Marks obtained for the Course i

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

WAM - Weighted Average Marks

Table - 1: Grading of the Courses for PG

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

Table - 2: Grading of the Final Performance for PG

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

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

Vision

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

Mission

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

Programme Educational Objectives (PEOs)

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

Programme Outcomes (POs)

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

Programme Specific Objectives (PSOs)

1. Graduates will acquire 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.

PROGRAMME STRUCTURE				
Semester	**Specification**	**Number of Courses**	**Hours**	**Credits**
1 - 4	Core Course	10	51	50
1 - 4	Core Practical	6	24	19
1, 2, 4	Elective	4	20	14
1	Ability Enhancement Course	1	2	1
2	Self-paced Learning	1	-	2
2	Skill Enhancement Course	1	4	3
2, 3	Generic Elective	2	8	6
3	Common Core	1	5	4
2 - 4	Extra Credit Course	3	-	(9)
4	Project Work and Viva Voce	1	6	5
4	Comprehensive Examination	1	-	2
2 - 4	Outreach Programme (SHEPHERD)	-	-	4
	Total	**30**	**120**	**110(9)**

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Course Details					Scheme of Exams		
Sem	**Course Code**	**Title of the Course**	**Hours**	**Credits**	**CIA**	**SE**	**Final**
1	23PBO1CC01	**Core Course - 1:** Plant Diversity - 1 (Algae, Fungi, Lichens and Bryophytes)	6	6	100	100	100
	23PBO1CC02	**Core Course - 2:** Plant Diversity - 2 (Pteridophytes, Gymnosperms and Paleobotany)	6	6	100	100	100
	23PBO1CP01	**Core Practical - 1:** Plant Diversity - 1 and 2	6	4	100	100	100
	23PBO1ES01	**Elective - 1:** Microbiology, Immunology and Plant Pathology	5	3	100	100	100
	23PBO1ES02	**Elective - 2:** Herbal Technology	5	3	100	100	100
	23PBO1AE01	**Ability Enhancement Course:** Nursery and Gardening	2	1	100	-	100
		Total	**30**	**23**			
2	23PBO2CC03	**Core Course - 3:** Plant Physiology	6	6	100	100	100
	23PBO2CC04	**Core Course - 4:** Plant Anatomy, Embryology and Morphogenesis	5	5	100	100	100
	23PBO2CP02	**Core Practical - 2:** Plant Physiology	3	2	100	100	100
	23PBO2CP03	**Core Practical - 3:** Plant Anatomy, Embryology and Morphogenesis	3	2	100	100	100
	23PBO2SP01	**Self-paced Learning:** Plant Breeding and Evolution*	-	2	50	50	50
	23PBO2ES03A	**Elective - 3:** Biophysics and Instrumentation	5	4	100	100	100
	23PBO2ES03B	**Elective - 3:** Plant Pathology					
	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3	100	-	100
	-	**Generic Elective - 1:** Refer ANNEXURE 1	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 1	-	(3)			
		Total	**30**	**27(3)**			
3	23PBO3CC05	**Core Course - 5:** Plant Systematics	5	5	100	100	100
	23PBO3CP04	**Core Practical - 4**: Plant Systematics	4	4	100	100	100
	23PBO3CC06	**Core Course - 6:** Biochemistry	5	5	100	100	100
	23PBO3CP05	**Core Practical - 5:** Biochemistry	4	4	100	100	100
	23PBO3CC07	**Core Course - 7:** Pharmacognosy	3	3	100	100	100
	23SBS3CC01	**Common Core:** Intellectual Property Rights	5	4	100	100	100
	-	**Generic Elective - 2:** Refer ANNEXURE 2	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 2		(3)			
		Total	**30**	**28(3)**			
4	23PBO4CC08	**Core Course - 8:** Research Methodology	5	5	100	100	100
	23PBO4CC09	**Core Course - 9:** Genetic Engineering and Biotechnology	5	5	100	100	100
	23PBO4CC10	**Core Course - 10:** Cell and Molecular Biology	5	4	100	100	100
	23PBO4CP06	**Core Practical - 6:** Research Methodology, Genetic Engineering and Biotechnology	4	3	100	100	100
	23PBO4ES04A	**Elective - 4:** Organic Farming	5	4	100	100	100
	23PBO4ES04B	**Elective - 4:** Genetics					
	23PBO4PW01	Project Work and Viva Voce	6	5	100	100	100
	23PBO4CE01	Comprehensive Examination*	-	2	50	50	50
	-	Extra Credit Courses (MOOC/Certificate Courses) - 3		(3)			
		Total	**30**	**28(3)**			
2 - 4	23PCW4OR01	Outreach Programme (SHEPHERD)		4			
1 - 4		**Total (2 years)**	**120**	**110**			

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

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

ANNEXURE 1
Generic Elective - 1 (WS)*

Course Details		
School	**Course Code**	**Title of the Course**
SBS	23PBI2EG01	Biochemistry of Natural Products
	23PBT2EG01	Medical Biotechnology

**Offered to students from other Departments within School*

ANNEXURE 2
Generic Elective - 1 (BS)*

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

**Offered to students from other Schools*

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PBO1CC01	**Core Course - 1:** Plant Diversity - 1 (Algae, Fungi, Lichens & Bryophytes)	6	6

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: Algae **(18 Hours)**

General account of algology, Contributions of Indian Phycologist (M.O.P. Iyanger, T.V. Desikachary and V. Krishnamurthy), Classification of algae by F.E. Fritsch (1935-45) & Silva (1982).Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Range of thallus organization, algae of diverse habitats, reproduction (vegetative, asexual and sexual) and life cycles. Phylogeny and inter-relationships of algae, origin and evolution of sex in algae.Structure, reproduction and life histories of the following genera: *Oscillatoria*, *Scytonema*, *Ulva*, *Codium*, Diatoms, *Dictyota* and *Gelidium*.

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

General Characteristics, occurrence and distribution. Mode of nutrition in fungi. Contributions of Indian Mycologists (C.V.Subramanian), Classification of Fungi by G.C. Ainsworth (1973) and Alexopoulos and Mims (1983) Phylogeny and inter-relationships of major groups of fungi. General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.Heterothallism in fungi, Para sexuality, sex hormones in fungi. Structure and reproduction of the following: Mastigomycotina -*Albugo*; Zygomycotina- *Rhizopus*; Ascomycotina - *Saccharomyces;* Basidiomycotina-*Puccinia*;Deutromycotina-*Cercospora*.

UNIT III: Lichens **(18 Hours)**

Introduction and Classification (Hale, 1969). Occurrence and inter-relationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens.

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

General characters and Classification of Bryophytes by Watson (1971). Distribution, structural variations and evolution of gametophytes and sporophytes in Hepaticopsida, Anthocerotopsida and Bryopsida. General characters of major groups - Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Reproduction - Vegetative, asexual and sexual, spore dispersal mechanisms in bryophytes, spore germination patterns in bryophytes.Structure, reproduction and life histories of the following genera: *Marchantia, Porella,nbbAnthoceros,*and *Polytrichum.*

UNIT V: Economic Importance **(18 Hours)**

Algae - Economic importance in Food and feed - Single cell protein, Industrial products (Agar-Agar, Carrageenan, Alginic acid, Iodine, biofertilizers, Vitamins and biofuel), Medicinal value and Diatomaceous earth. Fungi - Economic importance in food, industries and medicine. Culturing and cultivation of mushrooms (*Pleurotus*). Lichen -Ecological and economic importance. Bryophytes - Ecological and economic importance - industry, horticulture and medicine.

Teaching Methodology	Chalk and talk, PPT, charts, Video

Books for Study

1. Kumar, H. D. (1999). *Introductory Phycology*. Affiliated East-West Press.
2. Barsanti, L., & Guadtieri, P. (2014). *Algae: Anatomy, Biochemistry and Biotechnology*. (2nd Ed.). CRC Press.
3. Sharma, O. P. (2011). *Fungi and Allied Microorganisms*. McGraw-Hill.
4. Kavanagh, K. (2018). *Fungi Biology and Applications*, (3rd Ed.). Wiley Blackwell.
5. Pandey, P. B. (2014). *College Botany 1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant pathology, Industrial microbiology and Bryophyta*. Chand Publishing.
6. Singh, V. P., & Jain, D. K. (2020). *A textbook of botany*, (5th Ed.). Rastogi Publications.
7. Sharma, O. P. (2014). *Bryophyta*. McGraw-Hill.

Books for Reference

1. Sundaralingam, V. (1991). *Marine Algae*. Bishen Singh and Mahendra Pal Singh Publishers.
2. Lee, R. E. (2018). *Phycology*, (5th Ed.). Cambridge University Press.
3. Nash, T. H. (2008). *Lichen Biology*. Cambridge University press.
4. Johri, R. M., Lata, S., & Tyagi, K. (2012). *A Textbook of Bryophyta*. Dominant Publishers & Distributors Pvt. Ltd.
5. Alexopoulos, C. J., & Mims, M. (2007). *Introductory mycology*, (4th Ed.). Wiley Publishers.

Websites and eLearning Sources

1. https://www.britannica.com/science/algae
2. https://en.wikipedia.org/wiki/Bryophyte
3. https://www.britannica.com/plant/bryophyte/Ecology-and-habits
4. https://www.livescience.com/53618-fungus.html.
5. http://www.uobabylon.edu.iq/eprints/paper_11_20160_754.pdf
6. https://www.youtube.com/watch?v=vcYPI6y-Udo
7. https://www.youtube.com/watch?v=XQ_ZY57MY64
8. http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter22nf.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	relate to the structural organizations of algae, fungi, lichens and Bryophytes.	**K1**
CO2	demonstrate both the theoretical and practical knowledge understanding the diversity of basic life forms and their importance.	**K2**
CO3	explain life cycle patterns in algae, fungi, lichens and Bryophytes.	**K3**
CO4	compare and contrast the mode of reproduction in diverse groups basic plant forms.	**K4**
CO5	discuss and develop skills for effective conservation and utilization of lower plant forms.	**K5**
CO6	develop entrepreneurship skill through industrially important organisms	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
1	**23PBO1CC01**			**Core Course - 1:** Plant Diversity - 1 (Algae, Fungi, Lichens & Bryophytes)					**6**		**6**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	2	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	2	1	2	2	1	2	3	2	3	2	**2.0**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	**23PBO1CC02**	**Core Course - 2:** Plant Diversity - 2 (Pteridophytes, Gymnosperms and Paleobotany)	**6**	**6**

Course Objectives
To investigate the classification, distinctive traits, distribution and reproduction and life history of the various classes and major types of Pteridophytes and Gymnosperms.
To identify and characterize diversity of lower vascular plants in order to comprehend the dynamics of diversity to realize the importance of diversity.
To research the classification, phylogeny and economic importance of Pteridophytes and Gymnosperms.
To study and understand the phylogeny and Palaeontology of Pteridophytes and Gymnosperms.
To learn about the concept of fossils and process of fossilization; distinctive characteristics of fossil records of Pteridophytes and Gymnosperms.

UNIT I: Pteridophytes **(18 Hours)**

General characteristics and classification (Reimer, 1954). Range of structure, reproduction and evolution of the gametophytes, Gametophyte types - sex organs. Apogamy and Apospory. Life cycles. Stellar evolution. Heterospory and seed habit, Telome theory, morphogenesis, Economic importance of Pteridophytes.

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

Structure, anatomy, reproduction and life histories of the following genera: *Isoetes*, *Equisetum*, *Angiopteris*, *Osmunda*, *Pteris* and *Azolla*.

UNIT III: Gymnosperms **(18 Hours)**

General characters - A general account of distribution of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and classification (K.R.Sporne, 1965). Economic importance of Gymnosperms.

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

Structure (Exomorphic and endomorphic), anatomy, reproduction and life histories of the following genera: *Cycas*,*Pinus*, *Araucaria*, *Podocarpus*, *Gnetum*and *Ephedra*.

UNIT V: Paleobotany **(18 Hours)**

Geological Scale; Radiocarbon dating; Contribution of BirbalSahni to Paleobotany. Gondwana flora of India. Study of fossils in understanding evolution. Fossilization and fossil types. Economic importance of fossils - fossil fuels and industrial raw materials and uses. Study of organ genera: *Rhynia*, *Lepidocarpon*, *Calamites*, *Cordaites* and *Lyginopteris*.

Teaching Methodology	PPT, Video, Chalk and talk, charts

Books for Study

1. Vashishta, P. C., Sinha, A. K., & Kumar, A. (2016). *Botany for degree students - Gymnosperms*. S. Chand and Company Ltd.
2. Singh, V. P., Pande, C., & Jain, D. K. (2021). *A Textbook of Botany*. Rastogi Publications.
3. Bhatnagar, S. P. & Moitra, A. (2020). *Gymnosperms*. New Age International (P) Ltd.
4. Sharma, O. P. (2017). *Pteridophyta*. McGraw Hill Education.
5. Vashishta, P. C., Sinha, A. K., & Kumar, A. (2018). *Botany for degree students - Gymnosperms*. S. Chand and Company Ltd.
6. Johri, R. M., Lata, S. & Tyagi, K. (2005). *A Textbook of Gymnosperm.* Dominate Publishers and Distributers.

Books for Reference

1. Parihar, N. S. (2019). *An Introduction to Embryophyta: Pteridophytes,* (5th Ed.). Surjeet Publications.
2. Pandey, S. N., & Trivedi, P. S. (2015). *A textbook of botany* (Vol. 2), (12th Ed.) (Paperback). Vikas Publishing.
3. Rashid, A. (2013). *An Introduction to Pteridophyta - Diversity, Development and Differentiation,* (2nd Ed.). Vikas Publications.
4. Arnold, A. C. (2005). *An Introduction to Paleobotany*. Agrobios (India).
5. Sporne, K. R. (2017). *The Morphology of Pteridophytes (The structure of ferns and allied plants)* (Paperback). Andesite Press.
6. Sporne, K. R. (1967). *The Morphology of Gymnosperms*. Hutchinson & Co.
7. Taylor, E., Taylor, T., & Krings, M. (2008). *Paleobotany: The Biology and Evolution of Fossil Plants,* (2nd Ed.). Academic Press.

Websites and eLearning Sources

1. https://www.toppr.com/guides/biology/plant-kingdom/pteridophytes/
2. http://www.bsienvis.nic.in/Database/Pteridophytes-in-India_23432.aspx
3. https://books.google.co.in/books?
4. hl=en&lr=&id=Pn7CAAAQBAJ&oi=fnd&pg=PA1&dq=Introduction+to+Gymnosperms &ots=sfYSzCL02&sig=ysX1KRvetV0bAza4Sq6RWau4XU8&redir_esc=y#v=onepage&q =Introduction%20to%20Gymnosperms&f=false
5. https://books.google.co.in/books/about/
6. Botany_for_Degree_Gymnosperm_Multicolor.html?id=HTdFYFNxnWQC&redir_esc=y
7. https://books.google.co.in/books/about/Gymnosperms.html?id=4dvyNckni8wC
8. https://arboretum.harvard.edu/wp-content/uploads/2013-70-4-beyond-pine-cones-anintroduction-to-gymnosperms.pdf
9. https://www.palaeontologyonline.com/
10. https://books.google.co.in/books/about/Paleobotany.html?id=HzYUAQAAIAAJ
11. https://trove.nla.gov.au/work/11471742?q&versionId=46695996

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	recall on classification, recent trends in phylogenetic relationship, general characters of Pteridophytes and Gymnosperms.	**K1**
CO2	learn the morphological/anatomical organization, life history of major types of Pteridophytes and Gymnosperms.	**K2**
CO3	comprehend the economic importance of Pteridophytes, Gymnosperms, and fossils.	**K3**
CO4	understanding the evolutionary relationship of Pteridophytes and Gymnosperms.	**K4**
CO5	awareness on fossil types, fossilization and fossil records of Pteridophytes and Gymnosperms.	**K5**
CO6	develop entrepreneurship skill through industrially important organisms.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**23PBO1CC02**	**Core Course - 2:** Plant Diversity - 2 (Pteridophytes, Gymnosperms and Paleobotany)								**6**	**6**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	2	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	2	1	2	2	1	2	3	2	3	2	**2.0**
Mean Overall Score											**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PBO1CP01	**Core Practical - 1**: Plant Diversity 1 and 2	6	4

Course Objectives
To learn how to employ the use of instruments, technologies and methodologies related to thallophytes and non-flowering plant groups.
To enhance information on the identification of each taxonomical group by developing the skill-based detection of the morphology and microstructure of algae, and fungi.
To comprehend the fundamental concepts and methods used to identify Bryophytes, Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction.
To develop the technical abilities in staining, sectioning, sterilizing, and characterizing. Thallophytes and other varieties of non-flowering plants.
To compare the structural diversity of fossil and extant plant species.

Experiments

UNIT I: Algae

Study of algae in the field and laboratory of the genera included in theory.

External morphology and internal anatomy of the vegetative and reproductive structures of the following living forms: *Oscillatoria, Caulerpa, Ulva, Codium,* Diatoms, *Sargassum*and *Gracillaria* (depending on availability of the specimen).

To record the local algal flora-Study of their morphology and structure.

Identification of algae to species level (at least One).

Preparation of culture media and culture of green algae in the laboratory (Demonstration).

UNIT II: Fungi

Study of morphological and reproductive structures of the following living forms: *Plasmodiophora, Rhizopus, Pilobulus, Polyporus* and *Colletotrichum* (depending on availability of the specimen).

Preparation of culture media and culture of fungi in the laboratory.

Isolation and identification of fungi from soil, air, and Baiting method.

LICHENS: Study of morphological and reproductive structures of the genera *Usnea*.

UNIT III: Bryophytes

External morphology and internal anatomy of the vegetative and reproductive organs of thefollowing living forms: *Marchantia,Porella, Anthoceros*and *Polytrichum*(depending onavailability of thespecimen).

UNIT IV: Pteridophytes

External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Isoetes, Equisetum,Angiopteris, Osmunda, Pteris* and*Azolla*(depending onavailability of thespecimen).

Fossilslidesobservation:*Rhynia, Lepidocarpon, Calamites.*

UNIT V: Gymnosperms

External morphology and internal anatomy of the vegetative and reproductive organs of thefollowinglivingforms:*Cycas,Pinus, Araucaria, Podocarpus, Gnetum*and *Ephedra* (depending onavailability of thespecimen).

Fossil slides observation: *Cordaites* and *Lyginopteris*.

Teaching Methodology	Demonstration, videos, chart, PPT,

Books for Study

1. Kumar, H. D. (1999). *Introductory Phycology*. Affiliated East-West Press.
2. Das, S., & Saha, R. (2020). *Microbiology Practical Manual*. CBS Publishers and Distributors (P) Ltd.

3. Sharma, O. P. (2012). *Pteridophyta*. Tata McGraw-Hills Ltd.
4. Sharma, O. P., & Dixit S. (2002). *Gymnosperms*. Pragati Prakashan.
5. Johri, R. M., Lata, S., & Tyagi, K. (2005). *A Textbook of Gymnosperm.* Dominate Publishers and Distributers.

Books for Reference

1. Chmielewski, J. G., & Krayesky, D. (2013). *General Botany Laboratory Manual*. Author House.
2. Webster, J., & Weber, R. (2007). *Introduction to Fungi*, (3rd Ed.). Cambridge University Press.
3. Sharma, O. P. (2017). *Bryophyta*. MacMillan India Ltd.
4. Bendre, A., & Kumar, A. (2010). *A Textbook of Practical Botany: Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany*, (Rev. Ed.). Revised edition. Rastogi Publications.
5. Gangulee, H. C., & Kar, A. K. (2013). *College botany*, (5th Ed.). S. Chand.

Websites and eLearning Sources

1. https://www.frontiersin.org/articles/10.3389/fmicb.2017.00923/full
2. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
3. http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf
4. https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4
5. https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883
6. https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gy mnosperms&printsec=frontcover
7. https://www.amazon.in/Paleobotany-Biology-Evolution-Fossil-Plants/dp/0123739721

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	recall and applying the basic keys to distinguish at species level identification of important algae and fungi through its structural organizations	**K1**
CO2	demonstrate practical skills in thallophytes, Pteridophytes and Gymnosperms	**K2**
CO3	describe the structure of algae, fungi, lichens, Bryophytes, Pteridophytes and Gymnosperms	**K3**
CO4	determine the importance of structural diversity in the evolution of plant forms	**K4**
CO5	formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms	**K5**
CO6	develop entrepreneurship skill through industrially important organisms	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PBO1CP01**			**Core Practical - 1:** Plant Diversity - 1 and 2						**6**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	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	2	1	2	2	1	2	3	2	3	2	**2.0**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PBO1ES01	**Elective - 1:** Microbiology, Immunology and Plant Pathology	5	3

Course Objectives
The goal of the course is to provide students with basic understanding of microbiology, immunology, 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 microbes.
To study the principles of immune system, immunizing agents like antibodies and vaccines and gene therapy methods.
To enhance the knowledge and skills needed for self-employment using the microbial derived products.

UNIT I: Bacteria **(15 Hours)**

General characteristic of bacteria - Outline classification of Bergey's manual of 9th edition. Classification of bacteria based on Morphological, cultural, physiological and molecular characteristics. Bacterial growth - batch culture and continuous culture. Growth Curve. Factors affecting growth, Reproduction: Methods of preservation of Bacterial cultures.

UNIT II: Viruses **(15 Hours)**

General characters, Classification, Structure, Multiplication. Overview of Phycoviruses and Mycoviruses. Viruses of Eukaryotes - Animal & Plant viruses. Cultivation of viruses - in embryonated egg and in plants. Control of viral infections. Bacteriophages- classification, replication of DNA and RNA phages -Lytic and Lysogenic cycle. Viroids and prions. Mycoplasma: Structure and classification.

UNIT III: Food Microbiology **(15 Hours)**

Beneficial role of microbes - yoghurt, Olives, Cheese, Bread, Wine, Tempeh, Miso and Fermented green tea. Spoilage of fruits, vegetables, meats, poultry, eggs, bakery products and dairy products. Food poisoning and Food borne infections. Methods of food preservation. Soil Microbiology: Importance of Microbial flora of soil and factors affecting the microbial community in soil. Environmental Microbiology: Microbiology of water and air. Water borne diseases: diphtheria, chicken pox. Air borne diseases: Tuberculosis and Swine flu

UNIT IV: Immunology **(15 Hours)**

Introduction; Immune System; Types of Immunity - Innate and Acquired. Immune Cells - Hematopoiesis, B and T lymphocytes - Maturation, NK cells. Introduction to inflammation, Adaptive immune system, Innate Immune system. Antigen: Definition, Properties and types. Antibody - Structure, types and function. Generation of antibody diversity. Antigen - Antibody interactions. Definition, types, Precipitation, Agglutination, Complement fixation. Immune Response - Humoral and Cell Mediated. Vaccines - history, types and recombinant vaccines. Immunodiagnosis -Blood Grouping, Widal test, Enzyme-Linked Immunosorbent Assay (ELISA), Immunoelectrophoresis and Immunodiffusion.

UNIT V: Plant Pathology **(15 Hours)**

Concepts of Plant disease, history and significance of plant pathology. General symptoms and Classification of plant diseases,Pathogenesis:pathogens and their mode of dissemination, prepenetration, penetration and post penetration changes. Role of Chemical Weapons (Enzymes, Toxins) in disease development. Disease triangle. Defence mechanism in plants - structural and biochemical defences. Important diseases of crop plants in India -yellow vein Mosaic of Bhindi, Bacterial blight of rice, Late blight of potato and Little leaf of Brinjal. Principles of disease management: Cultural practices, physical, chemical and biological methods.

Teaching Methodology	Demonstration, videos, chart, PPT

Books for Study

1. Singh, R. S. (2018). *Introduction to Principles of Plant Pathology,* (4th Ed.).
2. Bilgrami, K. S., & Dube, H. C. (2010). *A Textbook of Modern Plant Pathology*. Vikas Publishing House (P) Ltd.
3. Mehrotra, R. S., & Aggarwal, A. (2017). *Plant Pathology*. McGraw Hill Publisher.
4. Dube, H. C. (2010). *A Textbook of Fungi, Bacteria and Viruses,* (3rd Ed.). Agrobios India.
5. Rao, C. V. (2006). *Immunology,* (2nd Ed.). Narosa Publisher.
6. Murphy, K. (2017). *Janeway's Immunobiology,* (9th Ed.). Garland Publisher.
7. Sullia, S. B., & Shantharam, S. (1998). *General Microbiology*. Oxford and IBH Publishing Co. Pvt. Ltd.
8. Adams, M. R. & Moss, M.O. (2008). *Food microbiology*. Royal Soc. Chem.

Books for Reference

1. Agrios, A. G. (2007). *Plant Pathology.* Elsevier.
2. Jeffery, C., & Pommerville. (2014). *Alcamo's Fundamentals of Microbiology*, (10th Ed.). Johnsand Bartlett Learning.
3. Pelczar, M. J. (2007). *Microbiology*, (35th Ed.). Tata-McGraw Hill Publications.
4. Ravichandra, N. G. (2013). *Fundamentals of Plant Pathology*. Phi Learning.
5. Willie, J., & Sherwood, L. (2016). *Prescott's Microbiology,* (10th Ed.). McGraw-Hill Education.
6. Chaube, H. S., & Singh, R. (2015). *Introductory Plant Pathology*. CBS Publishers.
7. Rangasamy, G. (2006). *Disease of Crop Plants in India,* (4th Ed.). Tata McGraw Hill.
8. Mishra, A. B. A., & Mishra, A. (2011). *Plant pathology-disease and management*. Agro Bios.

Websites and eLearning Sources

1. https://www.wileyindia.com/a-textbook-of-plant-pathology.html
2. https://www.britannica.com/science/plant-disease.
3. https://www.planetatural.com/pest-problem-solver/plant-disease/
4. https://www.elsevier.com/books/plant-pathology/agrios/978-0-08-047378-9
5. https://www.elsevier.com/life-sciences/immunology-and-microbiology/books
6. https://www.amazon.in/introduction-immunology-rafia-imran-ebook/dp/B09B66SD3J

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	recognize the general characteristics of microbes, plant defense and immune cells.	**K1**
CO2	explain about the stages in disease development and various defense mechanisms in plants and humans.	**K2**
CO3	elucidate concepts of microbial interactions with plant and humans.	**K3**
CO4	analyze the importance of harmful and beneficial microbes and immune system.	**K4**
CO5	determine and interpret the detection of pathogens and appreciate their adaptive strategies.	**K5**
CO6	appreciate the role of immune system in conferring disease resistance.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
1	**23PBO1ES01**		**Elective - 1:** Microbiology, Immunology and Plant Pathology							**5**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	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	2	1	2	2	1	2	3	2	3	2	**2.0**
Mean Overall Score											**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PBO1ES02	**Elective - 2:** Herbal Technology	5	3

Course Objectives
To understand various plants-based drugs used in Ayurveda, Unani, Homeopathy and Siddha.
To apply the knowledge to cultivate medical plants.
To know the pharmacological importance of medicinal plants.
To enlist phytochemicals and secondary metabolites of market and commercial value.
To design and develop their own business prepositions such as the making of herbal insecticides.

UNIT I: Herbal Medicines and Pharmacognosy **(15 Hours)**

Definition and importance of Herbal medicines. Pharmacognosy scope and importance - source - Crude Drugs - Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Cultivation, Collection and processing of crude drugs. Cultivation and utilization of medicinal and aromatic plants in India. National Medicinal Plants Board of India.

UNIT II: Plant Tissue Culture as Source of Plant material production for Medicines **(15 Hours)**

Plant tissue culture as source of medicines, Role of plant tissue culture in enhancing secondary metabolite production (*Withaniasomnifera*, *Rauwolfia93erpentine*, *Catheranthusroseus*, *Andrographispaniculata* and*Dioscorea*sp) - Elicitation - Biotransformation, Hairy root culture. Factors affecting secondary metabolites production.

UNIT III: Standardization of Plant Drug Materials and Phytochemicals **(15 Hours)**

Methods of Drug evaluation (Morphological, microscopic, physical and chemical). Phytochemical investigations - standardization and quality control of herbal drugs. Preliminary screening, Assay of Drugs - Biological evaluation/assays, Microbiological methods - Chemical Methods of Analysis, Detection of Adulterants: Chemical estimations, Spectrophotometry and fluorescence analysis. Drug adulteration - Types of adulterants.

UNIT IV: Analysis of Phytochemicals and Biological Screening **(15 Hours)**

Carbohydrates and derived products: Glycosides - extraction methods (*Digitalis, Dioscorea*); Tannins (Hydrolysable and Condensed types); Volatile oils - extraction methods (Clove, Mentha). Study of some herbal formulation techniques as drug cosmetics.

UNIT V: Types of Phytochemicals **(15 Hours)**

Alkaloids - extraction methods (*Taxus, Cinchona*); Flavonoids- extraction methods, Resins- extraction method: Application of phytochemicals in phytopharmacueticals; Biocides, Biofungicides, Biopesticides. Women entrepreneurship development - marketing cultivated medicinal plants.

Teaching Methodology	PPT, chalk and talk, herbal preparations and practical demonstration.

Books for Study

1. Kokate, C. K., Purohit, A. P., & Gokhale, S.B. (1996). *Pharmacognosy,* (4th Ed.). Nirali Prakashan.
2. Roseline, A. (2011). *Pharmacognosy*. MJP publishers.
3. Tilgner, S. M. (2018). *Herbal ABC's: The Foundation of Herbal Medicine*. Wise Acres LLC.
4. Hornok, L. (1997). *Natural Products in Medicine: A Biosynthetic Approach*. Wiley.
5. Chichister, U. K. J. (1999). *Cultivation and Processing of Medicinal Plants*. Wiley & Sons. Trease and Evans.
6. Mukherjee, P. K. (2008). *Quality Control of Herbal Drugs,* (3rd Ed.). Business Horizons Pharmaceutical Publishers.
7. Kirtikar, K. R., & Basu, B. D. (2012). *Indian Medicinal Plants*. University Bookstore.
8. Biswas, P. K. (2006). *Encyclopedia of Medicinal Plants.* (Vol. 1-7). Dominant Publishers.
9. Chaudhuri, A. B. (2007). *Endangered Medicinal Plants*. Daya Publishing House.

Books for Reference

1. Wallis, T. E. (1999). *Textbook of Pharmacognosy*. CBS Publishers and Distributors,
2. Kumaresan, V., & Regland, A. (2004). *Taxonomy of Angiosperms: Systematic botany, Economic botany, Botany & Ethnobotany*.
3. Anonymous. (2004). *Cultivation of Selected Medicinal Plants*. National Medicinal Plants Board, Govt. of India.
4. Rao, A. V. (2000). *Herbal Cure for Common Diseases*. Diamond books Pvt. Ltd.
5. Dey, A. C. (1998). *Indian Medicinal Plants used in Ayurvedic Preparations*. Bishen Singh Mahendra Pal Singh.
6. Sathya, S., Jaiganesh, K. P., & Sudha, T. (2019). *Current Trends in Herbal Drug Technology*. Pharmacy Council of India.
7. Lewis, W. H., & Elwin-Lewis, M. P. F. (1976). *Medical Botany: Plants Affecting man's Health*. Wiley Inter Science Publication. John Wiley and Sons.

Websites and eLearning Sources

1. https://www.kopykitab.com/Herbal-Science
2. https://kadampa.org/books/free-ebook-download-howtotyl?
3. gclid=CjwKCAiA6vXwBRBKEiwAYE7iS5t8yenurClUCTdV9olKo9TbyAh4fsoFqPYW Gs5qBTbytD22z7lo0BoCYnUQAvD_BwE
4. https://www.barnesandnoble.com/b/free-ebooks/nook-books/alternative-medicine naturalhealing/herbal-medicine/_/N-ry0Z8qaZ11iu
5. http://cms.herbalgram.org/heg/volume8/07July/HerbalEBooks.html? t=1310004932&ts=1579066352&signature=1dd0d5aef818b19bcdcd6c063a78e404
6. https://www.dattanibookagency.com/books-herbs-science.html
7. https://www.springer.com/gp/book/9783540791157

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	recollect the importance of herbal technology.	**K1**
CO2	understand the classification of crude drugs from various botanical sources.	**K2**
CO3	analyze on the application of secondary metabolites in modern medicine.	**K3**
CO4	create new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society.	**K4**
CO5	comprehend the current trade status and role of medicinal plants in socio economic growth.	**K5**
CO6	develop entrepreneurship skill through learning preparation processes of herbal drugs and phytoconstituents.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**	**Credits**	
1	**23PBO1ES02**		**Elective - 2:** Herbal Technology						**5**	**3**	
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	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	2	1	2	2	1	2	3	2	3	2	**2.0**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PBO1AE01	**Ability Enhancement Course:** Nursery and Gardening	2	1

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

UNIT I: Nursery **(6 Hours)**

Definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting: direct seeding and transplants.

UNIT II: Seed **(6 Hours)**

Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.

UNIT III: Vegetative Propagation **(6 Hours)**

Air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glasshouse.

UNIT IV: Gardening **(6 Hours)**

Definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping.

UNIT V: Gardening Operations **(6 Hours)**

Soil laying, manuring, watering, management of pests and diseases and harvesting. Sowing/ raising of seeds and seedlings: Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomato and carrot - Storage and marketing procedures.

Teaching Methodology	PPT, videos and practical demonstration.

Books for Study

1. Bose, T. K., & Mukherjee, D. (1972). *Gardening in India.* Oxford & IBH Publishing Co.
2. Sandhu, M. K. (1989). *Plant Propagation.* Wile Eastern Ltd.
3. Kumar, N. (1997). *Introduction to Horticulture*. Rajalakshmi Publications.
4. Agrawal, P. K. (1993). *Handbook of Seed Technology*. Dept. of Agriculture and Cooperation, National Seed Corporation Ltd.

Books for Reference

1. Prasad, S., & Kumar, U. (2005). *Greenhouse Management for Horticultural Crops,* (2nd Ed.). Agrobios.
2. Acquaah, G. (2002). *Horticulture: Principles and Practices*. Prentice Hall of India Pvt. Ltd.
3. Abraham, A., & Vatsala, P. (1981). *Introduction to Orchids*. Tropical Botanic Garden and Research Institute.
4. Hartman, H. T., & Kester, D. E. (1989). *Plant Propagation*. Prentice Hall Ltd.

Websites and eLearning Sources

1. https://www.kopykitab.com/Nursery-And-Gardening-SEC-by-Prof-C-D-Patil-Dr-G-MRane-Dr-S-A-Patil
2. https://www.wonderslate.com/nursery-and-gardening-management/ebook-details?siteName=books&bookId=38078&preview=true
3. https://books.google.co.in/books/about/Nursery_Hindi_Book_Bonsai_Plants_Nursery.html?id

=-nfDDwAAQBAJ&redir_esc=y

4. https://www.amazon.in/Gardening-Books/b?ie=UTF8&node=1318122031
5. https://www.worldcat.org/title/handbook-of-horticulture/oclc/688653648

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	compare and contrast cultivation of different vegetables and growth of plants in nursery and gardening.	**K4**
CO2	develop new strategies to enhance growth and quality of nursery plants.	**K5**
CO3	develop necessary skill in different propagation techniques in gardening	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PBO1AE01**			**Ability Enhancement Course:** Nursery and Gardening						**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	3	2	3	2	3	3	2	3	2	**2.6**
CO2	2	2	3	2	1	3	2	3	2	1	**2.1**
CO3	2	1	2	2	1	2	3	2	3	2	**2.0**
										Mean Overall Score	**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBO2CC03	**Core Course - 3:** Plant Physiology	6	6

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: Diffusion and osmosis, water potential. Water balance of plants: absorption by roots, transport through the xylem, transpiration. 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.

UNIT IV **(18 Hours)**

Nitrogen in the environment; assimilation of nitrate and ammonium-GS- GOGAT; biological nitrogen fixation. 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	Lecture, technologies, and group learning

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.

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, the 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	**23PBO2CC03**			**Core Course - 3:** Plant Physiology					**6**		**6**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	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/Week	Credits
2	23PBO2CC04	**Core Course - 4:** Plant Anatomy, Embryology and Morphogenesis	5	5

Course Objectives
To understand the primary and secondary structure of dicots and monocots with reference to root, stem and leaves.
To attain basic knowledge of the structure and development of male and female gametophytes in plants
To know the process of development in microsporogenesis and megasporogenesis.
To know fertilization, post fertilization changes and developmental process in embryology.
To understand the mechanisms underlying the developmental flexibility of plants.

UNIT I **(15 Hours)**

General account on theories of organization of shoot and root apical meristem, quiescent centre. Structural diversity and phylogenetic trends of specialization of xylem and phloem, Cambium - origin, cellular structure, cell division, storied and non-storied types. Role of cambium in budding, grafting and in wound healing. Trichomes, periderm and lenticels.

UNIT II **(15 Hours)**

Anatomical characteristics and vascular differentiation in primary and secondary structure of root and stem (Dicot and Monocot), Origin of lateral roots, Root stem transition, Anatomy of Dicot and Monocot leaf. Leaf abscission, stomata types, nodal anatomy, petiole anatomy, vascularization of flower and seedling.

UNIT III **(15 Hours)**

Microsporangium - Microsporogenesis, Microspores - morphology, ultrastructure, Microgametogenesis, Pollen - Stigma - Incompatibility, Methods to overcome incompatibility. Megasporangium - Megagametogenesis, Female gametophyte - Monosporic, Bisporic and Tetrasporic, Nutrition of embryo sac and fertilization.

UNIT IV **(15 Hours)**

Endosperm - Types, haustoria, Cytology and physiology and functions of endosperms, Embryo development - Dicot and Monocot, Nutrition of embryo. Polyembryony - Causes. Apomixis - Causes. Apospory - their role in plant improvement programs and seed development.

UNIT V **(15 Hours)**

Morphogenesis- Definition, morphogenesis and its relation to morphology, Turing's diffusionreaction theory, Morphogenetic factors - growth regulators, genetic and environment, polarity. Molecular basis of morphogenesis, Cellular level morphogenesis, Asymmetric divisions and their significance, Morphogenesis at tissue level - Differentiation, dedifferentiation and redifferentiation of vascular tissue *in vitro* and *in vivo* and in wounds. Plant galls and their importance in morphogenesis.

Teaching Methodology	PPT, videos and practical demonstration

Books for Study

1. Fahn, A. (1989). *Plant Anatomy*. Maxwell Pvt. Ltd.
2. Bhojwani, S.S., & Bhatnagar, S.P. (1981). *Embryology of Angiosperms*. Vikas Publishing House Pvt. Ltd.

Books for Reference

1. Bard, J. (1990). *Morphogenesis*. Cambridge University Press.
2. Agarwal, S. B. (1990). *Embryology of Angiosperms - a fundamental approach*. Sahitya Bhawan.

3. Pandey, B. P. (1989). *Plant Anatomy*. S. Chand & Co. Ltd.

Websites and eLearning Sources

1. https://academic.oup.com/book/53725/chapter-abstract/422168601?redirectedFrom=fulltext
2. https://www.jove.com/science-education/11094/plant-morphogenesis-growth-differentiation-and-communication
3. http://www.uprtou.ac.in/other_pdf/12_01_2023_DCBY_105.pdf

CO No.	Course Outcomes CO-Statements On successful completion of this course, the students will be able to	Cognitive Levels (K- Level)
CO1	acquire knowledge about the tissues of stem, root and leavesin plants.	**K1**
CO2	describe the primary and secondary structure of dicots andmonocots with reference to root, stem and leaves.	**K2**
CO3	attain basic knowledge of the structure and development ofmale and female gametophytes in plants.	**K3**
CO4	compare and determine the structure and development ofdicot and monocot embryos.	**K4**
CO5	integrate the morphogenesis, endosperm development and polyembryony.	**K5**
CO6	gain knowledge about morphogenesis at cellular level.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
2	**23PBO2CC04**			**Core Course - 4:** Plant Anatomy, Embryology and Morphogenesis					**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	2	2	3	2	2	2	2	**2.3**
CO2	2	3	2	2	1	2	3	2	2	2	**2.1**
CO3	2	2	3	2	1	3	3	2	3	1	**2.2**
CO4	3	3	2	1	1	2	1	2	1	2	**2.1**
CO5	2	3	2	2	3	2	3	2	2	3	**2.6**
CO6	2	1	2	3	2	2	3	2	1	2	**2.0**
Mean Overall Score											**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBO2CP02	**Core Practical - 2:** Plant Physiology	3	2

Experiments

1. Determination of water potential (Shardakov's method).
2. Determination of solute potential.
3. Hills 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 aminoacids 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

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Semester	Course Code	Title of the Course	Hours/Week	Credits
2	**23PBO2CP03**	**Core Practical - 3:** Plant Anatomy, Embryology and Morphogenesis	**3**	**2**

Plant Anatomy and Embryology

- Study of stem and root anatomy in dicot and monocot.
- Study of leaf anatomy - structure, types of stomata, Trichomes.
- Study the anomalous secondary features in *Boerhaavia* and *Bignonia*.
- Micrometry of xylem elements.
- study of pollen morphotypes (Malvaceae and Asteraceae)
- Isolation of different stages of embryo and polyembryony in citrus, Jamun (*Syzygium cumini*)
- Tests for pollen viability using stains and *in vitro* germination. Pollen germination using hanging drop technique.

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBO2SP01	**Self-paced Learning:** Plant Breeding and Evolution	-	2

Course Objectives
To outline the progress made in the field of plant breeding.
To comprehend the principles, techniques, modes of reproductionin crops and applications of plant breeding.
To demonstrate the theories of evolution.
To analyse the hybridization techniques.
To test the knowledge on heterosis, mutation and polyploidy.

UNIT I

Plant Breeding: Historical aspect of plant breeding and genetic basis. Breeding methods: sexual, asexual and apomitic reproduction. Floral Biology in relation to selfing and crossing techniques. Centres of diversity and origin of cultivated plants. Role of National and International Institutes.

UNIT II

Hybridization: Objectives, choice of parents, problems and causes of failure of hybridization. Incompatibility and sterility, Methods of handling genetic consequence of hybridization, method of handling segregation material for isolation of superior strains - Bulk method and pedigree method of selection. Role of interspecific and intergeneric hybridization in plant improvement.

UNIT III

Inbreeding depression and heterosis: Genetic basis and application in plant breeding. Steps in the production of single cross, double cross, three-way cross; induced polyploidy in plant breeding; role of auto- and allopolyploidy, Heteroploid, Mutation and crop improvement. Population genetics: Hardy-Weinberg principle; gene frequencies and the factors that change it.

UNIT IV

Back Crossing: Theory and procedure for transferring various types of character. Preservation and utilization of germplasm. Breeding of rice, sugarcane, groundnut and maize. Application of biotechnology to plant breeding - embryo rescue, somaclonal variation, doubled haploid, protoplast fusion and transgenic.

UNIT V

Evolution: Origin of life, theories of evolution of life forms: Lamarkism, Darwinism and Speciation. Variations - Definition, causes and types, Mutations (Principles of Hugo de Veries), Role of mutations in speciation. Evidences for evolution, adaptive radiation, biological evolution. Impact of evolution on human life.

Teaching Methodology	JOSTEL, Course material

Books for Study

1. Chaudhari, R. C. (2017*). Introductory Principles of Plant Breeding*. Kindle Edition.
2. Singh, P. (2017). *Fundamentals of Plant Breeding*. Kalyani Publishers,
3. Manokaran, K. V. (2010). *Essentials of Plant Breeding*. PHI Learning Private Limited Publishers.

Books for Reference

1. Brown, P.C., & Campos, H. (2014). *Introduction to Plant Breeding*. (2nd Ed.). Wiley BlackwellPublishers.
2. Izak, B., & Caligari, P. (2007). *Selection Methods in Plant Breeding*. Springer.

Websites and eLearning Sources

1. https://link.springer.com/chapter/10.1007/978-981-19-5434-4_1
2. https://www.seedworld.com/the-evolution-of-plant-breeding/
3. https://evolution.berkeley.edu/evolution-101/an-introduction-to-evolution/

CO No.	Course Outcomes CO-Statements On successful completion of this course, the students will be able to	Cognitive Levels (K - Level)
CO1	acquire knowledge on floral biology and selection of proper breeding method	K1
CO2	critically analyze information about life and its origins	K2
CO3	cultivate skill in emasculation and pollination of various crop plants	K3
CO4	gain expertise on hybrid seed production techniques	K4
CO5	learn to use the descriptors in various crops for selection of superior genotypes	K6
CO6	able to understand the importance of evolution in plant breeding.	K5

Relationship Matrix											
Semester	Course Code			Title of the Course						Hours	Credits
2	23PBO2SP01			**Self-paced Learning:** Plant Breeding and Evolution						-	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	2	2	3	3	1	2	2.3
CO2	2	3	2	2	3	2	3	2	3	1	2.3
CO3	2	3	2	3	1	2	3	3	2	3	2.4
CO4	1	3	2	3	2	2	3	2	3	2	2.3
CO5	2	2	2	3	2	2	3	2	3	3	2.4
CO6	3	1	2	3	2	3	2	2	3	2	2.3
Mean Overall Score											2.4 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBO2ES03A	**Elective - 3:** Biophysics and Instrumentation	5	4

Course Objectives
To acquire knowledge on various types of centrifugation, spectroscopy andtracer techniques.
To relate the importance of biophysics in modern biology.
To apply the laws of thermodynamics in biology.
To evaluate and illustrate the concept of redox potential in biologicalsystem.
To integrate various types of microscopy and their applications.

UNIT I **(15 Hours)**

Introduction to biophysics, its importance in modern biology. Bioenergetics: First and second law of thermodynamic, internal energy, enthalpy, entropy, concept of free energy, standard free energy change of a chemical reaction, ATP and high energy phosphate compounds.

UNIT II **(15 Hours)**

Biophotonics: Redox potential, Oxidation and reduction, redox potential and its calculation by Nernst equation, examples of redox potential in biological system. Osmosis and osmotic pressure, the role of osmosis in cell volume regulation. The iso, hypo, and hypertonic solutions, their influence on the cell. Ionic diffusion. Active and passive bioelectric properties of membranes.

UNIT III **(15 Hours)**

Microscopy: Bright field microscopy-magnification, resolving power and contrast. Dark field microscopy, phase-contrast microscopy, fluorescent microscopy, electron microscopy (SEM andTEM). Electrophoresis: AGE, PAGE, SDS-PAGE.

UNIT IV **(15 Hours)**

Centrifugation: Principle, procedure and application. Types of centrifugation - density gradient centrifugation, ultracentrifugation and differential centrifugation. Chromatography: Principles, instrumentation, and applications of Paper, thin layer, column chromatography, gas chromatography, HPTLC and GC-MS.

UNIT V **(15 Hours)**

Spectrophotometry: principles and instrumentation of UV/Vis, Atomic absorption spectrophotometer (AAS), NMR, ESR. Tracer techniques: Important stable radioisotopes and their uses in research. Radiation hazards and precautions in handling radioisotopes. Measurement of radioactivity-autoradiography, GM counter and scintillation counter.

Teaching Methodology	PPT, videos and practical demonstration

Books for Study

1. Banerjee, P.K. (2008). *Introduction to Biophysics*. S. Chand.
2. McMahon, G. (2007). *Analytical Instrumentation: A Guide to Laboratory, Portable and Miniaturized Instruments*. John Wiley & Sons, Ltd. ISBN: 9780470027950.

Books for Reference

1. Roy, R.N. *A text book of Biophysics*. New Central Book Agency Pvt. Ltd.
2. Upadhyay, Upadhyay & Nath. *Biophysical Chemistry*. Himalaya Publ. House.
3. Mohan Arora. *Biophysics*. Himalaya Publishing House.

Websites and eLearning Sources

1. https://microbenotes.com/microscope/
2. https://microbenotes.com/centrifugation-principle-types-and-applications/
3. https://www.nrc.gov/about-nrc/radiation/health-effects/measuring-radiation.html

CO No.	Course Outcomes CO-Statements On successful completion of this course, the students will be able to	Cognitive Levels (K - Level)
CO1	know the kinds of energy and differentiate entropy and enthalpy.	K1
CO2	value the importance of cell wall and the manipulation of cell wall.	K2
CO3	understand the basic principles and applications of microscope.	K3
CO4	apply the principles of centrifugation in biology.	K4
CO5	value the importance of radioisotopes in biology.	K5
CO6	integrate various types of chromatographic and spectroscopic techniques.	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
2	23PBO2ES03A	**Elective - 3:** Biophysics and Instrumentation								5	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	1	2	2	3	2	1	2	2.1
CO2	2	3	2	2	3	2	3	2	2	1	2.2
CO3	2	2	3	2	1	2	2	3	2	2	2.1
CO4	1	2	2	3	2	1	3	2	3	2	2.1
CO5	1	2	2	3	2	2	3	2	2	3	2.2
CO6	2	2	2	2	1	2	1	2	3	3	2.0
										Mean Overall Score	2.1 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBO2ES03B	**Elective - 3:** Plant Pathology	5	4

Course Objectives
To acquire knowledge on pathogenesis and disease establishment inplants
To learn the process of mode of dissemination and disease development
To recognize the effect of Microbe infection on host physiology
To comprehend the various different types of disease control mechanism
To familiarize the concepts in plant immunity and various defence mechanism in plants

UNIT I **(15 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 **(15 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 **(15 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 **(15 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 **(15 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	PPT, videos and practical demonstration

Books for Study

1. Singh, R.S. (2018). *Introduction to Principles of Plant Pathology*, (4th Ed.). Scientific International.
2. Mehrotra, R.S., & Aggarwal, A. (2017). *Plant Pathology*. McGraw Hill Publisher Co. Ltd.

Books for Reference

1. Sharma, P.D. (2001). *Microbiology and plant pathology*. Rastogi publications.
2. Rangasamy, G. (1998). *Diseases of crop plants in India*. Prentice- Hall of India.
3. Mukherjee, K.G., & Jayanti, B. (1986). *Plant diseases of India*. Tata MacGraw-Hill.
4. Harsfall, J.G., & Cowling, E.B. (1979). *Plant Disease, an Advanced Treatise.* Academic Press.

Websites and eLearning Sources

1. http://www.jnkvv.org/PDF/11042020102651plant_pathology.pdf
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3218475/#:~:text=Two%20layers%20of%20plant%20immune,perception%20of%20microbe%20general%20elicitors.

CO No.	Course Outcomes CO-Statements On successful completion of this course, the students will be able to	Cognitive Levels (K- Level)
CO1	acquaint with the structure, vector relationship, biology and management of plant-pathogen interaction.	K1
CO2	introduce the subject of Plant Pathology, its concepts and principles.	K2
CO3	recognize the effect of Microbe infection on host physiology	K3
CO4	learn the various methods/techniques/instruments used in the study of plant diseases/pathogens.	K4
CO5	educate about the nature, prevalence, etiology, factors affecting disease development and control measures of crop diseases.	K5
CO6	gain knowledge the molecular interaction of defence mechanism.	K6

Relationship Matrix												
Semester	Course Code					Title of the Course					Hours	Credits
2	23PBO2ES03B					**Elective - 3:** Plant Pathology					5	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	2	2	2	2	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	3	2	2	2	3	2	2	2	3	2.3	
Mean Overall Score											2.3 (High)	

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3

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

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

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

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

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

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

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

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

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

UNIT IV: Numerical Ability (12 Hours)

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

UNIT V: Test of Reasoning (12 Hours)

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

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT.

Book for Study

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

Books for Reference

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

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

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
2	**23PSS2SE01**			**Skill Enhancement Course:** Soft Skills					**4**		**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	2	3	2	3	2	3	**2.7**
CO2	3	3	3	2	3	3	3	3	3	3	**2.9**
CO3	3	2	2	3	3	3	3	3	3	3	**2.8**
CO4	3	3	2	2	3	3	3	3	3	3	**2.8**
CO5	3	3	3	2	2	3	3	3	3	3	**2.8**
CO6	3	3	3	2	2	3	3	3	3	3	**2.8**
										Mean Overall Score	**2.8 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PBO3CC05	**Core Course - 5:** Plant Systematics	5	5

Course Objectives
Understand plant diversity, classification, nomenclature, and evolutionary relationships through in-depth plant systematics study.
Proficiently use modern tools for plant identification, taxonomy, and phylogenetic analysis to contribute to plant systematics.
Critically analyze and synthesize scientific literature on plant systematics, 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 **(15 Hours)**

Overview of Plant Systematics - Phenetics (artificial, natural classification) and Cladistics (Phylogenetic systematics): terms and concepts, taxon selection, character analysis, cladogram construction, cladogram analysis - Angiosperm Phylogeny Group classification: principles of APG system, short version of APG I, APG II and APG III, detailed version of APG IV.

UNIT II **(15 Hours)**

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

UNIT III **(15 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 **(15 Hours)**

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

UNIT V **(15 Hours)**

Molecular systematics: 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	PPT, videos and practical demonstration.

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** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
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	**23PBO3CC05**				**Core Course - 5:** Plant Systematics				**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	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/Week	Credits
3	23PBO3CP04	**Core Practical - 4**: Plant Systematics	4	4

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/Week	Credits
3	23PBO3CC06	**Core Course - 6:** Biochemistry	5	5

Course Objectives
To make students understand the structure and function of carbohydrates
To understand the role of lipids and its metabolism
To make the students to understand the amino acids
To apply knowledge about the protein and its metabolism.
To know the various biochemical techniques and its industrial application

UNIT I **(15 Hours)**

Carbohydrates: Homoglycans: chemical structure and functions of starch, glycogen, cellulose, dextrin and inulin. Heteroglycan: chemical structure and functions of agar, alginic acid (sea weed polysaccharide), glycosaminoglycans, proteoglycanas, glycoproteins and pectins. Glycocalyxoligo saccharide. Over view of metabolism of carbohydrate.

UNIT II **(15 Hours)**

Lipids and Biomembranes: Triglycerides, phosphoglycerols, derived lipids- steroids, prostaglandins, spingolipids, leukotrienes and lipopoly saccharides. Structure of membrane model, lipid bilayer. Structure of membrane proteins and membrane receptors: adrenalin receptors, acetylcholine receptors and insulin receptors. Over view of metabolism of lipids.

UNIT III **(15 Hours)**

Amino acids and peptides: Amino acids: general structure and classification. Glutathione: structure, metabolism and function. Biology of cyclosporin. Metabolism of phenylalanine and tyrosine; glycine, cysteine and methionine. Over view of metabolism of vitamins.

UNIT IV **(15 Hours)**

Proteins: The peptide bond and primary structure. Secondary structure, domain, motif and backbone folding. Tertiary structure and stabilizing forces in collagen. Quaternary structure of haemoglobin and its regulatory features. Protein sequencing strategies - chemical and enzymatic. Ramachandran plot.

UNIT V **(15 Hours)**

Enzymes: Principles of catalysis, activation barrier and energy changes in reaction profile, initial velocity and principles of enzyme kinetics: Michaelis- Menten Equation, KM and VMax measurements - LB blot; active site organization; and role of cofactors/vitamins. Enzyme regulation: pH, temperature and substrate concentration. Inhibitions and regulation of glutamine synthetase. Industrial applications of enzymes.

Teaching Methodology	PPT, videos and practical demonstration.

Books for Study

1. Lubert, S. (2005). *Biochemistry*. W.H. Freeman & Co.
2. Nelson, D. L., Lehninger, A. L. & Cox, M. M. (2008). *Lehninger, Principles of Biochemistry*, (5th Ed.). Publisher: W. H. Freeman and Company.
3. Voet, D., & Voet, J.G (2011). *Biochemistry*, (14th Ed.). Publisher: John Wiley & Sons.

Books for Reference

1. Caret. *et al*. (1993). *Inorganic, Organic and Biological Chemistry*. WMC Brown.
2. Jeremy, M. B., John, L. T., & Lubert, S. (2010). *Biochemistry*, (17th Ed.). 74Publisher: W. H. Freeman.

Websites and eLearning Sources

1. https://www.medicalnewstoday.com/articles/161547#chemistry
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2642958/
3. https://bio.libretexts.org/Bookshelves/Biochemistry/Fundamentals_of_Biochemistry_(Jakubowski_and_Flatt)/01%3A_Unit_I-Structure_and_Catalysis/03%3A_Amino_Acids_

Peptides_and_Proteins/3.01%3A_Amino_Acids_and_Peptides
4. https://infinitabiotech.com/blog/principles-of-enzyme-catalysis/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the classification and structural organization of proteins.	**K1**
CO2	apply knowledge about the enzyme kinetics and its regulatory process.	**K2**
CO3	apply basic principles of chemistry to biological systems.	**K3**
CO4	infer the metabolism of amino acids and its regulation.	**K4**
CO5	design biochemical techniques to carry out experiments.	**K5**
CO6	understand the industrial importance of industrial enzymes.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
3	**23PBO3CC06**			**Core Course - 6:** Biochemistry					**5**		**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	3	2	1	2	3	2	2	3	**2.3**
CO2	1	3	2	2	2	3	3	1	2	3	**2.1**
CO3	2	2	3	2	3	2	3	3	2	1	**2.3**
CO4	3	1	3	3	1	2	2	2	3	2	**2.2**
CO5	1	3	2	2	2	2	3	1	2	3	**2.1**
CO6	3	1	3	3	1	2	2	2	3	2	**2.2**
										Mean Overall Score	**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PBO3CP05	**Core Practical - 5:**Biochemistry	4	4

Experiments

1. Estimation of glycogen / total polysaccharides
2. Estimation of hexosamine
3. Determination of total proteins (Bradford's / Lowry's)
4. Study of Enzyme Kinetics (experiments with acid phosphatase)
5. Effect of temperature on enzyme activity.
6. Effect of [S] on enzyme activity; measurement of V_{max} and Km.
7. Estimation of Ascorbic acid (Calorimetric /volumetric)
8. Estimation of Phenolics (Folin -Ciocalteau)
9. Estimation of Tannins (Folin-Denis / Vanillin hydrochloride)
10. Estimation of cholesterol
11. Thin Layer Chromatography
12. Native-PAGE

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Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PBO3CC07	**Core Course - 7:** Pharmacognosy	3	3

Course Objectives
To acquire the knowledge about understanding of Principle andTreatment 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 usingmodern biotechnology tools to ensure the sustainable utilization.
To evaluate the medicinal plants based drug efficacy and its variousapplications for different ailments
To create new drug formulations using phytochemical compounds forthe healthy life of society.

UNIT I **(9 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 **(9 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 **(9 Hours)**

Medicinally useful plant parts: Root -*Hemidesmus indicus*, *Withania somnifera* and *Rauvolfia serpentina*; Rhizome - *Zingiber officinalis, Acorus calamus* and *Curcuma longa*; Stem- *Tinospora cordifolia*, *Santalum album*; Bark - *Terminalia arjuna, Cinnamomum verum* and *Saraca asoca*; Leaf - *Adhatoda vasica*, *Ocimum sanctum* and *Cynodon dactylon*; Flowers - *Crocus sativus*, *Syzygium aromaticum* and *Leucus aspera*; Fruits - *Phyllanthus emblica*, *Piper longum* and *Terminalia chebula*; Seeds - *Azadirachta indica*, Trigonellafoenum-graecum and *Ricinus communis*.

UNIT IV **(9 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 remediesteas 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 **(9 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; WHO regulation and Guidelines for quality control and trade of herbal medicine.

Teaching Methodology	PPT, videos and practical demonstration

Books for Study

1. Green, J. (2000). *Herbal Medicine-Maker's Handbook*. Crossing Press.
2. Kokate, C.K., Purokit, A.P., & Gokahale. (2006). *Pharmacognosy*. NiraliPrakashan.
3. Somasundara, S. (1997). *Maruththuva Thavaraiyal.* Ilangovan Padhippagam.
4. Farooqui, A. A., & Sreeramu, B.S. (2004). *Cultivation of Medicinal and Aromatic crops*.

Universities Press.
5. Pulok, K. M. (2019). *Quality control and evaluation of Herbal Drugs*.

Books for Reference

1. Evans. (2009). *Pharmacognosy*. Elsevier Publications. Edinburgh.
2. Weiss., & Fritz, R. (2000). *Herbal Medicine*, (2nd Ed.). Thieme Medical Publishers

Websites and eLearning Sources

1. http://www.gallowglass.org/jadwiga/herbs/preparations.html
2. http://shawnacohen.tripod.com/thetribaltraditions/id51.html
3. http://www.vasundharaorissa.org/Research%20Reports/Globalisation
4. 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, the students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the Principle andTreatment methods of various Traditional system of medicines.	**K1**
CO2	identify pharmacological importance and processing of medicinal plants based on their classification and characterization.	**K2**
CO3	conserve medicinal plants usingmodern biotechnology tools to ensure the sustainable utilization.	**K3**
CO4	evaluate the medicinal plants based drug efficacy and its variousapplications for different ailments	**K4**
CO5	create new drug formulations using phytochemical compounds forthe healthy life of society.	**K5**
CO6	know the regulation and Guidelines for quality control and trade of herbal medicine	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
3	**23PBO3CC07**			**Core Course - 7:** Pharmacognosy					**3**		**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	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	2	2	3	1	2	1	3	3	2	3	**2.2**
									Mean Overall Score		**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23SBS3CC01	**Common Core:** Intellectual Property Rights	5	4

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

UNIT I **(15 Hours)**

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

UNIT II **(15 Hours)**

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

UNIT III **(15 Hours)**

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

UNIT IV **(15 Hours)**

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

UNIT V **(15 Hours)**

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

Teaching Methodology	PPT, videos and practical demonstration

Book for Study

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

Books for Reference

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

Websites and eLearning Sources

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

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

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
3	**23SBS3CC01**		**Common Core:** Intellectual Property Rights						**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	2	1	2	2	2	2	2	**2.2**
CO2	2	3	2	2	1	2	2	2	2	3	**2.1**
CO3	2	2	3	2	2	2	2	2	2	3	**2.2**
CO4	2	2	2	3	2	2	2	2	2	3	**2.2**
CO5	2	2	2	2	3	1	2	2	2	2	**2.2**
CO6	2	3	2	2	1	2	2	2	2	3	**2.2**
									Mean Overall Score		**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PBO4CC08	**Core Course - 8:** Research Methodology	5	5

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 databases and Citation Index.
To acquire skill in writing research articles and formatting thepapers.
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 bibliometrics in research: Citation Research, Science Citation Index. The Institute for Scientific Information (ISI), Thomson Reuter's Webmetric 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	PPT, videos and practical demonstration.

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** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
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 statistical tools in teaching and research.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
4	**23PBO4CC08**	**Core Course - 8:** Research Methodology								**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	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/Week	Credits
4	23PBO4CC09	**Core Course - 9:** Genetic Engineering and Biotechnology	5	5

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; **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), sstrDNA 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 **(15 Hours)**

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

UNIT IV **(15 Hours)**

Technology protection systems (GURT) - terminator gene technology. Biosafety aspects of GMOs and GM foods. Principles of biosafety; potential risks; environmental impacts; safety of food and animal feed derived from GM 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	PPT, videos and practical demonstration

Books for Study

1. Old, R.N. & Primrose, S. B. (2004). *Principles of Gene Manipulation*. Blackwell Sci.
2. Watson, J.D., Gilman, M., Witkowski, J., & Zoller, M. (1992). *Recombinant DNA*, (12th Ed.). WH Freeman Co.

Books for Reference

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

Websites and eLearning Sources

1. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/agrobacterium
2. https://www.frontiersin.org/articles/10.3389/fmicb.2021.766364/full

3. https://www.genome.gov/about-genomics/policy-issues/Synthetic-Biology

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the basics of gene cloning, role of enzymes and vectors for genetic engineering	**K1**
CO2	understand the basics of Gene transfer methods	**K2**
CO3	learn the techniques and safety measures of genetic engineering, genome mapping and gene therapy	**K3**
CO4	understand Totipotency and cytodifferentiation	**K4**
CO5	learn the concepts of callus culture, cell suspension culture, micropropagation, organogenesis, somatic embryogenesis and protoplast culture	**K5**
CO6	gain knowledge about synthetic genome.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**23PBO4CC09**		**Core Course - 9:** Genetic Engineering and Biotechnology							**5**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	3	2	3	2	**2.5**
CO2	2	3	2	3	2	2	3	2	2	3	**2.4**
CO3	2	2	3	2	3	3	3	2	3	1	**2.4**
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	2	2	3	2	3	3	3	2	3	1	**2.4**
										Mean Overall Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PBO4CC10	**Core Course - 10:** 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.
To analyse 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), 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, spliciosome assembly, splicing editing). Organization ofmRNA, RNA editing, mRNA export.

UNIT IV **(15 Hours)**

Translation: Genetic code - introduction, important features of the genetic code, exceptionsto 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 andnegative regulation. *lac* and *trp* operons of E. coli. Regulation of eukaryotic gene expression. Gene families and hormonal control in eukaryotes. Gene silencing: transcriptional and post transcriptional gene silencing.

Teaching Methodology	PPT, videos and practical demonstration.

Book for Study

1. Malacinski, G.M. (2015). Essentials of Molecular Biology. Jones and Bartlett.

Books for Reference

1. Cooper, M. (2000). *The Cell-a molecular biology approach*, (2nd Ed.). Sinauer Associates.
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.
3. Watson, JD. *et al*. (2004). *Molecular biology of the gene*. Pearson education.
4. Gardner. *et al*. (2004). *Principles of genetics*. John Wiley & Sons Inc.
5. Veer Bala Rastogi. (2016). *Principles of Molecular Biology*. Medtech publishers.

Websites and eLearning Sources

1. https://www.ncbi.nlm.nih.gov/books/NBK26824/
2. https://www.rrcs.org/Downloads/Cell%20Communication%20Slides.pdf
3. https://rwu.pressbooks.pub/bio103/chapter/regulation-of-gene-expression/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	describe the evolution, diversity and replication of cells;	**K1**
CO2	explain the role of compartmentalization and signalling in cellular biology;	**K2**
CO3	interpret and explain key experiments in the history of cell biology;	**K3**
CO4	evaluate and apply knowledge of modern techniques in cellular biology.	**K4**
CO5	describe genes structure, chromosomes and proteins	**K5**
CO6	comprehend various gene regulatory mechanisms.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
4	**23PBO4CC10**		**Core Course - 10:** 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	3	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	**2.1**
CO5	2	2	2	3	2	2	2	2	1	2	**2.0**
CO6	2	1	3	2	2	2	3	2	2	3	**2.1**
									Mean Overall Score		**2.1 (Medium)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PBO4CP06	**Core Practical - 6:** Research Methodology, Genetic Engineering and Biotechnology	4	3

Research Methodology

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

Genetic Engineering and Biotechnology

1. Callus induction and regeneration.
2. Clonal propagation.
3. Embryo culture
4. Electrophoretic separation of DNA, protein and restriction digestion.
5. Preparation of synthetic seeds.

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PBO4ES04A	**Elective - 4:** Organic Farming	5	4

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 **(15 Hours)**

Concepts and scope of organic farming, Requirements for organic farming, Farm componentsfor an organic farm. Conversion to organic farming- Process, green card systems and subsidies. A fundamental of Livestock farming, kitchen waste and, Poultry management.

UNIT II **(15 Hours)**

Types of Farming, Concept of different cropping systems in relation to Organic Farming (Inter cropping), nutrient uptake and balanced nutrient supply, organic manure, green and liquidmanure, biofertilizers and their method of use, Compost: decomposition, manure - Types vermicompost: Scope and importance, use of vermi castings in organic farming, Potentials and constraints for vermiculture in India.

UNIT III **(15 Hours)**

Soil formation, types of soil according to composition, methods of increasing soil productivity and fertility, Cultivation of crops with organic inputs: field crops and leguminous crops. Plant protection measures: integrated pest and disease management, biopesticides, treatment methods, importance of neem in organic agriculture.

UNIT IV **(15 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). Organic produce quality considerations, certification, accreditation process, marketing and Economics.

UNIT V **(15 Hours)**

National and international status of organic farming. Agencies and institutions related to organic farming. Organic Food Quality and Human Health. Entrepreneurship Development- Concept, characteristics and approaches. Income generation activities: Apiculture, Mushroom production, Organic milk production.

Teaching Methodology	PPT, videos and practical demonstration

Books for Study

1. Palaniappan, S.P., & A nnadurai, K. (2007). *Organic Farming - Theory and Practice*. Scientific Publishers.
2. Lakshmi, Narasaiah, M. (2010). *Agriculture and Water Management*. Discovery publishing House.

Books for Reference

1. Gupta, P.K. (2012). *Vermicomposting for sustainable Agriculture*. Agrobios.
2. Kumar, N. (2010). *Introduction to Horticulture*. Oxford &Ibh Publishing Co. Pvt. Ltd.
3. Kristensen, P., Taji, A., & Reganold, J. (2006). *Organic Agriculture: A GlobalPerspective*. CSIRO Press, Victoria.

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** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
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 plantproductivity.	**K4**
CO5	plan a proper pest management strategy for various crops.	**K5**
CO6	gain knowledge to develop into an entrepreneurial skills.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
4	**23PBO4ES04A**	**Elective - 4:** Organic Farming								**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	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/Week	Credits
4	23PBO4ES04B	**Elective - 4:** Genetics	5	4

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 **(15 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 **(15 Hours)**

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

UNIT III **(15 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 replicationmechanism of DNA: replication of linear and circular DNA, Replication of RNA genomes.

UNIT IV **(15 Hours)**

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

UNIT V **(15 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 Haemophilia, Stem cells- Definition, types & sources.

Teaching Methodology	PPT, videos and practical demonstration.

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.). JohnWiley and Sons Inc.
2. Strickberger. (2005). *Genetics*, (3rd Ed). 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** On the successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the principles of linkage, crossing over and thehereditary 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	**23PBO4ES04B**		**Elective - 4:** Genetics						**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	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/Week	Credits
4	23PBO4CE01	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, CO_2 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 andCorrelation; t-test.

Teaching Methodology	JosTEL.

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** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
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	**23PBO4CE01**	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	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)**