

INDIRA GANDHI UNIVERSITY, MEERPUR-REWARI, HARYANA-122502

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

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Syllabus and Scheme of Examination (in accordance with National Education Policy 2020) **for** **Post Graduate Programme** **in** **BOTANY**

Effective from Academic Session 2026-27

Department of Botany
Faculty of Life Science

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

Details of Approvals

Council/Board	Date	Remark
Staff Council		
Board of Studies		Online
Faculty Board		
Academic Council		
Year of implementation		

Chairperson
(Signature with Stamp)

VISION AND MISSION OF THE UNIVERSITY

VISION

To be a globally renowned university, recognized for excellence in teaching, innovative research, and welfare of the society, imbibing the spirit of “*Vasudhaiv kutumbkam*”.

MISSION

- To introduce and implement innovation in teaching and learning process matching up the global standards to strengthen academic delivery through curriculum design, teaching pedagogy and usage of ICT.
- To develop a mechanism that attracts talented, qualified and experienced faculty from across the globe for pursuing their academic and research careers at the University.
- To offer academic programs at UG, PG, Doctoral, Post-Doctoral levels which are learner-centric, industry focused, and adhere to outcome based international models.
- To create an ambiance that is conducive for undertaking sponsored research, innovation and consultancy services to a wide spectrum of societal and industrial requirements while encouraging interdisciplinary approach of learning, team work and research.
- To establish state of art centres of excellence in frontier areas of research and design innovation through industry collaboration to innovate and incubate the products and services.
- To establish smart campus and promote e-governance activities in the university for the digitally empowered society and knowledge economy.
- To provide a hygienic, modern, environment friendly and vivacious campus attuned to the urgent needs of Green Technology.
- To consider and implement norms, metrics, standards, procedures and benchmarks for assessing and improving the quality in every aspect of University system and achieve quality certifications by National and International bodies.
- To make society self-reliant by organizing various programmes including literacy, gender sensitization, health awareness and dissemination of information about livelihood generation.

VISION OF THE DEPARTMENT

To become a centre of excellence in plant science teaching, research and innovation, with a strong focus on classical botany, modern biological sciences, biodiversity conservation, sustainable development and societal welfare.

MISSION OF THE DEPARTMENT

- To provide quality education in Botany through a balanced integration of classical and modern plant sciences.
- To develop scientific curiosity, critical thinking and research aptitude among students.
- To promote biodiversity conservation, environmental awareness and sustainable use of plant resources.
- To strengthen practical, analytical and field-based learning through laboratory work, projects and interdisciplinary exposure.
- To prepare students for higher studies, research, teaching, competitive examinations and diverse career opportunities.
- To encourage ethical values, scientific temper and responsibility towards society and nature.

ABOUT THE PROGRAMME

The **M.Sc. Botany programme** is designed to provide advanced knowledge of plant sciences with emphasis on plant diversity, structure, function, reproduction, evolution, systematics, ecology, microbiology, mycology, physiology, genetics, cell biology, biotechnology and applied botany. The programme combines theoretical learning, laboratory training, field work, problem-solving and research orientation.

It is intended to develop students into competent postgraduates who can pursue careers in teaching, research, academia, environmental management, plant biotechnology, biodiversity studies, seed and plant resource sectors and related interdisciplinary areas.

INTAKE IN THE PROGRAMME

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MINIMUM ELIGIBILITY CRITERIA

A student shall be declared to have passed a course and the programme only if he/she:

- secures the minimum passing marks prescribed by the university in **theory, practical and internal assessment**, wherever applicable,
- secures the required aggregate marks in each semester and in the programme as a whole,
- completes all compulsory credits, practicals, seminars, field work and project/ dissertation components as prescribed,
- and fulfills all academic and attendance requirements of the university.

(Exact minimum marks may be seen on university website as per the university ordinance.)

PASSING CRITERIA

ELIGIBILITY FOR EXAMINATION

A student shall be eligible to appear in the semester examination if he/she:

- has attended the minimum required percentage of classes as prescribed by the university,
- has completed the required internal assessment, practical work and assignments,
- has fulfilled attendance and academic requirements for each course,
- and has not been debarred due to disciplinary or academic reasons.

DURATION FOR PASSING THE PROGRAMME

The programme shall ordinarily be completed in **2 years / 4 semesters**.

A student must complete the programme within the maximum period permitted by the university regulations.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	Build a strong foundation in classical and modern Botany for higher studies, teaching and research.
PEO 2	Apply botanical knowledge in biodiversity conservation, environmental sustainability and plant resource management.
PEO 3	Develop scientific, analytical and experimental skills required for laboratory, field and research-based careers.
PEO 4	Use modern tools and interdisciplinary approaches in plant science, biotechnology and related areas.
PEO 5	Demonstrate ethical conduct, scientific temper and a sense of responsibility towards society and nature.

PROGRAMME OUTCOMES (POs)

PO 1	Knowledge	Demonstrate in-depth knowledge of plant sciences, including structure, function, diversity, evolution, reproduction, genetics, ecology and applied botany.
PO 2	Research Aptitude	Develop research aptitude through scientific observation, hypothesis formulation, experimental design, data collection, analysis and interpretation in various areas of plant science.
PO 3	Communication	Communicate scientific ideas, experimental findings and botanical concepts effectively through oral presentations, scientific writing, practical reports and digital platforms.
PO 4	Problem-Solving	Identify, analyse and solve biological and environmental problems using scientific reasoning, analytical thinking and interdisciplinary approaches.
PO 5	Individual and Team Work	Demonstrate the ability to work responsibly both independently and collaboratively in laboratory, field-based and research-oriented activities.
PO 6	Investigation of Problems	Apply appropriate scientific methods, experimental techniques and critical evaluation to investigate complex problems related to plants, environment and biological systems.
PO 7	Modern Tool Usage	Use modern laboratory instruments, microscopy, computational resources, molecular techniques and other scientific tools relevant to botanical studies and research.
PO 8	Scientific temperament	Develop scientific temper, ethical values, environmental awareness and professional responsibility towards society, biodiversity conservation and sustainable development.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1	Understand the diversity, structure, classification, reproduction and evolution of plants (cryptogams to phanerogams), fungi and related microbial groups using classical and modern approaches in botany.
PSO 2	Apply knowledge of plant anatomy, physiology, genetics, ecology, embryology, molecular biology and biotechnology in laboratory, field and research-oriented studies.
PSO 3	Develop practical, analytical and research skills through scientific experimentation, field exploration, data interpretation and use of modern biological tools and techniques.
PSO 4	Demonstrate scientific temperament, environmental awareness and professional competence for higher studies, research, teaching and sustainable utilization of plant resources.

Scheme of Examination for Postgraduate Programme	
Subject	Botany
Total number of Semesters	4
Total Marks	2700
Total Credit	108
Framework	2
Scheme	P

Semester	Course Type	Course Code	Nomenclature of Course	Theory (T)/ Practical (P)	Credits		Contact hours per week L: Lecture P: Practical T: Tutorial To: Total				Internal Assessment Marks	End Term Examination Marks	Total Marks	Examination Hours
						To	L	T	P	To				
1	CC-1	26L6.0-BOT-101	Cryptogamic Plant Diversity	4T	4	26	4	-	0	4	30	70	100	3
	CC-2	26L6.0-BOT-102	Microbial Kingdom & Applied Mycology		4		4	-	0	4	30	70	100	3
	CC-3	26L6.0-BOT-103	Inheritance Biology & Genetic Engineering		4		4	-	0	4	30	70	100	3
	CC-4	26L6.0-BOT-104	Cell Biology & Biotechniques		4		4	-	0	4	30	70	100	3
	PC-1	26L6.0-BOT-105	Thallophytes and Microbial Diversity: Practical (based on 26L6.0-BOT-101 & 26L6.0-BOT-102)	4P	4		0	-	8	8	30	70	100	3
	PC-2	26L6.0-BOT-106	Cell Biology, Genetics and Techniques: Practical (based on 26L6.0-BOT-103 & 26L6.0-BOT-104)		4		0	-	8	8	30	70	100	3
	SEM	26L6.0-BOT-107	Seminar	2P	2		0	-	2	2	-	50	50	2
2	CC-5	26L6.0-BOT-201	Evolutionary Biology, Gymnosperms & Plant Anatomy	4T	4	26	4	-	0	4	30	70	100	3
	CC-6	26L6.0-BOT-202	Angiosperms Systematics & Embryology		4		4	-	0	4	30	70	100	3

	CC-7	26L6.0-BOT-203	Plant Ecology		4		4	-	0	4	30	70	100	3
	CC-8	26L6.0-BOT-204	Molecular Biology		4		4	-	0	4	30	70	100	3
	PC-3	26L6.0-BOT-205	Plant Evolution, Diversity and Reproductive Biology: Practical (<i>Based on 26L6.0-BOT-201 & 26L6.0BOT-202</i>)	4P	4		0	-	8	8	30	70	100	3
	PC-4	26L6.0-BOT-206	Ecological and Molecular Biology: Practical (<i>Based on 26L6.0-BOT-203 and 26L6.0-BOT-204</i>)		4		0	-	8	8	30	70	100	3
	CHM	26L6.0-CHM-201	Constitutional, Human and Moral Values and IPR	2T	2		2	-	0	2	15	35	50	2
	Internship	26L6.0-BOT-INT	An internship course of 4 Credits of 4-6 weeks duration during summer vacation after 2 nd semester is to be completed by every student. Internship can be either for enhancing the employability or for developing the research aptitude.								50	50	100	
3	CC-9	26L6.5-BOT-301	Plant Physiology & Developmental Genetics	4T	4	26	4	-	0	4	30	70	100	3
	CC-10	26L6.5-BOT-302	Plant Biochemistry		4		4	-	0	4	30	70	100	3
	DEC-1 (Any One)	26L6.5-BOT-303	Plant Stress Biology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-304	Advanced Phycology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-305	Biodiversity & Conservation		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-306	Biological Data Analytics		4		4	-	0	4	30	70	100	3
	DEC-2 (Any One)	26L6.5-BOT-307	Soil, Climate & Bioremediation		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-308	Plant Biotechnology & Recombinant DNA Technology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-309	Plant Breeding & Cytogenetics		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-310	Bioprospecting of Medicinal Plants & Pharmacognosy		4		4	-	0	4	30	70	100	3

Department of Botany

Scheme (PG) w.e.f. 2026-27

	PC-5	26L6.5-BOT-311	Plant Physiology and Biochemistry: Practical (Based on 26L6.5-BOT-301 and 26L6.5-BOT-302)	2P	4		0	-	8	8	30	70	100	3
	PC-6	26L6.5-BOT-312	DSE-1 and DSE-2: Practical (Based on 26L6.5-BOT-303/ 304/ 305/ 306 and 26L6.5-BOT-307/ 308/ 309/ 310)		4		0	-	8	8	30	70	100	3
	OEC	26L6.5-BOT-313	(*for the students of other than PG Programme Botany) Students of PG Programme Botany will choose from the pool of open elective offered by the university.	2T	2		2	-	0	2	15	35	50	2
4	CC-11	26L6.5-BOT-401	Economic Botany & Ethnobotany	4T	4	26	4	-	0	4	30	70	100	3
	CC-12	26L6.5-BOT-402	Innovation, Patent Rights & Biosafety Regulations		4		4	-	0	4	30	70	100	3
	DEC-3 (Any One)	26L6.5-BOT-403	Phytopathology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-404	Seed Science & Technology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-405	Natural Resources & Restoration Ecology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-406	Bioinformatics		4		4	-	0	4	30	70	100	3
	DEC-4 (Any One)	26L6.5-BOT-407	Nanotechnology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-408	Genomics & Proteomics		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-409	Plant Tissue Culture & Applications		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-410	GIS, Remote Sensing & Forensic Botany		4		4	-	0	4	30	70	100	3
	PC-5	26L6.5-BOT-411	Plant Resources and IPR: Practical (Based on 26L6.5-BOT-401 and 26L6.5-BOT-402)	2P	4		0	-	8	8	30	70	100	3

	PC-6	26L6.5-BOT-412	DSE-3 and DSE-4: Practical (Based on 26L6.5-BOT-403/ 404/ 405/ 406 and 26L6.5-BOT-407/ 408/ 409/ 410)		4		0	-	8	8	30	70	100	3
	EEC	26L6.5-EEC-RPE-400	Research Ethics	2T	2		2	-	0	2	15	35	50	2
Scheme of Semester IV when a student opts for Dissertation Work														
4	CC-11	26L6.5-BOT-401	Economic Botany & Ethnobotany	4T	4	26	4	-	0	4	30	70	100	3
	DEC-3 (Any One)	26L6.5-BOT-403	Phytopathology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-404	Seed Science & Technology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-405	Natural Resources & Restoration Ecology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-406	Bioinformatics		4		4	-	0	4	30	70	100	3
	DEC-4 (Any One)	26L6.5-BOT-407	Nanotechnology		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-408	Genomics & Proteomics		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-409	Plant Tissue Culture & Applications		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-410	GIS, Remote Sensing & Forensic Botany		4		4	-	0	4	30	70	100	3
		26L6.5-BOT-413	MOOC from SWAYAM/ NPTEL		4		4	-	0	4	30	70	100	3
	Dissertation	26L6.5-BOT-414	Dissertation	12D	12		0	-	12	12	90	210	300	
	EEC	26L6.5-EEC-RPE-400	Research Ethics	2T	2		2	-	0	2	15	35	50	2

Core Course: 4 credits (4+0)

Part A – Introduction			
Name of Programme	M.Sc. Botany		
Semester	I		
Nature of Course/ Course Composition	Theory		
Nomenclature of the Course	Cryptogamic Plant Diversity		
Course Code	26L6.0-BOT-101		
Course Type	CC-1		
Course Level	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO ₁	Explain the classification, diversity, structural organization, reproduction, habitats and evolutionary significance of algae and distinguish major algal groups.	
	CLO ₂	Identify and compare the salient features of major algal groups through representative genera, and evaluate their economic, ecological, industrial, and biotechnological importance, including their roles in biofertilizers, bioremediation, biofuel production, algal blooms, red tides and bioluminescence	
	CLO ₃	Describe the classification, morphology, reproduction, life cycles and evolutionary adaptations of major bryophyte groups and compare their structural and developmental features.	
	CLO ₄	Explain the classification, anatomy, reproduction, spore dispersal, evolutionary adaptations, heterospory, and seed-habit development in pteridophytes and compare representative groups with reference to their evolutionary and ecological significance	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B – Contents of the Course			
Instructions for Theory Paper-Setter			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			

Unit	Topics	CLO Attempt	Contact Hours
I	Exploring Cryptogamic Plant Diversity: 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. Introduction to Phycology: Thallus organization, reproduction, classification and classification criteria (pigments, reserve food, cell wall composition and flagella); algae in diversified habitats (terrestrial, aquatic).	1	14
II	Salient Features of Following Algal Groups: Prochlorophyta (<i>Prochlorococcus</i>), Cyanophyta (<i>Nostoc</i>), Chlorophyta (<i>Oedogonium</i>), Charophyta (<i>Chara</i>), Xanthophyta (<i>Vaucheria</i>), Bacillariophyta (<i>Cyclotella</i>), Phaeophyta (<i>Sargassum</i>) and Rhodophyta (<i>Polysiphonia</i>). Role of Algae: 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	2	16
III	Introduction to Bryology: Classification, reproduction and life-cycle, origin of alternation of generation (homologous and antithetic theory), adaptations for terrestrial life, economic and ecological importance. Comparative Morphology and Development of Following Groups: Marchantiales (<i>Marchantia</i>), Jungermanniales (<i>Pellia</i>), Anthocerotales (<i>Anthoceros</i>), Sphagnales (<i>Sphagnum</i>), Funariales (<i>Funaria</i>) and Polytrichales (<i>Polytrichum</i>).	3	14
IV	Introduction to Pteridology: Classification, reproduction and spore dispersal, adaptations and evolution (telome theory, enation theory, stellar system), heterospory and seed habit; economic and ecological importance. General Account of Following Groups: Psilopsida (<i>Psilotum</i>), Lycopsida (<i>Selaginella</i>), Sphenopsida (<i>Equisetum</i>) and Pteropsida (<i>Pteris</i>).	4	16
Total Contact Hours			60
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Written Examination: 70	
Seminar/ presentation/ assignment/ quiz/ class test etc.:	10		
Mid-Term Exam:	15		
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
- Bold, H.C. & Wynne, M.J. (1985) Introduction to the Algae: Structure and Reproduction (2nd Edn.). Prentice-Hall (Englewood Cliffs), pp. 720. - Dutta, A.C. (2005) A Class Book of Botany (14th Edn.). Oxford University Press (Oxford), pp. 918. - Gifford, E.M. & Foster, A.S. (1989) Morphology and Evolution of Vascular Plants (3rd Edn.). W.H. Freeman (New York), pp. 626. - Graham, L.E., Graham, J.M. & Wilcox, L.W. (2009) Algae. Benjamin Cummings (San Francisco), pp. 616. - Parihar, N.S. (1970) An Introduction to Embryophyta: Bryophyta. Central Book Depot (Allahabad), pp. 478.			

- Rashid, A. (1998) An Introduction to Pteridophyta: Diversity and Differentiation of Sporophytes. Vikas Publishing House Pvt. Ltd. (New Delhi), pp. 200.
- Round, F.E. (1981) The Ecology of Algae. Cambridge University Press (Cambridge), pp. 653.
- Smith, G.M. (2020) Cryptogamic Botany, Volume I: Algae and Fungi. McGraw-Hill Book Company Inc. (New York), pp. 546.
- Vashishta, B.R., Sinha, A.K. & Kumar, A. (2017) Botany for Degree Students: Algae, Fungi, Bryophyta, Pteridophyta, Gymnosperms and Microbiology. S. Chand & Company Ltd. (New Delhi), pp. 880.
- <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/cryptogam>.
- <https://archive.bsi.gov.in/cryptogams>.

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	2	1	2	1	2	3	2	1	2
CLO ₂	3	2	2	3	2	3	2	3	3	3	3	3
CLO ₃	3	2	1	2	1	2	1	2	3	2	2	3
CLO ₄	3	2	1	3	2	3	2	3	3	2	3	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	7
Entrepreneurship	5
Skill Enhancement	10
Communication Development	3
Indian Knowledge System	2
Environmental Awareness	12
Current Issues and Social Awareness	5
Gender issues	2
Public policies	2
Any Other (Evolutionary Concepts)	12

Important Notes (If any)

- Recent advances in cryptogamic plants, algal groups, bryophytes and pteridophytes, including their classification, morphology, anatomy, reproduction, life cycles, evolutionary patterns and ecological and economic importance, included in the syllabus are indicative. Depending upon regional availability, institutional resources and current scientific developments, equivalent representative examples, updated taxonomic concepts, recent advances, case studies and relevant contemporary applications may be used for teaching and evaluation.

Part A – Introduction			
Name of Programme	M.Sc. Botany		
Semester	I		
Nature of Course/ Course Composition	Theory		
Nomenclature of the Course	Microbial Kingdom & Applied Mycology		
Course Code	26L6.0-BOT-102		
Course Type	CC-2		
Course Level	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO ₁	Describe the diversity, structural organization, reproduction, classification, growth, stress responses and economic importance of major microbial groups and fungi.	
	CLO ₂	Classify major fungal groups and explain specialized fungal mechanisms and the structure, reproduction, types and economic importance of lichens.	
	CLO ₃	Explain the applications of fungal primary and secondary metabolites, biofertilizers, mycorrhizae and biocontrol agents in industry and agriculture.	
	CLO ₄	Explain the beneficial and harmful roles of fungi in biodeterioration and food processing, including food production, spoilage and toxicity.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B – Contents of the Course			
Instructions for Theory Paper-Setter			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO Attempt	Contact Hours
I	Overview of Microbial Diversity: History; structural organization, characteristics and economic importance of virus (including replication), bacteriophage (including lytic and lysogenic), virions, viroid, virusoid, phytoplasma, prions, archaebacteria and eubacteria. Bacterial growth yield and stress response.	1	14

	Principles of Mycology: General characters of fungi and their economic importance, thallus organization and cell wall composition, reproduction and kinds of spores; classification based on Alexopoulos et. al., 1996.		
II	General Account on Following Groups: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Specialized Mechanisms in Fungi and Lichen: Heterokaryosis, heterothallism, parasexuality and sex hormones. Structure, types (crustose, foliose, fructose) reproduction and economic importance of Lichens.	2	16
III	Primary and Secondary Metabolites by Fungi: Use of fungi in primary metabolites (industrial alcohol, organic acid, beer) and secondary metabolites (antibiotics, steroids, enzymes, amino acids, growth regulators, vitamins). Biofertilizers and Biocontrol Agents: Fungi as biofertilizers including endomycorrhizae and ectomycorrhizae. Fungi as biocontrol agents against plant pathogens and weeds.	3	14
IV	Biodeterioration: Fungal involvement in the deterioration of materials like paper, painted surfaces and wood. Food Processing: Fungal roles in food processing such as bread, cheese, oriental food, baker's yeast, health food sources, spoilage and toxicity.	4	16
Total Contact Hours			60
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Written Examination: 70	
Seminar/ presentation/ assignment/ quiz/ class test etc.:	10		
Mid-Term Exam:	15		
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
• Agrios, G.N. (2005) Plant Pathology (5th Edn.). Elsevier Academic Press (San Diego), pp. 890. • Alexopoulos, C.J., Mims, C.W. & Blackwell, M. (1996) Introductory Mycology (4th Edn.). John Wiley & Sons (Hoboken), pp. 886. • Carlile, M.J., Watkinson, S.C. & Gooday, G.W. (2001) The Fungi (2nd Edn.). Academic Press (London), pp. 588. • Deacon, J.W. (2013) Fungal Biology (4th Edn.). John Wiley & Sons (Hoboken), pp. 528. • Gnanamanickam, S.S. (ed.) (2006) Plant-Associated Bacteria. Springer (Berlin), pp. 432. • Gullino, M.L. & Bonants, P.J. (Eds.) (2016) Detection and Diagnostics of Plant Pathogens. Springer (Berlin), pp. 234. • Hawksworth, D.L. & Lucking, R. (2017) Fungal Diversity Revisited: 2 Decades of Fungal Biodiversity Studies. Springer (Cham), pp. 320. • Madigan, M.T. & Martinko, J.M. (2017) Brock Biology of Microorganisms (15th Edn.). Pearson (New York), pp. 1234. • Moore, D., Robson, G.D. & Trinci, A.P.J. (2011) 21st Century Guidebook to Fungi (2nd Edn.). Cambridge University Press (Cambridge), pp. 620. • Singh, U.S. & Mukhopadhyay, A.N. (Eds.) (2018) Plant Diseases: Identification & Management. CRC Press (Boca Raton), pp. 789. • Tortora, G.J., Funke, B.R. & Case, C.L. (2015) Microbiology: An Introduction (12th Edn.). Pearson (San Francisco), pp. 567.			

- <https://learn.genetics.utah.edu/content/microbiome/intro/>.
- <https://www.amnh.org/explore/microbe-facts#:~:text=What%20Are%20Microbes%3F,we%20call%20viruses%20microbes%20too>

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	1	1	3	1	2	3	3	2	2
CLO ₂	3	1	1	1	1	2	1	2	3	3	2	2
CLO ₃	3	2	1	2	2	2	3	3	2	3	3	3
CLO ₄	3	1	1	2	1	2	2	3	2	2	2	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	8
Entrepreneurship	5
Skill Enhancement	10
Communication Development	4
Indian Knowledge System	3
Environmental Awareness	8
Current Issues and Social Awareness	6
Gender issues	2
Public policies	4
Any Other (Evolutionary Concepts)	10

Important Notes (If any)

- Recent advances in major microbial groups and fungi, fungal structures, reproductive patterns, lichen types, biofertilizers, mycorrhizae, biocontrol agents, biodeterioration and food-processing applications included in the syllabus are indicative. Depending upon regional availability, institutional resources, current scientific developments and emerging biotechnological applications, equivalent representative examples, case studies, recent advances and contemporary issues may be used for teaching and evaluation.

Part A – Introduction			
Name of Programme	M.Sc. Botany		
Semester	I		
Nature of Course/ Course Composition	Theory		
Nomenclature of the Course	Inheritance Biology & Genetic Engineering		
Course Code	26L6.0-BOT-103		
Course Type	CC-3		
Course Level	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO ₁	Explain Mendelian principles, their extensions, gene interactions, inheritance patterns and their applications in genetic analysis.	
	CLO ₂	Explain linkage, crossing over, gene mapping, QTL analysis, complementation and extra-chromosomal inheritance with microbial genetic transfer mechanisms.	
	CLO ₃	Analyze quantitative inheritance, pedigree patterns, mutations, chromosome alterations, genetic fine structure and chromosome manipulation in plants.	
	CLO ₄	Explain the principles, tools and techniques of genetic engineering and evaluate their applications in transgenic crop development and nutritional improvement.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B – Contents of the Course			
Instructions for Theory Paper-Setter			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO Attempt	Contact Hours
I	Introduction to Mendelian Genetics: 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.	1	14

	Extensions of Mendelian Principles: 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.		
II	Gene Mapping Methods: Linkage and crossing over, linkage mapping and tetrad analysis; QTL mapping and its applications; complementation test. Molecular basis of chromosome pairing. Extra-Chromosomal Inheritance and Microbial Genetics: Inheritance of chloroplast genes and maternal inheritance. Genetic transfer methods (conjugation, sexduction, transformation and transduction), gene mapping.	2	16
III	Quantitative Genetics and Mutation Analysis: 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. Genetic fine structure and Chromosome Manipulation: Dosage compensation and mechanism of sex determination in plants; Alien gene transfer; transfer of whole genome in <i>Triticum</i> and <i>Brassica</i> .	3	14
IV	Basics of Genetic Engineering: Historical background and significance, Tools and techniques - restriction enzymes, DNA cloning vectors (plasmids, bacteriophages, cosmids, phagemids, shuttle vectors, transposons vectors). Constriction of genomic library and cDNA library. Applications of Genetic Engineering: General account on Agrobacterium mediated gene transfer, production of transgenic plant with respect to herbicide resistance, resistance against biotic and abiotic factor; transgenic crops and nutritional quality improvement.	4	16
Total Contact Hours			60
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Written Examination: 70	
Seminar/ presentation/ assignment/ quiz/ class test etc.:	10		
Mid-Term Exam:	15		
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
- Brooker, R.J. (2018) Genetics: Analysis and Principles (6th Edn.). McGraw-Hill Education (New York), pp. 864. - Brown, T.A. (2019) Genomes (4th Edn.). Garland Science (New York), pp. 950. - Griffiths, A.J.F., Wessler, S.R., Carroll, S.B. & Doebley, J. (2015) Introduction to Genetic Analysis (11th Edn.). W.H. Freeman (New York), pp. 900. - Lewin, B. (2019) Genes IX. Jones & Bartlett Learning (Burlington), pp. 850. - Malhotra, N. & Koul, S. (2019) Genetic Engineering: Principles and Applications. Oxford University Press (New Delhi), pp. 500. - Primrose, S.B. & Twyman, R.M. (2019) Principles of Gene Manipulation and Genomics (8th Edn.). Wiley-Blackwell (Oxford), pp. 700. - Russell, P.J. (2019) iGenetics: A Molecular Approach (4th Edn.). Pearson (New York), pp. 864.			

- Singh, B.D. (2021) Genetic Engineering: Principles and Methods. Kalyani Publishers (New Delhi), pp. 500.
- Snustad, D.P. & Simmons M.J. (2020) Principles of Genetics (8th Edn.). John Wiley & Sons (Hoboken), pp. 800.
- <https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/plant-genetics>.
- <https://royalsociety.org/news-resources/projects/gm-plants>

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	2	1	3	1	2	3	3	2	2
CLO ₂	3	3	1	2	1	3	2	2	3	3	3	2
CLO ₃	3	3	1	3	1	3	2	3	3	3	3	3
CLO ₄	3	3	1	3	2	3	3	3	2	3	3	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	8
Entrepreneurship	5
Skill Enhancement	12
Communication Development	4
Indian Knowledge System	2
Environmental Awareness	7
Current Issues and Social Awareness	6
Gender issues	2
Public policies	4
Any Other (Evolutionary Concepts)	10

Important Notes (If any)

- Representative examples of Mendelian and non-Mendelian inheritance, gene mapping, quantitative genetics, mutations, chromosome manipulation and genetic engineering included in the syllabus are indicative. In view of rapid advances in genomics, genome editing, CRISPR-based technologies, molecular breeding, transgenic crop development and other emerging genetic technologies, updated examples, recent research findings, case studies and contemporary applications may be incorporated during teaching and evaluation.

Part A – Introduction			
Name of Programme	M.Sc. Botany		
Semester	I		
Nature of Course/ Course Composition	Theory		
Nomenclature of the Course	Cell Biology & Biotechniques		
Course Code	26L6.0-BOT-104		
Course Type	CC-4		
Course Level	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO ₁	Explain the structural organization and functional mechanisms of membrane cell-cell/ matrix junctions and membrane transport systems, including their roles in cellular communication and adhesion.	
	CLO ₂	Describe the structure and functions of major cellular organelles and analyze the mechanisms of vesicle formation, protein sorting, intracellular trafficking, nuclear transport and receptor-mediated endocytosis.	
	CLO ₃	Explain the organization and functions of the cytoskeleton and analyze its role in cell movement, cell-cycle regulation, mitosis, meiosis, fertilization, cytokinesis and signal transduction.	
	CLO ₄	Apply the principles and techniques of microscopy, centrifugation, chromatography, spectroscopy and electrophoresis for the observation, separation, identification and analysis of cellular and biological components.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B – Contents of the Course			
Instructions for Theory Paper-Setter			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		CLO Attempt
			Contact Hours

I	Plasma Membrane Structure and Function: 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. Cell-Cell/ Matrix Junctions: Structures and functions of tight junctions, adherens junctions, gap junctions and plasmodesmata; cell-matrix adhesion mechanisms, integrins, collagen and non-collagen components.	1	14
II	Cellular Organelles: Structure and functions of ER and golgi apparatus, lysosomes, peroxisomes, plastids, vacuoles, chloroplast, mitochondria, nucleus and nucleolus (role in ribosome synthesis and assembly). Vesicle Formation and Protein Transport: 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.	2	16
III	Cytoskeleton and Cell Movement: Structure and organization of actin, myosin, microtubules, intermediate filaments, cilia and flagella. Cell Cycle and Signal Transduction: 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.	3	14
IV	Microscopy and Centrifugation: Principle and application of light, phase-contrast, fluorescence and electron microscope (SEM, TEM). Principles, types and applications of centrifuges (ultracentrifugation, density gradient centrifugation). Chromatography, Spectrophotometry and Electrophoresis: 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.	4	16
Total Contact Hours			60
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Written Examination: 70	
Seminar/ presentation/ assignment/ quiz/ class test etc.:	10		
Mid-Term Exam:	15		
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. (2015) Molecular Biology of the Cell (6th Edn.). Garland Science (New York), pp. 1464. - Bruce, A., Alexander, J., Julian, L., Martin, R., Keith, R. & Peter, W. (2018) Essential Cell Biology (5th Edn.). Garland Science (New York), pp. 864. - Cooper, G.M. & Hausman, R.E. (2013) The Cell: A Molecular Approach (6th Edn.). Sinauer Associates (Sunderland), pp. 832. - Hancock, J.T. (2010) Cell Signalling (3rd Edn.). Oxford University Press (Oxford), pp. 352. - Karp, G. (2013) Cell and Molecular Biology: Concepts and Experiments (7th Edn.) John Wiley & Sons (Hoboken), pp. 832.			

- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. & Martin, K.C. (2016) Molecular Cell Biology (8th Edn.). W.H. Freeman (New York), pp. 1308.
- Smith, J., & Green, M. R. (2012). Molecular Cloning: A Laboratory Manual (4th Edn.). Cold Spring Harbor Laboratory Press (Cold Spring Harbor, NY) pp. 78-234.
- Voet, D., Voet, J.G. & Pratt, C.W. (2013) Fundamentals of Biochemistry: Life at the Molecular Level (4th Edn.). John Wiley & Sons (Hoboken), pp. 1180.
- <https://www.labster.com/blog/7-molecular-biology-techniques-in-classroom>.
- <https://www.geeksforgeeks.org/cell-organelles-definition-structure-types-functions>

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	2	1	2	2	2	2	3	2	2
CLO ₂	3	3	1	2	1	2	2	2	2	3	3	2
CLO ₃	3	3	1	3	2	3	2	2	2	3	3	2
CLO ₄	3	3	2	3	2	3	3	2	1	3	3	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	8
Entrepreneurship	3
Skill Enhancement	18
Communication Development	5
Indian Knowledge System	2
Environmental Awareness	5
Current Issues and Social Awareness	6
Gender issues	2
Public policies	3
Any Other (Evolutionary Concepts)	8

Important Notes (If any)

- Recent research papers, case studies, demonstrations, virtual laboratory resources and contemporary biotechnology applications to connect classical cell biology techniques with current developments in plant and molecular sciences.

Part A – Introduction			
Name of Programme	M.Sc. Botany		
Semester	I		
Nature of Course/ Course Composition	Practical		
Nomenclature of the Course	Thallophytes and Microbial Diversity: Practical (based on 26L6.0-BOT-101 & 26L6.0-BOT-102)		
Course Code	26L6.0-BOT-105		
Course Type	PC-1		
Course Level	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO ₁	To develop an understanding of the working principles of dissecting and compound microscopes and to identify, classify and describe the taxonomic and morphological characteristics of representative algal members through practical observation.	
	CLO ₂	To develop practical skills in the identification, classification and morphological study of representative bryophytes and pteridophytes, including their vegetative and reproductive structures, through permanent slide observation and field collection of locally available cryptogamic plants.	
	CLO ₃	To develop practical skills in microbiological laboratory safety, GMLP, spillage management, microbial staining, growth analysis and aseptic techniques, along with the identification of important plant viruses.	
	CLO ₄	To develop competence in the microscopic identification and morphological characterization of representative fungi and lichens, including the study of antimicrobial sensitivity, fungal diversity through camera lucida drawings and identification of important macroscopic fungi.	
	Theory	Practical	Total
Credits	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)		3	
Part B – Contents of the Course			
Instructions for Examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics		CLO Attempt
			Contact Hours

I	Algal Diversity (26L6.0-BOT-101) - To study working principle of dissecting and compound microscope. - 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>. Note: The practicals listed above may be conducted according to the availability of plant material, laboratory resources, biochemical reagents, instruments and other facilities. The teacher may also select or introduce any other relevant experiment according to the objectives of the course.	1,2	30
II	Archaeogniata Diversity (26L6.0-BOT-101) - 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>. - Collection and submission of locally available cryptogamic plant species. Note: The practicals listed above may be conducted according to the availability of plant material, laboratory resources, biochemical reagents, instruments and other facilities. The teacher may also select or introduce any other relevant experiment according to the objectives of the course.	1,2	30
III	Microbial Kingdom (26L6.0-BOT-102) - To study about safety guidelines, Good microbiological laboratory practice (GMLP) and spillage management. - Study of important plant viruses (TMV, ToLCV and CaMV) - Differential staining method: Gram staining of bacteria. - Study of bacterial growth curve. - Sterile techniques for cell culture (bacterial/ yeast cells). Note: The practicals listed above may be conducted according to the availability of plant material, laboratory resources, biochemical reagents, instruments and other facilities. The teacher may also select or introduce any other relevant experiment according to the objectives of the course.	3,4	30
IV	Applied Mycology (26L6.0-BOT-102) - 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.). - Test of sensitivity of microbe against antimicrobial substances. - Camera Lucida drawings of fungal specimens. - Study identifying features of macroscopic fungi <i>Ganoderma</i>, <i>Agarics</i> and <i>Morchella</i>. - Study of characteristic features of lichens (crustose, foliose and fruticose). Note: The practicals listed above may be conducted according to the availability of plant material, laboratory resources, biochemical reagents,	3,4	30

instruments and other facilities. The teacher may also select or introduce any other relevant experiment according to the objectives of the course.			
Total Contact Hours			120
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Lab record	10
Practical File:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
- 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 (2nd 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/bonline/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.scribd.com/document/466228196/BIO-REPORT-EXP-2-docx			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	2	2	2	2	3	3	3	1	3	2
CLO ₂	3	3	2	2	3	3	3	3	3	1	3	3
CLO ₃	3	3	2	3	3	3	3	3	2	3	3	3
CLO ₄	3	3	2	3	2	3	3	3	3	2	3	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
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Employability	16
Entrepreneurship	6
Skill Enhancement	30
Communication Development	10
Indian Knowledge System	6
Environmental Awareness	16
Current Issues and Social Awareness	10
Gender issues	2
Public policies	6
Any Other (Evolutionary Concepts)	18

Important Notes (If any)

- Recent advances are connected with modern approaches such as AI-assisted microscopy, DNA barcoding, genomics, phylogenomics, bioinformatics, high-throughput sequencing, CRISPR-based diagnostics, biosensors, metabolomics and digital biodiversity documentation. These developments are transforming conventional identification and microscopy-based practical work into integrated morphological, molecular and computational approaches, thereby strengthening employability, research aptitude and modern-tool usage in botany. Field visit to see the thallophytes in original habitat condition is encouraged.

Part A – Introduction			
Name of Programme	M.Sc. Botany		
Semester	I		
Nature of Course/ Course Composition	Practical		
Nomenclature of the Course	Cell Biology, Genetics and Techniques: Practical (based on 26L6.0-BOT-103 & 26L6.0-BOT-104)		
Course Code	26L6.0-BOT-106		
Course Type	PC-2		
Course Level	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO₁	To develop practical skills in cytogenetic analysis, chromosome preparation, karyotyping and classical genetic problem-solving, including monohybrid and dihybrid crosses, gene interactions, tetrad analysis, gene mapping and complementation tests.	
	CLO₂	To develop practical competence in plant reproductive genetics and modern genetic analysis, including floral studies of self- and cross-pollinated crops, in-vitro pollen germination and viability testing and interpretation of GWAS and QTL mapping for understanding the genetic basis of important traits.	
	CLO₃	To develop practical competence in laboratory techniques, sterile cell culture practices, chromosome preparation, morphometric analysis, idiogram construction and assessment of chiasma frequency and terminalization coefficient for cytological studies.	
	CLO₄	To develop practical skills in DNA, RNA and protein isolation, purification and quantification, along with agarose gel electrophoresis and polyacrylamide gel electrophoresis (PAGE) for the analysis and characterization of plant nucleic acids and proteins.	
	Theory	Practical	Total
Credits	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Duration (in Hours)		3	
Part B – Contents of the Course			
<u>Instructions for Examiner:</u> Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			

Unit	Topics	CLO Attempt	Contact Hours
I	Inheritance Biology (26L6.0-BOT-103) - Study of strains and fixatives used in cytogenetics. - Study of karyotype using a given metaphase chromosome picture (<i>Allium cepa</i>). - Work out the genetics of a cross from the given F₂ harvest. - Problem solving regarding monohybrid/ dihybrid cross and gene interactions. Note: The practicals listed above may be conducted according to the availability of plant material, laboratory resources, biochemical reagents, instruments and other facilities. The teacher may also select or introduce any other relevant experiment according to the objectives of the course.	1,2	30
II	Genetic Engineering (26L6.0-BOT-103) - Genetic problem on tetrad analysis, gene mapping and complementation test. - Study of floral structure of self- and cross-pollinated crops. - Solve of problems related to GWAS and QTL mapping. - Study of in-vitro pollen germination and pollen viability. Note: The practicals listed above may be conducted according to the availability of plant material, laboratory resources, biochemical reagents, instruments and other facilities. The teacher may also select or introduce any other relevant experiment according to the objectives of the course.	1,2	30
III	Cell Biology (26L6.0-BOT-104) - To study about general equipment, apparatus and materials used in lab. - Sterile techniques for cell culture. - Preparation of mitotic and meiotic chromosomes. - Calculation of morphometric data and preparations of idiogram. - Determination of chiasma frequency and terminalization coefficient. Note: The practicals listed above may be conducted according to the availability of plant material, laboratory resources, biochemical reagents, instruments and other facilities. The teacher may also select or introduce any other relevant experiment according to the objectives of the course.	3,4	30
IV	Biotechniques (26L6.0-BOT-104) - DNA/ RNA extraction and quantification from cells. - Quantification of total protein by standard protocols - Isolation and purification of RNA/ DNA from plants - Agarose gel electrophoresis of RNA, chromosomal and plasmid DNA - Isolation of total plant protein. - Polyacrylamide gel electrophoresis of plant total protein. Note: The practicals listed above may be conducted according to the availability of plant material, laboratory resources, biochemical reagents,	3,4	30

instruments and other facilities. The teacher may also select or introduce any other relevant experiment according to the objectives of the course.			
Total Contact Hours			120
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Lab record	10
Practical file:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
- Brown, A.R. & White, L.E. (2018) Genetics Laboratory: Techniques and Applications. Wiley-Blackwell (New York), pp. 50-150. - Carter, S.D. & Miller, P.J. (2017) Molecular Genetics and Genetic Engineering: Practical Applications. Oxford University Press (London), pp. 30-80. - Clark, J.M. & Evans, L.K. (2020) Genetics and Biotechnology Laboratory Manual. Cengage Learning (Boston), pp. 20-70. - Cooper, G.M. & Hausman, R.E. (2019) The Cell: A Laboratory Manual (8th Edn.). Sinauer Associates (Sunderland), pp. 560. - King, R.C. (2018) A Laboratory Manual for Cell Biology (1st Edn.). Jones & Bartlett Learning (Burlington), pp. 432. - Kumar, A. & Gupta, S. (2016) Genetic Engineering Laboratory Manual: Techniques and Procedures. McGraw-Hill Education (New York), pp. 40-90. - Patel, K.D. & Singh, R.K. (2019) Advanced Genetics Laboratory: Methods and Protocols. Springer Nature (Berlin), pp. 75-125. - Pechenik, J.A. (2015) A Short Guide to Writing about Biology (9th Edn.). Pearson (New York), pp. 400. - Smith, J.T. & Johnson, M.R. (2020) Laboratory Manual for Basic Genetics: Concepts and Applications. Pearson Education Inc. (Boston), pp. 1-100. - Voet, D., Voet, J.G. & Pratt, C.W. (2016) Fundamentals of Cell Biology Laboratory Manual (1st Edn.). Wiley (Hoboken), pp. 464. - 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 (3rd Edn.). Princeton University Press (Princeton), pp. 368. https://practicalbiology.org/genetics. https://www.researchgate.net/publication/269038206_Practical_Plant_Genetics			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	3	2	2	3	3	3	3	3	3	3	3
CLO ₂	3	3	2	3	3	3	3	3	2	3	3	3
CLO ₃	3	3	2	3	3	3	3	3	2	3	3	3
CLO ₄	3	3	2	3	3	3	3	3	2	3	3	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	28
Entrepreneurship	12
Skill Enhancement	30
Communication Development	8
Indian Knowledge System	6
Environmental Awareness	8
Current Issues and Social Awareness	10
Gender issues	4
Public policies	6
Any Other (Evolutionary Concepts)	8

Important Notes (If any)

- Recent advances in digital karyotyping, FISH, AI-based chromosome analysis, automated image analysis, high-throughput DNA/RNA extraction, fluorescence-based nucleic-acid quantification and genomic sequencing as recent developments connected with conventional practical techniques. This will help students understand how classical cell biology and biotechnology techniques are being integrated with modern imaging, molecular and computational tools.

Part A – Introduction			
Name of Programme	M.Sc. Botany		
Semester	II		
Nature of Course/ Course Composition	Theory		
Nomenclature of the Course	Evolutionary Biology, Gymnosperms & Plant Anatomy		
Course Code	26L6.0-BOT-201		
Course Type	CC-5		
Course Level	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO₁	To explain the principles and mechanisms of evolution, natural selection, fossilization, seed development and paleobotanical evidence underlying plant diversification and ecological adaptation from algae to gymnosperms.	
	CLO₂	To explain the diversity, classification, life cycle, distribution, economic and ecological significance of gymnosperms and the evolutionary features of Progymnospermophyta and Pteridospermophyta.	
	CLO₃	To explain the morpho-anatomical features, reproductive structures, and reproductive processes of <i>Cycas</i> , <i>Cycadeoidea</i> , <i>Ginkgo</i> , <i>Pinus</i> , <i>Ephedra</i> and <i>Welwitschia</i> .	
	CLO₄	To explain plant tissue systems, meristem organization and anomalous secondary growth and the applications of plant anatomy in systematics, archaeology and climate change studies.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B – Contents of the Course			
<u>Instructions for Theory Paper-Setter</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours
I	Introduction to Evolutionary Biology: Theories, principles and mechanisms of evolution (Natural selection); significance of fossil gymnosperms in		14

	understanding plant evolution and ecological adaptations. Onset of seed development. Paleobotany: 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.		
II	Introduction to Gymnosperms: General characters, diversity and distribution in India, classification, life cycle, economic and ecological importance. Progymnospermophyta and Pteridospermophyta: Introduction to Progymnospermophyta and Pteridospermophyta; general account of Aneurophytales, Archaeopteridales, Glossopteridales and Caytoniales.	2	14
III	Morpho-anatomical Features and Reproduction in the following: Cycadales (<i>Cycas</i>), Cycadeoidales (<i>Cycadeoidea</i>) and Ginkgoales (<i>Ginkgo</i>). Morpho-anatomical Features and Reproduction in the following: Coniferales (<i>Pinus</i>), Ephedrales (<i>Ephedra</i>) and Welwitschiales (<i>Welwitschia</i>).	3	16
IV	Plant tissue system and Meristem Classification: Tissue types (parenchyma, collenchyma and sclerenchyma; xylem and phloem) and functions; apical, lateral and intercalary meristems; structure of xylem and phloem. Anatomy: 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.	4	16
Total Contact Hours			60
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Written Examination: 70	
Seminar/ presentation/ assignment/ quiz/ class test etc.:	10		
Mid-Term Exam:	15		
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
- Anderson, E., & Anderson, H. (2003). The Gymnosperms Handbook: A Practical Guide to the Cultivated Conifers. Timber Press (Portland), pp. 350. - Beck, C.B. (2005). An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century (2nd Edn.). Cambridge University Press (Cambridge), pp. 400. - Bowler, P.J. (2003). Evolution: The History of an Idea (3rd Edn.), University of California Press (Berkeley), pp. 350. - Esau, K. (1977). Anatomy of Seed Plants (2nd Edn.). John Wiley & Sons (New York), pp. 576. - Fahn, A. (1990). Plant Anatomy (4th Edn.). Pergamon Press (Oxford), pp. 588. - Futuyma, D.J. (2017). Evolution (4th Edn.), Sinauer Associates Inc. (Sunderland), pp. 1-500. - Gifford, E.M., & Foster, A.S. (2018). Morphology and Evolution of Vascular Plants (5th Edn.). W.H. Freeman (New York), pp. 600. - LePage, B.A. (2007). Fossil Plants and Spores: Modern Techniques. Indiana University Press (Bloomington), pp. 450. - Sporne, K.R. (2012). The Morphology of Gymnosperms: The Structure and Evolution of Primitive Seed			

Plants. Springer Science & Business Media (Berlin), pp. 550.

- Stace, C.A. (2010). Gymnosperms of the World (3rd Edn.), Kew Publishing (London), pp. 600.
- Stearns, S.C. & Hoekstra, R.F. (2005). Evolution: An Introduction (2nd Edn.), Oxford University Press (New York), pp. 400.
- <https://bsi.gov.in/uploads/userfiles/file/Rare%20Books/Morphology%20Of%20Gymnosperms.pdf>.
- <https://www.geeksforgeeks.org/evolution-ncert-notes-class-12-biology-chapter-6>
- <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/plant-anatomy>

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	2	1	2	1	2	3	1	2	2
CLO ₂	3	1	1	2	1	2	1	2	3	2	1	2
CLO ₃	3	1	1	2	1	2	1	2	3	3	2	2
CLO ₄	3	2	1	3	2	3	2	3	3	3	2	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	8
Entrepreneurship	4
Skill Enhancement	15
Communication Development	4
Indian Knowledge System	5
Environmental Awareness	10
Current Issues and Social Awareness	5
Gender issues	
Public policies	
Any Other (Scientific Temperament / Research Aptitude)	9

Important Notes (If any)

- Emphasize evolutionary concepts, gymnosperm diversity, morphology, anatomy, reproduction, ecological significance and their practical applications through observation, comparison and scientific discussion.

Part A – Introduction			
Name of Programme	M.Sc. Botany		
Semester	II		
Nature of Course/ Course Composition	Theory		
Nomenclature of the Course	Angiosperms Systematics & Embryology		
Course Code	26L6.0-BOT-202		
Course Type	CC-6		
Course Level	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO ₁	To explain taxonomic literature, botanical nomenclature, the role of BSI, and the evolution and phylogeny of angiosperms.	
	CLO ₂	To explain major systems of angiosperm classification, modern taxonomic tools, and the diagnostic features of important dicot families.	
	CLO ₃	To identify and compare the salient morphological features of major dicot and monocot families.	
	CLO ₄	To explain anther and ovule development, gametogenesis, pollination, fertilization, seed development, and major forms of apomixis and related reproductive phenomena.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B – Contents of the Course			
<u>Instructions for Theory Paper-Setter</u>			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO Attempt	Contact Hours
I	Taxonomic Literature: 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. Introduction and Phylogeny of Angiosperms: Evolution and inter-relationship of dicots and monocots; concept of Basal angiosperms and Magnolids; evolution of stamen and carpel.	1	14

II	System of Classification: Cronquist, Hutchinson, Benthem & Hooker, Dahlgren and Thorne based classification; modern tools of taxonomy (cytotaxonomy, chemotaxonomy, numerical taxonomy, serology). Salient Features of Dicot Families-I: Ranunculaceae, Papaveraceae, Cruciferae (Brassicaceae), Caryophyllaceae, Malvaceae, Rutaceae, Leguminosae (Fabaceae).	2	16
III	Salient Features of Dicot Families-II: Solanaceae, Umbelliferae (Apiaceae), Cucurbitaceae, Asclepiadaceae (Apocynaceae), Compositae (Asteraceae), Labiatae (Lamiaceae), Euphorbiaceae. Salient Features of Monocot Families: Araceae, Palmae (Arecaceae), Amaryllidaceae, Graminae (Poaceae), Cyperaceae, Liliaceae, Orchidaceae.	3	14
IV	Male Gametophyte and Pollination: Anther (structure and development), microsporogenesis and microspore tetrad; role of tapetum, pollenkit; pollen-pistil interaction, pollen development and pollen tube growth. Pollination mechanisms. Female Gametophyte, Fertilization and Seed Development: 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.	4	16
Total Contact Hours			60
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Written Examination: 70	
Seminar/ presentation/ assignment/ quiz/ class test etc.:	10		
Mid-Term Exam:	15		
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
• 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. • Cronquist, A. (1988) The Evolution and Classification of Flowering Plants (2nd Edn.). New York Botanical Garden Press (New York), pp. 555. • Dahlgren, R. (1980) A Revised System of Classification of the Angiosperms. Botanical Journal of the Linnean Society, 80(2), 91-124. • Maheshwari, P. (1950) An Introduction to the Embryology of Angiosperms. McGraw-Hill Book Company (New York), pp. 300. • Parihar, N.S. & Jain, A.K. (1997) A Textbook of Embryology of Angiosperms. Rastogi Publications (New Delhi), pp. 280. • Rao, M.N., Rao, P.N. & Babu, A.V.S. (2012) Angiosperm Taxonomy: Concepts and Applications. Himalaya Publishing House (Mumbai), pp. 150. • Shivanna, K.R. & Sawhney, V.K. (1997) Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press (Cambridge), pp. 150-200. • Soltis, D.E., Soltis, P.S., Endress, P.K. & Chase, M.W. (2005) Phylogeny and Evolution of Angiosperms. Sinauer Associates (Sunderland), pp. 370. • https://core.ac.uk/download/pdf/159148791.pdf			

- <https://letstalkscience.ca/educational-resources/backgrounders/plant-reproduction>

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	3	1	2	1	2	2	3	3	2	2	3
CLO ₂	3	3	1	3	1	3	3	3	3	3	3	3
CLO ₃	3	2	1	3	1	2	2	2	3	3	3	2
CLO ₄	3	3	1	3	2	3	3	3	3	3	3	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	8
Entrepreneurship	4
Skill Enhancement	15
Communication Development	4
Indian Knowledge System	5
Environmental Awareness	8
Current Issues and Social Awareness	5
Gender issues	
Public policies	3
Any Other (Evolutionary Concepts)	8

Important Notes (If any)

- Emphasize classical taxonomy alongside recent advances in DNA barcoding, phylogenomics, digital herbaria, AI-based plant identification, eDNA/metabarcoding, and integrative taxonomy, with focus on biodiversity assessment, conservation, and research applications.

Part A – Introduction				
Name of Programme	M.Sc. Botany			
Semester	II			
Nature of Course/ Course Composition	Theory			
Nomenclature of the Course	Plant Ecology			
Course Code	26L6.0-BOT-203			
Course Type	CC-7			
Course Level	400-499			
Pre-requisite for the course (if any)				
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO ₁	To explain environmental interactions, ecological differentiation, and niche dynamics, including niche breadth, overlap, resource partitioning and character displacement.		
	CLO ₂	To analyze population dynamics and regulation through growth models and to evaluate community structure, species diversity, dispersion patterns, edges and ecotones.		
	CLO ₃	To analyze species interactions, ecological succession, and ecosystem organization through population models, trophic dynamics.		
	CLO ₄	To analyze decomposition, biogeochemical cycling, ecosystem stability, and the ecological consequences of pollution and global environmental change.		
	Theory	Practical	Total	
Credits	4	0	4	
Teaching Hours per week	4	0	4	
Internal Assessment Marks	30	0	30	
End Term Exam Marks	70	0	70	
Max. Marks	100	0	100	
Examination Duration (in Hours)	3			
Part B – Contents of the Course				
<u>Instructions for Theory Paper-Setter</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.				
Unit	Topics		CLO Attempt	Contact Hours
I	The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Ecophene and ecotype, natural capital and techno-ecosystem.		1	14

	Habitat and Niche Ecology: 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.		
II	Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and k selection); age structured populations; factors affecting population. Community Ecology: 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.	2	16
III	Species Interactions and Ecological Succession: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis, Lotka Volterra Model. Types, mechanisms and models of succession; concept of climax. Ecosystem Organization: Structure and functions; primary production (global pattern and controlling factors); energy dynamics - trophic levels, energy flow and ecological efficiencies.	3	14
IV	Mineral Recycling: Decomposition (mechanism, substrate quality and climatic factors); global biogeochemical cycles of C, N, P & S, ecosystem stability (resistance and resilience). Global atmosphere changes: Environmental pollution (air, water and land), global environmental change and its consequences (CO2 fertilization, global warming sea level rise and UV radiation).	4	16
Total Contact Hours			60
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Written Examination: 70	
Seminar/ presentation/ assignment/ quiz/ class test etc.:	10		
Mid-Term Exam:	15		
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
- Ambasht, R.S. & Ambasht, N.K. (2002) A Textbook of Plant Ecology (15th Edn.). CBS Publishers & Distributors (New Delhi), pp. 452. - Begon, M., Townsend, C.R. & Harper, J.L. (2006) Ecology: From Individuals to Ecosystems (4th Edn.). Blackwell Publishing (Oxford), pp. 738. - Chapin III, F.S., Matson, P.A. & Vitousek, P.M. (2011) Principles of Terrestrial Ecosystem Ecology (2nd Edn.). Springer (New York), pp. 529. - Krebs, C.J. (2009) Ecology: The Experimental Analysis of Distribution and Abundance (6th Edn.). Benjamin Cummings (San Francisco), pp. 655. - Misra, R. (2010) Ecology Workbook. Oxford & IBH Publishing Co. Pvt. Ltd. (New Delhi), pp. 244. - Molles, M.C. (2019) Ecology: Concepts and Applications (8th Edn.). McGraw-Hill Education (New York), pp. 576. - Odum, E.P. & Barrett, G.W. (2005) Fundamentals of Ecology (5th Edn.). Brooks Cole (Belmont), pp. 624. - Singh, J.S., Singh, S.P. & Gupta, S.R. (2006) Ecology, Environment and Resource Conservation.			

Anamaya Publishers (New Delhi), pp. 688.

- Smith, T.M. & Smith, R.L. (2015) Elements of Ecology (9th Edn.). Pearson (Boston), pp. 704.
- Weaver, J.E. & Clements, F.E. (1973) Plant Ecology. McGraw-Hill Book Company (New York), pp. 602.
- <https://www.esa.org/about/what-does-ecology-have-to-do-with-me>
- <https://education.nationalgeographic.org/resource/ecology>
- <https://www.britishecologicalsociety.org/about/what-is-ecology>

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	3	1	3	1	3	2	3	1	3	3	2
CLO ₂	3	3	1	3	1	3	2	3	2	3	1	3
CLO ₃	3	3	1	3	2	3	2	2	1	3	2	3
CLO ₄	3	3	1	3	2	3	1	3	1	3	3	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	9
Entrepreneurship	3
Skill Enhancement	15
Communication Development	4
Indian Knowledge System	3
Environmental Awareness	12
Current Issues and Social Awareness	6
Gender issues	
Public policies	5
Any Other (Research Aptitude)	3

Important Notes (If any)

- Emphasize ecological processes through quantitative analysis, field-based observations, and current advances such as ML-based ecological modelling, species distribution modelling, biodiversity forecasting, remote sensing, with focus on conservation and ecosystem resilience.

Part A – Introduction			
Name of Programme	M.Sc. Botany		
Semester	II		
Nature of Course/ Course Composition	Theory		
Nomenclature of the Course	Molecular Biology		
Course Code	26L6.0-BOT-204		
Course Type	CC-8		
Course Level	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO ₁	To understand the molecular mechanisms of replication, transcription, translation and gene regulation.	
	CLO ₂	To explain transcription, RNA processing, post-transcriptional regulation and RNA editing in prokaryotes and eukaryotes.	
	CLO ₃	To explain the molecular mechanisms of translation, genetic code, tRNA aminoacylation, translational regulation and co- and post-translational protein processing.	
	CLO ₄	To analyze the molecular mechanisms governing gene expression and genome organization.	
	Theory	Practical	Total
Credits	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Duration (in Hours)	3		
Part B – Contents of the Course			
Instructions for Theory Paper-Setter The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO Attempt	Contact Hours
I	Introduction to Molecular Biology: Historical overview and Central Dogma; centromere and telomere, euchromatin and heterochromatin. DNA replication and Repair: Mechanism, DNA Polymerase, other enzymes and accessory proteins involved in Prokaryotic and Eukaryotic DNA replication, Extrachromosomal replicons; DNA damage and repair.	1	14
II	RNA Synthesis in Prokaryotes and Eukaryotes: Transcription factors and	2	16

	machinery, formation of initiation complex, elongation phase and termination (ρ - dependent and independent) RNA polymerases; transcriptional and post transcriptional gene silencing. RNA Processing: 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.		
III	Protein Synthesis in Prokaryotes and Eukaryotes: 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. Translation Regulation: Translational proof-reading, translational inhibitors and antibiotics, co and post- translational modification of proteins; tm-RNA processing, non-stop and non-sense mediated decay.	3	14
IV	Gene Expression Regulation: 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. Genome organization: Introduction and concept, chromosomal organization of genes and noncoding DNA, mobile DNA, concept of operon, unique and repetitive DNA, interrupted genes, gene families.	4	16
Total Contact Hours			60
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Written Examination: 70	
Seminar/ presentation/ assignment/ quiz/ class test etc.:	10		
Mid-Term Exam:	15		
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. (2015) Molecular Biology of the Cell (6th Edn.). Garland Science (New York), pp. 1464. - Brown, T.A. (2016) Gene Cloning and DNA Analysis: An Introduction (7th Edn.). Wiley-Blackwell (Oxford), pp. 376. - Dale, J.W. & von Schantz, M. (2011) From Genes to Genomes: Concepts and Applications of DNA Technology (3rd Edn.). Wiley-Blackwell (Oxford), pp. 372. - Gupta, P.K. (2014) Molecular Biology and Genetic Engineering. Rastogi Publications (Meerut), pp. 850. - Karp, G. (2018) Cell and Molecular Biology: Concepts and Experiments (8th Edn.). Wiley (Hoboken), pp. 832. - Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2018) Lewin's Genes XII. Jones & Bartlett Learning (Burlington), pp. 1056. - Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. & Matsudaira, P. (2016) Molecular Cell Biology (8th Edn.). W.H. Freeman (New York), pp. 1300. - Russell, P.J. (2010) iGenetics: A Molecular Approach (3rd Edn.). Pearson Education (Boston), pp. 816.			

- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. & Losick, R. (2013) Molecular Biology of the Gene (7th Edn.). Pearson Education (Boston), pp. 872.
- Weaver, R.F. (2018) Molecular Biology (5th Edn.). McGraw-Hill Education (New York), pp. 912.
- <https://plato.stanford.edu/entries/molecular-biology>
- <https://www.thermofisher.com/blog/ask-a-scientist/what-is-molecular-biology>

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	3	1	3	3	3	2	3	3	3
CLO ₂	3	3	1	3	1	3	3	3	1	3	3	2
CLO ₃	3	3	1	3	1	3	3	3	1	3	2	2
CLO ₄	3	3	1	3	2	3	3	3	1	3	3	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	8
Entrepreneurship	6
Skill Enhancement	15
Communication Development	4
Indian Knowledge System	1
Environmental Awareness	5
Current Issues and Social Awareness	6
Gender issues	
Public policies	4
Any Other (Scientific Temperament / Research Aptitude)	11

Important Notes (If any)

- Emphasize classical molecular biology principles and techniques alongside recent advances in CRISPR-based functional genomics, genome and epigenome editing, single-cell and spatial omics, multi-omics integration, long-read and high-throughput sequencing, transcriptomics, RNA-based regulation, gene silencing, genome annotation, functional genomics, systems biology and computational approaches for analysing complex genomic and molecular datasets.

Part A – Introduction				
Name of Programme	M.Sc. Botany			
Semester	II			
Nature of Course/ Course Composition	Practical			
Nomenclature of the Course	Taxonomic, Anatomical and Reproductive Biology: Practical (Based on 26L6.0-BOT-201 & 26L6.0BOT-202)			
Course Code	26L6.0-BOT-205			
Course Type	PC-3			
Course Level	400-499			
Pre-requisite for the course (if any)				
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO ₁	To collect, preserve, and document locally available gymnosperm specimens and identify major plant tissues and meristems through microscopic analysis.		
	CLO ₂	To identify, compare, and interpret the anatomical features, tissue organization, secondary growth, and anomalous secondary growth of dicot and monocot plants using microscopy.		
	CLO ₃	To identify and characterize angiosperm diversity using morphological, floral, placentation and floristic identification techniques.		
	CLO ₄	To analyze gametophyte development, pollen biology, ovule and endosperm development, embryogenesis and apomictic reproduction through microscopic techniques.		
	Theory	Practical	Total	
Credits	0	4	4	
Teaching Hours per week	0	8	8	
Internal Assessment Marks	0	30	30	
End Term Exam Marks	0	70	70	
Max. Marks	0	100	100	
Examination Duration (in Hours)		3		
Part B – Contents of the Course				
<u>Instructions for Examiner:</u> Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.				
Unit	Topics		CLO Attempt	Contact Hours
I	Gymnosperm Diversity, Morphology and Anatomy (26L6.0-BOT-201) - Study the morphology and anatomy of vegetative and reproductive parts of <i>Cycas</i>, <i>Pinus</i>, <i>Ginkgo</i>, <i>Cedrus</i>, <i>Araucaria</i>, <i>Cryptomeria</i>, <i>Ephedra</i>, <i>Gnetum</i> and <i>Taxus</i>. - Compare diagnostic morphological and anatomical characters of selected gymnosperms for identification and systematic placement. - Study permanent slides of representative gymnosperms showing		1,2	30

	vegetative and reproductive structures. • Study the anatomy of roots, stems and leaves of selected gymnosperms using permanent or temporary sections. • Study reproductive structures including male and female cones, ovules, pollen grains and seeds using suitable specimens or slides. • Study various meristems and permanent tissues through permanent and temporary slides. • Prepare temporary sections of selected gymnosperm organs and identify major tissue systems and their organization. • Collect, identify and document locally available or cultivated gymnosperms and prepare herbarium specimens. Note: The practicals listed above may be conducted according to the availability of plant material, permanent slides, stains, microscopes, laboratory resources and other facilities. The teacher may also select or introduce any other relevant practical related to gymnosperm diversity, morphology and anatomy.		
II	Evolutionary and Applied Aspects of Gymnosperms (26L6.0-BOT-201) • Compare primitive and advanced characters among major gymnosperm groups and interpret their evolutionary significance. • Study morphological, anatomical and reproductive adaptations of gymnosperms to terrestrial environments. • Compare reproductive features of selected gymnosperms with reference to evolutionary trends in seed plants. • Prepare a comparative account of major gymnosperm groups based on vegetative, reproductive and anatomical characters. • Study common gymnosperms used in Indian traditional medicine, horticulture and forestry with reference to their uses. • Document locally available gymnosperm diversity through field observation, photography and herbarium preparation. • Prepare an evolutionary relationship chart of selected gymnosperms using morphological and reproductive characters. Note: The practicals listed above may be conducted according to the availability of plant material, permanent slides, stains, microscopes, field sites, laboratory resources and other facilities. The teacher may also select or introduce any other relevant practical related to gymnosperm evolution, diversity and applied aspects.	1,2	30
III	Angiosperms Systematics and Floral Biology (26L6.0-BOT-202) • Study the morphology of cultivated and wild representatives of locally available angiosperm families and identify their diagnostic characters. • Study primitive and advanced floral characters and interpret their systematic significance. • Study the structure and variations of floral parts including calyx, corolla, androecium and gynoecium. • Study floral symmetry, sexuality, ovary position and insertion of floral parts using suitable specimens.	3,4	30

	• Prepare floral diagrams and floral formulae of representative angiosperm families. • Identify selected angiosperm families using diagnostic morphological characters and taxonomic keys. • Study different types of placentation by preparing transverse or longitudinal sections of ovaries from suitable flowers. • Conduct field studies of angiosperms occurring in different habitats and record their morphological and ecological characteristics. • Collect, identify and document locally available angiosperm species using appropriate field methods. • Prepare herbarium specimens of selected angiosperms following standard herbarium techniques. • Use regional floras, manuals and taxonomic keys for identification of field specimens. Note: The practicals listed above may be conducted according to the availability of plant material, field sites, floras, manuals, herbarium facilities, permanent slides, stains, microscopes and other laboratory resources. The teacher may also select or introduce any other relevant practical related to angiosperm systematics, floral morphology and plant identification.		
IV	Reproductive Biology and Embryology (26L6.0-BOT-202) • Study the structure of anther including epidermis, endothecium, middle layers and tapetum using permanent slides. • Study different types of microspore tetrads and their developmental significance. • Study pollen morphology, apertures and exine ornamentation using suitable microscopic preparations. • Determine pollen viability using suitable staining techniques. • Study pollen germination and pollen tube growth using a suitable in vitro germination method. • Study the structure and types of ovules using suitable permanent slides or fresh specimens. • Study the structure of embryo sac and its component cells including egg apparatus, antipodals and central cell. • Study different stages of embryo development in suitable monocot and dicot specimens. • Study different types of endosperm development including nuclear, cellular and helobial types using permanent slides. • Study apomixis and parthenocarpy using suitable specimens, slides or documented examples. • Study seed development and structure in selected monocot and dicot plants. • Compare selected embryological characters and discuss their systematic and evolutionary significance. Note: The practicals listed above may be conducted according to the availability of plant material, permanent slides, stains, microscopes, pollen	3,4	30

samples and other laboratory facilities. The teacher may also select or introduce any other relevant practical related to male and female gametophyte development, pollination, embryogenesis, seed development and reproductive biology.			
Total Contact Hours			120
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Lab record	10
Practical file:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
- Beck, C.B. (2010). An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century (2nd Edn.). Cambridge University Press (Cambridge), pp. 464. - Brown, A.T. & Smith, J.R. (2019) Practical Guide to Angiosperm Classification and Identification. Cambridge University Press (Cambridge). pp. 75-125. - Eames, A.J., & MacDaniels, L.H. (1947). An Introduction to Plant Anatomy (2nd Edn.). McGraw-Hill (New York), pp. 427. - Garcia, M.P. & Rodriguez, A.B. (2021) Hands-On Angiosperm Systematics: Techniques and Applications. Academic Press (London). pp. 50-100. - Johansen, D.A. (1940). Plant Microtechnique. McGraw-Hill (New York), pp. 523. - Rao, M.S. & Kumar, A. (2018) Laboratory Manual for Angiosperm Systematics: Techniques and Exercises. Narosa Publishing House (New Delhi), pp. 30-70. - Ruzin, S.E. (1999). Plant Microtechnique and Microscopy. Oxford University Press (New York), pp. 322. - Sharma, S. & Singh, P. (2019) Practical Manual for Angiosperm Systematics: Methods and Applications. Vikas Publishing House Pvt. Ltd. (New Delhi). pp. 50-90. - Wilson, D.J. & Thompson, L.P. (2017) Angiosperm Evolutionary Biology: Practical Exercises. Springer Nature (USA). pp. 100-150. http://cupac.bh.cornell.edu/anatomy_manual/CUPACplantanatomy.pdf https://courses.lumenlearning.com/wm-biology2/chapter/gymnosperms https://www.britannica.com/plant/angiosperm			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	2	1	2	2	2	3	3	3	2	3	3
CLO ₂	3	2	1	3	1	3	3	3	2	3	3	3
CLO ₃	3	2	2	2	2	2	2	3	3	2	3	3
CLO ₄	3	3	1	3	1	3	3	3	3	3	3	3

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	16

Entrepreneurship	6
Skill Enhancement	30
Communication Development	8
Indian Knowledge System	10
Environmental Awareness	14
Current Issues and Social Awareness	8
Gender issues	
Public policies	6
Any Other (Research Aptitude)	22

Important Notes (If any)

- Emphasize classical principles of angiosperm taxonomy and gymnosperm anatomy and evolution alongside recent advances in molecular systematics, DNA barcoding, phylogenomics, integrative taxonomy, digital herbarium resources, molecular identification, comparative anatomy, developmental studies, fossil evidence, palaeobotany and evolutionary genomics, supported by field visits to hilly and diverse natural habitats for documenting plant diversity, morphological variation, gymnosperm populations and field-based taxonomic and evolutionary observations.

Part A – Introduction				
Name of Programme	M.Sc. Botany			
Semester	II			
Nature of Course/ Course Composition	Practical			
Nomenclature of the Course	Ecological and Molecular Biology: Practical (Based on 26L6.0-BOT-203 and 26L6.0-BOT-204)			
Course Code	26L6.5-BOT-206			
Course Type	PC-4			
Course Level	400-499			
Pre-requisite for the course (if any)				
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO₁	To quantify ecological attributes using quadrat-based sampling, phytosociological analysis, species distribution and biodiversity indices.		
	CLO₂	To assess floristic diversity, forest resources, waste management, ecosystem restoration and environmental impacts using field-based and analytical techniques.		
	CLO₃	To demonstrate proficiency in molecular biology instrumentation and apply standard techniques for nucleic acid isolation and DNA quantification.		
	CLO₄	To apply molecular biology techniques for DNA size analysis, plasmid isolation, protein and nucleic acid detection and bacterial transformation		
	Theory	Practical	Total	
Credits	0	4	4	
Teaching Hours per week	0	8	8	
Internal Assessment Marks	0	30	30	
End Term Exam Marks	0	70	70	
Max. Marks	0	100	100	
Examination Duration (in Hours)		3		
Part B – Contents of the Course				
<u>Instructions for Examiner:</u> Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.				
Unit	Topics		CLO Attempt	Contact Hours
I	Population, Community and Biodiversity Analysis (26L6.0-BOT-203) - Study population density, frequency and abundance of plant species in a selected field site using quadrat methods. - Determine species richness, diversity and evenness of a plant community using appropriate ecological indices. - Study the population distribution pattern of selected plant species using quadrat data.		1,2	30

	- Determine frequency distribution and population density of selected species and interpret their ecological significance. - Construct age or size-class distributions of selected plant populations and interpret population structure. - Study community composition and similarity between two selected habitats using appropriate quantitative measures. - Determine species–area relationship for a selected plant community. - Study edge effect and ecotonal vegetation through comparative sampling of adjoining habitats. Note: The practicals listed above may be conducted according to the availability of suitable field sites, plant material and sampling facilities. The teacher may also select or introduce any other relevant experiment related to population, community and biodiversity analysis.		
II	Ecosystem, Soil, Pollution and Restoration Ecology (26L6.0-BOT-203) - Study soil physical and chemical properties such as texture, pH, moisture content and organic matter in selected habitats. - Determine soil moisture and water-holding capacity of different soil samples. - Estimate chlorophyll or other plant physiological parameters as indicators of environmental stress. - Study decomposition rate of selected plant litter under different environmental conditions. - Estimate soil organic carbon using a suitable laboratory method. - Study plant responses to different levels of environmental pollution using suitable plant material or field observations. - Determine air pollution effects on plants using suitable indicators such as leaf injury, dust deposition or stomatal characteristics. - Assess vegetation recovery in disturbed or restored sites using suitable ecological parameters. - Prepare a basic vegetation or habitat map of a selected area using field observations and available geospatial data. - Analyse ecological data statistically and graphically to compare vegetation, soil or environmental parameters between selected sites. Note: The practicals listed above may be conducted according to the availability of field sites, laboratory facilities, instruments and suitable datasets. The teacher may also select or introduce any other relevant experiment related to ecosystem, pollution and restoration ecology.	1,2	30
III	DNA, RNA and Molecular Techniques (26L6.0-BOT-204) - Isolate genomic DNA from plant tissues using a suitable extraction method. - Determine the concentration and purity of isolated DNA using spectrophotometric methods. - Study the integrity of isolated genomic DNA by agarose gel electrophoresis.	3,4	30

	- Isolate total RNA from plant tissues using an appropriate extraction method where facilities are available. - Determine the concentration and purity of isolated RNA using spectrophotometric methods. - Demonstrate PCR amplification of a selected DNA region using suitable primers. - Analyse amplified DNA fragments by agarose gel electrophoresis and interpret the banding pattern. - Perform restriction digestion of DNA and analyse restriction fragments by agarose gel electrophoresis. - Demonstrate DNA quantification using fluorometric or spectrophotometric methods where facilities are available. - Study DNA sequence data and identify homologous sequences using publicly available databases. Note: The practicals listed above may be conducted according to the availability of molecular biology equipment, PCR facilities, electrophoresis units and other laboratory resources. Where facilities are unavailable, demonstrations, recorded demonstrations, virtual laboratory exercises or suitable datasets may be used. The teacher may also select or introduce any other relevant experiment related to molecular biology.		
IV	Gene Expression and Molecular Analysis (26L6.0-BOT-204) - Study RNA integrity and quality using electrophoretic or spectrophotometric methods. - Demonstrate reverse transcription and cDNA preparation where facilities are available. - Demonstrate amplification of a selected expressed gene by RT-PCR where facilities are available. - Study gene expression using suitable PCR-based data and interpret relative expression patterns. - Demonstrate protein extraction from plant tissues and determine total protein concentration. - Separate extracted proteins by SDS-PAGE and interpret protein banding patterns. - Compare DNA or protein profiles of different plant tissues, varieties or treatments using suitable electrophoretic data. - Analyse nucleotide or protein sequences using sequence-alignment tools and identify conserved regions. - Identify functional domains or motifs in selected proteins using publicly available databases. - Construct and interpret a simple molecular phylogenetic tree using suitable nucleotide or protein sequence data. <i>Note: The practicals listed above may be conducted according to the availability of molecular biology, electrophoresis and computational facilities. Where specialized facilities are unavailable, demonstrations, recorded demonstrations, virtual laboratory exercises or suitable datasets may be used.</i>	3,4	30

<i>The teacher may also select or introduce any other experiment related to molecular biology.</i>			
Total Contact Hours			120
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Class Participation:	05	Lab record	10
Practical File:	10	Viva-Voce	20
Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C – Learning Resources			
Recommended Books/ Journals/ e-resources/ Learning Management Systems (LMS)			
- 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 (4th Edn.). McGraw-Hill (New York), pp. 273. - Clark, D.P. & Pazdernik, N.J. (2012) Biotechnology: Applying the Genetic Revolution (2nd 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 (4th Edn.). ASM Press (Washington, D.C.), pp. 1000. - Gupta, P.K. (2018) Molecular Biology and Genetic Engineering: Laboratory Manual (3rd Edn.). Rastogi Publications (Meerut), pp. 700. - Karp, G. (2009) Cell and Molecular Biology: Concepts and Experiments (6th Edn.). Wiley (New York), pp. 864. - Reddy, V.R. & Reddy, A.P.K. (2015) Molecular Biology: Techniques and Applications (2nd Edn.). Scientific Publishers (Jodhpur), pp. 550. - Smith, T.M. & Smith, R.L. (2015) Elements of Ecology Laboratory Manual (9th Edn.). Pearson (Boston), pp. 400. - Southwood, T.R.E. & Henderson, P.A. (2009) Ecological Methods (3rd 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			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PO ₁	PO ₂	PO ₃	PO ₄	PO ₅	PO ₆	PO ₇	PO ₈	PSO ₁	PSO ₂	PSO ₃	PSO ₄
CLO ₁	3	3	1	3	1	3	2	3	1	3	3	3
CLO ₂	3	3	2	2	2	3	2	3	2	3	3	3
CLO ₃	3	3	1	2	1	3	3	3	1	3	3	2
CLO ₄	3	3	1	2	2	3	3	3	1	3	3	2

Content Mapping with NEP thrust areas

Field	Designated Hrs.
Employability	16
Entrepreneurship	6
Skill Enhancement	30
Communication Development	8
Indian Knowledge System	8
Environmental Awareness	16
Current Issues and Social Awareness	10
Gender issues	
Public policies	6
Any Other (Research aptitude)	20

Important Notes (If any)

- Emphasize classical principles of ecology and molecular biology alongside recent advances in ecosystem ecology, population and community dynamics, ecological interactions, biodiversity assessment, molecular ecology, environmental DNA (eDNA), DNA barcoding, molecular markers, genomics, transcriptomics, microbiome analysis and molecular approaches for understanding ecological processes, adaptation, biodiversity and ecosystem responses to environmental change.

