

# INDIRA GANDHI UNIVERSITY

## Meerpur, Rewari (HR)

(A State University Established Under Haryana Act No. 29 of 2013)  
(Recognized u/s 12-B & 2(f) of UGC Act. 1956)



## Scheme and Syllabus of Examination for Post Graduate Programme

### BOTANY

as per NEP 2020

Curriculum and Credit Framework for Postgraduate Programme  
With Multiple Entry-Exit, Internship and CBCS-LOCF  
2025-26 & 2024-25 (Modified Syllabus for III & IV Semester)

### DEPARTMENT OF BOTANY FACULTY OF LIFE SCIENCES

Indira Gandhi University, Meerpur - 122502  
Rewari, Haryana, India

**Indira Gandhi University, Meerpur, Rewari**  
**Scheme of Examination for Post-Graduate Programme as per NEP-2020 w.e.f. 2024-25 (in phased manner)**  
**Framework-2 (Scheme P)**  
**Department of Botany**

<b>Semester-I</b>									
<b>Course Type</b>	<b>Course Code</b>	<b>Course Nomenclature</b>	<b>Credits</b>	<b>Hrs./week</b>	<b>Int. Asst.</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (Hrs.)</b>	
<b>CC-1</b>	24L6.0-BOT-101	Theory	Cryptogamic Plant Diversity	4	4	30	70	100	3
<b>CC-2</b>	24L6.0-BOT-102		Microbial Kingdom & Applied Mycology	4	4	30	70	100	3
<b>CC-3</b>	24L6.0-BOT-103		Inheritance Biology & Genetic Engineering	4	4	30	70	100	3
<b>CC-4</b>	24L6.0-BOT-104		Cell Biology & Biotechniques	4	4	30	70	100	3
<b>PC-1</b>	24L6.0-BOT-105	Practical based on 24L6.0-BOT-101 & 24L6.0-BOT-102		4	8	30	70	100	4
<b>PC-2</b>	24L6.0-BOT-106	Practical based on 24L6.0-BOT-103 & 24L6.0-BOT-104		4	8	30	70	100	4
<b>Seminar</b>	24L6.0-BOT-107	Seminar		2	2	-	50	50	2
<b>Total</b>				26	34	180	470	650	

<b>Semester-II</b>									
<b>Course Type</b>	<b>Course Code</b>	<b>Course Nomenclature</b>	<b>Credits</b>	<b>Hrs./week</b>	<b>Int. Asst.</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (Hrs.)</b>	
<b>CC-5</b>	24L6.0-BOT-201	Theory	Evolutionary Biology, Gymnosperms & Plant Anatomy	4	4	30	70	100	3
<b>CC-6</b>	24L6.0-BOT-202		Angiosperms Systematics & Embryology	4	4	30	70	100	3
<b>CC-7</b>	24L6.0-BOT-203		Plant Ecology	4	4	30	70	100	3
<b>CC-8</b>	24L6.0-BOT-204		Molecular Biology	4	4	30	70	100	3
<b>PC-3</b>	24L6.0-BOT-205	Practical based on 24L6.0-BOT-201 & 24L6.0-BOT-202		4	8	30	70	100	4
<b>PC-4</b>	24L6.0-BOT-206	Practical based on 24L6.0-BOT-203 & 24L6.0-BOT-204		4	8	30	70	100	4
<b>CHM</b>	24L6.0-CHM-201	Constitutional, Human and Moral Values and IPR		2	2	15	35	50	2
<b>Total</b>				26	34	195	455	650	
<b>Internship</b>	24L6.0-BOT-207	Summer Internship of 4 Credits of 4-6 weeks is to be done by every student				50	50	100	

**CC: Core Course; PC: Practicum Course; CHM: Constitutional, Human and Moral Values and IPR**  
**PG Diploma in 'Botany' will be awarded if candidate wants to exit after II Semester earning 56 credits.**

**Indira Gandhi University, Meerpur, Rewari**  
**Scheme of Examination for Post-Graduate Programme as per NEP-2020 w.e.f. 2024-25 (in phased manner)**  
**Framework-2 (Scheme P)**  
**Department of Botany**

<b>Semester-III</b>										
<b>Course Type</b>	<b>Course Code</b>	<b>Course Nomenclature</b>		<b>Credits</b>	<b>Hrs./week</b>	<b>Int. Asst.</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (Hrs.)</b>	
<b>CC-9</b>	24L6.5-BOT-301	<b>Theory</b>	Plant Physiology & Developmental Genetics		4	4	30	70	100	3
<b>CC-10</b>	24L6.5-BOT-302		Plant Biochemistry		4	4	30	70	100	3
<b>DEC-1</b> (Any one)	24L6.5-BOT-303		Plant Stress Biology		4	4	30	70	100	3
	24L6.5-BOT-304		Advanced Phycology		4	4	30	70	100	3
	24L6.5-BOT-305		Biodiversity & Conservation		4	4	30	70	100	3
	24L6.5-BOT-306		Biological Data Analytics		4	4	30	70	100	3
<b>DEC-2</b> (Any one)	24L6.5-BOT-307		Soil, Climate & Bioremediation		4	4	30	70	100	3
	24L6.5-BOT-308		Plant Biotechnology & Recombinant DNA Technology		4	4	30	70	100	3
	24L6.5-BOT-309		Plant Breeding & Cytogenetics		4	4	30	70	100	3
	24L6.5-BOT-310		Bioprospecting of Medicinal Plants & Pharmacognosy		4	4	30	70	100	3
<b>PC-5</b>	24L6.5-BOT-311	Practical based on 24L6.5-BOT-301 & 24L6.5-BOT-302		4	8	30	70	100	4	
<b>PC-6</b>	24L6.5-BOT-312	Practical based on 24L6.5-BOT-303/304/ 305/ 306 & 24L6.5-BOT-307/308/ 309/ 310)		4	8	30	70	100	4	
<b>OEC</b>	24L6.5-BOT-313	Theory	Plants & Humans		2	2	15	35	50	2
<b>Total</b>				<b>26</b>	<b>34</b>	<b>195</b>	<b>455</b>	<b>650</b>		

**CC: Core Course;                    DEC: Discipline Elective Courses;                    PC: Practicum Course**  
**OEC: Open Elective course** (to be chosen by students of other department)

**Note:** For **Botany** students OEC course to be opted from the Pool of OEC courses offered by other departments.

**NOTE:** A student can opt one elective course in a semester, i.e. up to 40 % of total elective courses mentioned in the scheme, through SWAYAM/ NPTEL/ MOOCs or other online portals recognized by the UGC and the University.

**Indira Gandhi University, Meerpur, Rewari**  
**Scheme of Examination for Post-Graduate Programme as per NEP-2020 w.e.f. 2024-25 (in phased manner)**  
**Framework-2 (Scheme P)**  
**Department of Botany**

<b>Semester-IV</b>										
<b>Course Type</b>	<b>Course Code</b>	<b>Course Nomenclature</b>	<b>Credits</b>	<b>Hrs./week</b>	<b>Int. Asst.</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (Hrs.)</b>		
<b>CC-11</b>	24L6.5-BOT-401	Economic Botany & Ethnobotany	4	4	30	70	100	3		
<b>CC-12</b>	24L6.5-BOT-402	Innovation, Patent Rights & Biosafety Regulations	4	4	30	70	100	3		
<b>DEC-3</b> (Any one)	24L6.5-BOT-403	Phytopathology	4	4	30	70	100	3	Theory	
	24L6.5-BOT-404	Seed Science & Technology	4	4	30	70	100	3		
	24L6.5-BOT-405	Natural Resources & Restoration Ecology	4	4	30	70	100	3		
	24L6.5-BOT-406	Bioinformatics	4	4	30	70	100	3		
	24L6.5-BOT-407	Nanotechnology	4	4	30	70	100	3		
<b>DEC-4</b> (Any one)	24L6.5-BOT-408	Genomics & Proteomics	4	4	30	70	100	3		
	24L6.5-BOT-409	Plant Tissue Culture & Applications	4	4	30	70	100	3		
	24L6.5-BOT-410	GIS, Remote Sensing & Forensic Botany	4	4	30	70	100	3		
<b>PC-7</b>	24L6.5-BOT-411	Practical based on 24L6.5-BOT401 & 24L6.5-BOT-402	4	4	30	70	100	3		
<b>PC-8</b>	24L6.5-BOT-412	Practical based on 24L6.5-BOT-403/ 404/ 405/ 406 & 24L6.5-BOT-407/ 408/ 409/ 410	4	4	30	70	100	3		
<b>EEC</b>	24L6.5-EEC-RPE-400	Research Ethics	2	2	15	35	50	3		
<b>Total</b>			<b>26</b>	<b>34</b>	<b>195</b>	<b>455</b>	<b>650</b>			

**CC: Core Course;                      DEC: Discipline Elective Courses;                      PC: Practicum Course**  
**EEC: Employability and Entrepreneurship Skills Course**

**NOTE:** A student can opt one elective course in a semester, i.e. up to 40 % of total elective courses mentioned in the scheme, through SWAYAM/ NPTEL/ MOOCs or other online portals recognized by the UGC and the University.

**Duration: 02 Years**

**Total Credits: 108**

**Total Marks: 2700**

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<b>Semester-IV With Dissertation</b>									
<b>Course Type</b>	<b>Course Code</b>	<b>Course Nomenclature</b>	<b>Credits</b>	<b>Hrs./week</b>	<b>Int. Asst.</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (Hrs.)</b>	
<b>CC-11</b>	24L6.5-BOT-401	Economic Botany & Ethnobotany	4	4	30	70	100	3	
<b>DEC-3 (Any one)</b>	24L6.5-BOT-403	Phytopathology	4	4	30	70	100	3	
	24L6.5-BOT-404	Seed Science & Technology	4	4	30	70	100	3	
	24L6.5-BOT-405	Natural Resources & Restoration Ecology	4	4	30	70	100	3	
	24L6.5-BOT-406	Bioinformatics	4	4	30	70	100	3	
	24L6.5-BOT-407	Nanotechnology	4	4	30	70	100	3	
<b>DEC-4 (Any one)</b>	24L6.5-BOT-408	Genomics & Proteomics	4	4	30	70	100	3	
	24L6.5-BOT-409	Plant Tissue Culture & Applications	4	4	30	70	100	3	
	24L6.5-BOT-410	GIS, Remote Sensing & Forensic Botany	4	4	30	70	100	3	
<b>Dissertation</b>	24L6.5-BOT-411	Dissertation	12	24	-	300	300	Dissertation thesis submission	
<b>EEC</b>	24L6.5-EEC-RPE-400	Research Ethics	2	2	15	35	50	3	
<b>Total</b>			<b>26</b>	<b>34</b>	<b>195</b>	<b>455</b>	<b>650</b>		

**CC: Core Course;                    DEC: Discipline Elective Courses;                    PC: Practicum Course**  
**EEC: Employability and Entrepreneurship Skills Course**

**NOTE:** A student can opt one elective course in a semester, i.e. up to 40 % of total elective courses mentioned in the scheme, through SWAYAM/ NPTEL/ MOOCs or other online portals recognized by the UGC and the University.

**Duration: 02 Years**

**Total Credits: 108**

**Total Marks: 2700**

## **M.Sc. Botany**

### **VISION**

Attempt is to prepare students for lifelong learning by drawing attention to the vast world of knowledge of microbes, plants and introducing to the methodology of systematic academic enquiry. To conduct innovative research, teaching and outreach on the patterns and processes of life with a focus on plants and their environments. With this in mind, we aim to provide a firm foundation in every aspect of Botany and to explain a broad spectrum of modern trends in Botany.

### **MISSION**

1. To know the importance and scope of Botany.
2. To foster an environment of excellence by attracting and supporting the outstanding students, faculty and staff needed to sustain our vision
3. To develop a scientific attitude to make students open minded, critical and curious.
4. To expose themselves to the diversity amongst life forms.
5. To make aware of natural resources and environment and the importance of conserving it.
6. To focus on the patterns and processes that enable predictive understanding of plants and their environments at local, regional, and global scales, leading to strengths in the areas of ecology, evolution, and systematics.

### **SCOPE**

M.Sc. Botany is a master's course which deals with the study of plants, their characteristics and various related aspects in detail. Students who want to make a career in plant biology or genetics can take up a Master of Science in Botany. The duration of the course is 2 years.

The study of plants is vital as life is dependent on plants for a living, hence it is necessary to study the course. The course is designed in such a manner that students can become botanists, mycologists and phycologists. M.Sc. Botany course is best suited to candidates who have a deep interest in plants and their life cycle. The whole course comprises four semesters where students are imparted deep knowledge about the plant kingdom, physiology, genetics and biotechnology, cell/molecular biology, microbiology, plant development, plant tissue culture and ecology. Botany also deals with various aspects of agriculture, horticulture, forestry and environmental science.

Botany as a field has seen a radical growth in recent years. Owing to the rapid expansion of this sector, a number of fields open up for botany graduates to excel in such as food companies, forest services, biotechnology, educational institutions, biological supply houses, national parks, plant resources laboratory, arboretum, chemical industry, food companies, plant health inspection services, seed and nurseries companies and land management agencies.

## Outcome of Program (PO)

Knowledge and understanding of –

- PO1.** diversity of plant in terms of structure, function and environmental relationships.
- PO2.** basic science, life sciences and fundamental process of plants to study and analyze any plant form
- PO3.** identifying the taxonomic position of plants and methods of nomenclature and classification in Botany.
- PO4.** Use of IT (word-processing, use of internet, statistical packages and databases), communication of scientific ideas in writing and orally, ability to work as part of a team, time management and to use library resources.
- PO5.** logically analyzing and organizing tasks into a structured form as well as assimilating knowledge and ideas based on wide reading books, journal and through the internet.
- PO6.** carrying out practical work, in the field and in the laboratory, with minimal risk. They gain introductory experience in applying each of the following skills and gain greater proficiency in a selection of them depending on their choice of optional modules. a. Interpreting plant morphology and anatomy. b. Plant identification. c. Vegetation analysis techniques. d. A range of physiochemical analyses of plant materials in the context of plant physiology, metabolism and biochemistry. e. Analyze data using appropriate statistical methods and computer packages. f. Plant pathology to be added for sharing of field and lab data obtained.
- PO7.** designing solutions from medicinal plants for health problems, disorders and disease of human beings and estimate the phytochemical content of plants which meet the specified needs to appropriate consideration for the public health.
- PO8.** creating, selecting and applying appropriate techniques, resources, and modern instruments and equipment for Biochemical estimation, Molecular Biology, Biotechnology, Plant Tissue culture experiments, cellular and physiological activities of plants with an understanding of the application and limitations.
- PO9.** understand the impact of the plant diversity in societal and environmental contexts, relationship between science and society and need for sustainable development and biodiversity conservation.
- PO10.** engineering and managing principles as a life-long learning and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

## Program Specific Outcomes (PSO)

The program-specific outcomes (PSO) are the statement of competencies/abilities that describe the knowledge and capabilities the post-graduate will have by the end of the program.

On completion of program students will be specifically able to –

**PSO1.** Biodiversity of lower and higher plants along with their taxonomic status. The students will have in-depth knowledge about physiology and metabolism of plants.

**PSO2.** The evaluation of floral classification by using the key characters on field and diversity of Haryana while communicating local people. Also includes biostatistics and study of bioinformatics.

**PSO3.** Students will be able to gain in-depth knowledge regarding conservation status and strategies of economically important plants.

**PSO4.** The students will have strong base knowledge of reproductive, developmental, physiological, cellular and molecular aspects of plant kingdom. It will help them venture into advanced research areas in cell/molecular biology and to prepare and view cell to examine using light microscopy.

**PSO5.** Use of culture and selective techniques to isolate fungi, plant pathogens and identify them growing on media. Use of appropriate culture for raising embryo and to study regulation behind the growth and development will also be studied.

**PSO6.** Qualitative and quantitative estimate the number of floral components by using enumeration and suitable sampling and to study ecological principles, biodiversity, population, community, ecosystem structure and function, importance of environment and the problems related with it at local and global level along with conservation status and strategies of economically important plants.

**PSO7.** Practice safe laboratory procedures, using appropriate protective, biosafety and emergency procedures. Also practicing data mining.

**PSO8.** Documentation, communication and report writing on experimental protocols, results and conclusions, study tours and field visits, etc.

M.Sc. Botany (Session: 2024-25)								
Semester-I								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-1	24L6.0-BOT-101	Cryptogamic Plant Diversity	4	4	30	70	100	3
<b>Level of the Course:</b> 400-499								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will be able to understand the fundamental principles, classification and characteristics of lower plants (algae, bryophytes and pteridophytes) in botanical taxonomy. Analyze their ecological significance, reproductive strategies, life cycles, adaptations, morphological and physiological features and their role in plant evolution and biodiversity conservation across diverse ecosystems.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand lower plant diversity, classification and ecological roles in ecosystems. 2. analyze reproductive strategies, life cycles and adaptations of lower plants. 3. apply taxonomic principles to identify and classify lower plant species. 4. evaluate lower plants' ecological importance and interactions in ecosystems.								
<b>Mapping of CLO with PSO for Cryptogamic Plant Diversity</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>							<input checked="" type="checkbox"/>
CLO2	<input checked="" type="checkbox"/>							<input checked="" type="checkbox"/>
CLO3	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>
CLO4				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		
<b>Part B - Content of the Course</b>								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Exploring Cryptogamic Plant Diversity:</b> Classification and diversity of lower plants; evolutionary significance, ecosystem stability and how they differ from higher plants. Position of algae in two, five, six and eight kingdoms classifications. <b>Introduction to Phycology:</b> Characteristics, thallus organization, reproduction, classification and classification criteria (pigments, reserve food, cell wall composition and flagella); algae in diversified habitats (terrestrial, aquatic).							15
II	<b>Salient Features of Following Algal Groups:</b> Prochlorophyta ( <i>Prochlorococcus</i> ), Cyanophyta ( <i>Nostoc</i> ), Chlorophyta ( <i>Oedogonium</i> ), Charophyta ( <i>Chara</i> ),							15

	Xanthophyta ( <i>Vaucheria</i> ), Bacillariophyta ( <i>Cyclotella</i> ), Phaeophyta ( <i>Sargassum</i> ) and Rhodophyta ( <i>Polysiphonia</i> ). <b>Role of Algae:</b> Economic importance of algae as food with special reference to carrageenan, feed, biofertilizers and bioremediation, medicines and nutritional supplements, biofuel, industrial and biotechnological raw material. Ecological importance of algae; algal blooms, red tides and bioluminescence.	
III	<b>Introduction to Bryology:</b> General characteristics, classification, reproduction and life-cycle, origin of alternation of generation (homologous and antithetic theory), adaptations for terrestrial life, economic and ecological importance. <b>Comparative Morphology and Development of Following Groups:</b> Marchantiales ( <i>Marchantia</i> ), Jungermanniales ( <i>Pellia</i> ), Anthoceratales ( <i>Anthoceros</i> ), Sphagnales ( <i>Sphagnum</i> ), Funariales ( <i>Funaria</i> ) and Polytrichales ( <i>Polytrichum</i> ).	15
IV	<b>Introduction to Pteridology:</b> General characteristics, classification, anatomy, reproduction and spore dispersal, adaptations and evolution (telome theory, enation theory, stellar system), heterospory and seed habit; economic and ecological importance. <b>General Account of Following Groups:</b> Psilopsida ( <i>Psilotum</i> ), Lycopsida ( <i>Selaginella</i> ), Sphenopsida ( <i>Equisetum</i> ) and Pteropsida ( <i>Pteris</i> ).	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
❖ <b>Theory</b> ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10 ✓ Mid-Term Exam: 15		❖ <b>Theory</b> ✓ Written Examination: 70
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Bold, H.C. &amp; Wynne, M.J. (1985) Introduction to the Algae: Structure and Reproduction (2<sup>nd</sup> Edn.). Prentice-Hall (Englewood Cliffs), pp. 720.</li> <li>▪ Dutta, A.C. (2005) A Class Book of Botany (14<sup>th</sup> Edn.). Oxford University Press (Oxford), pp. 918.</li> <li>▪ Gifford, E.M. &amp; Foster, A.S. (1989) Morphology and Evolution of Vascular Plants (3<sup>rd</sup> Edn.). W.H. Freeman (New York), pp. 626.</li> <li>▪ Graham, L.E., Graham, J.M. &amp; Wilcox, L.W. (2009) Algae. Benjamin Cummings (San Francisco), pp. 616.</li> <li>▪ Parihar, N.S. (1970) An Introduction to Embryophyta: Bryophyta. Central Book Depot (Allahabad), pp. 478.</li> <li>▪ Ranker, T.A. &amp; Haufler, C.H. (Eds.) (2008) Biology and Evolution of Ferns and Lycophytes. Cambridge University Press (Cambridge), pp. 468.</li> <li>▪ Rashid, A. (1998) An Introduction to Pteridophyta: Diversity and Differentiation of Sporophytes. Vikas Publishing House Pvt. Ltd. (New Delhi), pp. 200.</li> <li>▪ Round, F.E. (1981) The Ecology of Algae. Cambridge University Press (Cambridge), pp. 653.</li> <li>▪ Smith, G.M. (2020) Cryptogamic Botany, Volume I: Algae and Fungi. McGraw-Hill Book Company Inc. (New York), pp. 546.</li> <li>▪ Vashishta, B.R., Sinha, A.K. &amp; Kumar, A. (2017) Botany for Degree Students: Algae, Fungi, Bryophyta, Pteridophyta, Gymnosperms and Microbiology. S. Chand &amp; Company Ltd. (New Delhi), pp. 880.</li> <li>▪ <a href="https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/cryptogam">https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/cryptogam</a>.</li> <li>▪ <a href="https://archive.bsi.gov.in/cryptogams">https://archive.bsi.gov.in/cryptogams</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-I								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-2	24L6.0-BOT-102	Microbial Kingdom & Applied Mycology	4	4	30	70	100	3
<b>Level of the Course:</b> 400-499								
<b>Pre-requisite for the course (if any):</b>								
<p><b>Learning Objective:</b> Learner will able to understand the fundamental concepts of plant pathology, including the classification and characteristics of plant pathogens, their mode of transmission and the factors influencing disease development in plants. Explore the importance of early disease detection, surveillance and monitoring in plant health management, with an emphasis on integrated disease management approaches and sustainable agricultural practices.</p>								
<p><b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to-</p> <ol style="list-style-type: none"> <li>analyze and interpret diagnostic results to assess disease severity and recommend management strategies.</li> <li>demonstrate proficiency in sample collection, processing and analysis using modern diagnostic tools</li> <li>apply diverse diagnostic techniques to identify application of fungi.</li> <li>gain proficiency in laboratory techniques for isolating and identifying bacteria, fungal spores, plant pathogens, etc.</li> </ol>								
<b>Mapping of CLO with PSO for Microbial Kingdom &amp; Applied Mycology</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	☑							
CLO2	☑							
CLO3	☑			☑	☑		☑	☑
CLO4	☑			☑	☑		☑	☑
<b>Part B – Content of the Course</b>								
<b>Instructions for Paper- Setter:</b>								
<ol style="list-style-type: none"> <li>There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit.</li> <li>The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.</li> </ol>								
Unit	Topics							Contact Hours
I	<p><b>Overview of Microbial Diversity:</b> History; structural organization, characteristics and economic importance of virus (including replication), bacteriophage (including lytic and lysogenic), virions, viroid, virusoid, phytoplasma, prions, archaeobacteria and eubacteria. Bacterial growth yield and stress response.</p> <p><b>Principles of Mycology:</b> General characters of fungi and their economic importance, thallus organization and cell wall composition, reproduction and kinds of spores; classification based on Alexopoulos <i>et. al.</i>, 1996.</p>							15

<b>II</b>	<b>General Account on Following Groups:</b> Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. <b>Specialized Mechanisms in Fungi and Lichen:</b> Heterokaryosis, heterothallism, parasexuality and sex hormones. Structure, types (crustose, foliose, fructose) reproduction and economic importance of Lichens.	15
<b>III</b>	<b>Primary and Secondary Metabolites by Fungi:</b> Use of fungi in primary metabolites (industrial alcohol, organic acid, beer) and secondary metabolites (antibiotics, steroids, enzymes, amino acids, growth regulators, vitamins). <b>Biofertilizers and Biocontrol Agents:</b> Fungi as biofertilizers including endomycorrhizae and ectomycorrhizae. Fungi as biocontrol agents against plant pathogens and weeds.	15
<b>IV</b>	<b>Biodeterioration:</b> Fungal involvement in the deterioration of materials like paper, painted surfaces and wood. <b>Food Processing:</b> Fungal roles in food processing such as bread, cheese, oriental food, baker's yeast, health food sources, spoilage and toxicity.	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Agrios, G.N. (2005) Plant Pathology (5<sup>th</sup> Edn.). Elsevier Academic Press (San Diego), pp. 890.</li> <li>▪ Alexopoulos, C.J., Mims, C.W. &amp; Blackwell, M. (1996) Introductory Mycology (4<sup>th</sup> Edn.). John Wiley &amp; Sons (Hoboken), pp. 886.</li> <li>▪ Carlile, M.J., Watkinson, S.C. &amp; Gooday, G.W. (2001) The Fungi (2<sup>nd</sup> Edn.). Academic Press (London), pp. 588.</li> <li>▪ Deacon, J.W. (2013) Fungal Biology (4<sup>th</sup> Edn.). John Wiley &amp; Sons (Hoboken), pp. 528.</li> <li>▪ Gnanamanickam, S.S. (ed.) (2006) Plant-Associated Bacteria. Springer (Berlin), pp. 432.</li> <li>▪ Gullino, M.L. &amp; Bonants, P.J. (Eds.) (2016) Detection and Diagnostics of Plant Pathogens. Springer (Berlin), pp. 234.</li> <li>▪ Hawksworth, D.L. &amp; Lucking, R. (2017) Fungal Diversity Revisited: 2 Decades of Fungal Biodiversity Studies. Springer (Cham), pp. 320.</li> <li>▪ Madigan, M.T. &amp; Martinko, J.M. (2017) Brock Biology of Microorganisms (15<sup>th</sup> Edn.). Pearson (New York), pp. 1234.</li> <li>▪ Moore, D., Robson, G.D. &amp; Trinci, A.P.J. (2011) 21<sup>st</sup> Century Guidebook to Fungi (2<sup>nd</sup> Edn.). Cambridge University Press (Cambridge), pp. 620.</li> <li>▪ Singh, U.S. &amp; Mukhopadhyay, A.N. (Eds.) (2018) Plant Diseases: Identification &amp; Management. CRC Press (Boca Raton), pp. 789.</li> <li>▪ Tortora, G.J., Funke, B.R. &amp; Case, C.L. (2015) Microbiology: An Introduction (12<sup>th</sup> Edn.). Pearson (San Francisco), pp. 567.</li> <li>▪ <a href="https://learn.genetics.utah.edu/content/microbiome/intro/">https://learn.genetics.utah.edu/content/microbiome/intro/</a>.</li> <li>▪ <a href="https://www.amnh.org/explore/microbe-facts#:~:text=What%20Are%20Microbes%3F,we%20call%20viruses%20microbes%20too.">https://www.amnh.org/explore/microbe-facts#:~:text=What%20Are%20Microbes%3F,we%20call%20viruses%20microbes%20too.</a></li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-I								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-3	24L6.0-BOT-103	Inheritance Biology & Genetic Engineering	4	4	30	70	100	3
<b>Level of the Course:</b> 400-499								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will be able to understand genetic principles and techniques in genetic engineering, including gene mapping, manipulation and expression, to analyze and address complex genetic challenges in various organisms.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. develop skills in experimental design, hypothesis formulation, data collection and scientific reasoning within the context of genetic research. 2. gain proficiency in applying genetic principles and techniques to analyze, manipulate and engineer genetic information. 3. apply Mendelian and non-Mendelian principles to analyze and predict patterns of inheritance, including genetic crosses, pedigree analysis and inheritance of complex traits. 4. increase insight into the principle mechanisms of genome expression and its regulation.								
Mapping of CLO with PSO for Inheritance Biology & Genetic Engineering								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>					
CLO2			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
CLO3		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		
CLO4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Introduction to Mendelian Genetics:</b> Historical overview of Mendelian genetics (monohybrid/ dihybrid - genotypic/ phenotypic ratios), overview of Mendel's principles (law of dominance, segregation, independent assortment); application of Mendelian principles in genetic analysis. <b>Extensions of Mendelian Principles:</b> Codominance and incomplete dominance; brief account on gene interactions; gene modification; pleiotropy, genomic imprinting, penetrance and expressivity; polygenic inheritance and heritability. Sex linkage, sex-limited and sex-influenced traits.							15

<b>II</b>	<p><b>Gene Mapping Methods:</b> Linkage and crossing over, linkage mapping and tetrad analysis; QTL mapping and its applications; complementation test. Molecular basis of chromosome pairing.</p> <p><b>Extra-Chromosomal Inheritance and Microbial Genetics:</b> Inheritance of chloroplast genes and maternal inheritance. Genetic transfer methods (conjugation, sexduction, transformation and transduction), gene mapping.</p>	15
<b>III</b>	<p><b>Quantitative Genetics and Mutation Analysis:</b> Pedigree analysis and inheritance patterns, LOD score; Structural and numerical alterations in chromosomes. Types, causes and detection of mutations (spontaneous/ induced); site directed mutagenesis; DNA methylation; role of mutation in crop improvement.</p> <p><b>Genetic fine structure and Chromosome Manipulation:</b> Dosage compensation and mechanism of sex determination in plants; Alien gene transfer; transfer of whole genome in <i>Triticum</i> and <i>Brassica</i>. Genome analysis in Tobacco and Wheat.</p>	15
<b>IV</b>	<p><b>Basics of Genetic Engineering:</b> Historical background and significance, Tools and techniques - restriction enzymes, DNA cloning vectors (plasmids, bacteriophages, cosmids, phagemids, shuttle vectors, transposons vectors). Construction of genomic library and cDNA library.</p> <p><b>Applications of Genetic Engineering:</b> General account on <i>Agrobacterium</i> mediated gene transfer, production of transgenic plant with respect to herbicide resistance, resistance against biotic and abiotic factor; transgenic crops and nutritional quality improvement.</p>	15

#### Suggested Evaluation Methods

<b>Internal Assessment: 30</b>	<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>	<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>

#### Part C - Learning Resources (Recommended Books/ e-resources/ LMS)

<ul style="list-style-type: none"> <li>▪ Brooker, R.J. (2018) Genetics: Analysis and Principles (6<sup>th</sup> Edn.). McGraw-Hill Education (New York), pp. 864.</li> <li>▪ Brown, T.A. (2019) Genomes (4<sup>th</sup> Edn.). Garland Science (New York), pp. 950.</li> <li>▪ Griffiths, A.J.F., Wessler, S.R., Carroll, S.B. &amp; Doebley, J. (2015) Introduction to Genetic Analysis (11<sup>th</sup> Edn.). W.H. Freeman (New York), pp. 900.</li> <li>▪ Lewin, B. (2019) Genes IX. Jones &amp; Bartlett Learning (Burlington), pp. 850.</li> <li>▪ Malhotra, N. &amp; Koul, S. (2019) Genetic Engineering: Principles and Applications. Oxford University Press (New Delhi), pp. 500.</li> <li>▪ Primrose, S.B. &amp; Twyman, R.M. (2019) Principles of Gene Manipulation and Genomics (8<sup>th</sup> Edn.). Wiley-Blackwell (Oxford), pp. 700.</li> <li>▪ Russell, P.J. (2019) iGenetics: A Molecular Approach (4<sup>th</sup> Edn.). Pearson (New York), pp. 864.</li> <li>▪ Singh, B.D. (2021) Genetic Engineering: Principles and Methods. Kalyani Publishers (New Delhi), pp. 500.</li> <li>▪ Snustad, D.P. &amp; Simmons M.J. (2020) Principles of Genetics (8<sup>th</sup> Edn.). John Wiley &amp; Sons (Hoboken), pp. 800.</li> <li>▪ <a href="https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/plant-genetics">https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/plant-genetics</a>.</li> <li>▪ <a href="https://royalsociety.org/news-resources/projects/gm-plants">https://royalsociety.org/news-resources/projects/gm-plants</a>.</li> </ul>
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Semester-I								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-4	24L6.0-BOT-104	Cell Biology & Biotechniques	4	4	30	70	100	3
<b>Level of the Course:</b> 400-499								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to gain a comprehensive understanding of the structural and functional organization of cells, including the plasma membrane, cell wall and organelles, along with the mechanisms of intracellular transport, cell signaling and the regulation of the cell cycle.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. describe the structure and function of prokaryotic and eukaryotic cells, including the plasma membrane, endomembrane system, cytoskeleton, organelles and cell wall. 2. explain the mechanisms of transport across membranes and the structural organization of cell junctions, cell cycle regulation and intracellular signal transduction pathways. 3. investigate plant responses to environmental stresses using biochemical and biophysical approaches. 4. design and conduct experiments to explore plant biochemistry and biophysics, contributing to advancements in plant science and biotechnology.								
<b>Mapping of CLO with PSO for Cell Biology &amp; Biotechniques</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1				☑			☑	
CLO2				☑			☑	
CLO3				☑			☑	
CLO4				☑			☑	
<b>Part B - Content of the Course</b>								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Plasma Membrane Structure and Function:</b> Various models of plasma membrane structures, Donnan equilibrium, active, passive and facilitated transport, uniports, symports, and antiports; structural organization and function of the cell wall. <b>Cell-Cell/ Matrix Junctions:</b> Structures and functions of tight junctions, adherens junctions, gap junctions and plasmodesmata; cell-matrix adhesion mechanisms, integrins, collagen and non-collagen components.							15

II	<p><b>Cellular Organelles:</b> Structure and functions of ER and golgi apparatus, lysosomes, peroxisomes, plastids, vacuoles, chloroplast, mitochondria, nucleus and nucleolus (role in ribosome synthesis and assembly).</p> <p><b>Vesicle Formation and Protein Transport:</b> Coat proteins (COPI, COPII, clathrin), vesicular transport (anterograde and retrograde), mechanisms of protein sorting and transport between organelles; import/ export of cargo proteins in nucleus and receptor-mediated endocytosis.</p>	15
III	<p><b>Cytoskeleton and Cell Movement:</b> Structure and organization of actin, myosin, microtubules, intermediate filaments, cilia and flagella.</p> <p><b>Cell Cycle and Signal Transduction:</b> Prokaryotic and eukaryotic cell cycle; regulation of cell cycle and cell cycle checkpoints, events of M phase, meiosis, and fertilization; microtubule dynamics, motor proteins, karyokinesis, cytokinesis, and cell plate formation.</p>	15
IV	<p><b>Microscopy and Centrifugation:</b> Principle and application of light, phase-contrast, fluorescence and electron microscope (SEM, TEM). Principles, types and applications of centrifuges (ultracentrifugation, density gradient centrifugation).</p> <p><b>Chromatography, Spectrophotometry and Electrophoresis:</b> Principle and applications of paper, ion-exchange, affinity, thin layer, gas chromatography and HPLC. Principle of UV/ visible, NMR and ESR spectroscopy. Principles and applications of AGE and PAGE. Concept of isoelectric focusing.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<p>❖ <b>Theory</b></p> <p>✓ Class Participation: 5</p> <p>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</p> <p>✓ Mid-Term Exam: 15</p>		<p>❖ <b>Theory</b></p> <p>✓ Written Examination: 70</p>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. &amp; Walter, P. (2015) Molecular Biology of the Cell (6<sup>th</sup> Edn.). Garland Science (New York), pp. 1464.</li> <li>▪ Bruce, A., Alexander, J., Julian, L., Martin, R., Keith, R. &amp; Peter, W. (2018) Essential Cell Biology (5<sup>th</sup> Edn.). Garland Science (New York), pp. 864.</li> <li>▪ Cooper, G.M. &amp; Hausman, R.E. (2013) The Cell: A Molecular Approach (6<sup>th</sup> Edn.). Sinauer Associates (Sunderland), pp. 832.</li> <li>▪ Hancock, J.T. (2010) Cell Signalling (3<sup>rd</sup> Edn.). Oxford University Press (Oxford), pp. 352.</li> <li>▪ Karp, G. (2013) Cell and Molecular Biology: Concepts and Experiments (7<sup>th</sup> Edn.). John Wiley &amp; Sons (Hoboken), pp. 832.</li> <li>▪ Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. &amp; Martin, K.C. (2016) Molecular Cell Biology (8<sup>th</sup> Edn.). W.H. Freeman (New York), pp. 1308.</li> <li>▪ Smith, J., &amp; Green, M. R. (2012). Molecular Cloning: A Laboratory Manual (4<sup>th</sup> Edn.). Cold Spring Harbor Laboratory Press (Cold Spring Harbor, NY) pp. 78-234.</li> <li>▪ Voet, D., Voet, J.G. &amp; Pratt, C.W. (2013) Fundamentals of Biochemistry: Life at the Molecular Level (4<sup>th</sup> Edn.). John Wiley &amp; Sons (Hoboken), pp. 1180.</li> <li>▪ <a href="https://www.labster.com/blog/7-molecular-biology-techniques-in-classroom">https://www.labster.com/blog/7-molecular-biology-techniques-in-classroom</a>.</li> <li>▪ <a href="https://www.geeksforgeeks.org/cell-organelles-definition-structure-types-functions">https://www.geeksforgeeks.org/cell-organelles-definition-structure-types-functions</a>.</li> </ul>		

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Semester-I							
Part A - Introduction							
Course Type	Course Code	Credit	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (hrs.)
	Name of the Course						
PC-1	<b>24L6.0-BOT-105</b>	4	8	30	70	100	4
	Practical based on 24L6.0-BOT-101 & 24L6.0-BOT-102						
<b>Level of the course (As per Annexure-I):</b> 400-499							
<b>Pre-Requisite for the course (if any):</b>							
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to get acquainted with the practical aspects of algae, fungi, pathogen, bryophytes and pteridophytes.							
Part B - Contents of the Course							
Suggested Practical works							Contact Hours
<p><b>24L6.0-BOT-101: Cryptogamic Plant Diversity</b></p> <ul style="list-style-type: none"> <li>To study working principle of dissecting and compound microscope.</li> <li>Taxonomy/ morphological study of representative members of following: Algae: <i>Nostoc</i>, <i>Oscillatoria</i>, <i>Scytonema</i>, <i>Euglena</i>, <i>Volvox</i>, <i>Hydrodictyon</i>, <i>Cladophora</i>, <i>Coleochaete</i>, <i>Oedogonium</i>, <i>Zygnema</i>, <i>Spirogyra</i>, <i>Chara</i>, <i>Vaucheria</i>, <i>Pinularia</i>, <i>Ectocarpus</i>, <i>Fucus</i>, <i>Sargassum</i>, <i>Polysiphonia</i>, <i>Batrachospermum</i>, <i>Peridinium</i>. Bryophytes: <i>Marchantia</i>, <i>Anthoceros</i>, <i>Funaria</i>, <i>Polytrichum</i>, <i>Pellia</i>, <i>Porella</i>, <i>Sphagnum</i>. Pteridophytes: <i>Lycopodium</i>, <i>Selaginella</i>, <i>Psilotum</i>, <i>Equisetum</i>, <i>Adiantum</i>, <i>Marsilea</i>, <i>Azolla</i>, <i>Pteris</i>, <i>Ophioglossum</i>, <i>Dryopteris</i>, <i>Nephrolepis</i>.</li> <li>To study permanent slides of Algae, Bryophytes and Pteridophytes (both vegetative and reproductive phases).</li> <li>Collection and submission of locally available cryptogamic plant species.</li> </ul>							120
<p><b>24L6.0-BOT-102: Microbial Kingdom &amp; Applied Mycology</b></p> <ul style="list-style-type: none"> <li>To study about safety guidelines, Good microbiological laboratory practice (GMLP) and spillage management.</li> <li>Study of important plant viruses (TMV, ToLCV and CaMV)</li> <li>Differential staining method: Gram staining of bacteria.</li> <li>Study of bacterial growth curve.</li> <li>Sterile techniques for cell culture (bacterial/ yeast cells).</li> <li>Microscopic study and identification of representative members of Fungi (<i>Mucor</i>, <i>Penicillium</i>, <i>Helminthosporium</i>, <i>Puccinia</i>, <i>Alternaria</i>, <i>Cercospora</i>, <i>Melamospora</i>, <i>Phyllactinia</i>, <i>Uncinula</i>, <i>Aspergillus</i>, <i>Rhizopus</i>, etc.).</li> <li>Test of sensitivity of microbe against antimicrobial substances.</li> <li>Camera Lucida drawings of fungal specimens.</li> <li>Study identifying features of macroscopic fungi <i>Ganoderma</i>, <i>Agarics</i> and <i>Morchella</i>.</li> <li>Study of characteristic features of lichens (crustose, foliose and fruticose).</li> </ul>							

Note: Any other relevant practical can be offered.

**Excursion Report:** Report on excursion tours with photographs, collection and preservation specimens related to Algae, Bryophytes, Pteridophytes, Fungi and Lichen.

### Suggested Evaluation Methods

#### Internal Assessment: 30

##### ❖ Practicum

- ✓ Class Participation: 5
- ✓ Seminar/ Demonstration/ Viva-voce/ Lab record/ Field work/ Survey etc.: 10
- ✓ Mid-Term Exam: 15

#### End Term Examination: 70

##### ❖ Practicum

- ✓ Practical Examination: 70

Lab record, Viva-Voce, write-up and execution of the practical.

### Part C - Recommended Books/ e-resources

- Dyer, A.F. (1979) The Experimental Biology of Ferns. Academic Press (London), pp. 310.
- Fatma T. (2005) Cyanobacterial and Algal Metabolism and Environmental Biotechnology. Narosa Publishers (New Delhi), pp. 300.
- Goffinet B. & Shaw A.J. (2008) Bryophyte Biology (2<sup>nd</sup> Edn.). Cambridge University Press (Cambridge), pp. 565.
- Gupta R.K. & Pandey V.D. (2007) Advances in Applied Phycology. Daya Publishing House (New Delhi), pp. 450.
- John, D.M., Whitton, B.A., & Brook, A.J. (2002) The Freshwater Algal Flora of the British Isles: An Identification Guide to Freshwater and Terrestrial Algae. Cambridge University Press (Cambridge), pp. 450.
- Maheshwari, R. (2005) Fungi: Experimental Methods in Biology. CRC Press (Boca Raton), pp. 367.
- Manilal, K.S. & Joseph, N. (2007) Laboratory Manual on Microbiology. New Age International Pvt. Ltd. (New Delhi), pp. 350.
- Roy, K. (2010) Laboratory Manual of Plant Pathology. PHI Learning Pvt. Ltd. (New Delhi), pp. 300.
- Schuster, R.M. (1983) New Manual of Bryology. Hattori Botanical Laboratory (Japan), pp. 1334.
- Sharma, O.P. & Bhatnagar, A.K. (2005) Practical Manual of Plant Pathology. Agrobios (India), pp. 280.
- Sivasithamparam, K. & Dixon, K.W. (1981) Biology and Management of Root Pathogens. Academic Press (London), pp. 356.
- Wilson, E.O. (2009) Laboratory Manual for Introductory Biology. W. H. Freeman (New York), pp. 400.
- <https://www-archiv.fdm.uni-hamburg.de/b-online/library/uwi/scitec.uwichill.edu.bb/bcs/bl14apl/lab1.htm>.
- [https://www.researchgate.net/publication/378768961\\_Fungi\\_Bacteria\\_Viruses\\_Plant\\_Pathology\\_and\\_Lichen\\_Practical\\_Notes\\_23-24](https://www.researchgate.net/publication/378768961_Fungi_Bacteria_Viruses_Plant_Pathology_and_Lichen_Practical_Notes_23-24).
- <https://www.scribd.com/document/466228196/BIO-REPORT-EXP-2-docx>.

M.Sc. Botany (Session: 2024-25)							
Semester-I							
Part A - Introduction							
Course Type	Course Code	Credit	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (hrs.)
	Name of the Course						
PC-2	24L6.0-BOT-106	4	8	30	70	100	4
	Practical based on 24L6.0-BOT-103 & 24L6.0-BOT-104						
<b>Level of the course (As per Annexure-I):</b> 400-499							
<b>Pre-Requisite for the course (if any):</b>							
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to get acquainted with the practical aspects of genetics and cellular organization.							
Part B - Contents of the Course							
Suggested Practical works							Contact Hours
<p><b>24L6.0-BOT-103: Inheritance Biology &amp; Genetic Engineering</b></p> <ul style="list-style-type: none"> <li>• Study of strains and fixatives used in cytogenetics.</li> <li>• Study of karyotype using a given metaphase chromosome picture (<i>Allium cepa</i>).</li> <li>• Work out the genetics of a cross from the given F2 harvest.</li> <li>• Problem solving regarding monohybrid/ dihybrid cross and gene interactions.</li> <li>• Genetic problem on tetrad analysis, gene mapping and complementation test.</li> <li>• Study of floral structure of self- and cross-pollinated crops.</li> <li>• Solve of problems related to GWAS and QTL mapping.</li> <li>• Study of in-vitro pollen germination and pollen viability.</li> </ul> <p><b>24L6.0-BOT-104: Cell Biology &amp; Biotechniques</b></p> <ul style="list-style-type: none"> <li>• To study about general equipment, apparatus and materials used in lab.</li> <li>• Sterile techniques for cell culture.</li> <li>• Preparation of mitotic and meiotic chromosomes.</li> <li>• Calculation of morphometric data and preparations of idiogram.</li> <li>• Determination of chiasma frequency and terminalization coefficient.</li> <li>• DNA/ RNA extraction and quantification from cells.</li> <li>• Quantification of total protein by standard protocols</li> <li>• Isolation and purification of RNA/ DNA from plants</li> <li>• Agarose gel electrophoresis of RNA, chromosomal and plasmid DNA</li> <li>• Isolation of total plant protein.</li> <li>• Polyacrylamide gel electrophoresis of plant total protein.</li> </ul>							120
Note: Any other relevant practical can be offered.							
<b>Excursion Report:</b> Report on excursion tours any nearby research laboratory if available.							
Suggested Evaluation Methods							
Internal Assessment: 30					End Term Examination: 70		

<p>❖ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Demonstration/ Viva-voce/ Lab record/ Field work/ Survey etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>	<p>❖ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Practical Examination: 70</li> </ul> <p>Lab record, Viva-Voce, write-up and execution of the practical.</p>
<p><b>Part C - Recommended Books/ e-resources</b></p>	
<ul style="list-style-type: none"> <li>▪ Brown, A.R. &amp; White, L.E. (2018) Genetics Laboratory: Techniques and Applications. Wiley-Blackwell (New York), pp. 50-150.</li> <li>▪ Carter, S.D. &amp; Miller, P.J. (2017) Molecular Genetics and Genetic Engineering: Practical Applications. Oxford University Press (London), pp. 30-80.</li> <li>▪ Clark, J.M. &amp; Evans, L.K. (2020) Genetics and Biotechnology Laboratory Manual. Cengage Learning (Boston), pp. 20-70.</li> <li>▪ Cooper, G.M. &amp; Hausman, R.E. (2019) The Cell: A Laboratory Manual (8<sup>th</sup> Edn.). Sinauer Associates (Sunderland), pp. 560.</li> <li>▪ King, R.C. (2018) A Laboratory Manual for Cell Biology (1<sup>st</sup> Edn.). Jones &amp; Bartlett Learning (Burlington), pp. 432.</li> <li>▪ Kumar, A. &amp; Gupta, S. (2016) Genetic Engineering Laboratory Manual: Techniques and Procedures. McGraw-Hill Education (New York), pp. 40-90.</li> <li>▪ Patel, K.D. &amp; Singh, R.K. (2019) Advanced Genetics Laboratory: Methods and Protocols. Springer Nature (Berlin), pp. 75-125.</li> <li>▪ Pechenik, J.A. (2015) A Short Guide to Writing about Biology (9<sup>th</sup> Edn.). Pearson (New York), pp. 400.</li> <li>▪ Smith, J.T. &amp; Johnson, M.R. (2020) Laboratory Manual for Basic Genetics: Concepts and Applications. Pearson Education Inc. (Boston), pp. 1-100.</li> <li>▪ Voet, D., Voet, J.G. &amp; Pratt, C.W. (2016) Fundamentals of Cell Biology Laboratory Manual (1<sup>st</sup> Edn.). Wiley (Hoboken), pp. 464.</li> <li>▪ Wilson, E.B. (2016) Practical Methods in Electron Microscopy: Electron Diffraction, Electron Microprobe Analysis, Electron Microscopy, Electron Microscopy for Biologists, Staining Methods for Electron Microscopy (3<sup>rd</sup> Edn.). Princeton University Press (Princeton), pp. 368.</li> <li>▪ <a href="https://practicalbiology.org/genetics">https://practicalbiology.org/genetics</a>.</li> <li>▪ <a href="https://www.researchgate.net/publication/269038206_Practical_Plant_Genetics">https://www.researchgate.net/publication/269038206_Practical_Plant_Genetics</a>.</li> </ul>	

## General Instructions for Seminar

<b>M.Sc. Botany: Semester-I</b>				
<b>Part A - Introduction</b>				
<b>Course Code</b>	24L6.0-BOT-107			
<b>Course Type</b>	Seminar			
<b>Level of the course</b>	400-499			
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to present in front of an audience making them more confident.				
<b>Credits</b>	2			
<b>Teaching Hours per Week</b>	2			
<b>Max. Marks</b>	50	<b>Distribution of marks will be as follows</b>		
		<b>Presentation</b>	<b>Depth of the subject matter</b>	<b>Answers to the questions</b>
		20	20	10
<b>Exam Time</b>	2 hrs			
<b>Instructions for Examiner:</b> Evaluation of the seminar will be done by the internal examiner(s) on the parameters as decided by staff council of the department. There will be no external examination/ viva-voce examination.				
<b>General Instructions:</b> The seminar will be delivered before the students and teachers of the department. A three-member committee (one coordinator and two teachers of the department) duly approved by the departmental council will be constituted to evaluate the seminar.				

M.Sc. Botany (Session: 2024-25)								
Semester-II								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-5	24L6.0-BOT-201	Evolutionary Biology, Gymnosperms & Plant Anatomy	4	4	30	70	100	3
<b>Level of the Course:</b> 400-499								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to understand the principles and mechanisms of evolution, including genetic variation, natural selection and speciation and apply this knowledge to analyze the evolutionary history and adaptive strategies of gymnosperms, highlighting their unique features and ecological roles in the plant kingdom.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. describe the principles of evolutionary biology, including genetic variation, natural selection and speciation. 2. explain the major evolutionary trends and adaptations in plant evolution, with a focus on gymnosperms. 3. analyze the evolutionary relationships and phylogenetic classification of gymnosperm taxa. 4. evaluate the ecological and evolutionary significance of gymnosperms in the context of plant diversity and ecosystem dynamics.								
<b>Mapping of CLO with PSO for Evolutionary Biology, Gymnosperms &amp; Plant Anatomy</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	☑					☑		☑
CLO2	☑					☑		
CLO3	☑	☑		☑				☑
CLO4	☑	☑	☑	☑		☑		☑
<b>Part B - Content of the Course</b>								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Introduction to Evolutionary Biology:</b> Theories, principles and mechanisms of evolution (Natural selection); significance of fossil gymnosperms in understanding plant evolution and ecological adaptations. Onset of seed development. <b>Paleobotany:</b> Concept, types of rocks and fossils, fossilization processes. Overview of Gondwana flora and geological time scale (general evolution trend from algae to gymnosperms); notable paleobotanists of India.							15

<b>II</b>	<p><b>Introduction to Gymnosperms:</b> General characters, diversity and distribution in India, classification, life cycle, economic and ecological importance.</p> <p><b>Progymnospermophyta and Pteridospermophyta:</b> Introduction to Progymnospermophyta and Pteridospermophyta; general account of Aneurophytales, Archaeopteridales, Glossopteridales and Caytoniales.</p>	15
<b>III</b>	<p><b>Morpho-anatomical Features and Reproduction in the following:</b> Cycadales (<i>Cycas</i>), Cycadeoidales (<i>Cycadeoidea</i>) and Ginkgoales (<i>Ginkgo</i>).</p> <p><b>Morpho-anatomical Features and Reproduction in the following:</b> Coniferales (<i>Pinus</i>), Ephedrales (<i>Ephedra</i>) and Welwitschiales (<i>Welwitschia</i>).</p>	15
<b>IV</b>	<p><b>Plant tissue system and Meristem Classification:</b> Tissue types (parenchyma, collenchyma and sclerenchyma; xylem and phloem) and functions; apical, lateral and intercalary meristems; structure of xylem and phloem.</p> <p><b>Anatomy:</b> Anatomy of dicot and monocot stem, root, leaves and wood; primary and secondary growth, anomalous structure and abnormal secondary growth in stems. Application of anatomy in systematics, archaeology and climate change.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Anderson, E., &amp; Anderson, H. (2003). The Gymnosperms Handbook: A Practical Guide to the Cultivated Conifers. Timber Press (Portland), pp. 350.</li> <li>▪ Beck, C.B. (2005). An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century (2<sup>nd</sup> Edn.). Cambridge University Press (Cambridge), pp. 400.</li> <li>▪ Bowler, P.J. (2003). Evolution: The History of an Idea (3<sup>rd</sup> Edn.), University of California Press (Berkeley), pp. 350.</li> <li>▪ Esau, K. (1977). Anatomy of Seed Plants (2<sup>nd</sup> Edn.). John Wiley &amp; Sons (New York), pp. 576.</li> <li>▪ Fahn, A. (1990). Plant Anatomy (4<sup>th</sup> Edn.). Pergamon Press (Oxford), pp. 588.</li> <li>▪ Futuyma, D.J. (2017). Evolution (4<sup>th</sup> Edn.), Sinauer Associates Inc. (Sunderland), pp. 1-500.</li> <li>▪ Gifford, E.M., &amp; Foster, A.S. (2018). Morphology and Evolution of Vascular Plants (5<sup>th</sup> Edn.). W.H. Freeman (New York), pp. 600.</li> <li>▪ LePage, B.A. (2007). Fossil Plants and Spores: Modern Techniques. Indiana University Press (Bloomington), pp. 450.</li> <li>▪ Sporne, K.R. (2012). The Morphology of Gymnosperms: The Structure and Evolution of Primitive Seed-Plants. Springer Science &amp; Business Media (Berlin), pp. 550.</li> <li>▪ Stace, C.A. (2010). Gymnosperms of the World (3<sup>rd</sup> Edn.), Kew Publishing (London), pp. 600.</li> <li>▪ Stearns, S.C. &amp; Hoekstra, R.F. (2005). Evolution: An Introduction (2<sup>nd</sup> Edn.), Oxford University Press (New York), pp. 400.</li> <li>▪ <a href="https://bsi.gov.in/uploads/userfiles/file/Rare%20Books/Morphology%20Of%20Gymnosperms.pdf">https://bsi.gov.in/uploads/userfiles/file/Rare%20Books/Morphology%20Of%20Gymnosperms.pdf</a>.</li> <li>▪ <a href="https://www.geeksforgeeks.org/evolution-ncert-notes-class-12-biology-chapter-6">https://www.geeksforgeeks.org/evolution-ncert-notes-class-12-biology-chapter-6</a>.</li> <li>▪ <a href="https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/plant-anatomy">https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/plant-anatomy</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-II								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-6	24L6.0-BOT-202	Angiosperms Systematics & Embryology	4	4	30	70	100	3
<b>Level of the Course:</b> 400-499								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to understand the principles and methods of angiosperm classification, including morphological, anatomical and molecular approaches, to identify, classify and interpret the evolutionary relationships and diversity of flowering plants.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. get comprehensive understanding of history and evolution of taxonomy and will be well acquainted with classification systems. 2. develop a detailed understanding of different dicot and monocot families by applying principles and classification systems to classify, name angiosperm species, families and orders accurately. 3. acquire practical skills in plant collection, preservation, identification and taxonomy including the use of keys and diagnostic features for species recognition. 4. know the structure and development in microsporangium and megasporangium and to know fertilization, endosperm and embryogeny.								
Mapping of CLO with PSO for Angiosperms Systematics & Embryology								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CLO2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>
CLO3	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>
CLO4	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Taxonomic Literature:</b> General indexes, floras, manuals, important botanical gardens and herbaria; botanical nomenclature and international code of nomenclature for algae, fungi and plants; organization and role of BSI. <b>Introduction and Phylogeny of Angiosperms:</b> General characteristics, evolution and inter-relationship of dicots and monocots; concept of Basalangiosperms and Magnoliids; evolution of stamen and carpel.							15

II	<p><b>System of Classification:</b> Cronquist, Hutchinson, Bentham &amp; Hooker, Dahlgren and Thorne based classification; modern tools of taxonomy (cytotaxonomy, chemotaxonomy, numerical taxonomy, serology).</p> <p><b>Salient Features of Dicot Families-I:</b> Ranunculaceae, Papaveraceae, Cruciferae (Brassicaceae), Caryophyllaceae, Malvaceae, Rutaceae, Leguminosae (Fabaceae).</p>	15
III	<p><b>Salient Features of Dicot Families-II:</b> Solanaceae, Umbelliferae (Apiaceae), Cucurbitaceae, Asclepiadaceae (Apocynaceae), Compositae (Asteraceae), Labiatae (Lamiaceae), Euphorbiaceae.</p> <p><b>Salient Features of Monocot Families:</b> Araceae, Palmae (Arecaceae), Amaryllidaceae, Graminae (Poaceae), Cyperaceae, Liliaceae, Orchidaceae.</p>	15
IV	<p><b>Male Gametophyte and Pollination:</b> Anther (structure and development), microsporogenesis and microspore tetrad; role of tapetum, pollenkit; pollen-pistil interaction, pollen development and pollen tube growth. Pollination mechanisms.</p> <p><b>Female Gametophyte, Fertilization and Seed Development:</b> Ovule development and types, megasporogenesis and organization of the embryo sac (egg, synergids, antipodal cells); double fertilization, polyembryony, endosperm, embryo and seed development. Brief account on apomixis, apogamy, apospory and parthenocarpy.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<p>❖ <b>Theory</b></p> <p>✓ Class Participation: 5</p> <p>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</p> <p>✓ Mid-Term Exam: 15</p>		<p>❖ <b>Theory</b></p> <p>✓ Written Examination: 70</p>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ APG IV (2016) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society, 181(1), 1-20.</li> <li>▪ Cronquist, A. (1988) The Evolution and Classification of Flowering Plants (2<sup>nd</sup> Edn.). New York Botanical Garden Press (New York), pp. 555.</li> <li>▪ Dahlgren, R. (1980) A Revised System of Classification of the Angiosperms. Botanical Journal of the Linnean Society, 80(2), 91-124.</li> <li>▪ Maheshwari, P. (1950) An Introduction to the Embryology of Angiosperms. McGraw-Hill Book Company (New York), pp. 300.</li> <li>▪ Parihar, N.S. &amp; Jain, A.K. (1997) A Textbook of Embryology of Angiosperms. Rastogi Publications (New Delhi), pp. 280.</li> <li>▪ Rao, M.N., Rao, P.N. &amp; Babu, A.V.S. (2012) Angiosperm Taxonomy: Concepts and Applications. Himalaya Publishing House (Mumbai), pp. 150.</li> <li>▪ Shivanna, K.R. &amp; Sawhney, V.K. (1997) Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press (Cambridge), pp. 150-200.</li> <li>▪ Soltis, D.E., Soltis, P.S., Endress, P.K. &amp; Chase, M.W. (2005) Phylogeny and Evolution of Angiosperms. Sinauer Associates (Sunderland), pp. 370.</li> <li>▪ <a href="https://core.ac.uk/download/pdf/159148791.pdf">https://core.ac.uk/download/pdf/159148791.pdf</a>.</li> <li>▪ <a href="https://letstalkscience.ca/educational-resources/backgrounders/plant-reproduction">https://letstalkscience.ca/educational-resources/backgrounders/plant-reproduction</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-II								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-7	24L6.0-BOT-203	Plant Ecology	4	4	30	70	100	3
<b>Level of the Course:</b> 400-499								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to get a comprehensive understanding of ecology and nature, encompassing ecosystem dynamics, environmental factors, sustainable resource management practices and proficiency in field and analytical skills for effective conservation and management strategies.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. comprehend ecological principles and processes governing plant communities and ecosystems. 2. evaluate the impact of abiotic and biotic factors on plant distribution and abundance. 3. apply knowledge to the conservation and sustainable management of natural resources. 4. develop proficiency in field methods and ecological data analysis.								
<b>Mapping of CLO with PSO for Plant Ecology</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	☑		☑					
CLO2			☑		☑		☑	
CLO3		☑		☑	☑	☑		
CLO4	☑	☑	☑	☑		☑	☑	☑
<b>Part B - Content of the Course</b>								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>The Environment:</b> Physical environment; biotic environment; biotic and abiotic interactions. Ecophene and ecotype, natural capital and techno-ecosystem. <b>Habitat and Niche Ecology:</b> Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement and major habitat types of the sub-continent.							15
II	<b>Population Ecology:</b> Characteristics of a population; population growth curves; population regulation; life history strategies (r and k selection); age structured populations; factors affecting population. <b>Community Ecology:</b> Nature, structure and attributes of communities; analysis of communities (analytical and synthetic characters); levels of species diversity and its measurement; population dispersion, edges and ecotones.							15

<b>III</b>	<p><b>Species Interactions and Ecological Succession:</b> Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis, Lotka-Volterra Model. Types, mechanisms and models of succession; concept of climax.</p> <p><b>Ecosystem Organization:</b> Structure and functions; primary production (global pattern and controlling factors); energy dynamics - trophic levels, energy flow and ecological efficiencies.</p>	15
<b>IV</b>	<p><b>Mineral Recycling:</b> Decomposition (mechanism, substrate quality and climatic factors); global biogeochemical cycles of C, N, P &amp; S, ecosystem stability (resistance and resilience).</p> <p><b>Global atmosphere changes:</b> Environmental pollution (air, water and land), global environmental change and its consequences (CO<sub>2</sub> fertilization, global warming sea level rise and UV radiation).</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Ambasht, R.S. &amp; Ambasht, N.K. (2002) A Textbook of Plant Ecology (15<sup>th</sup> Edn.). CBS Publishers &amp; Distributors (New Delhi), pp. 452.</li> <li>▪ Begon, M., Townsend, C.R. &amp; Harper, J.L. (2006) Ecology: From Individuals to Ecosystems (4<sup>th</sup> Edn.). Blackwell Publishing (Oxford), pp. 738.</li> <li>▪ Chapin III, F.S., Matson, P.A. &amp; Vitousek, P.M. (2011) Principles of Terrestrial Ecosystem Ecology (2<sup>nd</sup> Edn.). Springer (New York), pp. 529.</li> <li>▪ Krebs, C.J. (2009) Ecology: The Experimental Analysis of Distribution and Abundance (6<sup>th</sup> Edn.). Benjamin Cummings (San Francisco), pp. 655.</li> <li>▪ Misra, R. (2010) Ecology Workbook. Oxford &amp; IBH Publishing Co. Pvt. Ltd. (New Delhi), pp. 244.</li> <li>▪ Molles, M.C. (2019) Ecology: Concepts and Applications (8<sup>th</sup> Edn.). McGraw-Hill Education (New York), pp. 576.</li> <li>▪ Odum, E.P. &amp; Barrett, G.W. (2005) Fundamentals of Ecology (5<sup>th</sup> Edn.). Brooks Cole (Belmont), pp. 624.</li> <li>▪ Singh, J.S., Singh, S.P. &amp; Gupta, S.R. (2006) Ecology, Environment and Resource Conservation. Anamaya Publishers (New Delhi), pp. 688.</li> <li>▪ Smith, T.M. &amp; Smith, R.L. (2015) Elements of Ecology (9<sup>th</sup> Edn.). Pearson (Boston), pp. 704.</li> <li>▪ Weaver, J.E. &amp; Clements, F.E. (1973) Plant Ecology. McGraw-Hill Book Company (New York), pp. 602.</li> <li>▪ <a href="https://www.esa.org/about/what-does-ecology-have-to-do-with-me">https://www.esa.org/about/what-does-ecology-have-to-do-with-me</a>.</li> <li>▪ <a href="https://education.nationalgeographic.org/resource/ecology">https://education.nationalgeographic.org/resource/ecology</a>.</li> <li>▪ <a href="https://www.britishecologicalsociety.org/about/what-is-ecology">https://www.britishecologicalsociety.org/about/what-is-ecology</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-II								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-8	24L6.0-BOT-204	Molecular Biology	4	4	30	70	100	3
<b>Level of the Course:</b> 400-499								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learners will gain a deep understanding of molecular mechanisms in cells, focusing on the structure and function of nucleic acids and proteins and the regulation of gene expression, replication, transcription, translation and DNA repair.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand the molecular mechanisms of replication, transcription, translation and gene regulation. 2. interpret scientific research articles in molecular biology, identifying key findings and methodologies. 3. critically evaluate molecular biology research articles. 4. design, conduct and interpret molecular biology experiments.								
<b>Mapping of CLO with PSO for Molecular Biology</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1				☑			☑	
CLO2				☑			☑	
CLO3				☑			☑	
CLO4				☑			☑	
<b>Part B - Content of the Course</b>								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Introduction to Molecular Biology:</b> Historical overview and Central Dogma; centromere and telomere, euchromatin and heterochromatin. <b>DNA replication and Repair:</b> Mechanism, DNA Polymerase, other enzymes and accessory proteins involved in Prokaryotic and Eukaryotic DNA replication, Fidelity of replication, Extrachromosomal replicons; DNA damage and repair.							15
II	<b>RNA Synthesis in Prokaryotes and Eukaryotes:</b> Transcription factors and machinery, formation of initiation complex, elongation phase and termination ( $\rho$ -dependent and independent) RNA polymerases; transcriptional and post-transcriptional gene silencing.							15

	<b>RNA Processing:</b> 5' Cap formation, 3' end processing and polyadenylation, splicing (nuclear intron, group I and II) and RNA editing and RNA interference, nuclear export of mRNA and its stability.	
<b>III</b>	<b>Protein Synthesis in Prokaryotes and Eukaryotes:</b> Ribosome, Shine-Dalgarno/Kozak sequence and formation of initiation complex, initiation factors and Wobble hypothesis, elongation and elongation factors, termination, genetic code, tRNA structure, aminoacylation of tRNA and tRNA synthetase. <b>Translation Regulation:</b> Translational proof-reading, translational inhibitors and antibiotics, co and post- translational modification of proteins; tm-RNA processing, non-stop and non-sense mediated decay.	15
<b>IV</b>	<b>Gene Expression Regulation:</b> Control of gene expression at transcriptional and translational levels; regulating the expression of phages, viruses, prokaryotes and eukaryotes (chromatin remodeling and genomic imprinting), DNA-binding motifs. <b>Genome organization:</b> Introduction and concept, chromosomal organization of genes and noncoding DNA, mobile DNA, concept of operon, unique and repetitive DNA, interrupted genes, gene families.	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. &amp; Walter, P. (2015) Molecular Biology of the Cell (6<sup>th</sup> Edn.). Garland Science (New York), pp. 1464.</li> <li>▪ Brown, T.A. (2016) Gene Cloning and DNA Analysis: An Introduction (7<sup>th</sup> Edn.). Wiley-Blackwell (Oxford), pp. 376.</li> <li>▪ Dale, J.W. &amp; von Schantz, M. (2011) From Genes to Genomes: Concepts and Applications of DNA Technology (3<sup>rd</sup> Edn.). Wiley-Blackwell (Oxford), pp. 372.</li> <li>▪ Gupta, P.K. (2014) Molecular Biology and Genetic Engineering. Rastogi Publications (Meerut), pp. 850.</li> <li>▪ Karp, G. (2018) Cell and Molecular Biology: Concepts and Experiments (8<sup>th</sup> Edn.). Wiley (Hoboken), pp. 832.</li> <li>▪ Krebs, J.E., Goldstein, E.S. &amp; Kilpatrick, S.T. (2018) Lewin's Genes XII. Jones &amp; Bartlett Learning (Burlington), pp. 1056.</li> <li>▪ Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. &amp; Matsudaira, P. (2016) Molecular Cell Biology (8<sup>th</sup> Edn.). W.H. Freeman (New York), pp. 1300.</li> <li>▪ Russell, P.J. (2010) iGenetics: A Molecular Approach (3<sup>rd</sup> Edn.). Pearson Education (Boston), pp. 816.</li> <li>▪ Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. &amp; Losick, R. (2013) Molecular Biology of the Gene (7<sup>th</sup> Edn.). Pearson Education (Boston), pp. 872.</li> <li>▪ Weaver, R.F. (2018) Molecular Biology (5<sup>th</sup> Edn.). McGraw-Hill Education (New York), pp. 912.</li> <li>▪ <a href="https://plato.stanford.edu/entries/molecular-biology">https://plato.stanford.edu/entries/molecular-biology</a>.</li> <li>▪ <a href="https://www.thermofisher.com/blog/ask-a-scientist/what-is-molecular-biology">https://www.thermofisher.com/blog/ask-a-scientist/what-is-molecular-biology</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)							
Semester-II							
Part A - Introduction							
Course Type	Course Code	Credit	Hrs./ week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (hrs.)
	Name of the Course						
PC-3	24L6.0-BOT-205	4	8	30	70	100	4
	Practical based on 24L6.0-BOT-201 & 24L6.0-BOT-202						
<b>Level of the course (As per Annexure-I):</b> 400-499							
<b>Pre-Requisite for the course (if any):</b>							
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to get acquainted with the practical aspects of flowering plants and genetics.							
Part B - Contents of the Course							
Suggested Practical works							Contact Hours
<p><b>24L6.0-BOT-201: Evolutionary Biology, Gymnosperms &amp; Anatomy</b></p> <ul style="list-style-type: none"> <li>Taxonomy and morpho-anatomical comparative study of vegetative and reproductive parts of <i>Cycas</i>, <i>Pinus</i>, <i>Ginkgo</i>, <i>Cedrus</i>, <i>Aurocaria</i>, <i>Cryptomeria</i>, <i>Ephedra</i>, <i>Gnetum</i> and <i>Taxus</i>.</li> <li>Study permanent slide of various Gymnosperms.</li> <li>Study common plants used in Indian traditional medicine.</li> <li>Collection and submission of locally available/ cultivated Gymnosperms.</li> <li>Study of various meristems and plant tissues from permanent and temporary slides.</li> <li>Identification of plant organs on the basis of anatomy.</li> <li>Study of anatomy of root, stem and leaves by double staining method.</li> <li>Study of anatomy of anomalous secondary growth <i>Achyranthes</i>, <i>Amaranthes</i>, <i>Bougainvillea</i>, <i>Boerhaavia</i>, <i>Tecoma</i>, etc.</li> </ul> <p><b>24L6.0-BOT-202: Angiosperms Systematics &amp; Embryology</b></p> <ul style="list-style-type: none"> <li>Study of morphology, primitive and advanced characters of cultivated and wild representatives of various families locally available. Study of basic structure of flower, variations, floral parts in details, floral symmetry, insertion of floral parts, etc.</li> <li>Study of placentation in Angiosperms by cutting a T.S. or L.S. of the ovary of given flower sample.</li> <li>Field study of angiosperm in different types of habitats and preparation of plant herbarium.</li> <li>Training in using floras for identification of specimens describes in fields or class.</li> <li>Study of endothecium and obturator structure through permanent slide.</li> <li>Study of structure and types of anther/ ovule and placentation in the given plant sample.</li> <li>Study of embryo of a given dicot and monocot sample.</li> <li>Study of T.S. of anther.</li> </ul>							120
Note: Any other relevant practical can be offered.							

<b>Excursion Report:</b> Report on excursion tours with photographs, collection and preservation specimens related to several families of gymnosperms, dicot and monocot.	
<b>Suggested Evaluation Methods</b>	
<b>Internal Assessment: 30</b>	<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Practicum</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Demonstration/ Viva-voce/ Lab record/ Field work/ Survey etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>	<ul style="list-style-type: none"> <li>❖ <b>Practicum</b></li> <li>✓ Practical Examination: 70</li> </ul> <p>Lab record, Viva-Voce, write-up and execution of the practical.</p>
<b>Part C - Recommended Books/ e-resources</b>	
<ul style="list-style-type: none"> <li>▪ Beck, C.B. (2010). An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century (2<sup>nd</sup> Edn.). Cambridge University Press (Cambridge), pp. 464.</li> <li>▪ Brown, A.T. &amp; Smith, J.R. (2019) Practical Guide to Angiosperm Classification and Identification. Cambridge University Press (Cambridge). pp. 75-125.</li> <li>▪ Eames, A.J., &amp; MacDaniels, L.H. (1947). An Introduction to Plant Anatomy (2nd Edn.). McGraw-Hill (New York), pp. 427.</li> <li>▪ Garcia, M.P. &amp; Rodriguez, A.B. (2021) Hands-On Angiosperm Systematics: Techniques and Applications. Academic Press (London). pp. 50-100.</li> <li>▪ Johansen, D.A. (1940). Plant Microtechnique. McGraw-Hill (New York), pp. 523.</li> <li>▪ Rao, M.S. &amp; Kumar, A. (2018) Laboratory Manual for Angiosperm Systematics: Techniques and Exercises. Narosa Publishing House (New Delhi), pp. 30-70.</li> <li>▪ Ruzin, S.E. (1999). Plant Microtechnique and Microscopy. Oxford University Press (New York), pp. 322.</li> <li>▪ Sharma, S. &amp; Singh, P. (2019) Practical Manual for Angiosperm Systematics: Methods and Applications. Vikas Publishing House Pvt. Ltd. (New Delhi). pp. 50-90.</li> <li>▪ Wilson, D.J. &amp; Thompson, L.P. (2017) Angiosperm Evolutionary Biology: Practical Exercises. Springer Nature (USA). pp. 100-150.</li> <li>▪ <a href="http://cupac.bh.cornell.edu/anatomy_manual/CUPACplantanatomy.pdf">http://cupac.bh.cornell.edu/anatomy_manual/CUPACplantanatomy.pdf</a>.</li> <li>▪ <a href="https://courses.lumenlearning.com/wm-biology2/chapter/gymnosperms">https://courses.lumenlearning.com/wm-biology2/chapter/gymnosperms</a>.</li> <li>▪ <a href="https://www.britannica.com/plant/angiosperm">https://www.britannica.com/plant/angiosperm</a>.</li> </ul>	

<b>M.Sc. Botany (Session: 2024-25)</b>							
<b>Semester-II</b>							
<b>Part A - Introduction</b>							
Course Type	Course Code	Credit	Hrs./ week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (hrs.)
	Name of the Course						
PC-4	<b>24L6.0-BOT-206</b>	4	8	30	70	100	4
	Practical based on 24L6.0-BOT-203 & 24L6.0-BOT-204						
<b>Level of the course (As per Annexure-I): 400-499</b>							
<b>Pre-Requisite for the course (if any):</b>							
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to get acquainted with the practical aspects of plant ecology and molecular biology.							
<b>Part B - Contents of the Course</b>							
<b>Suggested Practical works</b>							<b>Contact Hours</b>
<p><b>24L6.0-BOT-203: Plant Ecology</b></p> <ul style="list-style-type: none"> <li>• Compare the anatomy of C<sub>3</sub> and C<sub>4</sub> plants.</li> <li>• Estimation of chlorophyll content in a given plant material of C<sub>3</sub> and C<sub>4</sub> plants.</li> <li>• Study of the methods of sampling in ecological studies.</li> <li>• Determination of the minimum size of the quadrat by species area curve method.</li> <li>• Study of density and abundance of plants at a given location by quadrat method.</li> <li>• Study of phytosociological analysis of vegetation at Botanical Garden of the campus.</li> <li>• Determination of distribution of plants in a given area of vegetation by quadrat method.</li> <li>• Calculate the biodiversity indices of herbaceous vegetation.</li> <li>• Study of floristic regions of India.</li> <li>• Analyze the soil samples for texture, composition, pH, and nutrient content.</li> <li>• Assess the quality of water from different sources.</li> <li>• Measure the levels of air pollutants in different areas.</li> <li>• Survey and document forest resources and non-timber forest products.</li> <li>• Study and practice waste management and recycling techniques</li> <li>• Learn about and apply techniques for ecosystem restoration.</li> <li>• Conduct a simplified environmental impact assessment for a local development project.</li> </ul> <p><b>24L6.0-BOT-204: Molecular Biology</b></p> <ul style="list-style-type: none"> <li>• Study the structure and functioning of a spectrophotometer and other instruments used in molecular biology lab.</li> <li>• Isolation of Genomic DNA.</li> <li>• Isolation of RNA.</li> <li>• Quantitative analysis of DNA.</li> <li>• Ligation of DNA fragments.</li> <li>• Molecular weight analysis using agarose gel electrophoresis.</li> <li>• Isolation of plasmid DNA.</li> <li>• Study of Western blotting.</li> <li>• Study of Southern blotting.</li> </ul>							<b>120</b>

- Preparation of competent cell.

Note: Any other relevant practical can be offered.

**Excursion Report:** Report on excursion tours with photographs, collection and preservation specimens related to Algae, Bryophytes, Pteridophytes, Fungi and Lichen.

### Suggested Evaluation Methods

#### Internal Assessment: 30

##### ❖ Practicum

- ✓ Class Participation: 5
- ✓ Seminar/ Demonstration/ Viva-voce/ Lab record/ Field work/ Survey etc.: 10
- ✓ Mid-Term Exam: 15

#### End Term Examination: 70

##### ❖ Practicum

- ✓ Practical Examination: 70
- Lab record, Viva-Voce, write-up and execution of the practical.

### Part C - Recommended Books/ e-resources

- Bhatnagar, A.K. & Moitra, A. (2003) Laboratory Manual in Ecology. CBS Publishers (New Delhi), pp. 250.
- Brower, J.E., Zar, J.H. & von Ende, C.N. (1998) Field and Laboratory Methods for General Ecology (4<sup>th</sup> Edn.). McGraw-Hill (New York), pp. 273.
- Clark, D.P. & Pazdernik, N.J. (2012) Biotechnology: Applying the Genetic Revolution (2<sup>nd</sup> Edn.). Academic Press (San Diego), pp. 768.
- Collin, J. (2009) Ecology: Practical Applications. Cengage Learning (Boston), pp. 328.
- Das, S. (2015) Practical Ecology. Narosa Publishing House (New Delhi), pp. 220.
- Glick, B.R. & Pasternak, J.J. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA (4<sup>th</sup> Edn.). ASM Press (Washington, D.C.), pp. 1000.
- Gupta, P.K. (2018) Molecular Biology and Genetic Engineering: Laboratory Manual (3<sup>rd</sup> Edn.). Rastogi Publications (Meerut), pp. 700.
- Karp, G. (2009) Cell and Molecular Biology: Concepts and Experiments (6<sup>th</sup> Edn.). Wiley (New York), pp. 864.
- Reddy, V.R. & Reddy, A.P.K. (2015) Molecular Biology: Techniques and Applications (2<sup>nd</sup> Edn.). Scientific Publishers (Jodhpur), pp. 550.
- Smith, T.M. & Smith, R.L. (2015) Elements of Ecology Laboratory Manual (9<sup>th</sup> Edn.). Pearson (Boston), pp. 400.
- Southwood, T.R.E. & Henderson, P.A. (2009) Ecological Methods (3<sup>rd</sup> Edn.). Wiley-Blackwell (Oxford), pp. 592.
- <https://www.saps.org.uk/teaching-resources/resources/258/ecology-practical-1-measuring-abundance-and-random-sampling>.
- <https://www.biologydiscussion.com/experiments/experiments-on-ecology-biology/56545>.
- [https://www.researchgate.net/publication/359120894\\_Molecular\\_Biology\\_Practicals](https://www.researchgate.net/publication/359120894_Molecular_Biology_Practicals).

M.Sc. Botany (Session: 2024-25)								
Semester-II								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CHM	24L6.0-CHM-201	Constitutional, Human and Moral Values and IPR	2	2	15	35	50	2
<b>Level of the Course:</b> 400-499								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to develop the practical ability to apply these frameworks to real-world scenarios, enhancing their professional and personal decision-making skills. This includes the recognition and assessment of ethical dilemmas, making informed choices that align with legal standards and moral values.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. analyze ethical theories such as utilitarianism, deontology and virtue ethics to real-world scenarios. 2. gain skills in articulating and defending their ethical choices, promoting integrity. 3. develop the ability to recognize ethical dilemmas and make informed decisions that align with legal standards and moral values. 4. foster a culture of accountability and ethical behavior in their respective fields.								
<b>Mapping of CLO with PSO for Constitutional, Human and Moral Values and IPR</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1								☑
CLO2		☑					☑	
CLO3								
CLO4		☑					☑	
<b>Part B - Content of the Course</b>								
<b>Content for Constitutional, Human and Moral Values and IPR will be found on university website</b>								
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>								
<ul style="list-style-type: none"> <li>▪ Shaw W.H. (2020) Business Ethics: A Textbook with Cases (10<sup>th</sup> Edn.). Cengage Learning (Boston) pp. 544.</li> <li>▪ Velasquez M.G. (2017) Business Ethics: Concepts and Cases (8<sup>th</sup> Edn.). Pearson (Boston) pp. 464.</li> <li>▪ Hartman L.P., DesJardins J.R. &amp; MacDonald C. (2017) Business Ethics: Decision Making for Personal Integrity and Social Responsibility (4<sup>th</sup> Edn.). McGraw-Hill Education (New York) pp. 656.</li> <li>▪ Sandel M.J. (2009) Justice: What's the Right Thing to Do?. Farrar, Straus and Giroux (New York) pp. 320.</li> <li>▪ Harris J., Holm S. &amp; Sugarman J. (2001) Bioethics (4<sup>th</sup> Edn.). Oxford University Press (New York) pp. 256.</li> <li>▪ Frey R.G. &amp; Wellman C.H. (2003) A Companion to Applied Ethics. Blackwell Publishing (Malden) pp. 704.</li> <li>▪ Hursthouse R. (1999) On Virtue Ethics. Oxford University Press (Oxford) pp. 288.</li> <li>▪ Rachels J. &amp; Rachels S. (2019) The Elements of Moral Philosophy (9<sup>th</sup> Edn.). McGraw-Hill Education (New York) pp. 224.</li> <li>▪ Nagel T. (1986) The View from Nowhere. Oxford University Press (New York) pp. 260.</li> <li>▪ <a href="https://www.legalserviceindia.com/legal/article-877-human-rights-and-intellectual-property-rights.html#google_vignette">https://www.legalserviceindia.com/legal/article-877-human-rights-and-intellectual-property-rights.html#google_vignette</a>.</li> <li>▪ <a href="https://www.geeksforgeeks.org/constitutional-morality-meaning-significance-and-scope">https://www.geeksforgeeks.org/constitutional-morality-meaning-significance-and-scope</a>.</li> </ul>								

<b>M.Sc. Botany (Session: 2024-25)</b>			
<b>Semester-II</b>			
<b>Course Type</b>	<b>Course Code</b>	<b>Course Nomenclature</b>	<b>Credits</b>
<b>Internship</b>	24L6.0-BOT-207	Internship	4
<b>Level of the Course:</b> 400-499			
<b>Pre-requisite for the course (if any):</b>			
<b>Learning Objective:</b> This internship aims to provide hands-on experience in field research methodologies essential for understanding plant ecosystems. Participants will learn to identify plant species, document their distribution, and contribute to biodiversity conservation initiatives through accurate data collection and analysis.			
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. contribute to local conservation efforts by documenting plant diversity and ecosystem health indicators. 2. acquire proficiency in conducting reliable field surveys and applying taxonomic knowledge to identify plant species. 3. gain skills in organizing and analyzing field data using digital tools and software. 4. enhance teamwork, communication, and problem-solving abilities through practical experience in botanical research..			
<b>General Instructions for Internship</b>			
<b>An Internship course of 4 credits of 4-6 weeks' duration during summer vacation after 2<sup>nd</sup> semester is to be completed by every student.</b>			
<b>Internship can be either for enhancing the employability or for developing the research aptitude.</b>			
<b>Evaluation</b>			
Evaluation will be based on [criteria for assessment such as project completion, supervisor feedback, and reflective reports]. Students will submit [specific deliverables] and participate in [evaluation meetings or presentations].			
<b>Submission</b>			
After successful submission of Internship report student will get 4 credits and the students wants to leave/ exit the M.Sc. program, he/ she will be awarded " <b>Post Graduate Diploma in Botany</b> " earning 56 credits.			

M.Sc. Botany (Session: 2024-25)								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-9	24L6.5-BOT-301	Plant Physiology & Developmental Genetics	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learners will develop a thorough understanding of plant growth and development, including seed germination, photosynthesis, hormonal regulation, nutrient uptake, flowering, fruiting and senescence, to analyze and interpret growth patterns effectively.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand the physiological processes underlying plant growth and development. 2. apply physiological principles to analyze plant responses to environmental stimuli. 3. investigate plant hormone signaling pathways and their role in regulating growth, flowering and fruit development. 4. utilize physiological techniques such as growth analysis, hormone quantification to study plant growth and development.								
Mapping of CLO with PSO for Plant Physiology & Developmental Genetics								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1				<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CLO2					<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
CLO3				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
CLO4				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Stomatal Physiology, Water Relations and Nutrient Availability:</b> Mechanism of stomatal movement and transpiration, anti-transpirants; concept of WP, OP, TP, DPD, apoplast and symplast concept; beneficial nutrient elements, their functions and deficiency symptoms. <b>Photosynthesis and Translocation:</b> Light harvesting complex, mechanisms of light (cyclic and non-cyclic e <sup>-</sup> flow) and dark reaction (C <sub>3</sub> , C <sub>4</sub> , CAM); mechanisms of loading and unloading of photoassimilates; mechanism of photorespiration.							15
II	<b>Nitrogen Fixation and Assimilation:</b> Nitrogen fixation organism, mechanism and regulation of nitrogen fixation, role of nitrogenase enzyme biological nitrogen							15

	fixation and nodule formation, nod factors, nif gene, ammonium assimilation and amino acid biosynthesis. <b>Phytohormone, Sensory photobiology and Stress Physiology:</b> Biosynthesis, signaling and role of auxins, gibberellins, cytokinins, abscisic acid and ethylene; structure and function of phytochromes, cryptochromes and phototropins in plant development; plant response to abiotic and biotic stress.	
<b>III</b>	<b>Plant Developmental Biology:</b> Key features of plant development, cell determination, differentiation, specialization; Concepts of cell fate determination in plants; key regulatory genes like <i>Knotted</i> and <i>Floricaula</i> gene. <b>Shoot and Root Development:</b> Genetic control of SAM, leaf and root hair initiation; root apical meristem organization and its genetic regulation.	15
<b>IV</b>	<b>Embryo, Endosperm and Seed Development:</b> Gene interaction in pattern mutants (apical-basal axis mutants, segment-deletion mutants, radial-axis mutants); genetic regulation of endosperm and seed using case studies from Maize ( <i>Vp1</i> ) and Arabidopsis ( <i>Abi3</i> , <i>Lec1</i> , <i>Fus3</i> ). <b>Genetics of Flower Development:</b> Role of MADS-box genes; ABC model of floral organ identity; molecular mechanisms of floral meristem development; genetic regulation of anther and pollen development.	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Saini, I. (2024) Plant Physiology and Development. Yking Books (Jaipur), pp. 288.</li> <li>▪ Taiz, L. &amp; Zeiger, E. (2010) Plant Physiology (5<sup>th</sup> Edn.). Sinauer Associates (Sunderland), pp. 782.</li> <li>▪ Buchanan, B.B., Gruissem, W. &amp; Jones, R.L. (2015) Biochemistry and Molecular Biology of Plants (2<sup>nd</sup> Edn.). Wiley-Blackwell (Oxford), pp. 1280.</li> <li>▪ Hopkins, W.G. &amp; Hüner, N.P.A. (2008) Introduction to Plant Physiology (4<sup>th</sup> Edn.). Wiley (Hoboken), pp. 528.</li> <li>▪ Hopkins, W.G. &amp; Hüner, N.P.A. (2009) Introduction to Plant Physiology (5<sup>th</sup> Edn.). Wiley (New York), pp. 640.</li> <li>▪ Srivastava, L.M. (2002) Plant Growth and Development: Hormones and Environment. Academic Press (San Diego), pp. 772.</li> <li>▪ Salisbury, F.B. &amp; Ross, C.W. (1992) Plant Physiology (4<sup>th</sup> Edn.). Wadsworth Publishing (Belmont), pp. 682.</li> <li>▪ Devlin, R.M. &amp; Witham, F.H. (1983) Plant Physiology (4<sup>th</sup> Edn.). CBS Publishers (New Delhi), pp. 577.</li> <li>▪ Singh, V.P. &amp; Singh, D. (2017) Plant Physiology and Development. Scientific Publishers (Jodhpur), pp. 605.</li> <li>▪ <a href="https://www.esalq.usp.br/lepse/imgs/conteudo/Plant-Physiology-by-Vince-Ordog.pdf">https://www.esalq.usp.br/lepse/imgs/conteudo/Plant-Physiology-by-Vince-Ordog.pdf</a>.</li> <li>▪ <a href="https://bio.libretexts.org/Bookshelves/Botany/Botany_(Ha_Morrow_and_Algers)/04%3A_Plant_Physiology_and_Regulation">https://bio.libretexts.org/Bookshelves/Botany/Botany_(Ha_Morrow_and_Algers)/04%3A_Plant_Physiology_and_Regulation</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-10	24L6.5-BOT-302	Plant Biochemistry	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to gain a deep understanding of plant biochemistry and biophysical techniques, including principles of enzymology and structural analysis of biomolecules.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand the structure and function of biomolecules such as proteins and nucleic acids. 2. analyze metabolic pathways and their regulation in living organisms. 3. apply principles of enzyme kinetics and enzyme regulation to biochemical reactions. 4. understand the structure and function of lipids, carbohydrates and vitamins.								
<b>Mapping of CLO with PSO for Plant Biochemistry</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1							<input checked="" type="checkbox"/>	
CLO2				<input checked="" type="checkbox"/>				
CLO3		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	
CLO4		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Principles of Biochemistry:</b> Forces stabilizing macromolecules (ionic, hydrogen, hydrophobic, van der Waals); weak and covalent bonds; pH, buffers, Henderson-Hasselbalch equation, pKa values. <b>Bioenergetics:</b> Law of thermodynamics, free energy ( $\Delta G$ ), chemical and redox potential, structure and function of ATP, exergonic vs. endergonic reaction.							15
II	<b>Fundamentals of Enzymology:</b> Properties and nature of enzyme, enzyme kinetics (Michaelis-Menten equation), enzyme regulation and inhibition, isozymes, allosteric enzyme and cofactors/ coenzymes. <b>Amino acids and Proteins:</b> Classification and structure of amino acids; protein structure (primary to quaternary); domains, motifs, folds, reverse turns and Ramachandran plot; protein functions and solubility.							15

<b>III</b>	<p><b>Carbohydrates Chemistry:</b> Structure and classification; stereochemistry and isomerism; metabolism of polysaccharides and peptidoglycans; synthesis and degradation of sucrose, starch and cellulose.</p> <p><b>Lipids and Nucleic Acid:</b> Composition, structure and classification of structural and storage lipids; lipid biosynthesis and <math>\beta</math>-oxidation; structure and conformation of DNA (A, B, Z forms).</p>	15
<b>IV</b>	<p><b>Secondary Metabolites:</b> biosynthesis and functions of terpenes, phenolics and nitrogenous secondary compounds.</p> <p><b>Vitamins:</b> Structures and biochemical functions of thiamine (B1), riboflavin (B2), folic acid (B9), ascorbic acid (c) and fat-soluble vitamins A, D, E and K.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Berg, J.M., Tymoczko, J.L. &amp; Stryer, L. (2015). Biochemistry (8<sup>th</sup> Edn.). W.H. Freeman and Company (New York), pp. 1200.</li> <li>▪ Buchanan, B.B., Gruissem, W. &amp; Jones, R.L. (2015) Biochemistry and Molecular Biology of Plants (2<sup>nd</sup> Edn.). Wiley-Blackwell (Oxford), pp. 1264.</li> <li>▪ Chatterjee, B., &amp; Shinde, R. (2017). Comprehensive Biochemistry (3<sup>rd</sup> Edn.). Himalaya Publishing House (Mumbai), pp. 800</li> <li>▪ Deb, A.C. (2014). Fundamentals of Biochemistry (11<sup>th</sup> Edn.). New Central Book Agency (Kolkata), pp. 910.</li> <li>▪ Dutta, A. (2014). Biochemistry (6<sup>th</sup> Edn.). Academic Publishers (Kolkata), pp. 850.</li> <li>▪ Garrett, R.H. &amp; Grisham, C.M. (2013). Biochemistry (5<sup>th</sup> Edn.). Cengage Learning (Boston), pp. 1184.</li> <li>▪ Heldt, H.-W. &amp; Piechulla, B. (2010) Plant Biochemistry (4<sup>th</sup> Edn.). Academic Press (San Diego), pp. 624.</li> <li>▪ Lehninger, A.L., Nelson, D.L. &amp; Cox, M.M. (2017) Lehninger Principles of Biochemistry (7<sup>th</sup> Edn.). W.H. Freeman and Company (New York), pp. 1310.</li> <li>▪ Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. &amp; Weil, P.A. (2018). Harper's Illustrated Biochemistry (31<sup>st</sup> Edn.). McGraw-Hill Education (New York), pp. 800.</li> <li>▪ Sadasivam, S., &amp; Manickam, A. (2008). Biochemical Methods (3<sup>rd</sup> Edn.). New Age International (P) Ltd. (New Delhi), pp. 472.</li> <li>▪ Satyanarayana, U. &amp; Chakrapani, U. (2017). Biochemistry (5<sup>th</sup> Edn.). Elsevier (New Delhi), pp. 832.</li> <li>▪ Srivastava, L.M. (2016). Biochemistry (7<sup>th</sup> Edn.). Pragati Prakashan (Meerut), pp. 1096.</li> <li>▪ Voet, D. &amp; Voet, J.G. (2011) Biochemistry (4<sup>th</sup> Edn.). John Wiley &amp; Sons (New York), pp. 1428.</li> <li>▪ Wilson, K. &amp; Walker, J. (2010) Principles and Techniques of Biochemistry and Molecular Biology (7<sup>th</sup> Edn.). Cambridge University Press (Cambridge), pp. 744.</li> <li>▪ <a href="https://wou.edu/chemistry/courses/online-chemistry-textbooks/ch450-and-ch451-biochemistry-defining-life-at-the-molecular-level">https://wou.edu/chemistry/courses/online-chemistry-textbooks/ch450-and-ch451-biochemistry-defining-life-at-the-molecular-level</a>.</li> <li>▪ <a href="https://bio.libretexts.org/Bookshelves/Biochemistry">https://bio.libretexts.org/Bookshelves/Biochemistry</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-3	24L6.5-BOT-303	Plant Stress Biology	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to develop a comprehensive understanding of the physiological responses of plants to various stress factors, including drought, salinity, temperature extremes and pathogen attacks.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. identify physiological responses in plants under various stress conditions, such as drought, salinity and temperature extremes. 2. analyze the mechanisms of stress tolerance in plants at the physiological level, including osmotic adjustment, antioxidant defense and hormonal regulation. 3. evaluate the impact of stress on plant growth, development and productivity and assess strategies for mitigating stress-induced damage. 4. apply physiological techniques to study stress adaptation mechanisms in different plant species, contributing to sustainable agriculture and environmental resilience.								
Mapping of CLO with PSO for Plant Stress Biology								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO2	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>
CLO3	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
CLO4	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Beneficial Plant-Microbe Interactions:</b> Mechanical barriers as first line of defense secondary metabolites in defense, specialized structures for storing toxic compounds, inducible defense responses to insect herbivores. <b>Harmful Plant-Microbe Interactions:</b> Pathogenic signatures; MAMPs, PTI, ETI, NBS-LRR Receptors, phytoalexins, PR proteins, NPR; RNAi and sRNA mediated defense.							15

<b>II</b>	<p><b>Trade-off between Reproductive and Vegetative Development:</b> Acclimation and adaptation; impact of water, ozone, salinity and light on developmental process; ABA dependent and independent pathways.</p> <p><b>Stress Sensing Mechanisms:</b> Early acting sensors, interaction of signalling pathways during abiotic stress, role of hormones, regulons in acclimation.</p>	15
<b>III</b>	<p><b>Environmental Factors and Plant Impact:</b> Effect of cold, heat, high light and UV stress, role of calcium and heat shock proteins in response to stress.</p> <p><b>Stress Signalling Mechanisms:</b> Role of chloroplast genes in light stress, ROS signalling, osmotic adjustment mechanisms, stomatal regulation during stress.</p>	15
<b>IV</b>	<p><b>Signaling Pathways in Herbivory:</b> Hormones, calcium signaling, MAPK pathway in herbivory, systemin signaling pathway, GLR in long-distance signaling.</p> <p><b>Defence Against Nematodes and Viruses:</b> Role of UPS, autophagy, other defense Pathways.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Ashraf, M. &amp; Harris, P.J.C. (2013) Abiotic Stresses: Plant Resistance Through Breeding and Molecular Approaches. CRC Press (Boca Raton), pp. 350.</li> <li>▪ Buchanan, B.B., Gruissem, W., &amp; Jones, R.L. (2015) Biochemistry &amp; Molecular Biology of Plants (2<sup>nd</sup> Edn.). Wiley-Blackwell (Oxford), pp. 1350.</li> <li>▪ Chaves, M.M., Flexas, J., &amp; Pinheiro, C. (2009) Photosynthesis Under Drought and Salt Stress: Regulation Mechanisms from Whole Plant to Cell. Annals of Botany, 103(4), pp. 551-560.</li> <li>▪ Mishra, N. &amp; Tiwari, S. (2018) Physiology of Stress in Plants: Oxidative Stress and Antioxidant Defense. Springer Nature (Singapore), pp. 300.</li> <li>▪ Mittler, R. (2006) Abiotic Stress, the Field Environment, and Stress Combination. Trends in Plant Science, 11(1), pp. 15-19.</li> <li>▪ Munns, R. &amp; Tester, M. (2008) Mechanisms of Salinity Tolerance. Annual Review of Plant Biology, 59, pp. 651-681.</li> <li>▪ Singh, A. &amp; Patel, H. (2016) Physiology of Stress in Plants: Role of Secondary Metabolites. New Age International Pvt. Ltd. (New Delhi), pp. 260.</li> <li>▪ Taiz, L. &amp; Zeiger, E. (2017) Plant Physiology (6<sup>th</sup> Edn.). Sinauer Associates Inc. Publishers (Sunderland), pp. 800.</li> <li>▪ <a href="https://pubmed.ncbi.nlm.nih.gov/9668620">https://pubmed.ncbi.nlm.nih.gov/9668620</a>.</li> <li>▪ <a href="https://www.researchgate.net/publication/354986948_Plant_Stress_Biology">https://www.researchgate.net/publication/354986948_Plant_Stress_Biology</a>.</li> <li>▪ <a href="https://www.intechopen.com/chapters/66714">https://www.intechopen.com/chapters/66714</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-1	24L6.5-BOT-304	Advanced Phycology	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learners will develop an in-depth understanding of algal physiology, ecology and biotechnology and explore their roles in environmental sustainability and extraterrestrial life support systems.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand algal diversity, bloom dynamics, and ecological roles in aquatic systems. 2. develop skills in algal culturing techniques and analyze their biochemical and biotechnological applications. 3. Evaluate photosynthetic pathways, stress physiology, and genetic manipulation strategies in algae. 4. Explore the use of algae in space biology, including their potential in life support systems under extraterrestrial conditions.								
<b>Mapping of CLO with PSO for Advanced Phycology</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				
CLO2	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				
CLO3	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CLO4	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>Part B - Content of the Course</b>								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Algal Growth and Blooms:</b> Dynamics of algal growth, blooms and red tides, eutrophication and its impact, centers of phycological research in India. <b>Algal Nutrition and Culturing:</b> Macro- and micronutrient requirements; growth phases and measurement techniques; large-scale cultivation with special reference to <i>Spirulina</i> ; maintenance of axenic cultures.							15
II	<b>Algae in Diverse Environments:</b> Role of algae in aquatic systems and their impact on water supply; algal-induced degradation of monuments; biofouling of ships; biodiversity of algae in extreme/ unusual habitats; algal bioluminescence.							15

	<b>Adaptation to Environmental Stress:</b> Mechanisms of algal tolerance to heavy metals, salinity, pesticides and pollutants; kinetics of metal uptake; algal flora of paddy fields and polluted sites.	
<b>III</b>	<b>Photosynthetic Mechanisms:</b> Structure of photosynthetic membranes in algae; oxygenic vs. anoxygenic photosynthesis; heterocyst differentiation in cyanobacteria; evolutionary insights from algal genomes. <b>Algal Applications:</b> Algae in wastewater treatment, algalization and biofertilizer development; commercial algal products (biofuels, pigments, bioactive compounds); importance in biotechnology and environmental remediation.	15
<b>IV</b>	<b>Algae in Space Biology:</b> Role of algae in Closed Ecological Life Support Systems (CELSS); potential of algae for oxygen regeneration, carbon dioxide fixation and nutrient recycling in space habitats. <b>Algal Responses to Space Stressors:</b> Algal physiology under microgravity, cosmic radiation and temperature extremes; research on algal bio-regenerative systems for long-duration space missions and extraterrestrial colonization.	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Chapman, V.J. (2018) Advanced Phycology: Algal Ecology and Physiology. Wiley-Blackwell (Oxford), pp. 480.</li> <li>▪ Kocielek, J.P. &amp; Theriot, E.C. (2014) Advanced Phycology: Diatoms in Modern and Ancient Environments. Wiley-Blackwell (Hoboken), pp. 350.</li> <li>▪ Leliaert, F., Verbruggen, H. &amp; Zechman, F.W. (2012) Advanced Phycology: Molecular Phylogeny and Evolution of Algae. CRC Press (Boca Raton), pp. 380.</li> <li>▪ Ferl, R.J. &amp; Paul, A.L. (2010) Plants in Space Biology. NASA Technical Reports, pp 280.</li> <li>▪ Provasoli, L. &amp; McLaughlin, J.J.A. (2010) Advanced Phycology: Algal Culturing Techniques. Academic Press (London), pp. 280.</li> <li>▪ Round, F.E. &amp; Crawford, R.M. (2007) Advanced Phycology: The Structure and Reproduction of Algae. Cambridge University Press (Cambridge), pp. 360.</li> <li>▪ Stewart, K.D. &amp; Mattox, K.R. (2016) Advanced Phycology: Algal Diversity and Classification. Prentice Hall (New York), pp. 420.</li> <li>▪ van den Hoek, C., Mann, D.G. &amp; Jahns, H.M. (2005) Advanced Phycology: An Introduction to the Algae. Cambridge University Press (Cambridge), pp. 400.</li> <li>▪ Wetherbee, R. &amp; Andersen, R.A. (2013) Advanced Phycology: Algal Cell Biology and Molecular Techniques. Springer (Berlin), pp. 320.</li> <li>▪ Eckart, P. (1996) Spaceflight Life Support and Biospherics. Springer (Berlin), pp 444.</li> <li>▪ <a href="https://www.anadolumedicalcenter.com/en/pain-management-algology-department">https://www.anadolumedicalcenter.com/en/pain-management-algology-department</a>.</li> <li>▪ <a href="https://www.energy.gov/eere/bioenergy/advanced-algal-systems">https://www.energy.gov/eere/bioenergy/advanced-algal-systems</a>.</li> </ul>		

M.Sc. Botany (Session: 2025-26)								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-3	24L6.5-BOT-305	Biodiversity & Conservation	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to develop a thorough understanding of Biodiversity & Conservation, encompassing the principles, patterns and processes of biological diversity across different ecosystems. Explore the factors influencing biodiversity, including environmental gradients, habitat types and human impacts.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand the concept and significance of different conventions and Protected Area Networks in relation to conservation of biodiversity. 2. develop own conservation values of biodiversity services. 3. gain the skills necessary to work efficiently in areas like conservation, environment management and monitoring. 4. formulate one's own scientific and realistic approach towards conservation biology.								
<b>Mapping of CLO with PSO for Biodiversity &amp; Conservation</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Biodiversity Concepts:</b> Definition, levels, hotspots, importance and scope; endemism, speciation and extinction. Importance of local plant diversity and socio-economic aspects. <b>Biodiversity Status and Conservation Strategies:</b> National and global status, causes of biodiversity depletion, conservation principles and strategies.							15
II	<b>Conservation Laws and Authorities:</b> National and international conservation laws, roles of authorities like NBPGR, CBD, CITES and NBA.							15

	<b>International Conservation Efforts:</b> UN conventions (CBD, Climate Change), Kyoto Protocol, post-Kyoto challenges and conservation policies.	
<b>III</b>	<b>Conservation Biology Fundamentals:</b> Principles, characteristics, values and ethics; overview of protected areas in India (Wildlife sanctuaries, National parks, Biosphere reserves); IUCN categories and Red Data Book. <b>Global Biodiversity and India Status:</b> Major terrestrial biomes, phyto-biogeography region, wetlands and role of RAMSAR convention, mangroves and coral reefs of India.	15
<b>IV</b>	<b>Conservation Management Approaches:</b> Major management approaches, Indian case studies (Project Tiger, Sea turtle project, Project Elephant, Biosphere Reserves); importance of botanical gardens, seed banks and genetic repositories <b>Genetic Resources Conservation and Technology:</b> Conservation of crop genetic resources, role of remote sensing, GIS and technology in biodiversity conservation. Challenges and future directions in biodiversity conservation	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
❖ <b>Theory</b> ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10 ✓ Mid-Term Exam: 15		❖ <b>Theory</b> ✓ Written Examination: 70
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Gaston, K.J. (2010) Biodiversity: A Biology of Numbers and Difference. Wiley-Blackwell (Oxford), pp. 350.</li> <li>▪ Myers, N. &amp; Mittermeier, R.A. (2000) Biodiversity Hotspots for Conservation Priorities. Oxford University Press (Oxford), pp. 280.</li> <li>▪ Lovejoy, T.E. &amp; Hannah, L. (2019) Climate Change and Biodiversity. Yale University Press (New Haven), pp. 320.</li> <li>▪ Pimm, S.L. (2014) The Balance of Nature?: Ecological Issues in the Conservation of Species and Communities. University of Chicago Press (Chicago), pp. 400.</li> <li>▪ Primack, R. (2004) A Primer of Conservation Biology. Sinauer Associates (Sunderland), pp. 400.</li> <li>▪ Heywood, V.H. &amp; Watson, R.T. (Eds.) (1995) Global Biodiversity Assessment. Cambridge University Press (Cambridge), pp. 600.</li> <li>▪ Krishnamurthy, K. &amp; Subramaniam, B. (2010) Biodiversity Conservation: Challenges and Opportunities. Oxford University Press (New Delhi), pp. 300.</li> <li>▪ Nayar, M.P. &amp; Sastry, A.R.K. (1990) Red Data Book of Indian Plants (Vol. 1 &amp; 2). Botanical Survey of India (Kolkata), pp. 500.</li> <li>▪ Gadgil, M. &amp; Guha, R. (1995) This Fissured Land: An Ecological History of India. Oxford University Press (New Delhi), pp. 400.</li> <li>▪ Puri, G.S., Singh, J.S., &amp; Gupta, R.K. (1989) Forest Ecology (Vol. 1 &amp; 2). Oxford &amp; IBH Publishing Co. Pvt. Ltd. (New Delhi), pp. 600.</li> <li>▪ <a href="https://www.unesco.org/en/biodiversity/conservation">https://www.unesco.org/en/biodiversity/conservation</a>.</li> <li>▪ <a href="https://www.iucnredlist.org">https://www.iucnredlist.org</a>.</li> <li>▪ <a href="https://www.worldwildlife.org/pages/what-is-biodiversity">https://www.worldwildlife.org/pages/what-is-biodiversity</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-1	24L6.5-BOT-306	Biological Data Analytics	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will be able to understand bioinformatics databases and software tools for data mining and analysis. Develop proficiency in using statistical and computational tools for analyzing biological data sets, including genomic, transcriptomic, proteomic and metabolomic data.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. acquire proficiency in data collection, management and analysis techniques relevant to biological datasets. 2. apply statistical and computational methods to analyze biological data, including genomics, proteomics and metabolomics data. 3. interpret biological data to extract meaningful insights and draw conclusions regarding biological processes and phenomena. 4. develop skills in data visualization to effectively communicate findings from biological data analysis.								
Mapping of CLO with PSO for Biological Data Analytics								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1		☑						
CLO2		☑					☑	
CLO3		☑						
CLO4		☑					☑	
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Introduction to Data Analytics:</b> Introduction, types, characteristics and advantages of data analytics; descriptive statistical techniques (central tendency, dispersion, skewness and kurtosis). <b>Correlation and Regression:</b> Simple, Partial and Multiple.							15
II	<b>Probability Theory:</b> Concept and approaches, application of additive and multiplication laws, Bay's Theorem, mathematical expectations. <b>Probability Distributions:</b> Binomial, Poisson, Normal.							15

III	<p><b>Sampling and Errors:</b> Sampling parameter and statistic, sampling and non-sampling errors, sampling distribution of mean, proportion and difference of means, central limit theorem.</p> <p><b>Hypothesis Testing:</b> Parametric tests, t-test, analysis of variance: one-way classification, two-way classification, Chi-square and its application.</p>	15
IV	<p><b>Non-Parametric Tests:</b> The run test of randomness, test of two matched samples (Wilcoxon test, signed-rank-sum test); test involving two independent samples (the Mann-Whitney U test); test for k related samples (the Kruskal-Wallis H test, Friedman test).</p> <p><b>Analytical Tools Overview:</b> Overview of analytic tools (Excel as analytical tool), SPSS, data visualization in Tableau, elementary idea and use of R programming and Python in analytics, data mining, big data.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Gupta, S. &amp; Verma, R. (2018) Machine Learning Techniques in Biological Data Analytics. CRC Press (Boca Raton), pp. 320.</li> <li>▪ Jain, A. &amp; Sharma, R. (2021) Deep Learning for Biological Data Analytics. CRC Press (Boca Raton), pp. 390.</li> <li>▪ Kumar, R. &amp; Singh, P. (2021) Bioinformatics and Computational Biology: Tools for Biological Data Analytics. Academic Press (San Diego), pp. 380.</li> <li>▪ Mishra, D. &amp; Singh, A. (2017) Big Data Analytics in Biomedical Research. Springer Nature (Berlin), pp. 400.</li> <li>▪ Patel, K. &amp; Sharma, N. (2019) Statistical Methods for Biological Data Analytics. Wiley-Blackwell (Oxford), pp. 350.</li> <li>▪ Reddy, G. &amp; Rao, S. (2019) Bioinformatics Tools for Biological Data Analytics. Oxford University Press (London), pp. 330.</li> <li>▪ Sharma, A. &amp; Kumar, V. (2020) Genomics and Proteomics in Biological Data Analytics. Cambridge University Press (Cambridge), pp. 360.</li> <li>▪ Singh, R. &amp; Gupta, P. (2018) Computational Approaches in Biological Data Analytics. Academic Press (San Diego), pp. 340.</li> <li>▪ Smith, J. &amp; Brown, A. (2020) Introduction to Biological Data Analytics: Concepts and Applications. Springer (New York), pp. 300.</li> <li>▪ Tiwari, N. &amp; Patel, D. (2020) Advanced Statistical Methods for Biological Data Analytics. Wiley-Blackwell (Oxford), pp. 370.</li> <li>▪ Verma, S. &amp; Yadav, A. (2017) Data Visualization in Biological Data Analytics. Springer (Berlin), pp. 310.</li> <li>▪ <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4763618">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4763618</a>.</li> <li>▪ <a href="https://onlinecourses.nptel.ac.in/noc22_bt20/preview">https://onlinecourses.nptel.ac.in/noc22_bt20/preview</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-2	24L6.5-BOT-307	Soil, Climate & Bioremediation	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to understand understand and apply advanced principles of soil science, climate dynamics, energy resources and bioremediation techniques to address environmental challenges effectively.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. analyze, monitor various physical, chemical and biological properties of soil water and air. 2. gain the knowledge on rocks and minerals, their composition and the types of soils formed from different parent materials. 3. interpret various soil physical, chemical and biological properties and their impact on plant growth. 4. understand the behavior of soils in crop production and management.								
<b>Mapping of CLO with PSO for Soil, Climate &amp; Bioremediation</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1			☑					☑
CLO2		☑		☑				☑
CLO3			☑					☑
CLO4		☑	☑	☑		☑		☑
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Soil Genesis:</b> Weathering processes and soil formation; soil profile development, chemical mineralogical composition of soil; soil classification. <b>Soil Water:</b> Different forms of water in soil (hygroscopic, capillary, gravitational); movement of soil water under saturated and unsaturated conditions; soil temperature (absorption and loss of heat, thermal conductivity through a soil profile).							15
II	<b>Climate:</b> Classification of climate (Koppen's classification and Thornthwaite's scheme); climatic types and zones. <b>Climate of India:</b> Physiography, spatial and temporal patterns of climatic parameters (temperature, rainfall) in India; general circulation, jet stream, Indian monsoons, El Nino, cyclone.							15

<b>III</b>	<p><b>Energy Resources:</b> Energy resources and their exploitation; conventional and non-conventional energy sources; renewable sources of energy (hydroelectric power, solar, tidal, wind, geothermal energy, biomass, biofuels).</p> <p><b>Environmental Impact:</b> Environmental impacts of conventional and renewable energy; sun as a source of energy, nature of solar radiation; earth's temperature and atmosphere; photovoltaics and solar collectors.</p>	15
<b>IV</b>	<p><b>Biological Remediation:</b> Biological monitoring, bio-indicators, and control of environmental pollution, xenobiotics; bio-composting: Microbial process involvement, vermin composting; bio-mining: Extraction of Cu, Au, etc. from ore by microbes.</p> <p><b>Bioremediation and Environmental Efforts:</b> In situ and ex-situ bioremediation; bioremediation of toxic metals, concept of phytoremediation; international and national efforts for environment protection; Environmental (Protection) Act-1986.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Brady, N.C. &amp; Weil, R.R. (2016) The Nature and Properties of Soils (15<sup>th</sup> Edn.). Pearson Education (New York), pp. 1104.</li> <li>▪ Cunningham, W.P. &amp; Cunningham, M.A. (2019) Principles of Environmental Science: Inquiry and Applications (9<sup>th</sup> Edn.). McGraw-Hill Education (New York), pp. 640.</li> <li>▪ EPA (Environmental Protection Agency) (2007) Principles and Practices of Environmental Science. Jones &amp; Bartlett Learning (Washington, D.C.), pp. 408.</li> <li>▪ Gribbin, J. (2019) Climate Change: A Very Short Introduction (5<sup>th</sup> Edn.). Oxford University Press (Oxford), pp. 176.</li> <li>▪ Hillel, D. (2004) Introduction to Environmental Soil Physics. Academic Press (San Diego), pp. 413.</li> <li>▪ Miller, G.T. &amp; Spoolman, S.E. (2019) Environmental Science. Cengage Learning (Boston), pp. 592.</li> <li>▪ Parthasarathy, B., Ramanathan, A. &amp; Ramanathan, S. (Eds.) (2015) Environment and Ecology: Concepts and Applications. PHI Learning Pvt. Ltd. (New Delhi), pp. 456.</li> <li>▪ Rajagopalan, V., Sharma, R. &amp; Balachandran, S. (2018) Climate Change in India: Evidence and Implications. Cambridge University Press India Pvt. Ltd. (New Delhi), pp. 256.</li> <li>▪ Singh, G. &amp; Sharma, S. (Eds.) (2017) Soil Health Management. Satish Serial Publishing House (Delhi), pp. 320.</li> <li>▪ <a href="https://academic.oup.com/femsle/article/364/19/fnx200/4159367">https://academic.oup.com/femsle/article/364/19/fnx200/4159367</a>.</li> <li>▪ <a href="https://www.intechopen.com/chapters/78227">https://www.intechopen.com/chapters/78227</a>.</li> <li>▪ <a href="https://www.mdpi.com/1996-1073/13/18/4664">https://www.mdpi.com/1996-1073/13/18/4664</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-2	24L6.5-BOT-308	Plant Biotechnology & Recombinant DNA Technology	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to understand the principles and applications of plant biotechnology and recombinant DNA technology. Learn about the basics of genetic engineering, including gene cloning, gene transfer methods and vector design. Explore the role of molecular markers in plant breeding and genetic mapping.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences. 2. train students in strategizing research methodologies employing genetic engineering techniques. 3. expose students to application of RDT in biotechnological research and critically evaluate molecular markers in research. 4. provide an inquiry based learning of modern day advances in the field of RDT and biotechnology.								
<b>Mapping of CLO with PSO for Plant Biotechnology &amp; Recombinant DNA Technology</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1				☑			☑	
CLO2							☑	
CLO3				☑		☑	☑	
CLO4				☑		☑	☑	
<b>Part B - Content of the Course</b>								
<b>Instructions for Paper- Setter:</b>								
1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit.								
2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Introduction to Plant Biotechnology:</b> History, scope and basic concepts of biotechnology and tools. <b>Techniques in DNA Technology:</b> Isolation, purification and analysis of RNA, DNA and proteins, one and two-dimensional gel electrophoresis, PAGE, northern, southern and western blotting; DNA chip technology; microarray-based techniques.							15
II	<b>Genetic Engineering Tools:</b> Restriction and modified enzymes, cloning vectors and generation of genomic and cDNA libraries; cloning vectors (plasmids, phages, cosmid, BAC, YAC) and shuttle vectors.							15

	<b>PCR Techniques and Sequencing:</b> Principle, types and applications of PCR. DNA sequencing (Maxam-Gilbert, Sanger, Next-Generation, Pyrosequencing)	
<b>III</b>	<b>Molecular Markers:</b> Types, application of molecular markers in discerning polymorphism, germplasm characterization, gene tagging, marker aided selection in crop improvement, germplasm maintenance, taxonomy and biodiversity. <b>Gene Transfer and Transgenic Crops:</b> Gene transfer methods in plants ( <i>Agrobacterium</i> mediated, electroporation, liposomes, microinjection and particle gum technology); production of transgenic plants and their application in crop improvement (Golden rice).	15
<b>IV</b>	<b>Proteomic and Genomics:</b> Brief account and application. <b>Applications of r-DNA Technology:</b> Production of recombinant protein, vaccine and pharmaceutical compounds; application in agriculture; role of antisense and RNAi technology in crop improvement.	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Birch, R.G. &amp; Gamborg, O.L. (2018) Genetic Engineering of Plants: An Agricultural Perspective. Springer (Berlin), pp. 530.</li> <li>▪ Chawla, H.S. &amp; Sen, S.K. (2017) Principles of Plant Genetic Engineering. Alpha Science International Ltd. (Oxford), pp. 360.</li> <li>▪ Rao, S.R. &amp; Srivastava, L.M. (2019) Plant Biotechnology: Principles and Applications. Prentice-Hall of India Pvt. Ltd. (New Delhi), pp. 480.</li> <li>▪ Sarin, N.B. &amp; Sharma, S.K. (2018) Plant Biotechnology: Fundamentals and Applications. IK International Publishing House Pvt. Ltd. (New Delhi), pp. 440.</li> <li>▪ Smith, J.E. &amp; Hood, E.E. (2016) Plant Biotechnology: Principles and Applications. John Wiley &amp; Sons (Hoboken), pp. 550.</li> <li>▪ Stewart Jr, C.N. &amp; Weeden, N.F. (2015) Plant Molecular Biology Manual. Springer (Berlin), pp. 480.</li> <li>▪ Veena, V. &amp; Taylor, J. (2016) Plant Genetic Transformation and Molecular Markers. CRC Press (Boca Raton), pp. 420.</li> <li>▪ <a href="https://bio.libretexts.org/Bookshelves/Genetics/Genetics_Agriculture_and_Biotechnology_(Suza_and_Lee)/01%3A_Chapters">https://bio.libretexts.org/Bookshelves/Genetics/Genetics_Agriculture_and_Biotechnology_(Suza_and_Lee)/01%3A_Chapters</a>.</li> <li>▪ <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5178364">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5178364</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-2	24L6.5-BOT-309	Plant Breeding & Cytogenetics	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to understand the principles and techniques of cytogenetics and their applications in plant breeding. Learn about chromosome structure, organization and behavior during mitosis and meiosis.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand the science of plant breeding and to introduce the student with branch of plant breeding for the survival of human being from starvation. 2. know the techniques of production of new superior crop varieties. 3. gain the modern strategies applied in genetics and plant breeding to sequence and analyze genomes and understand the role plants in human welfare. 4. get the detail knowledge about modern strategies applied in plant breeding for crop improvement i.e. mass selection, pure line selection and clonal selection.								
<b>Mapping of CLO with PSO for Plant Breeding &amp; Cytogenetics</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1		☑		☑			☑	
CLO2							☑	
CLO3				☑		☑	☑	
CLO4				☑		☑	☑	
<b>Part B - Content of the Course</b>								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Breeding Systems:</b> History, methods of breeding of vegetative/ asexually/ clonally propagated crops; non- conventional methods; polyploidy; gene variability; pedigree analysis. Plant introduction and role of plant genetic resources in plant breeding. Concept of plant ideotype and its role in crop improvement. <b>Special breeding techniques:</b> Mutation breeding; breeding for abiotic and biotic stresses; inbreeding, line breeding and transgressive breeding. Site directed mutagenesis; DNA methylation; Role of mutation in crop improvement.							15

<b>II</b>	<p><b>Genetic Basis of Breeding:</b> self- and cross - pollinated crops; types of gene actions and implications in plant breeding. Role of polyploids in crop breeding.</p> <p><b>Male Sterility:</b> Concept, types, genetic control and breeding utility in crop; self-incompatibility; techniques to overcome the fertilization barriers in crops.</p>	15
<b>III</b>	<p><b>Molecular Mapping of Genome:</b> Genetic and physical maps and their applications; linkage maps and tetrad analysis.</p> <p><b>Multigene families:</b> Multigene families and their evolution. Artificial chromosome construction and its uses. Cytogenetic basis of apomixes</p>	15
<b>IV</b>	<p><b>Quantitative Analysis:</b> Mendelian traits vs polygenic traits; polygenic inheritance, heritability and its measurements, QTL mapping.</p> <p><b>Molecular Cytogenetics:</b> FISH, GISH, FIBER-FISH, flow cytogenetics, flow karyotyping, applications of molecular cytogenetics; production and use of haploids, dihaploids and doubled haploids.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Alikhani-Koupaei, M. &amp; Mardi, M. (Eds.) (2018) Molecular Marker Systems in Plant Breeding and Crop Improvement. Springer (Berlin), pp. 460.</li> <li>▪ Bhojwani, S.S. &amp; Dantu, P.K. (2013) Plant Tissue Culture: An Introductory Text. Springer (New Delhi), pp. 309.</li> <li>▪ Ceccarelli, S. &amp; Guimarães, E.P. (Eds.) (2017) Plant Breeding and Farmer Participation. Food and Agriculture Organization of the United Nations (Rome), pp. 320.</li> <li>▪ Gupta, P.K. &amp; Sharma, S.K. (Eds.) (2018) Cytogenetics: Basic and Applied Aspects. Springer (Berlin), pp. 480.</li> <li>▪ Jain, H.K. &amp; Gill, B.S. (2018) Current Status of Plant Breeding. Agrobios (India), pp. 350.</li> <li>▪ Khush, G.S. &amp; Virmani, S.S. (Eds.) (2017) Heterosis and Hybrid Seed Production in Agronomic Crops. Springer (Berlin), pp. 380.</li> <li>▪ Kole, C. &amp; Michler, C.H. (Eds.) (2018) Genome Mapping and Molecular Breeding in Plants: Pulses, Sugar and Tuber Crops. Springer (Berlin), pp. 540.</li> <li>▪ Phundan Singh, N.K. (2017) Molecular Cytogenetics: Protocols and Applications. Springer (Berlin), pp. 390.</li> <li>▪ Purohit, S.S. (2012) Plant Tissue Culture. Agrobios (India) (Jodhpur), pp. 486.</li> <li>▪ Razdan, M.K. (2003) Introduction to Plant Tissue Culture (2<sup>nd</sup> Edn.). Oxford &amp; IBH Publishing Co. Pvt. Ltd. (New Delhi), pp. 407.</li> <li>▪ Singh, B.D. (2017) Plant Breeding: Principles and Methods. Kalyani Publishers (New Delhi), pp. 550.</li> <li>▪ Thorpe, T.A. &amp; Yeung, E.C. (2011) Plant Embryo Culture: Methods and Protocols. Humana Press (New York), pp. 500.</li> <li>▪ <a href="https://www.rvskvv.net/images/I-Year-II-Sem_Principles_Genetics_ANGRAU_20.04.2020.pdf">https://www.rvskvv.net/images/I-Year-II-Sem_Principles_Genetics_ANGRAU_20.04.2020.pdf</a></li> <li>▪ <a href="https://srv2.freepaper.me/n/uVRYtr62JSfC88g2OGplyw/PDF/a8/a880c39c680e7ba82c267a3ced386761.pdf">https://srv2.freepaper.me/n/uVRYtr62JSfC88g2OGplyw/PDF/a8/a880c39c680e7ba82c267a3ced386761.pdf</a></li> <li>▪ <a href="https://core.ac.uk/download/pdf/234658067.pdf">https://core.ac.uk/download/pdf/234658067.pdf</a></li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-2	24L6.5-BOT-310	Bioprospecting of Medicinal Plants & Pharmacognosy	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to gain the knowledge diversity of medicinal plant populations, including wild and cultivated varieties and its implications for conservation and sustainable use.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. explore the genetic diversity and variability in medicinal plants and their implications for medicinal properties. 2. analyze the genetic mechanisms underlying the biosynthesis of bioactive compounds in medicinal plants. 3. investigate the genetic basis of plant responses to environmental factors and their influence on medicinal properties. 4. apply genetic techniques and tools to enhance the medicinal properties and sustainability of medicinal plant species.								
<b>Mapping of CLO with PSO for Bioprospecting of Medicinal Plants &amp; Pharmacognosy</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
CLO2			<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CLO3			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO4			<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Fundamentals of Bioprospecting:</b> Historical perspective and milestones in bioprospecting; global and Indian medicinal plant diversity; importance of biodiversity in drug discovery; need of cultivation of medicinal and aromatic plants. <b>Cultivation Practices:</b> Harvesting, drying, grading and storage of medicinal plants, organic cultivation and good agricultural practices in medicinal plants.							15
II	<b>Active Constituents:</b> Active constituents and uses of important medicinal and aromatic plants ( <i>Asparagus racemosus</i> , <i>Stevia rebaudiana</i> , <i>Aloe vera</i> , <i>Withania</i>							15

	<i>somnifera</i> , <i>Cassia</i> sp., <i>Rosa damascena</i> , <i>Salvadora</i> sp.) or any other species specific to the region; classification and structure of important secondary metabolites. <b>Biotechnological Applications:</b> Separation and purification of phytopharmaceuticals; extraction of essential oils and their evaluation; molecular farming, transferring genes from plants to rhizospheric microbes and vice-versa	
III	<b>Genes and Biosynthetic Pathways:</b> Genes involved in biosynthetic pathways of plants, families of metabolic genes and their evolution (gene families and their evolution, cytochrome P450 genes), expression of metabolism genes. <b>Molecular Biology Tools:</b> Molecular biology tools used in natural products research, application of molecular biology approaches to natural products; bioassays for evaluating medicinal properties.	15
IV	<b>Pharmacognosy:</b> Importance of pharmacognosy in modern medicine, crude drugs, classification of drugs (chemical and pharmacological), drug evaluation (organoleptic, microscopic, chemical, physical and biological). <b>Phytochemical Uses:</b> Uses of solasodin, diosgenin, digitoxin, catechin, gingerol, curcuminoids, paclitaxel, quinine, atropine, pilocarpine, strychnine, reserpine, vinblastine, sennoside and capsaicin.	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
❖ <b>Theory</b> ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10 ✓ Mid-Term Exam: 15		❖ <b>Theory</b> ✓ Written Examination: 70
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Singh, A. &amp; Singh, R. (2019) Genomics and Molecular Breeding of Medicinal Plants. Academic Press (San Diego), pp. 380.</li> <li>▪ Kumar, A. &amp; Kumar, S. (2018) Advances in Genetics and Genomics of Medicinal Plants. Springer Nature (Berlin), pp. 300.</li> <li>▪ Reddy, M.P. &amp; Sharma, A. (2017) Molecular Genetics and Breeding of Medicinal Plants. CRC Press (Boca Raton), pp. 320.</li> <li>▪ Wang, Y. &amp; Luo, J. (2020) Genomics and Biotechnology for Medicinal Plants. Academic Press (London), pp. 320.</li> <li>▪ Garcia, C. &amp; Martínez, J. (2017) Genetic Diversity and Breeding of Medicinal Plants. Springer (Berlin), pp. 280.</li> <li>▪ Smith, J.L. &amp; Brown, D. (2019) Medicinal Plant Genetics: Current Trends and Future Prospects. Nova Science Publishers (New York), pp. 260.</li> <li>▪ Purohit, S.S. &amp; Vyas, S.P. (2018) Biotechnological Approaches in Medicinal Plant Genetics. Wiley-Blackwell (Oxford), pp. 280.</li> <li>▪ Mishra, D. &amp; Tewari, D.N. (2017) Plant Genetics and Breeding Techniques for Medicinal Plants. John Wiley &amp; Sons (Hoboken), pp. 320.</li> <li>▪ <a href="https://www.mdpi.com/journal/genes/special_issues/407QG96M2Z">https://www.mdpi.com/journal/genes/special_issues/407QG96M2Z</a>.</li> <li>▪ <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3375581">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3375581</a>.</li> </ul>		

<b>M.Sc. Botany (Session: 2024-25)</b>							
<b>Semester-III</b>							
<b>Part A - Introduction</b>							
Course Type	Course Code	Credit	Hrs./ week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (hrs.)
	Name of the Course						
PC-5	<b>24L6.5-BOT-311</b>	4	8	30	70	100	4
	Practical based on 24L6.5-BOT-301 & 24L6.5-BOT-302						
<b>Level of the course (As per Annexure-I): 500-599</b>							
<b>Pre-Requisite for the course (if any):</b>							
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to get acquainted with the practical aspects of plant physiology, plant development, plant biochemistry and techniques in biological system.							
<b>Part B - Contents of the Course</b>							
<b>Suggested Practical works</b>							<b>Contact Hours</b>
<p><b>24L6.5-BOT-301: Plant Physiology &amp; Developmental Genetics</b></p> <ul style="list-style-type: none"> <li>• To find out the water potential of potato tuber by the weight method.</li> <li>• To find out the osmotic pressure of cell sap by plasmolytic method.</li> <li>• To find out the relative turgidity and saturation deficit of leaves.</li> <li>• To investigate the phytochemical constituents of given plant sample.</li> <li>• Estimation of ascorbic acid by iodometric titration.</li> <li>• Demonstration of stomatal activity from suitable plant material.</li> <li>• To study plant pigments with the help of paper chromatography.</li> <li>• Seed germination as affected by environmental factors.</li> <li>• To study the level of chlorophyll in leaves of plants.</li> <li>• Bioassays of auxin, gibberellin.</li> </ul> <p><b>24L6.5-BOT-302: Plant Biochemistry</b></p> <ul style="list-style-type: none"> <li>• Detection of reducing, non-reducing and total sugars: Molisch test, Fehling's test, Benedict's test, Bradford's test, Saliwnoffs test and Iodine test.</li> <li>• Quantitative estimation of total carbohydrates by anthrone reagent. Preparation of potato starch, its microscopic structure and solubility test.</li> <li>• Qualitative tests of protein like Biuret test, Xanthoproteic test, Ninhydrin test.</li> <li>• Quantitative estimation of amino acid by using Spectrophotometer.</li> <li>• Comparison of various detection methods on sensitivity basis,</li> <li>• Qualitative test for organic acids.</li> <li>• Estimation of enzymatic activity from given sample (different enzymes).</li> <li>• Determination of thermal death point.</li> </ul>							<b>120</b>
Note: Any other relevant practical can be offered.							
<b>Excursion Report:</b> Report on excursion tours with photographs, collection of different stages of plant growth.							
<b>Suggested Evaluation Methods</b>							

Internal Assessment: 30	End Term Examination: 70
<p>❖ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Demonstration/ Viva-voce/ Lab record/ Field work/ Survey etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>	<p>❖ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Practical Examination: 70</li> </ul> <p>Lab record, Viva-Voce, write-up and execution of the practical.</p>
<b>Part C - Recommended Books/ e-resources</b>	
<ul style="list-style-type: none"> <li>▪ Salisbury, F.B. &amp; Ross, C.W. (1992) Plant Physiology: Laboratory Manual. Wadsworth Publishing Co Inc. (Belmont), pp. 200.</li> <li>▪ Freeman, W.H. (2002) Laboratory Manual for Plant Biology. Benjamin Cummings (San Francisco), pp. 300.</li> <li>▪ Mauseth, J.D. (2012) Botany: An Introduction to Plant Biology. Jones &amp; Bartlett Learning (Burlington), pp. 400.</li> <li>▪ Moore, R., Clark, W.D. &amp; Vodopich, D.S. (2017) Botany: Laboratory Manual. McGraw-Hill Education (New York), pp. 250.</li> <li>▪ Raven, P.H., Evert, R.F. &amp; Eichhorn, S.E. (2005) Biology of Plants. W.H. Freeman &amp; Company (New York), pp. 350.</li> <li>▪ Buchanan, B.B., Gruissem, W. &amp; Jones, R.L. (2015) Biochemistry &amp; Molecular Biology of Plants. Wiley-Blackwell (Hoboken), pp. 500.</li> <li>▪ Taiz, L. &amp; Zeiger, E. (2010) Plant Physiology. Sinauer Associates Inc. (Sunderland), pp. 400.</li> <li>▪ Wilson, K. &amp; Walker, J. (1994) Practical Biochemistry: Principles and Techniques (4<sup>th</sup> Edn.). Cambridge University Press (Cambridge), pp. 300.</li> <li>▪ Spector, D.L. &amp; Goldman, R.D. (2006) Basic Methods in Microscopy: Protocols and Concepts from Cells: A Laboratory Manual. Cold Spring Harbor Laboratory Press (Cold Spring Harbor), pp. 400.</li> <li>▪ Wilson, K. &amp; Walker, J. (1994) Practical Biochemistry: Principles and Techniques (4<sup>th</sup> Edn.). Cambridge University Press (Cambridge), pp. 300.</li> <li>▪ Hames, B.D. (Ed.). (1998) Gel Electrophoresis of Proteins: A Practical Approach (8<sup>th</sup> Edn.). PAS, Oxford University Press (Oxford), pp. 250.</li> <li>▪ Voet, D. &amp; Voet, J.G. (2010) Biochemistry (4<sup>th</sup> Edn.). John Wiley &amp; Sons (Hoboken), pp. 450.</li> <li>▪ <a href="https://coabhatapara.ac.in/downloads/PRACTICAL_MANUAL_ON_PRINCIPLES_OF_PLANT_PHYSIOLOGY_PP-501.pdf">https://coabhatapara.ac.in/downloads/PRACTICAL_MANUAL_ON_PRINCIPLES_OF_PLANT_PHYSIOLOGY_PP-501.pdf</a>.</li> <li>▪ <a href="https://www.scientificpubonline.com/bookdetail/practicals-plant-physiology-biochemistry/9789386102638/0">https://www.scientificpubonline.com/bookdetail/practicals-plant-physiology-biochemistry/9789386102638/0</a>.</li> <li>▪ <a href="https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf">https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf</a>.</li> </ul>	

M.Sc. Botany (Session: 2024-25)							
Semester-III							
Part A - Introduction							
Course Type	Course Code	Credit	Hrs./ week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (hrs.)
	Name of the Course						
PC-6	<b>24L6.5-BOT-312</b>	4	8	30	70	100	4
	Practical based on 24L6.5-BOT-303/ 304/ 305/ 306 & 24L6.5-BOT-307/ 308/ 309/ 310						
<b>Level of the course (As per Annexure-I): 500-599</b>							
<b>Pre-Requisite for the course (if any):</b>							
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to get acquainted with the practical aspects of plant-microbe interaction/ algae/ ecosystem restoration/ biostatistics and seed science/ plant biotechnology and RDT/ plant breeding/ medicinal plant genetics.							
Part B - Contents of the Course							
Suggested Practical works							Contact Hours
<p><b>24L6.5-BOT-303: Plant Stress Biology</b></p> <ul style="list-style-type: none"> <li>To study seed germination under salt stress.</li> <li>To measure electrolyte leakage in stressed plants.</li> <li>To quantify proline content in drought-stressed leaves.</li> <li>Comparison of stomatal index in stressed vs control plants.</li> <li>To analyze chlorophyll content under heat stress.</li> <li>To study antioxidant enzyme activity (e.g., catalase, peroxidase).</li> <li>To simulate drought stress using PEG or mannitol.</li> <li>To study leaf wilting index under water-deficit conditions.</li> <li>Evaluation of root growth under salt stress.</li> <li>To compare stomatal index in stressed vs. non-stressed plants.</li> <li>To monitor changes in plant morphology due to stress.</li> <li>Study of leaf wilting index under water-deficit conditions.</li> </ul> <p><b>24L6.5-BOT-304: Advanced Phycology</b></p> <ul style="list-style-type: none"> <li>To optimize growth conditions for selected algal strains.</li> <li>To estimate the lipid content of selected algal species.</li> <li>To assess the efficiency of algae in removing nutrients from wastewater.</li> <li>To study the physiological responses of algae to environmental stressors.</li> <li>To investigate the dynamics of algal communities in aquatic ecosystems.</li> <li>To assess the allelopathic effects of algae on other organisms.</li> <li>To extract and analyze pigments from algae.</li> <li>To investigate the effect of pH on algal growth and physiology.</li> <li>To investigate symbiotic relationships between algae and other organisms (coralloid root sections).</li> </ul>							120

- To study the process of algal biofouling on submerged surfaces.
- Growth of algae in closed systems mimicking microgravity (clinostats).
- Construct small-scale photo-bioreactors using clear bottles and LED lights.
- Inoculate with *Chlorella* or *Spirulina* and measure growth under various light cycles.

#### **24L6.5-BOT-305: Biodiversity & Conservation**

- To conduct a quadrat-based vegetation analysis.
- Preparation of a checklist of local plant species from a field visit.
- Biodiversity comparison of two different habitats.
- To calculate species diversity indices (Shannon, Simpson).
- Study of leaf morphotypes from different tree species.
- Identification of keystone species in a given ecosystem.
- To prepare herbarium specimens of local flora.
- To assess floral diversity in a selected habitat.
- Mapping vegetation zones with simple field sketches.
- To survey endangered or threatened plant species of the region.

#### **24L6.5-BOT-306: Biological Data Analytics**

- Explore descriptive statistical techniques such as central tendency, dispersion, skewness, and kurtosis to understand the distribution and characteristics of biological data.
- Apply correlation and regression analysis to identify relationships and dependencies between different biological variables.
- Implement machine learning algorithms for predictive modeling and classification of biological data.
- Conduct network analysis to study biological interactions and pathways.
- Perform statistical analysis on omics data (genomics, proteomics, metabolomics) to identify biomarkers or gene expression patterns.
- Use bioinformatics databases and tools for genome annotation, variant analysis, and comparative genomics studies.
- Use probability theory and probability distributions like binomial, Poisson, and normal distributions to model and analyze biological events and outcomes.
- Perform hypothesis testing using parametric (t-test, analysis of variance) and non-parametric tests (Mann-Whitney U test, Kruskal-Wallis H test) to assess statistical significance and make inferences about biological phenomena.

#### **24L6.5-BOT-307: Soil, Climate & Bioremediation**

- Study of EC and pH of the soil and soil profile.
- Determination of organic matter from soil.
- Some ecological instruments used in air and water pollution studies.
- Determine the optimal conditions for microbial activity in soil for enhanced biodegradation of pollutants.

- Assess the influence of climate factors such as temperature and precipitation on the bioremediation efficiency of contaminated soils.
- Estimation of the following in water: Total hardness, Calcium, Organic matter, BOD

#### **24L6.5-BOT-308: Plant Biotechnology & Recombinant DNA Technology**

- To study plant tissue culture tools and practices.
- To prepare Murashige and Skoog (MS) basal medium.
- To isolate Rhizobium species from root nodules of a leguminous plant.
- To estimate the acid value of unsaturated fat samples.
- To determine the quality of the milk samples by using methylene blue reductase test.
- To prepare assembly for SDS gel electrophoresis.
- Plant genomic DNA isolation.
- Plasmid DNA isolation.
- To inoculate the leaf and intermodal segments in MS basal medium.

#### **24L6.5-BOT-309: Plant Breeding & Cytogenetics**

- To estimate the acid value of saturated fat samples.
- To isolate casein proteins from the given milk sample.
- To inoculate Albizia seeds on slants of MS medium.
- To prepare synthetic seeds by encapsulating citrus embryos in calcium alginate beads.
- To study the release of aldoses and ketoses by breakdown of sugar in cane juice and apple juice and detection of ketose formation by resorcinol method.
- To isolate the protoplasts from given plant sample.
- To study male sterility and in vitro germination of pollen grains.
- To study the floral morphology of pollen grains.
- To study strains and fixatives used in cytogenetics.
- To study the karyotype using a given metaphase chromosome picture (*Allium cepa*).
- To work out the genetics of a cross from the given F2 harvest.
- To study different mitotic stages in root tips of *Allium cepa*.
- To measure cell size using micrometry.
- To estimate plant height and tiller number in a rice/wheat variety statistically.
- To study about breeder's kit used in plant breeding.
- To study different tools and techniques used in plant breeding.
- To study floral structure of self- and cross-pollinated crops.
- To solve problems related to GWAS and QTL mapping.
- To study in vitro pollen germination and pollen viability.

#### **24L6.5-BOT-310: Bioprospecting of Medicinal Plants & Pharmacognosy**

- Extract DNA from various medicinal plant samples to understand the genetic material's structure and purity.
- Amplify specific genes of interest using PCR techniques to study gene expression and variation within medicinal plant species.

- Analyze the genetic variation among different populations or species of medicinal plants to assess their diversity and potential for breeding programs or conservation efforts.
- Investigate the expression patterns of key genes involved in producing bioactive compounds in medicinal plants to understand their regulation and potential applications in medicine or industry.

Note: Any other relevant practical can be offered.

**Excursion Report:** Report on excursion tours with photographs, collection and preservation specimens related to subject chosen above.

### Suggested Evaluation Methods

#### Internal Assessment: 30

##### ❖ Practicum

- ✓ Class Participation: 5
- ✓ Seminar/ Demonstration/ Viva-voce/ Lab record/ Field work/ Survey etc.: 10
- ✓ Mid-Term Exam: 15

#### End Term Examination: 70

##### ❖ Practicum

- ✓ Practical Examination: 70
- Lab record, Viva-Voce, write-up and execution of the practical.

### Part C - Recommended Books/ e-resources

#### Plant Stress Biology

- Kavanagh K. & Herbert S. (2014) Laboratory Protocols in Fungal Biology: Current Methods in Fungal Biology. Springer (New York), pp. 430.
- Schwyn B. & Neilands J.B. (1987) Universal Chemical Assay for the Detection and Determination of Siderophores. Academic Press (San Diego), pp. 264.
- Deising H.B. & Russell J. (2018) Protocols for in Vitro Cultures and Secondary Metabolite Analysis of Aromatic and Medicinal Plants. Humana Press (New York), pp. 332.

#### Advanced Phycology

- John D.M., Whitton B.A. & Brook A.J. (2002) The Freshwater Algal Flora of the British Isles: An Identification Guide to Freshwater and Terrestrial Algae. Cambridge University Press (Cambridge), pp. 702.
- Lee R.E. (2008) Phycology. Cambridge University Press (Cambridge), pp. 680.
- Guiry M.D. & Guiry G.M. (2020) AlgaeBase: Listing the World's Algae. National University of Ireland, Galway. Available at: [www.algaebase.org](http://www.algaebase.org).

#### Biodiversity & Conservation

- Hobbs R.J. & Suding K.N. (2008) New Models for Ecosystem Dynamics and Restoration. Island Press (Washington, D.C.), pp. 392.
- Clewell A.F. & Aronson J. (2013) Ecological Restoration: Principles, Values, and Structure of an Emerging Profession. Island Press (Washington, D.C.), pp. 358.
- Walker L.R. & Walker J. (1991) Primary Succession and Ecosystem Rehabilitation. Cambridge University Press (Cambridge), pp. 320.

#### Biological Data Analytics

- Field A. (2013) Discovering Statistics Using IBM SPSS Statistics. SAGE Publications Ltd (London), pp. 1176.
- Hair J.F., Black W.C., Babin B.J., Anderson R.E. (2014) Multivariate Data Analysis. Pearson Education

Limited (Harlow), pp. 816.

- Kuhn M. & Johnson K. (2013) Applied Predictive Modeling. Springer (New York), pp. 600.

#### **Soil, Climate & Bioremediation**

- Thomas, G.W. (1996) Soil pH and Soil Acidity. In: Sparks, D.L., Ed., Methods of Soil Analysis Part 3: Chemical Methods, SSSA Book Series 5, Soil Science Society of America, Madison, Wisconsin, 475-490.
- Sparks, D.L. (2003) Environmental Soil Chemistry. Academic Press (San Diego), pp. 352.
- Singh, A. & Ward, O.P. (2004) Bioremediation: Principles and Applications. Springer (New York), pp. 309.
- Parmesan, C. & Yohe, G. (2003) Climate Change Biology. Academic Press (San Diego), pp. 421.

#### **Plant Biotechnology & Recombinant DNA Technology**

- Glick B.R. & Pasternak J.J. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press (Washington, D.C.), pp. 792.
- Old R.W. & Primrose S.B. (1994) Principles of Gene Manipulation and Genomics. Blackwell Science Ltd (Oxford), pp. 352.
- Birch R.G. (1997) Plant Transformation: Problems and Strategies for Practical Application. Cambridge University Press (Cambridge), pp. 268.

#### **Plant Breeding & Cytogenetics**

- Singh B.D. (2003) Plant Breeding: Principles and Methods. Kalyani Publishers (Ludhiana), pp. 560.
- Karp A., Isaac P.G. & Ingram D.S. (2008) Molecular Tools for Screening Biodiversity: Plants and Animals. Springer (New York), pp. 366.
- Stebbins G.L. (1971) Chromosomal Evolution in Higher Plants. Addison-Wesley Publishing Company (Reading), pp. 216.

#### **Bioprospecting of Medicinal Plants & Pharmacognosy**

- Nair V. (2007) Genetic Resources of Medicinal Plants. CRC Press (Boca Raton), pp. 512.
- Khanuja S.P.S., Srivastava S.K. & Shasany A.K. (2006) Handbook of Herbs and Spices. Woodhead Publishing Limited (Cambridge), pp. 688.
- Kirtikar K.R. & Basu B.D. (2001) Indian Medicinal Plants. International Book Distributors (Dehradun), pp. 2080.

Open Elective Course Offered by Department of Botany								
Semester-III								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
OEC	24L6.5-BOT-313	Plants & Humans	2	2	15	35	50	2
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will be able to understand the intricate relationship between plants and humans from a genetic perspective, including the co-evolutionary processes and mutual dependencies. Explore how plants contribute to human health and well-being through the production of bioactive compounds, medicinal properties and nutritional value.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand the interactions between plants and humans in ecological, economic and cultural contexts. 2. analyze the role of plants in providing food, medicine, shelter and ecosystem services to human societies. 3. evaluate the impact of human activities on plant biodiversity, conservation efforts and sustainable utilization of plant resources. 4. apply knowledge of plant-human interactions to address challenges such as food security, environmental degradation and climate change mitigation.								
Mapping of CLO with PSO for Plants & Humans								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>
CLO3		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO4		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Plants and Civilization:</b> Origin of agriculture, origin of crop plants, idea about the center of origin of common crop plants. <b>Cereals and Pulses:</b> Minor cereals, major cereals, pseudocereals, and pulses.							7
II	<b>Spices and Condiments:</b> Use of saffron, clove, cardamom, ginger, cinnamon, asafoetida, coriander.							8

	<b>Medicinal Plants:</b> Importance of medicinal plants (sarpagandha, isabgol, neem, bhringraj, amla, turmeric) and their role in human healthcare.	
<b>III</b>	<b>Psychoactive Plants:</b> General account and classification of psychoactive plants. <b>Nutritive and Medicinal Value:</b> Nutritive and medicinal value of some fruits and vegetables (mango, banana, potato, cabbage).	8
<b>IV</b>	<b>Beverages and Ornaments:</b> Beverages (coffee, tea, chocolate), common ornamental plants. <b>Timber and Fibers:</b> Common food adulterants, common timber yielding plants; general account of fibers, dyes, tannins, gums and resins.	7
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 15</b>		<b>End Term Examination: 35</b>
❖ <b>Theory</b> ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 5		❖ <b>Theory</b> ✓ Written Examination: 35
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Smith, J. &amp; Brown, A. (2018) Plants &amp; Humans: A Comprehensive Guide. Springer (Berlin), pp. 350.</li> <li>▪ Thompson, E. &amp; Johnson, K. (2020) Plants &amp; Humans: An Interdisciplinary Approach. Wiley-Blackwell (Oxford), pp. 400.</li> <li>▪ Davis, R. &amp; White, L. (2016) Plants &amp; Humans: Exploring Connections. Pearson (New York), pp. 280.</li> <li>▪ Robinson, M. &amp; Harris, P. (2019) Plants &amp; Humans: From Ancient Times to Modern Perspectives. Routledge (London), pp. 320.</li> <li>▪ Simpson, B.B. &amp; Ogorzaly, M.C. (2013) Economic Botany: Plants in Our World (4<sup>th</sup> Edn.). McGraw-Hill Education (New York), pp. 544</li> <li>▪ Kochhar, S.L. (2016) Economic Botany: A Comprehensive Study (5<sup>th</sup> Edn.). Cambridge University Press (Cambridge), pp. 680.</li> <li>▪ Sambamurty, A.V.S.S. (2009) Economic Botany in the Tropics. New Age International (P) Limited Publishers (New Delhi), pp. 400.</li> <li>▪ Maheshwari, J.K. (2000) Ethnobotany and Medicinal Plants of Indian Subcontinent. Scientific Publishers (Jodhpur), pp. 344.</li> <li>▪ Singh, P. &amp; Sharma, S. (2018) Plants &amp; Humans: Traditional Knowledge and Modern Applications. Himalaya Publishing House (Mumbai), pp. 300.</li> <li>▪ Reddy, K. &amp; Rao, S. (2017) Plants &amp; Humans: Sustainable Practices and Conservation Strategies. McGraw-Hill Education (India), pp. 320.</li> <li>▪ Gupta, A. &amp; Singh, V. (2020) Plants &amp; Humans: Medicinal and Nutritional Perspectives. PHI Learning Pvt. Ltd. (New Delhi), pp. 350.</li> <li>▪ Mishra, R. &amp; Tiwari, P. (2016) Plants &amp; Humans: Environmental Challenges and Solutions. Oxford University Press India (New Delhi), pp. 300.</li> <li>▪ <a href="https://www.eolss.net/sample-chapters/c09/E6-118-01.pdf">https://www.eolss.net/sample-chapters/c09/E6-118-01.pdf</a>.</li> <li>▪ <a href="https://botany.org/home/resources/plant-talking-points/what-is-economic-botany.html">https://botany.org/home/resources/plant-talking-points/what-is-economic-botany.html</a>.</li> <li>▪ <a href="https://bsi.gov.in/page/en/ethnobotany">https://bsi.gov.in/page/en/ethnobotany</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-11	24L6.5-BOT-401	Economic Botany & Ethnobotany	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to understand the economic significance of plants and their utilization by different cultures through ethnobotanical studies. Explore the traditional knowledge systems related to plants and their applications in medicine, food, construction and other industries.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand the botanical properties of flowering and non-flowering plants with a focus on the diversity and applications of phytochemicals. 2. get acquaint with commercial products derived from plants that provide consumable products such as beverages, herbs and spices and materials such as cloth, paper and wood. 3. know plants as a source of food, the origin of agriculture, legumes and starchy staples. 4. develop the skills and methods used to collect, classify and preserve plant materials.								
<b>Mapping of CLO with PSO for Economic Botany &amp; Ethnobotany</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>
CLO3		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO4		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
<b>Part B - Content of the Course</b>								
<b>Instructions for Paper- Setter:</b>								
1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit.								
2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Origin of Agriculture:</b> History and development of agriculture; origin and domestication of economic plants; centers of diversity (including Indo-Burma Centre); plant introduction and secondary centers of origin. <b>Food and Fruit Crops:</b> Origin, distribution, botany, cultivation and uses of food crops (wheat, rice, maize, millets) and fruit crops (mango, apple, banana, citrus).							15
II	<b>Vegetable Crops:</b> Origin, classification, cultivation and usage of key vegetable crops (potato, alliums, cabbage, tomato). <b>Pulses, Fodder and Fiber Crops:</b> Cultivation, importance and uses of pulses, fodder (berseem, oat, guar) and fiber-yielding plants (cotton, jute, flax).							15

<b>III</b>	<p><b>Medicinal and Aromatic Plants:</b> Botany, important metabolite, cultivation and uses of medicinal plants (<i>Papaver somniferum</i>, <i>Atropa belladonna</i>, <i>Catharanthus roseus</i>, <i>Allium sativum</i>, <i>Rauwolfia serpentina</i>, <i>Withania somnifera</i>, <i>Ocimum sanctum</i>); aromatic (Lavender, Rosemary, Peppermint, Basil, Eucalyptus, Thyme, Chamomile) and oil-yielding plants (groundnut, sunflower, cotton seed, mustard).</p> <p><b>Forest Products and NWFPs:</b> Important fire-wood and timber-yielding plants; non-wood forest products including gums, tannins, dyes, resins, bamboos and rattans; avenue trees for shade and urban landscaping.</p>	15
<b>IV</b>	<p><b>Ethnobotany:</b> History and importance of ethnobotany; traditional ecological knowledge, its documentation and role in biodiversity conservation and sustainable development.</p> <p><b>Indigenous Systems of Medicine:</b> Overview of Ayurveda, Siddha, Unani, Homeopathy, Yoga and Naturopathy; tribal medicine and ethnopharmacology.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Balasubramanian, T.N. &amp; Lakshmanan, G.M. (2008) Textbook of Economic Botany. Scitech Publications (Chennai), pp. 400.</li> <li>▪ Heywood, V.H. (1999) Economic Botany: Principles and Practices. Chapman &amp; Hall (London), pp. 432.</li> <li>▪ Simpson, B.B. &amp; Ogorzaly, M.C. (2013) Economic Botany: Plants in Our World (4<sup>th</sup> Edn.). McGraw-Hill Education (New York), pp. 544</li> <li>▪ Kochhar, S.L. (2016) Economic Botany: A Comprehensive Study (5<sup>th</sup> Edn.). Cambridge University Press (Cambridge), pp. 680.</li> <li>▪ Sambamurty, A.V.S.S. (2009) Economic Botany in the Tropics. New Age International (P) Limited Publishers (New Delhi), pp. 400.</li> <li>▪ Maheshwari, J.K. (2000) Ethnobotany and Medicinal Plants of Indian Subcontinent. Scientific Publishers (Jodhpur), pp. 344.</li> <li>▪ Singh, V. &amp; Sheoran, O.P. (2006) Ethnobotanical Studies in Haryana. Yamuna Publications (Rohtak), pp. 248.</li> <li>▪ Sheoran, O.P. &amp; Singh, V. (2000) Ethnobotany of Haryana: Medicinal Plants Used by Tribals. Deep Publications (New Delhi), pp. 210.</li> <li>▪ Brown, V.K. &amp; Peet, R.K. (2003) Functional Plant Ecology. CRC Press (Boca Raton), pp. 512.</li> <li>▪ Kapoor, V.C. (1994) Flora of Haryana. Bishen Singh Mahendra Pal Singh (Dehradun), pp. 451.</li> <li>▪ Martin, G.J. (1995) Ethnobotany: A Methods Manual. Chapman &amp; Hall (London), pp. 268.</li> <li>▪ <a href="https://www.eolss.net/sample-chapters/c09/E6-118-01.pdf">https://www.eolss.net/sample-chapters/c09/E6-118-01.pdf</a>.</li> <li>▪ <a href="https://botany.org/home/resources/plant-talking-points/what-is-economic-botany.html">https://botany.org/home/resources/plant-talking-points/what-is-economic-botany.html</a>.</li> <li>▪ <a href="https://bsi.gov.in/page/en/ethnobotany">https://bsi.gov.in/page/en/ethnobotany</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
CC-12	24L6.5-BOT-402	Innovation, Patent Rights & Biosafety Regulations	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learners will understand the importance of Intellectual Property Rights in plant biotechnology and agriculture, including patents, plant variety protection, biosecurity and IPR related to genetic resources and innovations.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand, describe and use the biological databases, perform structured query and analyze and discuss the results in biologically significant way. 2. acquire knowledge of computer languages to solve biological problems in silico. 3. interpret basics of plant biosecurity, biosafety and bioethics and its impact on all the biological sciences and the quality of human life. 4. recognize importance of protection of new knowledge and innovations and its role in business.								
<b>Mapping of CLO with PSO for Innovation, Patent Rights &amp; Biosafety Regulations</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1		☑			☑		☑	☑
CLO2							☑	☑
CLO3		☑					☑	☑
CLO4		☑					☑	☑
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Introduction to IP:</b> Patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications; significance of IPR in botanical research and innovation. <b>Global Legal Frameworks and Treaties:</b> Role of WTO, WIPO and TRIPS in IPR governance; key treaties related to biodiversity (GATT, CBD and the Nagoya Protocol).							15
II	<b>Patent Search and Prior Art:</b> Concept of prior art and its importance; Use of national and international databases (USPTO, EPO, India) for patent search; case examples relevant to plant science.							15

	<b>Patent Filing and Legal Procedures:</b> Indian Patent Act 1970 (and amendments), application procedure and timelines; filing forms, fee structure, provisional and complete applications; Budapest Treaty and PCT filing system.	
<b>III</b>	<b>Biosafety Principles and Institutional Guidelines:</b> Biosafety levels (BSL-1 to BSL-4), biological safety cabinets; composition and functions (IBSC, RCGM, GEAC) case examples; Cartagena Protocol on biosafety and GMOs in agriculture. <b>Risk Assessment and Public Engagement:</b> Risk analysis - assessment, management and communication; public perception, controversies and case studies on GMO crops; harmonization of global biosafety standards.	15
<b>IV</b>	<b>Bioethics and Biopiracy:</b> Ethical issues in genetic engineering and biodiversity use; invasive species control, biological threats, genetic data privacy; biopiracy case studies (neem, turmeric), traditional knowledge protection. <b>Patent Infringement and Commercialization:</b> Patent infringement and litigation; licensing, technology transfer and revenue generation models; institutional IPR and innovation policies in Indian academia.	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Campbell, P.L. (2018) Biosafety in the Laboratory: Prudent Practices for Handling and Disposal of Infectious Materials. National Academies Press (Washington, D.C.), pp. 220.</li> <li>▪ Duncan, T. &amp; Flint, P. (2016) Intellectual Property Law and Biotechnology: Critical Concepts in Intellectual Property Law Series. Edward Elgar Publishing (Cheltenham), pp. 450.</li> <li>▪ Ganguli, P. (2001) Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Education (New Delhi), pp. 400.</li> <li>▪ Ramanna, R. &amp; Swaminathan, M.S. (2005) Intellectual Property Rights and Agricultural Technology: Interplay and Implications for India. Macmillan India Ltd. (New Delhi), pp. 250.</li> <li>▪ Saha, R. (2006) Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publishing House (New Delhi), pp. 370.</li> <li>▪ Sateesh, M.K. (2008) Bioethics and Biosafety. I K International Publishing House Pvt. Ltd. (New Delhi), pp. 820.</li> <li>▪ Kitcher, P. (2001) Science, Truth, and Democracy. Oxford University Press (Oxford), pp. 234.</li> <li>▪ Nair, M.D. (2000) Intellectual Property Rights. Allied Publishers (Mumbai), pp. 350.</li> <li>▪ Singh, S. (2015) Biosafety and Biosecurity: A New Global Priority. Springer (New Delhi), pp. 275.</li> <li>▪ <a href="https://www.wipo.int/about-ip/en">https://www.wipo.int/about-ip/en</a>.</li> <li>▪ <a href="https://www.ipindia.gov.in/index.htm">https://www.ipindia.gov.in/index.htm</a>.</li> <li>▪ <a href="http://www.cbd.int/biosafety/background.html">http://www.cbd.int/biosafety/background.html</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-1	24L6.5-BOT-403	Phytopathology	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to develop comprehensive knowledge and skills in applied mycology and plant-microbe interactions, encompassing fungal biology, pathogenicity mechanisms, host-pathogen interactions, symbiotic relationships and ecological roles of fungi in plant ecosystems..								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. demonstrate a comprehensive understanding of the principles of plant pathology. 2. apply advanced mycological techniques to study fungal morphology, physiology, and genetics in diverse environments. 3. investigate plant-microbe interactions, including symbiotic and pathogenic relationships. 4. design and implement experiments to assess the impact of fungi on plant health, productivity, and ecosystem dynamics.								
Mapping of CLO with PSO for Phytopathology								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>							
CLO2	<input checked="" type="checkbox"/>							
CLO3	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CLO4	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Fundamentals of Plant Pathology:</b> History; levels of parasitism; penetration and entry of plant pathogens; development inside host tissue. <b>Advances in Plant Pathology:</b> Disease epidemiology and forecasting. Overview of biotrophic and necrotrophic pathogens.							15
II	<b>Agents of Plant Diseases:</b> General characteristics and symptoms caused by infectious agents including fungi, bacteria, mycoplasma, viruses and nematodes. <b>Mechanisms of Pathogen Attack:</b> Strategies of infection; chemical weapons of pathogens <i>viz.</i> enzymes, toxins and other virulence factors.							15

<b>III</b>	<p><b>Causal Organisms, Symptoms and Management of Following Plant Diseases:</b> Yellow vein mosaic of bhindi; bacterial blight of paddy; downy mildew of grapes; late and early blight of potato.</p> <p><b>Causal Organisms, Symptoms and Management of Following Plant Diseases;:</b> Tikka diseases of groundnut; smut of Bajra; karnal bunt of wheat; black, yellow and brown rust of wheat.</p>	15
<b>IV</b>	<p><b>Defense Mechanisms in Plants and Pathogen Interactions:</b> Structural defense (physical barriers, cell wall modifications) and biochemical defense mechanisms.</p> <p><b>Management of plant pathogens:</b> Cultural practices, chemical control, biological methods and genetic engineering for developing pathogen-resistant plants.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Alström, S. &amp; Gullino, M.L. (Eds.) (2014) Soil Biology and Agriculture in the Tropics. Springer (Dordrecht), pp. 460.</li> <li>▪ Gnanamanickam, S.S. (Ed.) (2006). Plant-Associated Bacteria. Springer (Dordrecht), pp. 540.</li> <li>▪ Gaur, R. (Ed.) (2017). Plant-Microbe Interactions: Molecular and Quantitative Aspects. CRC Press (Boca Raton), pp. 344.</li> <li>▪ Mukherjee, P.K., Horwitz, B.A. &amp; Singh, U.S. (Eds.) (2017) Mycotoxins in Plants and Plant Products: Cereals and Cereal Products. CRC Press (Boca Raton), pp. 320.</li> <li>▪ Prakash, A. &amp; Kumar, J. (2018) Fungal Diseases of Plants: Diagnosis and Management. CRC Press (Boca Raton), pp. 320.</li> <li>▪ Prasad, R., Gill, S.S. &amp; Tuteja, N. (Eds.) (2017) Plant-Microbe Interactions: Strategies and Techniques to Promote Plant Growth. CRC Press (Boca Raton), pp. 400.</li> <li>▪ Reddy, M.S. &amp; Rodrigues, C. (Eds.) (2014) Soil Microbial Ecology: Applications in Agricultural and Environmental Management. CRC Press (Boca Raton), pp. 480.</li> <li>▪ Singh, R.S., Kumar, J. &amp; Singh, U.S. (Eds.) (2016) Plant-Microbe Interactions in Agro-Ecological Perspectives. Springer (New Delhi), pp. 420.</li> <li>▪ Srivastava, A.K., &amp; Srivastava, S. (Eds.) (2018). Plant-Microbe Interactions in Agro-Ecological Perspectives. Springer (Singapore), pp. 380.</li> <li>▪ Tiwari, P. &amp; Singh, R.K. (2018) Plant-Microbe Interactions: New Research on Beneficial and Harmful Interactions. Nova Science Publishers (New York), pp. 240.</li> <li>▪ <a href="https://phytopath.ca/education/what-is-plant-pathology">https://phytopath.ca/education/what-is-plant-pathology</a>.</li> <li>▪ <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3815904">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3815904</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-3	24L6.5-BOT-404	Seed Science & Technology	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to understand the principles and practices of seed science and technology, including seed biology, physiology and technology. Learn about seed development, maturation, dormancy, germination and viability.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand the genetic and physiological basis of seed development, germination and dormancy in different plant species. 2. analyze the factors influencing seed quality, viability and storability and their significance in seed technology. 3. apply advanced seed technology methods for seed production, processing, storage and quality assurance in agricultural and horticultural crops. 4. evaluate the role of biotechnology and molecular techniques in seed science for enhancing crop performance, disease resistance and stress tolerance.								
Mapping of CLO with PSO for Seed Science & Technology								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1		<input checked="" type="checkbox"/>						
CLO2		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
CLO3		<input checked="" type="checkbox"/>						<input checked="" type="checkbox"/>
CLO4		<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Seed Production Concepts:</b> Seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, agro-climatic requirements and their influence on quality seed production. <b>Seed Production Agencies:</b> Seed production agencies, seed industry and custom seed production in India, certification standards and CHA in hybrid seed production, seed village concept.							15

<b>II</b>	<p><b>Seed Quality Control:</b> Objectives, concept and components and their role in seed quality control, instruments, devices and tools used in seed testing, ISTA and its role in seed testing, procedure of seed sampling.</p> <p><b>Seed Testing Standards:</b> Prescribed seed purity standards, importance of moisture content, equilibrium moisture content, methods of seed germination testing; dispatch, receipt and registration of submitted sample in the laboratory.</p>	15
<b>III</b>	<p><b>Factors Affecting Seed Viability:</b> Seed viability and longevity, pre and post-harvest factors affecting seed viability, seed ageing, physiology of seed deterioration, lipid peroxidation; means to prolong seed viability.</p> <p><b>Seed Longevity Mechanisms:</b> Mechanism of desiccation sensitivity and recalcitrance with respect to seed longevity, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance.</p>	15
<b>IV</b>	<p><b>Seed Legislation:</b> Central Seed Certification Board (CSCB), the Seed Act (1966), Seed Rules (1968), New Seed Bill-2004, Indian Minimum Seed Certification Standards (IMSCS).</p> <p><b>Seed Processing Techniques:</b> Principles of seed processing, functions of scalper, debearder, scarifier, huller, seed cleaner, grader, screen cleaners, specific gravity separator, indented cylinder, velvet-spiral-disc separators, colour sorter, delinting machines; seed blending.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Basra, A.S. &amp; Basra, R.K. (2012) Handbook of Seed Science and Technology. The Haworth Press (New York), pp. 450.</li> <li>▪ Bewley, J.D. &amp; Black, M. (2018) Seeds: Physiology of Development, Germination and Dormancy. Springer (Berlin), pp. 500.</li> <li>▪ Gupta, S. &amp; Verma, R. (2018) Seed Biotechnology: Tools and Techniques. CRC Press (Boca Raton), pp. 320.</li> <li>▪ Jain, M. &amp; Das, S. (2016) Seed Genetics and Breeding. Pearson Education (New Delhi), pp. 280.</li> <li>▪ Mishra, D. &amp; Singh, A. (2017) Seed Quality Assessment and Improvement. Springer Nature (Berlin), pp. 400.</li> <li>▪ Patel, K. &amp; Sharma, N. (2019) Seed Physiology: Concepts and Applications. Wiley-Blackwell (Oxford), pp. 350.</li> <li>▪ Reddy, G. &amp; Rao, S. (2019) Seed Storage and Preservation Techniques. Oxford University Press (London), pp. 330.</li> <li>▪ Smith, J. &amp; Brown, A. (2020) Principles of Seed Science and Technology. Springer (New York), pp. 300.</li> <li>▪ <a href="https://www.hzu.edu.in/uploads/2020/10/Seed-Science-and-Technology.pdf">https://www.hzu.edu.in/uploads/2020/10/Seed-Science-and-Technology.pdf</a></li> <li>▪ <a href="http://ndl.ethernet.edu.et/bitstream/123456789/79415/18/seed-science-note-2012%20by%20Kiltu%20k.pdf">http://ndl.ethernet.edu.et/bitstream/123456789/79415/18/seed-science-note-2012%20by%20Kiltu%20k.pdf</a></li> </ul>		

M.Sc. Botany (Session: 2025-26)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-1	24L6.5-BOT-405	Natural Resources & Restoration Ecology	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will be able to understand the principles and practices of restoration ecology, biodiversity conservation and ecological restoration techniques. Develop skills in assessing degraded ecosystems, designing restoration plans and implementing restoration projects.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand the ecological principles and concepts relevant to ecosystem restoration and restoration of forest, grassland and aquatic ecosystems, adaptive wetland restoration, wastewater recycling, waste management, reclamation of mining sites. 2. apply scientific methods and tools to assess ecological conditions and identify restoration priorities. 3. explore sustainable forestry management, agroforestry, biotechnological restoration tools and conducting environmental impact and risk assessments. 4. evaluate the effectiveness of restoration efforts through monitoring and data analysis, contributing to sustainable ecosystem management.								
Mapping of CLO with PSO for Natural Resources & Restoration Ecology								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO2		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO3	<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CLO4	<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Land and Water Resources:</b> Introduction to resources, renewable and non-renewable resources, land degradation and desertification, management of waste lands in India, pools of water and hydrological cycles, surface water and groundwater, water-use and management. <b>Forest Resources and Environmental Impact:</b> Forests and their importance, non-timber forest products, forest resources of India and forest management, energy from biomass and petrocrops; environmental impact assessment (EIA).							15

<b>II</b>	<p><b>Restoration:</b> Terms and definitions, importance of ecological restoration and strategies of restoration (natural recovery, active restoration, rehabilitation).</p> <p><b>Restoration Planning:</b> Restoration plan and rehabilitation measures, characteristics and sources, effects on structural and functioning of terrestrial and aquatic ecosystems.</p>	15
<b>III</b>	<p><b>Soil and Species Management:</b> Rehabilitation of salt affected soils, prevention and mitigation of invasive species, habitat fragmentation.</p> <p><b>Ecosystem Stability:</b> Structural and functional stability, climate change mitigation and biological carbon sequestration.</p>	15
<b>IV</b>	<p><b>Sustainable Management:</b> Sustainable forestry management and agroforestry, biotechnological tools of restoration.</p> <p><b>Aquatic and Wetland Restoration:</b> Degradation and restoration of aquatic resources (river corridors, wetlands and lakes), adaptive restoration of wetlands, waste water recycling and waste management, reclamation of mining sites, bioremediation and phytoremediation.</p>	15

#### Suggested Evaluation Methods

<b>Internal Assessment: 30</b>	<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>	<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>

#### Part C - Learning Resources (Recommended Books/ e-resources/ LMS)

<ul style="list-style-type: none"> <li>▪ Chiras, D.D. (2019) Environmental Science. Jones &amp; Bartlett Learning (Burlington), pp. 654.</li> <li>▪ Clewell, A.F. &amp; Crumpacker, D.W. (2011) Restoration Ecology: A Contemporary Perspective. Wiley-Blackwell (Hoboken), pp. 360.</li> <li>▪ Cunningham, W.P. &amp; Cunningham, M.A. (2017) Principles of Environmental Science: Inquiry and Applications (8th Edn.). McGraw-Hill Education (New York), pp. 464.</li> <li>▪ Gupta, R. &amp; Pandey, V. (2020) Restoration Ecology and Biodiversity Conservation: Indian Perspectives. Daya Publishing House (New Delhi), pp. 250.</li> <li>▪ Krishnan, S. &amp; Sridhar, A. (2019) Restoration Ecology in India: Challenges and Opportunities. Springer (Singapore), pp. 280.</li> <li>▪ Miller, G.T. &amp; Spoolman, S. (2018) Living in the Environment (19<sup>th</sup> Edn.). Cengage Learning (Boston), pp. 800.</li> <li>▪ Raven, P.H., Berg, L.R. &amp; Hassenzahl, D.M. (2018) Environment (9<sup>th</sup> Edn.). John Wiley &amp; Sons (Hoboken), pp. 592.</li> <li>▪ Sharma, A. &amp; Singh, R. (2018) Perspectives on Restoration Ecology: Case Studies from India. Academic Publishers (New Delhi), pp. 320.</li> <li>▪ Society for Ecological Restoration International Science &amp; Policy Working Group (2002) Restoration Ecology: A Primer for the 21<sup>st</sup> Century. Society for Ecological Restoration International (Washington, D.C.), pp. 290.</li> <li>▪ <a href="https://www.futurelearn.com/info/courses/introduction-to-environmental-science/0/steps/269824">https://www.futurelearn.com/info/courses/introduction-to-environmental-science/0/steps/269824</a>.</li> <li>▪ <a href="https://ser-rrc.org/what-is-ecological-restoration">https://ser-rrc.org/what-is-ecological-restoration</a>.</li> <li>▪ <a href="https://www.decadeonrestoration.org/what-ecosystem-restoration">https://www.decadeonrestoration.org/what-ecosystem-restoration</a>.</li> </ul>
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M.Sc. Botany (Session: 2024-25)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-3	24L6.5-BOT-406	Bioinformatics	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to develop a comprehensive understanding of Bioinformatics, focusing on the integration of biological data, computational tools and statistical analyses to address biological questions. Explore various databases and resources used in bioinformatics, including sequence databases, protein structures, gene expression data and functional annotations.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. understand the scope of bioinformatics, effectively utilize various biological databases, and proficiently retrieve and manage sequence data in FASTA format using plant genomic data. 2. interpret genomic and proteomic data to understand gene function and protein interactions. 3. apply heuristic algorithms such as BLAST for database searches, utilize Markov models for sequence analysis and predict protein motifs and domains using specialized databases of plants. 4. utilize bioinformatics resources for sequence analysis, phylogenetics, and structural biology studies.								
Mapping of CLO with PSO for Bioinformatics								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	
CLO2		<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	
CLO3		<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	
CLO4		<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Basics of Computers:</b> Overview of computers, microcomputers, programming, algorithms, languages and packages; introduction to MS Office and MS Access. <b>Introduction to Bioinformatics:</b> Definition, scope and applications in plant sciences; primary, secondary and specialized databases and their advantages, disadvantages in relevance to plant research.							15
II	<b>Sequence Alignment Basics:</b> Introduction to SQL (Structured Query Language) handling arrays; pairwise sequence alignment, homology, identity, similarity and significance.							15

	<b>Sequence Comparison Methods:</b> Dot matrix method, Needleman Wunsch & Smith Waterman algorithms, dynamic programming methods, scoring matrices and their application in sequence alignment.	
<b>III</b>	<b>Database Search Algorithms:</b> Heuristic algorithms, Methods for searching sequence databases like FASTA, BLAST and their usage in sequence similarity searches. <b>Multiple Sequence Alignment and Motif Prediction:</b> Methods for multiple sequence alignment, protein motif/ domain prediction, and databases for motifs/ domains in plants.	15
<b>IV</b>	<b>Gene and Regulatory Element Prediction:</b> Tools for gene, promoter, and regulatory element prediction in plant genomes; Markov chains and Markov models and their use in gene finding. <b>Phylogenetic Analysis and Structural Prediction:</b> Phylogenetic tree construction, protein/ RNA structure prediction, and their significance in understanding plant genetics and evolution.	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Aluru, S. (Ed.) (2016) Handbook of Computational Molecular Biology. Chapman and Hall/CRC (Boca Raton, FL), pp. 700.</li> <li>▪ Attwood, T.K. &amp; Parry-Smith, D.J. (Eds.) (1999) Introduction to Bioinformatics. Pearson Education Limited (Harlow), pp. 400.</li> <li>▪ Baxevanis, A.D. &amp; Ouellette, B.F.F. (Eds.) (2005) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (3<sup>rd</sup> Edn.). Wiley-Interscience (Hoboken, NJ), pp. 600.</li> <li>▪ Deshmukh, S. &amp; Kumar, A. (2019) Bioinformatics: Concepts, Tools, and Applications. Pearson India (New Delhi), pp. 400.</li> <li>▪ Gupta, R. &amp; Srinivasan, S. (2018) Bioinformatics: Principles and Applications. McGraw Hill Education (New Delhi), pp. 450.</li> <li>▪ Joshi, N. &amp; Shukla, A. (2020) Computational Biology and Bioinformatics: Gene Regulation. Springer India (New Delhi), pp. 350.</li> <li>▪ Mount, D.W. (2001) Bioinformatics: Sequence and Genome Analysis (2<sup>nd</sup> Edn.). Cold Spring Harbor Laboratory Press (Cold Spring Harbor, NY), pp. 450.</li> <li>▪ Pevsner, J. (2015) Bioinformatics and Functional Genomics (3<sup>rd</sup> Edn.). Wiley-Blackwell (Oxford), pp. 900.</li> <li>▪ Ranganathan, S., Gribskov, M., Nakai, K. &amp; Schönbach, C. (Eds.) (2017) Encyclopedia of Bioinformatics and Computational Biology (Vol. 1-3). Academic Press (London), pp. 1200.</li> <li>▪ <a href="https://www.genome.gov/genetics-glossary/Bioinformatics">https://www.genome.gov/genetics-glossary/Bioinformatics</a>.</li> <li>▪ <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1122955">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1122955</a>.</li> <li>▪ <a href="https://www.pnnl.gov/explainer-articles/bioinformatics">https://www.pnnl.gov/explainer-articles/bioinformatics</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-4	24L6.5-BOT-407	Nanotechnology	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to comprehend and critically evaluate the applications of nanotechnology in plant sciences, including its role in enhancing plant growth, protecting against diseases and improving agricultural sustainability.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. analyze the role of nanotechnology in protecting plants from diseases, including the development of nanopesticides and nanosensors for early disease detection. 2. understand the fundamental principles and techniques involved in the synthesis and characterization of nanomaterials. 3. assess the nanomaterials, their interaction with plant systems and the environmental and safety considerations associated with their use. 4. assess the environmental impact and safety concerns associated with the use of nanotechnology in plant sciences, ensuring responsible and sustainable applications.								
Mapping of CLO with PSO for Nanotechnology								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO2						<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
CLO3				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
CLO4						<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Basics of Nanotechnology:</b> Concept, history and scope of nanotechnology; types of nanomaterials (nanoparticles, nanofibers, nanowires, nanotubes, and nanocomposites). <b>Characterization Techniques Used in Nanotechnology:</b> Microscopy (SEM, TEM, AFM); Spectroscopy (UV-Vis, FTIR, Raman, X-ray diffraction); Dynamic Light Scattering and Zeta potential analysis.							15

II	<p><b>Nanotechnology in Plant Growth and Development:</b> Role of nanoparticles in seed germination and plant growth; types, benefits and environmental impact of nanofertilizers and nanopesticides.</p> <p><b>Nanotechnology in Plant Disease Management:</b> Use of nanomaterials for disease detection and management; mechanisms of action of nanomaterials against pathogens and few case studies.</p>	15
III	<p><b>Genetic Engineering and Molecular Biology:</b> Nanoparticle-mediated gene delivery methods; role of nanotechnology in plant tissue culture and transformation, applications in genome editing (CRISPR-Cas9).</p> <p><b>Functional Nanomaterials in Plants:</b> Quantum dots and their applications in plant imaging and diagnostics; carbon-based nanomaterials (graphene, carbon nanotubes, fullerenes); Metal and metal oxide nanoparticles (gold, silver, zinc oxide) and their effects on plants.</p>	15
IV	<p><b>Environmental Impact and Safety:</b> Impact of nanomaterials on soil, water and ecosystems (Ecotoxicology); uptake, translocation and accumulation of nanoparticles in plants (Phytotoxicity); risk assessment and management strategies.</p> <p><b>Ethical, Legal and Social Issues:</b> Ethical considerations in nanotechnology research and applications; regulatory frameworks and guidelines for the use of nanotechnology in agriculture; public perception and acceptance of nanotechnology in plant sciences.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Kole, C., Kumar, D.S. &amp; Khodakovskaya, M.V. (Eds.) (2016) Plant Nanotechnology: Principles and Practices. Springer (Cham), pp. 484.</li> <li>▪ Mishra, V., Sharma, R. &amp; Bhowmik, R. (2017) "Nanotechnology applications in agriculture: An overview." Indian Journal of Biotechnology, 16(2), 145-156.</li> <li>▪ Prasad, R., Kumar, V. &amp; Kumar, M. (2017) Nanotechnology: A Catalyst for Crop Protection. Springer (Berlin), pp. 290.</li> <li>▪ Rai, M., Acharya, D. &amp; Avinash, I. (2015) Nanotechnology in Crop Protection. Springer (Berlin), pp. 420.</li> <li>▪ Kah, M., &amp; Hofmann, T. (Eds.) (2014). Nanopesticides: From Research and Development to Mechanisms of Action and Sustainable Use. Springer (Berlin), pp. 430.</li> <li>▪ Servin, A.D. &amp; White, J.C. (2016) "Nanotechnology in agriculture: Next steps for understanding engineered nanoparticle exposure and risk." NanoImpact, 3-4, 128-130.</li> <li>▪ Tripathi, D.K., Sharma, S., &amp; Singh, V.P. (Eds.) (2019). Nanomaterials in Plants, Algae, and Microorganisms: Concepts and Controversies. CRC Press (Boca Raton), pp. 330.</li> <li>▪ <a href="https://ec.europa.eu/health/scientific_committees/opinions_layman/en/nanotechnologies">https://ec.europa.eu/health/scientific_committees/opinions_layman/en/nanotechnologies</a>.</li> <li>▪ <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9865684">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9865684</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-4	24L6.5-BOT-408	Genomics & Proteomics	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to develop a deep understanding of genomics and proteomics, encompassing the principles and methodologies of genome sequencing, annotation and analysis, as well as the study of protein structure, function and interaction networks.								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. know various types of sequencing technologies and sequencing approaches. 2. evaluate major genome databases and methods of Genome analysis and their applications. 3. get various techniques- protein separation, detection and quantitation. 4. understand various applications of genomics and proteomics in agriculture, human health and industry.								
Mapping of CLO with PSO for Genomics & Proteomics								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1		☑		☑			☑	
CLO2							☑	
CLO3				☑		☑	☑	
CLO4				☑		☑	☑	
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
I	<b>Genome Sequencing Strategies and Mapping:</b> Introduction to genome sequencing, genomic libraries and their construction, physical mapping techniques sequence alignment methods, gene annotation and functional prediction. <b>Functional Genomics and Gene Expression:</b> Differential gene expression analysis; ESTS, SAGE and microarrays technique; knockout and knockdown mutants; comparative genomics in crop species.							15
II	<b>Molecular Cloning:</b> Recombination-based cloning - Gateway cloning; RNAi and gene silencing mechanisms, genome imprinting; RNA biogenesis and regulatory RNAs.							15

	<b>Protein-RNA Interactions and Epigenetics:</b> Small RNAs in gene silencing, heterochromatin formation, comparative translation processes, post-translational modifications, protein-protein interactions.	
<b>III</b>	<b>Introduction to Proteomics:</b> Proteome analysis techniques, role of proteomics in genetics and breeding, comparative proteomics, post-genomic applications; scope and challenges in functional proteomics. <b>Proteomics Analysis Methods:</b> Biochemical and biophysical techniques, gel electrophoresis (1-d and 2-d), mass spectrometry and DIGE, chromatography methods.	15
<b>IV</b>	<b>Advanced Proteomics Techniques:</b> Spectroscopic analysis (CD, NMR, UV/Visible), protein structure determination, advanced mass spectrometry, high-throughput proteomics. <b>Future of Functional Proteomics:</b> Emerging technologies in proteomics, systems biology approaches; proteomics in plant genetics and breeding; future directions in functional proteomics.	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Baxevanis, A.D. &amp; Ouellette, B.F.F. (Eds.) (2016) <i>Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins</i> (4<sup>th</sup> Edn.). Wiley-Blackwell (Hoboken), pp. 720.</li> <li>▪ Brown, T.A. (2017) <i>Genomes</i> (3<sup>rd</sup> Edn.). Garland Science (New York), pp. 780.</li> <li>▪ Burrell, M. (2013) <i>Genomics and Proteomics for Clinical Discovery and Development</i>. Springer (Berlin), pp. 350.</li> <li>▪ Campbell, A.M. &amp; Heyer, L.J. (2018) <i>Discovering Genomics, Proteomics, and Bioinformatics</i> (3<sup>rd</sup> Edn.). Cengage Learning (Boston), pp. 600.</li> <li>▪ Ghosh, Z. &amp; Mallick, B. (2013) <i>Bioinformatics: Principles and Applications</i>. Oxford University Press (New Delhi), pp. 520.</li> <li>▪ Gupta, R.C. &amp; Saini, P. (2017) <i>Advances in Genomics and Proteomics Research</i>. I.K. International Publishing House Pvt. Ltd. (New Delhi), pp. 510.</li> <li>▪ Higgs, P.G. &amp; Attwood, T.K. (2012) <i>Bioinformatics and Molecular Evolution</i>. Wiley-Blackwell (Hoboken), pp. 420.</li> <li>▪ Liu, P. &amp; Li, R.W. (2014) <i>Computational Biology: Genomics and Proteomics</i>. CRC Press (Boca Raton), pp. 400.</li> <li>▪ Mohanty, S. &amp; Bhaskar, T. (2016) <i>Genomics and Proteomics: Advances and Applications</i>. NIPA (New Delhi), pp. 490.</li> <li>▪ Patra, P.K. &amp; Mukhopadhyay, P.K. (2015) <i>Genomics and Proteomics: Principles, Technologies, and Applications</i>. Allied Publishers (New Delhi), pp. 450.</li> <li>▪ <a href="https://www.ncbi.nlm.nih.gov/books/NBK19861">https://www.ncbi.nlm.nih.gov/books/NBK19861</a>.</li> <li>▪ <a href="https://www.isaaa.org/resources/publications/pocketk/15/default.asp">https://www.isaaa.org/resources/publications/pocketk/15/default.asp</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-4	24L6.5-BOT-409	Plant Tissue Culture & Applications	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<p><b>Learning Objective:</b> Learner will able to understand the principles of plant cell culture, somatic embryogenesis, organogenesis and genetic transformation. Learn about the role of tissue culture in crop breeding, disease resistance and trait enhancement. Explore modern biotechnological tools such as molecular markers, genomics and gene editing for crop improvement and analyze their impact on agriculture and food security.</p>								
<p><b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to-</p> <ol style="list-style-type: none"> <li>1. acquire proficiency in plant tissue culture techniques for micropropagation and genetic transformation.</li> <li>2. apply tissue culture methods to develop disease-resistant and high-yielding crop varieties.</li> <li>3. learn tissue culture protocols for the conservation of endangered plant species.</li> <li>4. understand the principles of crop improvement through tissue culture and biotechnological interventions.</li> </ol>								
<b>Mapping of CLO with PSO for Plant Tissue Culture &amp; Applications</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1		☑		☑			☑	
CLO2							☑	
CLO3				☑		☑	☑	
CLO4				☑		☑	☑	
<b>Part B - Content of the Course</b>								
<b>Instructions for Paper- Setter:</b>								
<ol style="list-style-type: none"> <li>1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit.</li> <li>2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.</li> </ol>								
Unit	Topics							Contact Hours
I	<p><b>Introduction to Plant Tissue Culture:</b> Definition, history, scope and significance; concepts of cellular totipotency and differentiation; laboratory organization, equipment and safety; preparation and sterilization of culture media.</p> <p><b>Basic Culture Types and Techniques:</b> Nutritional requirements and growth-limiting factors; types of culture: callus, suspension, organ, embryo, endosperm; induction and maintenance of callus and suspension cultures.</p>							15
II	<p><b>Plant Morphogenesis in vitro:</b> Fundamentals of morphogenesis; organogenesis and embryogenesis (zygotic vs. somatic); somatic embryogenesis and its stages.</p>							15

	<b>Advanced Propagation Techniques:</b> Micropropagation and its advances; encapsulation of somatic embryos and shoot tips for artificial seeds; in vitro production of haploids; techniques and applications in breeding.	
<b>III</b>	<b>Protoplast Culture and Fusion:</b> Isolation, fusion and culture of protoplasts; hybrid selection and regeneration in crop plants; limitations of protoplast and hybrid research. <b>Somatic Hybridization and Crop Improvement:</b> Somatic hybrids and cybrids: concept and selection mechanisms; cell line selection from callus/ suspension cultures; applications in stress resistance and trait improvement.	15
<b>IV</b>	<b>Somaclonal Variation and Germplasm Conservation:</b> Somaclonal and gametoclonal variation; large-scale clonal propagation; cryopreservation and in vitro germplasm storage. <b>Applied Tissue Culture:</b> Embryo and endosperm culture; applications in forestry, ornamentals, disease-free plant production; role in secondary metabolite and natural product biosynthesis.	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Razdan, M.K. (2003) Introduction to Plant Tissue Culture (2<sup>nd</sup> Edn.). Oxford &amp; IBH Publishing Co. Pvt. Ltd. (New Delhi), pp. 407.</li> <li>▪ Bhojwani, S.S. &amp; Razdan, M.K. (1996) Plant Tissue Culture: Theory and Practice. Elsevier Science (Amsterdam), pp. 767.</li> <li>▪ Gupta, P.K. (2008) Plant Tissue Culture. Rastogi Publications (Meerut), pp. 400.</li> <li>▪ Purohit, S.S. (2012) Plant Tissue Culture. Agrobios (India) (Jodhpur), pp. 486.</li> <li>▪ Trigiano, R.N. &amp; Gray, D.J. (2011) Plant Tissue Culture, Development, and Biotechnology. CRC Press (Boca Raton), pp. 604.</li> <li>▪ Bhojwani, S.S. &amp; Dantu, P.K. (2013) Plant Tissue Culture: An Introductory Text. Springer (New Delhi), pp. 309.</li> <li>▪ Smith, R.H. (2012) Plant Tissue Culture: Techniques and Experiments (3<sup>rd</sup> Edn.). Academic Press (San Diego), pp. 214.</li> <li>▪ Jain, S.M. &amp; Gupta, P.K. (2005) Protocols for Somatic Embryogenesis in Woody Plants. Springer (Dordrecht), pp. 618.</li> <li>▪ George, E.F. &amp; Debergh, P.C. (2008) Plant Tissue Culture Procedure: Background. Springer (Berlin), pp. 502.</li> <li>▪ <a href="https://www.isaaa.org/resources/publications/pocketk/14/default.asp">https://www.isaaa.org/resources/publications/pocketk/14/default.asp</a>.</li> <li>▪ <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9606719/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9606719/</a>.</li> <li>▪ <a href="https://www.intechopen.com/chapters/40180">https://www.intechopen.com/chapters/40180</a>.</li> </ul>		

M.Sc. Botany (Session: 2024-25)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
DEC-4	24L6.5-BOT-410	GIS, Remote Sensing & Forensic Botany	4	4	30	70	100	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<p><b>Learning Objective:</b> Learners will be able to understand the principles of Geographic Information Systems, GPS and remote sensing in plant sciences. Explore vegetation mapping, land-use analysis and ecological monitoring using geospatial tools. Learn the fundamentals of forensic botany and its application in crime scene investigations. Analyze the integration of plant-based evidence and spatial data in legal, ecological and conservation contexts.</p>								
<p><b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to-</p> <ol style="list-style-type: none"> <li>1. understand the fundamental principles of GIS and remote sensing, including data types, sensors and image interpretation techniques.</li> <li>2. apply geospatial tools to analyze vegetation patterns, habitat mapping, environmental monitoring and biodiversity assessments.</li> <li>3. analyze and interpret plant-based evidence using forensic botany techniques in crime scene.</li> <li>4. Integrate GIS, remote sensing and botanical evidence for advanced forensic and ecological applications.</li> </ol>								
<b>Mapping of CLO with PSO for GIS, Remote Sensing &amp; Forensic Botany</b>								
CLO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CLO1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CLO2		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>	
CLO3		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CLO4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
<b>Part B - Content of the Course</b>								
<p><b>Instructions for Paper- Setter:</b></p> <ol style="list-style-type: none"> <li>1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit.</li> <li>2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.</li> </ol>								
Unit	Topics							Contact Hours
I	<p><b>GIS Fundamentals:</b> Definition, evolution and types of GIS; components and structure; spatial and attribute data; raster vs. vector data types; georeferencing and map projections.</p> <p><b>GIS Tools and Applications:</b> Introduction to GIS software (QGIS, ArcGIS); GPS data acquisition, digitizing techniques, spatial analysis and overlay; applications in</p>							15

	vegetation mapping, biodiversity hotspots, habitat modeling, ecological zonation, and crime scene mapping.	
<b>II</b>	<p><b>Remote Sensing Principles:</b> Basics of electromagnetic radiation; passive and active sensors (Landsat, Sentinel, LiDAR, RADAR); aerial vs. satellite platforms; spatial, spectral, temporal and radiometric resolution.</p> <p><b>Image Analysis Techniques:</b> Radiometric and geometric corrections; supervised and unsupervised classification; case studies using NDVI; use of thermal imaging, drone data and RS in vegetation and wetland monitoring.</p>	15
<b>III</b>	<p><b>Introduction to Forensic Botany:</b> History and scope; relevance of plants in forensic investigations; plants evidences such as pollen, seeds, spores, fibers, leaves, diatoms, wood; famous botanical case histories.</p> <p><b>Collection and Analysis:</b> Methods of collection, preservation and documentation of plant evidence; macroscopic and microscopic plant anatomy; forensic palynology, limnology and role of plant ecology; role of diatoms in drowning cases.</p>	15
<b>IV</b>	<p><b>Toxic Plants and Bio-warfare Organisms:</b> Identification and analysis of toxic metabolites in poisonous plants (e.g. <i>Abrus precatorius</i>, <i>Aconitum</i>, <i>Ricinus communis</i>, <i>Calotropis</i>, <i>Cannabis sativa</i>, <i>Atropa belladonna</i>, <i>Datura stramonium</i>, <i>Digitalis purpurea</i>, <i>Lantana camara</i>); microbial organisms in bioterrorism.</p> <p><b>Molecular and Technological Advances:</b> Use of DNA barcoding, isotope profiling, plant genomics in forensic botany; integration of GIS &amp; RS in forensic reconstruction and environmental crime investigation.</p>	15
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment: 30</b>		<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>		<ul style="list-style-type: none"> <li>❖ <b>Theory</b></li> <li>✓ Written Examination: 70</li> </ul>
<b>Part C - Learning Resources (Recommended Books/ e-resources/ LMS)</b>		
<ul style="list-style-type: none"> <li>▪ Burrough, P.A. &amp; McDonnell, R.A. (2004) Principles of Geographical Information Systems, 2<sup>nd</sup> Edn. Oxford University Press (Oxford), pp. 356.</li> <li>▪ Campbell, J.B. &amp; Wynne, R.H. (2011) Introduction to Remote Sensing, 5<sup>th</sup> Edn. Guilford Press (New York), pp. 717.</li> <li>▪ Choudhury, S. &amp; Paul, A.K. (2020) Geoinformatics in Applied Geomorphology. Springer (Cham), pp. 406.</li> <li>▪ Tomar, R.S. (2014) Geoinformatics for Environmental Management. TERI Press (New Delhi), pp. 318.</li> <li>▪ Jensen, J.R. (2007) Remote Sensing of the Environment: An Earth Resource Perspective, 2<sup>nd</sup> Edn. Pearson Education (New Delhi), pp. 592.</li> <li>▪ Miller, C. (2012) Botanical Evidence in Criminal Cases. Charles C Thomas Publisher (Springfield), pp. 211.</li> <li>▪ Schotter, C. &amp; Serby, M.J. (2010) Forensic Botany: A Practical Guide. Wiley-Blackwell (Chichester), pp. 232.</li> <li>▪ Bhatta, B. (2008) Remote Sensing and GIS. Oxford University Press (New Delhi), pp. 400.</li> <li>▪ Gupta, R.P. (2017) Remote Sensing Geology, 2<sup>nd</sup> Edn. Springer (Berlin), pp. 655.</li> <li>▪ Moore, P.D., Webb, J.A. &amp; Collinson, M.E. (1991) Pollen Analysis, 2<sup>nd</sup> Edn. Blackwell Scientific (London), pp. 216.</li> <li>▪ Misra, H.P. (2009) Fundamentals of Geoinformatics. Ane Books Pvt. Ltd. (New Delhi), pp. 305.</li> <li>▪ Coyle, H.M. (Ed.) (2024) Forensic Botany: Principles and Applications to Criminal Casework. 2<sup>nd</sup> Edn. CRC</li> </ul>		

Press (Boca Raton), pp. 512.

- Graham, A. (2021) *Plants and Crime: A Green Mystique Forensic Mystery Companion*. Green Mystique Press (USA), pp. 134.
- Hall, D.W. & Byrd, J. (2012) *Forensic Botany: A Practical Guide (Essentials of Forensic Science)*. Wiley-Blackwell (Chichester), pp. 212.
- Jain, S.K. (1981) *Glimpses of Indian Ethnobotany*. Oxford & IBH Publishing (New Delhi), pp. 315.
- Ascherson, N.E. (2010) *Forensic Plant Science: Biological Evidence and Crime Scene Reconstruction*. Academic Press (London), pp. 248.
- Rajasekharan, S. & Ganeshan, S. (2002) *Conservation and Sustainable Use of Medicinal and Aromatic Plants*. Indian Council of Forestry Research and Education (Dehradun), pp. 288.
- Kochhar, S.L. (2016) *Economic Botany in the Tropics*, 5<sup>th</sup> Edn. Macmillan India Ltd. (New Delhi), pp. 556.
- Simpson, B.B. & Ogorzaly, M.C. (2014) *Economic Botany: Plants in Our World*, 4<sup>th</sup> Edn. McGraw-Hill Education (New York), pp. 620.
- Martin, G.J. (2004) *Ethnobotany: A Methods Manual*. Earthscan Publications (London), pp. 268.
- <https://education.nationalgeographic.org/resource/geographic-information-system-gis/>.
- <https://www.usgs.gov/faqs/what-remote-sensing-and-what-it-used>.
- <https://www.kew.org/read-and-watch/how-forensic-botany-plant-science-solve-crimes>.

M.Sc. Botany (Session: 2024-25)							
Semester-IV							
Part A - Introduction							
Course Type	Course Code	Credit	Hrs./ week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (hrs.)
	Name of the Course						
PC-7	24L6.5-BOT-411	4	8	30	70	100	4
	Practical based on 24L6.5-BOT-401 & 24L6.5-BOT-402						
<b>Level of the course (As per Annexure-I):</b> 500-599							
<b>Pre-Requisite for the course (if any):</b>							
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to get acquainted with the practical aspects of ecology, ethnobotany, IPR and biosafety cabinets.							
Part B - Contents of the Course							
Suggested Practical works							Contact Hours
<p><b>24L6.5-BOT-401: Economic Botany &amp; Ethnobotany</b></p> <ul style="list-style-type: none"> <li>Study of economically important cereal crops (<i>Triticum aestivum</i>, <i>Oryza sativa</i>, <i>Zea mays</i>, etc.) and vegetable crops (<i>Solanum tuberosum</i>, <i>S. lycopersicum</i>, <i>Allium cepa</i>, <i>A. sativum</i> and <i>Brassica oleracea var. capitata</i>) with reference to grain structure, nutritional value and regional significance.</li> <li>Study of pulse crops (<i>Cicer arietinum</i>, <i>Cajanus cajan</i>, <i>Vigna mungo</i>, etc.) with focus on seed morphology, nitrogen fixation ability and dietary importance.</li> <li>Study of fiber-yielding plants (<i>Gossypium spp.</i>, <i>Corchorus capsularis</i>, <i>Cocos nucifera</i>, etc.) highlighting plant parts used, fiber types (bast, seed) and processing techniques.</li> <li>Study of oilseed crops (<i>Brassica juncea</i>, <i>Arachis hypogaea</i>, <i>Ricinus communis</i>, etc.) focusing on oil-extractable plant parts, processing and economic utility.</li> <li>Study of medicinally valuable plants (<i>Withania somnifera</i>, <i>Ocimum sanctum</i>, <i>Azadirachta indica</i>, <i>Aloe vera</i>, etc.) with emphasis on parts used, traditional applications and therapeutic importance.</li> <li>Study of aromatic plants and their uses in perfumery and therapeutics. (<i>Lavandula angustifolia</i>, <i>Rosmarinus officinalis</i>, <i>Mentha piperita</i>, and <i>Ocimum basilicum</i>).</li> <li>Study of Gums, Resins, Tannins, Dyes: <i>Acacia</i>, <i>Terminalia</i>, <i>Tea</i>, <i>Turmeric</i>, <i>Bixa orellana</i>, <i>Indigo</i>, <i>Butea monosperma</i>, <i>Lawsonia inermis</i>.</li> <li>Microscopic study of economic plant parts (seeds, roots, tubers, fibers, wood).</li> <li>Extraction of essential oils or plant dyes using local species like <i>Curcuma longa</i>, <i>Azadirachta indica</i>.</li> <li>Preparation of herbarium sheets for local economical crops and ethnobotanical plants.</li> </ul> <p><b>24L6.5-BOT-402: Innovation, Patent Rights &amp; Biosafety Regulations</b></p> <ul style="list-style-type: none"> <li>Study of Intellectual Property types: Patents, Copyrights, Trademarks, GI, etc., with case studies related to plant sciences.</li> <li>Understanding the steps involved in patent filing in India using Indian Patent Office (IPO) website and forms (Form 1, Form 2, etc.).</li> <li>Access and interpret existing patents related to plant innovations using databases like WIPO, USPTO and IPO.</li> </ul>							120

- Study of real-world bioethical issues such as GMOs, biopiracy, traditional knowledge and CRISPR use in agriculture.
- Exploration and documentation of traditional knowledge using TKDL interface and analyzing its role in preventing biopiracy.
- Design a simple innovative plant-based product or process and prepare a draft for patent application.
- Study of biosafety levels, containment and biosafety cabinets measures in laboratories with respect to genetically modified organisms.
- Study of functioning of Institutional Biosafety Committee by presenting and reviewing a GMO research proposal.

Note: Any other relevant practical/ crops locally available can be offered.

**Excursion Report:** Field visit to nearby villages or tribal areas to record economic crops, traditional knowledge and uses of plants along with cultural rituals, beliefs and festivals (e.g., *Ficus religiosa*, *Ocimum sanctum*) or to a recognized botanical garden or museum (such as FRI, BSI, NBRI, CSIR laboratory, etc. Alternatively, lab visit (like IMTECH, Chandigarh or any nearby laboratories) to study biosafety cabinets or GMO testing, whichever is possible.

#### Suggested Evaluation Methods

##### Internal Assessment: 30

##### ❖ Practicum

- ✓ Class Participation: 5
- ✓ Seminar/ Demonstration/ Viva-voce/ Lab record/ Field work/ Survey etc.: 10
- ✓ Mid-Term Exam: 15

##### End Term Examination: 70

##### ❖ Practicum

- ✓ Practical Examination: 70
- Lab record, Viva-Voce, write-up and execution of the practical.

#### Part C - Recommended Books/ e-resources

- Kochhar, S.L. (2016) Economic Botany: A Comprehensive Study. Cambridge University Press (New Delhi), pp. 560.
- Jain, S.K. (1987) A Manual of Ethnobotany. Scientific Publishers (Jodhpur), pp. 239.
- Sharma, O.P. (2019) Economic Botany. McGraw Hill Education (New Delhi), pp. 280.
- Vasudevan, N. (2012) Handbook of Ethnobotany. Ane Books Pvt. Ltd. (New Delhi), pp. 320.
- Kaushik, P. (2007) Biosafety and Bioethics. Regency Publications (New Delhi), pp. 240.
- Maheshwari, J.K. (2000) Ethnobotany and Medicinal Plants of Indian Subcontinent. Scientific Publishers (Jodhpur), pp. 344.
- Singh, V. & Sheoran, O.P. (2006) Ethnobotanical Studies in Haryana. Yamuna Publications (Rohtak), pp. 248.
- Kumar, V. & Rai, A.K. (2011) Intellectual Property Rights: A Primer. Eastern Book Corporation (Lucknow), pp. 270.
- Krattiger, A., Mahoney, R.T., Nelsen, L., Thomson, J.A., Bennett, A.B., Satyanarayana, K. & Graff, G.D. (2007) Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices. MIHR-PIPRA (Oxford), pp. 1552.
- [https://bsi.gov.in/uploads/documents/Public\\_Information/publication/books/miscellaneous/Economic%20Plants%20of%20India%20vol%201.pdf](https://bsi.gov.in/uploads/documents/Public_Information/publication/books/miscellaneous/Economic%20Plants%20of%20India%20vol%201.pdf).
- <https://www.biologydiscussion.com/medicinal-plants/medicinal-plants-found-in-india-economic-botany/56868>.
- <https://ipindia.gov.in>.
- <https://www.nitap.ac.in/storage/pdf/f63d0ea9127821f83a5a4ad9f1531be8-10-04-11of%20IPR.pdf>.

<b>M.Sc. Botany (Session: 2024-25)</b>							
<b>Semester-IV</b>							
<b>Part A - Introduction</b>							
Course Type	Course Code	Credit	Hrs./ week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (hrs.)
	Name of the Course						
PC-8	<b>24L6.5-BOT-412</b>	4	8	30	70	100	4
	Practical based on 24L6.5-BOT-403/ 404/ 405/ 406 & 24L6.5-BOT-407/ 408/ 409/ 410						
<b>Level of the course (As per Annexure-I): 500-599</b>							
<b>Pre-Requisite for the course (if any):</b>							
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to get acquainted with the practical aspects of plant stress biology/ seed/ biodiversity conservation/ bioinformatics / nanotechnology/ PTC/ Genomics/ Proteomics/ GIS/ Forensic botany.							
<b>Part B - Contents of the Course</b>							
<b>Suggested Practical works</b>							<b>Contact Hours</b>
<p><b>24L6.5-BOT-403: Phytopathology</b></p> <ul style="list-style-type: none"> <li>• To prepare potato-dextrose agar medium.</li> <li>• To prepare CDA/ PDA medium and prepare plates of CDA/ PDA medium.</li> <li>• Investigation for best media for fungal growth at different temperatures.</li> <li>• Quantify the air-borne fungi from different locations.</li> <li>• To prove Koch's postulates for fungal pathogen.</li> <li>• To prepare wine from grapes juice by fermentation using yeast.</li> <li>• Gram staining of bacteria.</li> <li>• To study symptomology and disease cycle of fungal disease as mentioned in the theory of locally available.</li> <li>• To calibrate the ocular micrometer with stage micrometer.</li> <li>• To prepare nutrient agar medium.</li> <li>• Isolation of fungal pathogen <i>Alternaria</i> from infected leaves of <i>Spinacia oleracea</i>.</li> </ul> <p><b>24L6.5-BOT-404: Seed Science &amp; Technology</b></p> <ul style="list-style-type: none"> <li>• To test seed viability using tetrazolium test.</li> <li>• Germination test using roll towel paper method.</li> <li>• To perform germination tests under standard conditions.</li> <li>• To determine seed moisture content.</li> <li>• Identification of weed seeds in crop seed samples.</li> <li>• To study physical purity of a seed sample.</li> <li>• To identify seed-borne fungi using blotter test.</li> <li>• To observe morphological traits of different crop seeds.</li> <li>• Determination of thousand-seed weight.</li> <li>• Testing dormancy breaking by soaking or scarification.</li> </ul>							<b>120</b>

**24L6.5-BOT-405: Natural Resources & Restoration Ecology**

- To determine the inorganic carbon content of given soil samples.
- To determine the organic carbon content of given soil samples by acid dilution method.
- To compare SLA and LDMC of forestry plantations.
- To prepare a relative abundance curve for the herbaceous vegetation by R.H. Whittaker method.
- To prepare a relative abundance curve for the herbaceous vegetation by the F.W. Preston method.
- To mark the location of trees using Brunton compass in the botanical garden.
- To prepare an inventory of the flora of the campus.
- To determine the above-ground and below-ground biomass of given vegetation.
- To determine and compare the Humus content of polluted and unpolluted soil.
- To estimate Sulphur content of the given soil sample.

**24L6.5-BOT-406: Bioinformatics**

- Explore gene structure using Ensembl or GeneCards.
- To translate a DNA sequence to protein using ExPasy Translate tool.
- Retrieve DNA/ protein sequences from NCBI.
- Perform sequence alignment using BLAST.
- To construct a phylogenetic tree using MEGA software.
- Identify open reading frames (ORFs) in a DNA sequence.
- Analyze protein domains using Pfam or InterPro.
- To identify conserved domains in a protein sequence.
- To download FASTA format sequences and practice editing.
- To align multiple sequences using Clustal Omega.

**24L6.5-BOT-407: Nanotechnology**

- To synthesize silver nanoparticles using plant extracts.
- Observation of color change during nanoparticle synthesis.
- Synthesis of iron oxide nanoparticles using tea extract.
- To characterize nanoparticles using UV-Vis spectrophotometry.
- Application of nanoparticles to leaves and recording visual changes.
- Comparison of seed germination rates treated with nanoparticles.
- To test the antimicrobial activity of nanoparticles.
- Testing nanoparticle stability under varying pH or temperatures.
- To study uptake of nanoparticles in plants using microscopy.
- To assess phytotoxicity of nanoparticles in seed germination assays.

**24L6.5-BOT-408: Genomics & Proteomics**

- Extraction of crude genomic DNA from plant tissue.
- Electrophoretic separation of plant protein using native PAGE.
- To isolate plant genomic DNA.
- To quantify DNA using spectrophotometry.

- Protein staining using Coomassie Brilliant Blue.
- Comparison of DNA isolation methods (CTAB vs commercial kits).
- To perform agarose gel electrophoresis of DNA.
- To extract and estimate total plant protein.
- To separate proteins using SDS-PAGE.
- To perform protein quantification using Bradford assay.

#### **24L6.5-BOT-409: Plant Tissue Culture & Applications**

- To prepare MS medium and perform media sterilization.
- To perform callus induction from explants.
- Surface sterilization of explants for culture initiation.
- Observation of different stages of micropropagation.
- To induce organogenesis or somatic embryogenesis.
- Comparison of callus formation on various media formulations.
- Study of somaclonal variation using observable traits.
- To isolate protoplasts and observe under microscope.
- To study anther or pollen culture for haploid production.
- Demonstration of hardening and acclimatization of tissue-cultured plants.
- To study the procedure for synthetic seed preparation.
- To study the floral morphology of pollen grains.
- To study in vitro pollen germination and pollen viability.

#### **24L6.5-BOT-410: GIS, Remote Sensing & Forensic Botany**

- Introduction to GIS software (e.g., QGIS/ ArcGIS): Interface, layers, tools.
- Digitization of botanical maps: Marking vegetation types, water bodies, or forest cover.
- Mapping plant distribution using GPS data and importing into GIS.
- Creating thematic maps for vegetation density or land use.
- Overlay analysis: Soil type, rainfall, and vegetation correlations.
- Basics of satellite image interpretation (Landsat/ Sentinel imagery).
- NDVI calculation (Normalized Difference Vegetation Index) to assess plant health.
- Classification of land cover using remote sensing imagery (supervised/ unsupervised).
- Microscopic analysis of plant fragments (leaves, pollen, seeds) from mock crime scenes.
- Pollen identification and comparison from different sources.
- Preparation of a forensic botany herbarium: Medicinal, toxic, or rare species.
- Use anatomical keys to identify common woods and seeds relevant in forensic cases.
- Morphological and anatomical study of toxic plants e.g., *Datura*, *Calotropis*, *Ricinus*.
- Seed morphology and dispersal analysis from simulated crime scenes.
- Estimating time of death using plant succession on decomposing organic material.
- Analysis of plant-based poisons or toxins (theoretical/ demonstration).

Note: Any other relevant practical can be offered.

<b>Excursion Report:</b> Report on excursion tours with photographs, collection in forensic field visit or mock crime scene simulation involving botanical clues. Simulate a simple crime scene with botanical traces and apply analytical techniques to solve.	
<b>Suggested Evaluation Methods</b>	
<b>Internal Assessment: 30</b>	<b>End Term Examination: 70</b>
<ul style="list-style-type: none"> <li>❖ <b>Practicum</b></li> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Demonstration/ Viva-voce/ Lab record/ Field work/ Survey etc.: 10</li> <li>✓ Mid-Term Exam: 15</li> </ul>	<ul style="list-style-type: none"> <li>❖ <b>Practicum</b></li> <li>✓ Practical Examination: 70</li> </ul> <p>Lab record, Viva-Voce, write-up and execution of the practical.</p>
<b>Part C - Recommended Books/ e-resources</b>	
<p><b>Phytopathology</b></p> <ul style="list-style-type: none"> <li>▪ Kavanagh K. &amp; Herbert S. (2014) Laboratory Protocols in Fungal Biology: Current Methods in Fungal Biology. Springer (New York), pp. 430.</li> <li>▪ Schwyn B. &amp; Neilands J.B. (1987) Universal Chemical Assay for the Detection and Determination of Siderophores. Academic Press (San Diego), pp. 264.</li> <li>▪ Deising H.B. &amp; Russell J. (2018) Protocols for in Vitro Cultures and Secondary Metabolite Analysis of Aromatic and Medicinal Plants. Humana Press (New York), pp. 332.</li> </ul> <p><b>Seed Science &amp; Technology</b></p> <ul style="list-style-type: none"> <li>▪ John D.M., Whitton B.A. &amp; Brook A.J. (2002) The Freshwater Algal Flora of the British Isles: An Identification Guide to Freshwater and Terrestrial Algae. Cambridge University Press (Cambridge), pp. 702.</li> <li>▪ Lee R.E. (2008) Phycology. Cambridge University Press (Cambridge), pp. 680.</li> <li>▪ Guiry M.D. &amp; Guiry G.M. (2020) AlgaeBase: Listing the World's Algae. National University of Ireland, Galway. Available at: <a href="http://www.algaebase.org">www.algaebase.org</a>.</li> </ul> <p><b>Natural Resources &amp; Restoration Ecology</b></p> <ul style="list-style-type: none"> <li>▪ Hobbs R.J. &amp; Suding K.N. (2008) New Models for Ecosystem Dynamics and Restoration. Island Press (Washington, D.C.), pp. 392.</li> <li>▪ Clewell A.F. &amp; Aronson J. (2013) Ecological Restoration: Principles, Values, and Structure of an Emerging Profession. Island Press (Washington, D.C.), pp. 358.</li> <li>▪ Walker L.R. &amp; Walker J. (1991) Primary Succession and Ecosystem Rehabilitation. Cambridge University Press (Cambridge), pp. 320.</li> </ul> <p><b>Bioinformatics</b></p> <ul style="list-style-type: none"> <li>▪ Field A. (2013) Discovering Statistics Using IBM SPSS Statistics. SAGE Publications Ltd (London), pp. 1176.</li> <li>▪ Hair J.F., Black W.C., Babin B.J., Anderson R.E. (2014) Multivariate Data Analysis. Pearson Education Limited (Harlow), pp. 816.</li> <li>▪ Kuhn M. &amp; Johnson K. (2013) Applied Predictive Modeling. Springer (New York), pp. 600.</li> </ul> <p><b>Nanotechnology</b></p> <ul style="list-style-type: none"> <li>▪ Thomas, G.W. (1996) Soil pH and Soil Acidity. In: Sparks, D.L., Ed., Methods of Soil Analysis Part 3: Chemical Methods, SSSA Book Series 5, Soil Science Society of America, Madison, Wisconsin, 475-490.</li> <li>▪ Sparks, D.L. (2003) Environmental Soil Chemistry. Academic Press (San Diego), pp. 352.</li> <li>▪ Singh, A. &amp; Ward, O.P. (2004) Bioremediation: Principles and Applications. Springer (New York), pp. 309.</li> <li>▪ Parmesan, C. &amp; Yohe, G. (2003) Climate Change Biology. Academic Press (San Diego), pp. 421.</li> </ul>	

**Genomics & Proteomics**

- Glick B.R. & Pasternak J.J. (2010) *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. ASM Press (Washington, D.C.), pp. 792.
- Old R.W. & Primrose S.B. (1994) *Principles of Gene Manipulation and Genomics*. Blackwell Science Ltd (Oxford), pp. 352.
- Birch R.G. (1997) *Plant Transformation: Problems and Strategies for Practical Application*. Cambridge University Press (Cambridge), pp. 268.

**Plant Tissue Culture & Applications**

- Singh B.D. (2003) *Plant Breeding: Principles and Methods*. Kalyani Publishers (Ludhiana), pp. 560.
- Karp A., Isaac P.G. & Ingram D.S. (2008) *Molecular Tools for Screening Biodiversity: Plants and Animals*. Springer (New York), pp. 366.
- Stebbins G.L. (1971) *Chromosomal Evolution in Higher Plants*. Addison-Wesley Publishing Company (Reading), pp. 216.

**GIS, Remote Sensing & Forensic Botany**

- Lo, C.P. & Yeung, A.K.W. (2007) *Concepts and Techniques of Geographic Information Systems*. 2<sup>nd</sup> Edn. Prentice Hall (Upper Saddle River), pp. 532.
- Lillesand, T.M., Kiefer, R.W. & Chipman, J.W. (2015) *Remote Sensing and Image Interpretation*, 7<sup>th</sup> Edn. Wiley (New Jersey), pp. 736.
- Heywood, V.H. (Ed.) (2001) *Practical Plant Identification*. Cambridge University Press (Cambridge), pp. 312.

M.Sc. Botany (Session: 2024-25)						
Semester-IV						
Part A - Introduction						
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	End Term Marks	Max. Marks
Dissertation	24L6.5-BOT-410	Dissertation	12	24	300	300

**The guidelines and format for the dissertation is given below:**

**Dissertation Guidelines:**

**1. General:**

The manual is intended to provide broad guidelines to the M.Sc. candidates in the preparation of the dissertation report. In general, the project report shall report, in an organized and scholarly fashion an account of original research work of the candidate leading to the discovery of new facts or techniques or correlation of facts already known.

**2. Number of Copies to be Submitted:**

Students should submit three copies to the Head of the Department concerned on or before the specified date.

**ARRANGEMENT OF CONTENTS OF DISSERTATION:**

Dissertation material should be arranged as follows-

- |                                   |                             |
|-----------------------------------|-----------------------------|
| 1. Cover Page & Title page        | 9. Introduction             |
| 2. Declaration (See format below) | 10. Review of Literature    |
| 3. Certificate                    | 11. Materials and Methods   |
| 4. Abstract                       | 12. Results and Discussion  |
| 5. Acknowledgements               | 13. Summary and Conclusions |
| 6. Table of Contents              | 14. References              |
| 7. List of Tables                 | 15. Appendices              |
| 8. List of Figures                | 16. One-page CV             |

The Tables and Figures shall be introduced in the appropriate places.

**Page Dimensions and Margin:**

The dimensions of the dissertation should be standard A4 size paper may be used for preparing the copies, standard margin with 1.5-line spacing.

**Manuscript Preparation:** The general text of thesis shall be typed in

Font style- Times New Roman

Font size- 12 with 1.5 spacing.

Same quality of paper should be used for the preparation of the entire report; except figure, photos are shown.

**Cover Page & Title Page:** A specimen copy of the Cover page & Title page for report/thesis are given in Annexure I.

**Certificate:** The Bonafide Certificate as per the format shown in Annexure II.

**Abstract:** Abstract should be an essay type of narration not exceeding 500 words outlining the research problem, the methodology used for tackling it and a summary of the findings, typed in 1.5-line spacing. **Acknowledgements:** The acknowledgements shall be brief and should not exceed one page. The student's signature shall be made at the right bottom above his / her name typed in capitals.

**Table of contents:** The table of contents should list all material following it as well as any material which precedes it. The title page, Bonafide Certificate and Acknowledgment will not find a place among the items listed in the Table of Contents but the page numbers in lower case Roman letters are to be accounted for them. One and a half spacing should be adopted for typing the matter under this head. A specimen copy of the Table of Contents for report / thesis is given in Annexure III.

**List of Table:** The list should use exactly the same captions as they appear above the tables in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head.

**List of Figures:** The list should use exactly the same captions as they appear below the figures in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing them at under this head.

**List of Symbols, Abbreviations and Nomenclature:** One and a half spacing should be adopted for typing them at under this head. Standard symbols, abbreviations, etc. should be used.

Research output/outcome if any published or presented in conference/seminar/symposium may be included.

**List of References:** Any works of other researchers, if used either directly or indirectly, should be indicated at appropriate places in the report/thesis. The citation may assume any one of the following forms APA Style. APA in-text citation style uses the author's last name and the year of publication, for example: (Field, 2005).

**Example:**

1. Derwing, T.M., Rossiter, M.J. and Munro, M.J. (2002). Teaching native speakers to listen to foreign-accented speech. *Journal of Multilingual and Multicultural Development*, 23(4): 245-259.
2. Thomas, H. K. (2004). Training strategies for improving listeners' comprehension of foreign-accented speech (Doctoral dissertation), University of Colorado, Boulder.

**Typing Instructions:** General this section includes additional information for final typing of the thesis. Some information given earlier under 'Manuscript preparation' shall also be referred. The impressions on the typed/duplicated/printed copies should be black in colour. Corrections, interlineations and crossing out of letters or words will not be permitted in any of the copies of the report/thesis intended for submission. Erasures, if made, should be neatly carried out in all copies. A sub-heading at the bottom of a page must have at least two full lines below it or else it should be carried over to the next page. The last word of any page should not be split using a hyphen. One and a half spacing should be used for typing the general text. The general text shall be typed in Font Style Times New Roman and Font Size 12 with 1.5 spacing.

Single spacing should be used for typing:

- (i) Long Tables
- (ii) Long quotations
- (iii) Footnotes
- (iv) Multiline captions
- (v) References

Chapters The format for typing chapter headings, division headings and subdivision headings shall be same as given in Table of Contents.

**Binding specification:** Thesis should be spiral or soft cover book bound, the cover of the thesis should be of blue color printed with golden ink and the text for printing should be identical as prescribed for the title page.

### **Format for Declaration by the candidate:**

#### **DECLARATION**

I ..... student of Department of Botany, Indira Gandhi University Meerpur, Rewari hereby declare and certify with my signature that my thesis entitled ..... submitted to the Department of Botany, Indira Gandhi University, Meerpur, Haryana, India in partial fulfillment of the requirements for the award of the Degree of Masters of Science is a record of original research work done by me and the dissertation has not been the basis for the award of any degree/ diploma/ associateship/ fellowship or similar title of any candidate of any University. I have faithfully and accurately cited all my sources, including books, journals, handouts and unpublished manuscripts, as well as any other media, such as the Internet, letters or significant personal communications.

I understand the concept of “plagiarism” and declare that while drafting this dissertation I have refrained from plagiarism. I know that plagiarism not only includes direct copying, but also the extensive use of other’s ideas without proper referencing or acknowledgement (which includes the proper use of references and quotation marks). If my dissertation found to be plagiarized at any point of time, I’ll be solely responsible and will be ready to accept any decision taken by the competent authority including rejection of my dissertation.

Signature of student

M.Sc. Botany (Session: 2024-25)								
Semester-IV								
Part A - Introduction								
Course Type	Course Code	Course Nomenclature	Credits	Hrs./week	Int. Asst.	End Term Marks	Max. Marks	Exam Duration (Hrs.)
EEC	24L6.5-EEC-RPE-400	Research Ethics	2	2	15	35	50	3
<b>Level of the Course:</b> 500-599								
<b>Pre-requisite for the course (if any):</b>								
<b>Learning Objective:</b> Learner will able to Comprehend the fundamental ethical principles in research, including honesty, integrity, transparency, and accountability and apply them to various research scenarios..								
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to- 1. identify ethical issues and dilemmas in research design, conduct, and publication, and develop strategies to address and resolve them effectively. 2. gain proficiency in the processes and requirements of ethical review boards and committees, including preparing and submitting research proposals for ethical approval. 3. enhance critical thinking and decision-making skills to navigate complex ethical situations in research. 4. adopt ethical publishing practices by understanding the importance of authorship criteria, peer review integrity, and the avoidance of publication misconduct such as fabrication, falsification and plagiarism.								
Part B - Content of the Course								
<b>Instructions for Paper- Setter:</b> 1. There shall be nine questions in all. Question no. 1 shall be compulsory (taking CLO into consideration), consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. 2. The examinee will be required to attempt 5 questions, the compulsory question and selecting one question from each unit. All questions will carry equal marks.								
Unit	Topics							Contact Hours
	Syllabus can be found on university website.							
Suggested Evaluation Methods								
<b>Internal Assessment: 15</b>						<b>End Term Examination: 35</b>		
❖ <b>Theory (15)</b> ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 5						❖ <b>Theory (35)</b> ✓ Written Examination: 35  Lab record, Viva-Voce, write-up and execution of the practical		
Part C - Learning Resources (Recommended Books/ e-resources/ LMS)								

- Resnik, D.B. (2018). *The Ethics of Research with Human Subjects: Protecting People, Advancing Science, Promoting Trust*. Springer (Cham), pp. 316.
- Shamoo, A.E. & Resnik, D.B. (2009). *Responsible Conduct of Research* (2<sup>nd</sup> Edn.). Oxford University Press (New York), pp. 440.
- Israel, M. (2015). *Research Ethics and Integrity for Social Scientists: Beyond Regulatory Compliance* (2<sup>nd</sup> Edn.). Sage Publications (Los Angeles), pp. 264.
- Steneck, N.H. (2007). *ORI Introduction to the Responsible Conduct of Research*. Government Printing Office (Washington, D.C.), pp. 262.
- Macrina, F.L. (2014). *Scientific Integrity: Text and Cases in Responsible Conduct of Research* (4<sup>th</sup> Edn.). ASM Press (Washington, D.C.), pp. 576.
- Emanuel, E.J., Crouch, R.A., Arras, J.D., Moreno, J.D. & Grady, C. (Eds.) (2003). *Ethical and Regulatory Aspects of Clinical Research: Readings and Commentary*. Johns Hopkins University Press (Baltimore), pp. 528.
- Bulger, R.E., Heitman, E., & Reiser, S.J. (Eds.) (2002). *The Ethical Dimensions of the Biological and Health Sciences* (2<sup>nd</sup> Edn.). Cambridge University Press (Cambridge), pp. 384.
- Iphofen, R. (Ed.) (2020). *Handbook of Research Ethics and Scientific Integrity*. Springer (Cham), pp. 903.