Kurukshetra University, Kurukshetra

(Established by the State Legislature Act-XII of 1956)
("A++" Grade, NAAC Accredited)

Syllabus of the Programme
for
Post Graduate Programme

M.Sc. BOTANY

as per NEP 2020
Curriculum and Credit Framework for Postgraduate Programme

With Multiple Entry-Exit, Internship and CBCS-LOCF
With effect from the session 2024-25 (in phased manner)

DEPARTMENT OF BOTANY
FACULTY OF LIFE SCIENCES

KURUKSHETRA UNIVERSITY, KURUKSHETRA -136119
HARYANA, INDIA

Chairman
Department of Botany
Kurukshetra University
KURUKSHETRA-136119

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Session: 2024-25			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**I**		
Name of the Course	**Algae & Fungi**		
Course Code	**M24-BOT-101**		
Course Type	**CC-1**		
Level of the course	**400-499**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand criteria for classification of algae, evolutionary trends and economic importance of algae. CLO2. Learn about the life cycle patterns, biological diversity and unusual habitats of algae. CLO3. Understand how to distinguish fungi from other groups and life cycle patterns of fungi. CLO4. Learn about different plant diseases, lichens and degeneration of sex in fungi.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. Criteria for algal classification (pigments, reserve food, flagella etc.) and	15

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	their taxonomic importance. 2. Comparative account of important systems classification and recent trends. 3. Thallus organisation in algae and evolutionary trends. 4. Economic importance of algae as food, feed, uses in industries etc, algal biofertilizers and biofuels. 5. Origin and evolution of sex.	
II	1. Biodiversity of algae in different habitats (terrestrial, freshwater, marine, thermal, psychrophilic, subaerial, symbiotic, parasitic, epiphytic, halophytic. etc) 2. Dynamics and consequences of algal blooms and red tides. Phytoplankton, cyanophages, phycoviruses, control of algal nuisance. 3. Morphological features, reproduction and life cycle patterns of the following: Cyanophyta: Nostoc, Nitrogen fixation, heterocyst, range of thallus Chlorophyta: Range of thallus, *Vaucheria*, and *Chara* Xanthophyta: *Botrydium* Bacillariophyta: Thallus structure, and reproduction Phaeophyta: *Ectocarpus, and Sargassum* Rhodophyta: *Batrachopsermum, Polysiphonia*	15
III	1. General characters of fungi: Thallus organisation, nutrition, different kinds of spores and their dispersal and reproduction. 2. Classification of fungi by Ainsworth (1973), Alexopoulos et. al (1996), Hawksworth et al. (1995). 3. General account and life cycle of the following: a) Dictyosteliomycota and Myxomycota: *Dictyostelium* and *Physarum* b) Chytridiomycota and Oomycota: *Synchytrium, Phytophthora* and downy mildews c) Zygomycota: *Rhizopus* d) Ascomycota: Ascocarp types, *Taphrina, Venturia*, powdery mildew *e)* Basidiomycota: *Agracius, Puccinia, Melamspora, Ustilago, Neovossia* *f)* Deuteromycota: Sporulating structures, *Fusarium, Curvularia, Alternaria, Helminthospoirum* 4. Concept of Homothallism, Heterothallism and parasexual cycle	15
IV	1. Degeneration of sex in fungi, economic importance of fungi in nutrient cycling, decomposition, humus formation, decay and deterioration of wood & timber. 2. Causal organisms, symptoms, and management of: Late and early blight of potato, downy mildew of grapes, powdery mildew of peas, green ear disease of Bajra, apple scab, wilt of pigeon pea, karnal bunt of wheat, loose smut of wheat, black, yellow and brown rust of wheat, tikka disease of groundnut 3. Lichens: structure, classification, reproduction, and economic	15

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	importance.	
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Carr, N.G. & Whitton , B.A. (1982): The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.
2. Dubey, R.C. (2014): Advanced Biotechnology, S Chand & Company Pvt. Ltd., New Delhi.
3. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental Biotechnology, Narosa Publishers.
4. Fay, P & C van Baalen (1987): The cyanobacteria, Elsevier Science Publishers, B.V. Amsterdam, Netherlands.
5. Gupta, R.K. & Pandey, V.D. (2007): Advances in Applied Phycology, Daya Publishing House, Daryaganj, New Delhi.
6. Lee, R.E. (1999): Phycology, 4th edition, Cambridge University Press.
7. Agrios, G. N. (2022). *Plant pathology* (6th ed.). Academic Press.
8. Brasier, C. M., & Buck, K. W. (2015). *Fungal pathology: An introduction* (2nd ed.). Wiley-Blackwell.
9. Lucas, J. A. (2019). *Plant pathology and plant pathogens* (5th ed.). John Wiley & Sons.
10. Gullino, M. L., Bottex, B., & Fletcher, J. (Eds.). (2016). *Integrated pest and disease management in greenhouse crops* (2nd ed.). Springer Science & Business Media.
11. Schumann, G. L., & D'Arcy, C. J. (2017). *Essential plant pathology* (3rd ed.). American Phytopathological Society.

Session: 2024-25	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**I**
Name of the Course	**Bryophytes & Pteridophytes**
Course Code	**M24-BOT-102**

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Course Type	**CC-2**		
Level of the course	**400-499**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand and describe the characteristic features, classification, and the structure and development of gametophytes and sporophytes of major bryophyte orders. CLO2. Analyse the origin, evolution, reproduction methods, cytogenetics, and ecological and economic importance of bryophytes. CLO3. Understand and describe the characteristic features, classification, and the structure and development of gametophytes and sporophytes of major pteridophyte orders. CLO4. Analyse the structure and development of gametophytes and sporophytes of specific pteridophyte orders, and understand the evolutionary theories and economic and ecological significance of pteridophytes.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. Characteristic features of bryophytes, classification of bryophytes (Crandall-Stotler, Strotler and Lang 2009; Stotler and Crandall-Stotler 2005; Goffinet, Buck and Shaw 2008), general account of structure and development of gametophyte and sporophyte of Marchantiales (*Riccia*	15

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	and *Marchantia*), Jungermanniales (*Jungermannia*) and Anthocerotales (*Anthoceros*). 2. General account of structure and development of gametophyte and sporophyte of Sphagnales (*Sphagnum*), Funariales (*Physcomitrium*) and Polytrichales (*Polytrichum*).	
II	1. Origin of bryophytes (algal and pteridophytic), evolution of bryophytes (progressive, regressive and recent concepts), origin of alternation of generation (homologous and antithetic theory). 2. Apogamy and apospory, vegetative reproduction and cytogenetics of bryophytes, ecological (plant succession and pollution monitoring) and economic importance of bryophytes.	15
III	1. Characteristic features of pteridophytes, classification of pteridophytes (Pteridophyte Phylogeny Group 2016, Reimers 1954 and Sporne 1966). 2. General account of structure and development of gametophyte and sporophyte of Psilophytales (*Psilophyton, Rhynia, Asteroxylon and Zosterophyllum*), Psilotales (*Psilotum*), Lycopodiales (*Lycopodium*), Selaginellales (*Selaginella*), Lepidodendrales (*Lepidodendron*) and Sphenophyllales (*Equisetum*).	15
IV	1. General account of structure and development of gametophyte and sporophyte of Ophioglossales (*Ophioglossum*), Filicales (*Dryoptesis*) and Marsileales (*Marsilea*). 2. Origin and evolution of pteridophytes (algal, bryophytic and recent concepts), stelar system in pteridophytes, telome theory, enation theory, heterospory and seed habit, economic importance of pteridophytes.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Glime, J. M. (2017). Bryophyte Ecology. Volume 1. Physiological Ecology. E-book. Michigan Technological University. Available at: http://digitalcommons.mtu.edu/bryophyte-ecology/
2. Shaw, A. J., & Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press.

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3. Goffinet, B., & Shaw, A. J. (2008). Bryophyte Biology (2nd ed.). Cambridge University Press.
4. Gifford, E. M., & Foster, A. S. (1989). Morphology and Evolution of Vascular Plants (3rd ed.). W. H. Freeman.
5. Ranker, T. A., & Haufler, C. H. (Eds.). (2008). Biology and Evolution of Ferns and Lycophytes. Cambridge University Press.
6. Ganguly, S., & Kar, A. K. (2011). *College Botany: Volume II.* New Central Book Agency.

Session: 2024-25			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**I**		
Name of the Course	**Cytogenetics & Plant Breeding**		
Course Code	**M24-BOT-103**		
Course Type	**CC-3**		
Level of the course	**400-499**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. The students get acquainted about the different cytogenetic and molecular techniques used for genome analysis. CLO2. This course will enable the students to use linkage and recombination frequencies in gene mapping. CLO3. The students get familiarised about the chromosomal variations and their effects on the biological system as well as the role of chromosomes in sex determination and generation of variations. CLO4. The students will know about the methods that can be used to create the desired genotype/phenotype through breeding techniques and use of molecular markers in breeding.		
Credits	**Theory**	**Practical**	**Total**
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30

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End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. Chromatin structure and organisation: Chromosome structure and DNA packaging; euchromatin and heterochromatin. 2. Organisation of plastid and mitochondrial genomes. 3. Special Chromosomes: Structure, occurrence and behaviour of polytene, lampbrush, B and sex chromosomes. 4. Karyotype analysis, FISH, GISH and flow cytometry.	15
II	1. Cell cycle: Cell cycle phases, checkpoints and regulation. 2. Chromosome banding techniques and their applications. 3. Linkage and crossing over: Molecular mechanism of crossing over and role of different enzymes; linkage groups. 4. Chromosome mapping- Two point and three point test crosses.	15
III	1. Sex determination: Chromosomal and gene determining sex in plants, animals, *Drosophila* and humans; Gene dosage compensation. 2. Structural alterations in chromosomes – Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes. 3. Variation in chromosome number: Haploids, aneuploids and euploids-origin, production, effects and uses; polyploidy and crop improvement.	15
IV	1. Introduction to plant breeding methods for self-pollinated, cross-pollinated, and asexually propagated crops, including heterosis and hybrid vigor. 2. Overview of marker-assisted molecular breeding, molecular tagging of genes/traits, and examples of marker-assisted selection for qualitative and quantitative traits. Basics of QTL mapping, genotyping by sequencing, and genome-wide association studies, along with the evolution of markers used in breeding. 3. Concepts of male sterility, including its classification (genetic, cytoplasmic, cytoplasmic-genetic, chemical), genetic control, inheritance patterns, and breeding applications.	15

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		Total Contact Hours	60
Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Alberts B, Johnson A, Lewis J. Raff M, Roberts K and Walter P (2008) Molecular Biology of the Cell (5th Ed.). Garland Publishing Inc., New York.
2. Karp G (1999) Cell and Molecular Biology, John Wiley and Sons, USA.
3. Krebs JE, Goldstein ES and Kalpatrick ST (2010) Lewin's Essential Genes (2nd Ed.), Jones and Barlett Publishers.
4. Lewin B (2010) Gene X, Jones and Barlett Publishers.
5. Lodish H, Berk A, Kaiser, CA, Krieger M, Scott MP Bretscher A Ploegh H and Matsudaira P (2008) Molecular Cell Biology (6th Ed), W.H. Freeman and Company, New York, USA.
6. Pierce BA (2012) Genetics- A Conceptual Approach (4th Ed.), W.H. Freeman and Company, New York, USA.
7. Snustad P and Simmons MJ (2011) Principles of Genetics. (6th Ed.), John Wiley, New York.
8. Watson, JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene (6th Ed.), CSHLP, New York.
9. Singh, B.D. (2022) Plant breeding Principles and methods, 12th edition, MedTech Science Press.
10. Acquaah, G. (2020) principles of Genetics and Breeding, 3rd Edition, Willet-Blackwell.

Session: 2024-25	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**I**
Name of the Course	**Ecology**
Course Code	**M24-BOT-104**
Course Type	**CC-4**
Level of the course	**400-499**

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Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Students will be able to understand about limiting factors controlling distribution and growth of organisms. CLO2. Students will be able to develop insights about the concepts of populations, community and ecosystems and can use them in management of natural resources for sustainable development. CLO3. Students will be able to comprehend interactions among components of ecosystems for better stability. CLO4. By understanding the concept of ecological principles and environmental issues, the students will be able to develop attitude, value system and ethics towards environmental related issues.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. Introduction to ecology: History, levels of organisation, approaches to study ecology and scope. 2. The Environment: Solar radiations and temperature, Physical environment, biotic environment, biotic and abiotic interactions, tolerance range and limiting factors, ecotypes; plant-water relations; soil as a reservoir of life. 3. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realised niche; resource partitioning; character displacement.	15

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II	1. Population ecology: Concept, characteristics, population growth and regulation, species interactions—mutualism, competition, allelopathy, predation, parasitism, Life-history strategies and r-and K selection, concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations 2. Community structure and organisation; Nature of communities, community structure and its attributes; species diversity, Edges and ecotones, vegetation characteristics (analytical and synthetic characters, methods of analysis. 3. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.	15
III	1. Ecosystem organisation: structure and functions; primary production (global pattern and controlling factors); energy dynamics—trophic levels, energy flow pathways and ecological efficiencies. 2. Invasion of alien plants: Concept, ecological impact and management. 3. Decomposition (mechanism, substrate quality and climatic factors); global biogeochemical cycles of C, N, P, & S, ecosystem stability (resistance and resilience).	15
IV	1. Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India, speciation and extinction, endemism. 2. Global atmosphere changes: Environmental pollution (air, water and land), global environmental change and its consequences (CO_2 fertilisation, global warming sea level rise and UV radiation). 3. Bioremediation and phytoremediation.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Botkin, D.B. and E.A. Keller (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.
2. Odum, E.P. (1983), Basic Ecology, Sanders, Philadelphia.
3. Peter H. Raven, P.H. and Berg , L. R. Berg. 2005. Environment, 5th Edition. John Wiley & Sons Inc., New York.
4. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, New York.

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5. Steffen, W., A. Sanderson, P. D. Tyson, J. Jager, P. M. Matson, B. Moore, III, F. Oldfield, K. Richardson, H.J. Schnellnhuber, B. L. Turner, II, and R. J. Wasson. 2004. Global change and the Earth system: a Planet under Pressure. Springer-Verlag, New York, New York, USAReference books.
6. Townsend, C.R., Begon, M. And Harper, J.L. 2003. Essentials of Ecology. Second Edition. Blackwell Publishing, Oxford.
7. Jakhar, S. (2024). Fundamentals of Ecology. TechSar, New Delhi.

Session: 2024-25			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**I**		
Name of the Course	**Practical based on M24-BOT-101 & M24-BOT-102**		
Course Code	**M24-BOT-105**		
Course Type	**PC-1**		
Level of the course	**400-499**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	Get acquainted with the practical aspects of algae, fungi, bryophytes and pteridophytes.		
Credits	**Theory**	**Practical**	**Total**
	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 Time		6 hours	
Part B- Contents of the Course			
Practicals			**Contact hours**
List of Practicals **M24-BOT-101: Algae & Fungi** 1. To study working principle of compound microscope.			**120**

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2. Microscopic study and identification of members of Cyanophyceae (*Nostoc, Oscillatoria*).
3. Microscopic study and identification of members of Chlorophyceae (*Chlamydomonas, Chlorella, Volvox, Vaucheria. Oedogonium, Spirogyra, Caulerpa, Chara, Halimeda, Ulva, Hydrodictyon, Zygnema*).
4. Microscopic study and identification of members of Pheophyceae (*Dictyota, Ectocarpus, Sargassum*).
5. Microscopic study and identification of members of Rhodophyceae (*Batrachospermum, Polysiphonia*).
6. Camera lucida drawings of algal specimens.
7. To distinguish and study the various pigments present in plants through the process of paper chromatography.
8. To study identifying features of macroscopic fungi G*anoderma, Agarics* and *Morchella.*
9. Microscopic study and identification of representative members of Fungi (Mucor, *Penicillium*, *Helminthosporium, Puccinia, Alternaria, Cercospora, Melamospora, Phyllactinia, Uncinula, Aspergillus, Rhizopus etc.*)
10. To study symptomology and disease cycle of fungal diseases:
    a) Brown spot disease of Rice
    b) Stem rust of wheat (black/brown/yellow)
    c) Leaf spot disease of Brassica
    d) Early blight of Potato
    e) Late Blight of Potato
    f) Tikka disease of groundnut
    g) Leaf spot of Spinach
    h) Rust of Linseed/Euphorbia
    i) Powdery mildew of Sisso and grapes
11. Camera lucida drawings of fungal specimens.
12. To study preservation and maintenance of fungal cultures.
13. To study preservation of disease samples or maintenance of herbaria.
14. To study characteristic features of lichens.

M24-BOT-102: Bryophytes & Pteridophytes

15. Morpho-anatomical study and identification of genus *Plagiochasma.*
16. Morpho-anatomical study and identification of genus *Fissidens.*
17. Morpho-anatomical study and identification of genus *Physcomitrium.*
18. Morpho-anatomical study and identification of genus *Bryum.*
19. Morpho-anatomical study and identification of genus *Barbula.*
20. Morpho-anatomical study and identification of genus *Riccia.*
21. Morpho-anatomical study and identification of genus *Pteris.*
22. Morpho-anatomical study and identification of genus *Adiantum.*
23. Morpho-anatomical study and identification of genus *Pteridium.*
24. Morpho-anatomical study and identification of genus *Dryopteris.*
25. Morpho-anatomical study and identification of genus *Polystichum.*
26. Morpho-anatomical study and identification of genus *Diplazium.*
27. Morpho-anatomical study and identification of genus *Chelianthes.*

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*Other experiments relevant to the course.	

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental Biotechnology, Narosa Publishers.
2. Gupta, R.K. & Pandey, V.D. (2007): Advances in Applied Phycology, Daya Publishing House, Daryaganj, New Delhi.
3. Agrios, G. N. (2022). *Plant pathology* (6th ed.). Academic Press.
4. Brasier, C. M., & Buck, K. W. (2015). *Fungal pathology: An introduction* (2nd ed.). Wiley-Blackwell.
5. Shaw, A. J., & Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press.
6. Goffinet, B., & Shaw, A. J. (2008). Bryophyte Biology (2nd ed.). Cambridge University Press.

Session: 2024-25	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**I**
Name of the Course	**Practical based on M24-BOT-103 & M24-BOT-104**
Course Code	**M24-BOT-106**
Course Type	**PC-2**
Level of the course	**400-499**
Pre-requisite for the course (if any)	**Nil**
Course Learning Outcomes	Get acquainted with the practical aspects of

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(CLOs): After completing this course, the learner will be able to:	cytogenetics, plant breeding and ecology.		
Credits	**Theory**	**Practical**	**Total**
	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 Time		6 hours	

Part B- Contents of the Course

Practicals	**Contact hours**
List of Practicals **M24-BOT-103: Cytogenetics & Plant Breeding** 1. To study strains and fixatives used in cytogenetics. 2. To study the karyotype using a given metaphase chromosome picture (*Allium cepa*). 3. To work out the genetics of a cross from the given F_2 harvest. 4. To study different mitotic stages in root tips of *Allium cepa*. 5. To measure cell size using micrometry. 6. To estimate plant height and tiller number in a rice/wheat variety statistically. 7. To study about breeder's kit used in plant breeding. 8. To study different tools and techniques used in plant breeding. 9. To study floral structure of self- and cross-pollinated crops. 10. To solve problems related to GWAS and QTL mapping. 11. To study in vitro pollen germination and pollen viability. **M24-BOT-104: Ecology** 12. To compare the anatomy of C3 and C4 plants. 13. To estimate chlorophyll content in a given plant material of C3 and C4 plants. 14. To study the methods of sampling in ecological studies. 15. To determine the minimum size of the quadrat by species area curve method. 16. To study the density and abundance of plants at a given location by quadrat method. 17. To study phytosociological analysis of vegetation at Botanical Garden,	**120**

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KUK. 18. To determine the distribution of plants in a given area of vegetation by quadrat method. 19. To calculate biodiversity indices of herbaceous vegetation. 20. To analyse the population structure of tree species growing in the botanical garden, KUK. 21. To study the floristic regions of India. *Other experiments relevant to the course.	

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Watson, JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene (6th Ed.), CSHLP, New York.
2. Karp G (1999) Cell and Molecular Biology, John Wiley and Sons, USA.
3. Singh, B.D. (2022) Plant breeding Principles and methods, 12th edition, MedTech Science Press.
4. Acquaah, G. (2020) principles of Genetics and Breeding, 3rd Edition, Willet-Blackwell.
5. Odum, E.P. (1983), Basic Ecology, Sanders, Philadelphia.
6. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, New York.

Session: 2024-25	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**I**
Name of the Course	**Seminar**
Course Code	**M24-BOT-107**
Course Type	**Seminar**
Level of the course	**400-499**

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Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	The students will be able to present in front of an audience making them more confident.
Credits	**Seminar**
	2
Teaching Hours per week	2
Max. Marks	50
Internal Assessment Marks	0
End Term Exam Marks	50
Examination Time	1 hour
Instructions for Examiner: Evaluation of the seminar will be done by the internal examiner(s) on the parameters as decided by staff council of the department. There will be no external examination/viva-voce examination.	

Session: 2024-25	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**II**
Name of the Course	**Microbiology & Biostatistics**
Course Code	**M24-BOT-201**
Course Type	**CC-5**
Level of the course	**400-499**
Pre-requisite for the course (if any)	**Nil**
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Students will understand the fundamental characteristics, structural components, and reproductive mechanisms of prokaryotes, including differences between gram-positive and gram-negative bacteria. CLO2. Students will explore the mechanisms of horizontal gene transfer in bacteria, the diversity among microbial groups like actinomycetes and archaebacteria, and the life cycles of viruses and bacteriophages. CLO3. Students will gain proficiency in sampling techniques, data representation, and statistical measures

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	such as central tendency, dispersion, and distribution shape in biological research. CLO4. Students will apply probability theorems, understand probability distributions, and perform statistical analyses including correlation, regression, and hypothesis testing in biological studies.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. General features and classification of prokaryotes, size and shape, staining, cell wall and membrane system in gram positive and negative bacteria, structure of surface appendages (flagella, pili and fimbriae). 2. Endospore formation, bacterial genome, plasmids, culture media, growth curve and reproduction, sterilization techniques.	15
II	1. Horizontal gene transfer (transformation, transduction and conjugation), interrupted mating, general features of actinomycetes, mycoplasmas and cyanobacteria, archaebacteria (characteristics, important members, importance and differences from bacteria). 2. General features and classification of viruses, bacteriophage life-cycle (lytic and lysogenic), plaque assay, important plant viruses (TMV, ToLCV and CaMV), prions, viroid and virusoid.	15
III	1. Introduction, sampling techniques (random and non-random), sampling errors, graphical representation of data, measures of central tendency (mean, median and mode). 2. Measures of dispersion (range, mean deviation, variance and standard deviation), skewness and kurtosis.	15

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IV	1. Theorems of probability (addition and multiplication rule), probability distributions (binomial, Poisson and normal), correlation and regression analysis. 2. Tests of significance (comparison of means of two samples and three or more samples) parametric and non-parametric test.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Pelezar, MJ, Chaing, ECS & Krieg, NR (1993). Microbiology, Tata McGraw Hill Publ. New Delhi.
2. Prescott, LM., Harley, JP & Klein, DA (1996). Microbiology Wm. C. Brown Publ. USA.
3. Singh R.P. (1990): Introductory Biotechnology, Central Book Depot, Allahabad, India.
4. Sumbali, G. 2005: The Fungi, Narosa Publ. House, New Delhi.
5. Statistics for Biologists (1974) Campbell R.C. Cambridge University Press, Cambridge.
6. Statistics in Biology, Vol. 1 (1967) Bliss, C.I.K, McGraw Hill, New York

Session: 2024-25	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**II**
Name of the Course	**Natural Resources & Biodiversity Management**
Course Code	**M24-BOT-202**
Course Type	**CC-6**
Level of the course	**400-499**
Pre-requisite for the course (if any)	**Nil**
Course Learning Outcomes (CLOs): After completing this	CLO1. Understand resource types, degradation, and conservation methods, including land and water

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course, the learner will be able to:	management and environmental pollution. CLO2. Learn about forest resources, energy types, and ecosystem restoration briefly. CLO3. Explore biodiversity importance, threats, distribution patterns, and hotspots globally and in India. CLO4. Gain knowledge on biodiversity conservation strategies, protected areas, and sustainable development principles and indicators.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. Resources: Types, Renewable and non-renewable resources; resources degradation and conservation. 2. Land resources: Land degradation and desertification; management of waste lands in India. 3. Water resources: Pools of water and Hydrological cycles, surface water and groundwater; water-use and management. Environmental pollution of air, water and soil-types, sources and effects.	15
II	1. Forest resources: Forests and their importance, Non timber forest produce, forest resources of India and forest management. 2. Types of energy resources, renewable sources of energy-wind energy, wave energy, Energy from biomass, bioconversion technologies, energy plantation and petrocrops. 3. Ecosystem restoration and Environment impact assessment- Brief account.	15
III	1. Principles of resources conservation and conservation strategies. 2. Biological diversity: importance, concept and levels of biodiversity,	15

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	threats to biodiversity- habitat loss and fragmentation, exotic species, pollution, species extinctions; IUCN categories of threat. 3. Distribution and global patterns of biodiversity, centres of plant diversity and endemism, mega biodiverse countries. 4. Terrestrial and marine hotspots of biodiversity, Hottest hotspots, Hotspots of biodiversity in India.	
IV	1. *In situ* conservation of biodiversity: Protected area in India wildlife sanctuaries, national parks, biosphere reserves. 2. Conservation of biodiversity of wetlands, mangroves and coral reefs. 3. *Ex situ* biodiversity conservation: principles and practices, field gene banks, seed banks and cryopreservation. 4. Sustainable development: concept, principles and strategies; sustainability indicators.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Ball, J.B. 2001. Global forest resources: history and dynamics. In: *Forest Handbook Volume*
2. Chape, S., Fish, L. Fox, P. and Spalding, M. 2003. United Nations list of protected areas. UCN/UNEP/World Conservation Monitoring Centre, Gland, Switzerland/Cambridge.
3. Huston, M.A. 1994. *Biological Diversity*: The Coexistence of Species on Changing Landscapes. Cambridge University Press, Cambridge.
4. Raven, P.H. and Berg, L.R. 2005. Environment, 5th Edition, John Wiley & Sons Inc., New York.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
6. Jakhar, S. (2024). Fundamentals of Ecology. TechSar Pvt. Ltd, New Delhi.

Session: 2024-25	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**

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Semester	**II**		
Name of the Course	**Gymnosperms & Ethnobotany**		
Course Code	**M24-BOT-203**		
Course Type	**CC-7**		
Level of the course	**400-499**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand characteristics, classification, distribution, and economic importance of gymnosperms, and an overview of Progymnospermophyta and Pteridospermophyta. CLO2. Learn morphological, anatomical, and reproductive features of Cycadales, Cycadeoidales, Ginkgoales, Cordaitales, Voltziales, Coniferales, Ephedrales, Gnetales, and Welwitschiales. CLO3. Understand fossilization, types of fossils, paleopalynology, dating techniques, molecular tools, geological time scale, and evolutionary significance of fossil gymnosperms. CLO4. Explore ethnobotany, research methods, indigenous medicine systems, major Ayurveda disciplines, and herbal medicine use by tribal communities.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.			

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Unit	Topics	Contact Hours
I	1. Characteristic features of gymnosperms, classification of gymnosperms (Gifford and Foster, 1989; Bhatnagar and Moitra, 1996), their distribution in India and economic importance. 2. General account of Progymnospermophyta and Pteridospermophyta: Aneurophytales (*Aneurophyton*), Archaeopteridales (*Archaeopteris*), Glossopteridales (*Glossopteris*), Caytoniales (*Caytonia*).	15
II	1. Morpho-anatomical features and reproduction in the following: Cycadales (*Cycas*), Cycadeoidales (*Cycadeoidea*), Ginkgoales (*Ginkgo*), Cordaitales (*Cordaites*). 2. Morpho-anatomical features and reproduction in the following: Voltziales (*Voltzia*), Coniferales (*Pinus*), Ephedrales (*Ephedra*), Gnetales (*Gnetum*) and Welwitschiales (*Welwitschia*).	15
III	1. Fossilization process and types of fossils, paleopalynology, dating techniques of fossils, molecular tools used in palaeobotanical studies. 2. Geological time scale with reference to the evolution of plants, the Indian Gondwana flora with reference to the geological time scale, evolutionary significance of fossil gymnosperms.	15
IV	1. History, concept, scope and importance of ethnobotany, subdisciplines of ethnobotany, methods of research in ethnobotany. 2. Systems of indigenous medicine (Ayurveda, Siddha, Unani, Homeopathy, Yoga and Naturopathy), major disciplines of ayurveda, use of herbal medicines by tribals.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Singh, H. (2017). Embryology of Gymnosperms (2nd ed.). Springer.
2. Farjon, A. (2017). A Handbook of the World's Conifers (2nd ed.). Brill.
3. Christenhusz, M. J. M., & Byng, J. W. (2016). The Gymnosperms Handbook. Plant Gateway Ltd.

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4. Balick, M. J., & Cox, P. A. (2020). Plants, People, and Culture: The Science of Ethnobotany (2nd ed.). CRC Press.
5. Schultes, R. E., von Reis, S., & Raffauf, R. F. (1998). Ethnobotany: Evolution of a Discipline. Timber Press.
6. Ganguly, S., & Kar, A. K. (2011). *College Botany: Volume II.* New Central Book Agency.

Session: 2024-25			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**II**		
Name of the Course	**Molecular Genetics**		
Course Code	**M24-BOT-204**		
Course Type	**CC-8**		
Level of the course	**400-499**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. The students will have enhanced understanding of genome structure, evolution and its replication. CLO2. This course will impart the knowledge of basics of mutations and their importance; DNA repair mechanisms. CLO3. The students will learn about the methods of genetic recombination in bacteria. CLO4. The students will gain insight into the principle mechanisms of genome expression and its regulation.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.			

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The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. Eukaryotic genome: Different forms of DNA, C- value paradox, unique and repetitive DNA, gene families, hybridization kinetics and split genes. 2. Transposable elements: Mechanisms of transposition; transposons in bacteria, maize, *Drosophila* and yeast. 3. DNA Replication: Semi-conservative, bidirectional, replication origins, replication machinery.	15
II	1. Mutations: types, isolation of mutants, molecular basis of mutations. 2. DNA damage and repair: Causes of DNA damage; Photoreactivation, excision, mismatch, post replication and error prone repair systems. 3. Fine structure of gene: *cis-trans* test, rII locus, fine structure analysis of eukaryotes. 4. Bacterial genetics: conjugation, transduction and transformation.	15
III	1. Transcription: Initiation, elongation and termination in prokaryotes and eukaryotes, RNA polymerases. 2. RNA Processing: Processing of mRNA, rRNA and tRNA. 3. Genetic code: Deciphering the genetic code, characteristics. 4. Translation: Initiation, elongation and termination in prokaryotes and eukaryotes.	15
IV	1. Regulation of gene expression in prokaryotes: Operon concept, lac operon regulation by positive and negative mechanism, trp operon, regulation by negative and attenuation. 2. Regulation of gene expression in eukaryotes: a) Transcriptional level – Regulatory sequences, nucleosome positioning, chromatin remodeling, histone modifications. b) Post-transcriptional level – RNA splicing, RNA stability. 3. Translational level and post-translational level.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		

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• Mid-Term Exam:	15

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Alberts B, Johnson A, Lewis J. Raff M, Roberts K and Walter P (2008) Molecular Biology of the Cell (5th Ed.). Garland Publishing Inc., New York.
2. Brown TA (1999) Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
3. Hartl DL (1999) Genetics Principles and analysis. (4th Ed.) Jones and Bartle, Boston.
4. Lewin B (2005) Genes VIII. Oxford University Press, New York.
5. Lodish H, Berk A, Kaiser, CA, Krieger M, Scott MP Bretscher A Ploegh H and Matsudaira P (2008).
6. Pierce BA (2012) Genetics- A Conceptual Approach (4th Ed.), W.H. Freeman and Company, New York, USA.
7. Russell PJ (2006) Genetics (6th Ed.), Addison Wesley Longman, California, USA.
8. Snustad P and Simmons MJ (2011), Principles of Genetics. (6th Ed.), John Wiley, New York.
9. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene (6th Ed.), CSHLP, New York.

Session: 2024-25			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**II**		
Name of the Course	**Practical based on M24-BOT-201 & M24-BOT-203**		
Course Code	**M24-BOT-205**		
Course Type	**PC-3**		
Level of the course	**400-499**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	Get acquainted with the practical aspects of microbiology, biostatistics, gymnosperms and ethnobotany.		
Credits	**Theory**	**Practical**	**Total**
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70

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Max. Marks	0	100	**100**
Examination Time		6 hours	

Part B- Contents of the Course

Practicals	**Contact hours**
List of Practicals **M24-BOT-201: Microbiology & Biostatistics** 1. To study about safety guidelines, Good microbiological laboratory practice (GMLP) and spillage management. 2. To study about general equipment, apparatus and materials used in microbiology lab. 3. To study about different media for culturing/sub-culturing of microbes, sterilization and disinfection methods. 4. To study about inoculation and other aseptic procedures. 5. To study essential methods for maintaining, preparing and using cultures. 6. Isolation and microscopic study of microorganisms from soil and water samples. 7. To study the growth curve of bacteria. 8. To study a differential staining method: Gram staining of bacteria. 9. To test the sensitivity of microbe against antimicrobial substances. 10. To study numerical problems related to probability. 11. To study numerical problems related to correlation and regression analysis. 12. To study numerical problems related to tests of significance (Non-parametric test). 13. To study numerical problems related to tests of significance (Parametric test). **M24-BOT-203: Gymnosperms & Palaeobotany** 14. Morpho-anatomical study of genus *Pinus.* 15. Morpho-anatomical study of genus *Cycas.* 16. Morpho-anatomical study of genus *Ephedra.* 17. Morpho-anatomical study of genus *Juniperus.* 18. Morpho-anatomical study of genus *Thuja* 19. Morpho-anatomical study of genus *Agathis.* 20. Morpho-anatomical study of genus *Gingko.* 21. Morpho-anatomical study of genus *Cedrus.* 22. Morpho-anatomical study of genus *Araucaria.* 23. To study common plants used in Indian traditional medicine. *Other experiments relevant to the course.	**120**

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Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Singh R.P. (1990): Introductory Biotechnology, Central Book Depot, Allahabad, India.
2. Sumbali, G. 2005: The Fungi, Narosa Publ. House, New Delhi.
3. Statistics for Biologists (1974) Campbell R.C. Cambridge University Press, Cambridge.
4. Statistics in Biology, Vol. 1 (1967) Bliss, C.I.K, McGraw Hill, New York
5. Schultes, R. E., von Reis, S., & Raffauf, R. F. (1998). Ethnobotany: Evolution of a Discipline. Timber Press.
6. Ganguly, S., & Kar, A. K. (2011). *College Botany: Volume II.* New Central Book Agency.

Session: 2024-25			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**II**		
Name of the Course	**Practical based on M24-BOT-202 & M24-BOT-204**		
Course Code	**M24-BOT-206**		
Course Type	**PC-4**		
Level of the course	**400-499**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	Get acquainted with the practical aspects of natural resources, biodiversity and molecular genetics.		
Credits	**Theory**	**Practical**	**Total**
	0	4	4
Teaching Hours per week	0	8	8

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Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	**100**
Examination Time		6 hours	

Part B- Contents of the Course

Practicals	**Contact hours**
List of practicals **M24-BOT-202: Natural Resources & Biodiversity Management** 1. To determine the water holding capacity of a given soil sample by using the percolation method. 2. To measure pH, EC, and TDS of different soil samples. 3. To compare pH, EC, TDS, and salinity of different water samples. 4. To estimate the bulk density and moisture content of soil in the given area. 5. To study non-timber forest products in the University Campus, KUK. 6. To find out the specific gravity of the given soil sample. 7. To measure the height of the plant using a hypsometer. 8. To prepare an inventory of alien invasive species of the KUK campus. 9. To study the characteristics of different types of soil. 10. To study the biotic component of a pond ecosystem. Make a diagram of a pond ecosystem. **M24-BOT-204: Molecular Genetics** 11. To study the different types of chemicals, their grades, handling, storage and major manufacturers. 12. To study different meiotic stages in the flower buds of *Allium cepa*. 13. To study the structure and functioning of a spectrophotometer. 14. To prepare standard curve for the estimation of proteins using Lowry's method. 15. To isolate and estimate the four seed protein fractions. 16. To study the preparation of dendrogram from the given DNA/protein banding pattern. 17. To prepare standard curve for the estimation of DNA using diphenylamine reaction. 18. To prepare standard curve for the estimation of RNA using orcinol reaction. 19. To study Hardy-Weinberg's law of equilibrium using given chickpeas seed mixture. 20. To calculate correlation and regression coefficient for plant height and tiller number in a wheat variety. *Other experiments relevant to the course.	**120**

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Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Huston, M.A. 1994. *Biological Diversity*: The Coexistence of Species on Changing Landscapes. Cambridge University Press, Cambridge.
2. Raven, P.H. and Berg, L.R. 2005. Environment, 5th Edition, John Wiley & Sons Inc., New York.
3. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
4. Hartl DL (1999) Genetics Principles and analysis. (4th Ed.) Jones and Bartle, Boston.
5. Lewin B (2005) Genes VIII. Oxford University Press, New York.

Session: 2025-26	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**III**
Name of the Course	**Plant Physiology & Biochemistry**
Course Code	**M24-BOT-301**
Course Type	**CC-9**
Level of the course	**500-599**
Pre-requisite for the course (if any)	**Nil**
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand plant water relations, water potential, absorption, transpiration, antitranspirants, and the roles and deficiencies of micro and macro-nutrients. CLO2. Study photosynthesis processes, carbon assimilation pathways (C3, C4, CAM), and the accumulation and partitioning of photosynthates. CLO3. Explore respiration mechanisms, glycolysis, Krebs cycle, electron transport, nitrogen fixation, nitrate

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	and ammonium assimilation, and amino acid precursors. CLO4. Learn about lipid metabolism, fatty acid biosynthesis and breakdown, triglyceride synthesis, enzyme structure and kinetics, and enzyme inhibition and regulation.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. **Plant water relations:** Concept and components of water potential, soil-water relations, passive and active absorption of water, transpiration and factors governing transpiration, antitranspirants, bulk flow in xylem, water movement from leaf to atmosphere. 2. **Mineral Nutrition:** Role and mode of action of micro and macro-nutrients, deficiency disorders.	15
II	**1. Photosynthesis:** Photo-oxidation of water, cyclic and non-cyclic photophosphorylation, photorespiration and its significance. The sequence of reactions in photosynthesis, the path of carbon assimilation (C3 and C4 cycles, CAM pathway), Blackman's law of limiting factors. **2. Accumulation and partitioning of photosynthates:** Formation and mobilisation of chloroplast starch, sucrose biosynthesis, transport and signalling.	15
III	1. **Respiration:** Mechanism and regulation of glycolysis, underground metabolism in glycolytic pathway, Krebs cycle (with reference to plant specific reactions), electron transport chain (with reference to plant specific reactions), pentose phosphate pathway, glyoxylate cycle.	15

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	2. **Nitrogen Metabolism:** Biochemistry of nitrogen fixation, nitrate reductase, nitrite reductase, nitrate assimilation, ammonium assimilation (major and alternate route), transamination reactions, symbiotic and free living nitrogen fixation, root nodule formation, nitrogenase, amino acid biosynthesis.	
IV	1. **Lipid Metabolism:** Fatty acid nomenclature, structure and classification, triglycerides and waxes, conjugated lipids (phospholipids and glycolipids), fatty acid biosynthesis and desaturation, triglyceride biosynthesis and breakdown, carnitine cycle and its importance, alpha and beta oxidation, conversion into carbohydrates. 2. **Enzymes:** Nomenclature, classification and structure, models for enzyme-substrate interaction, factors affecting rate of enzymatic reactions, kinetics of enzymatic reactions, reversible and irreversible enzyme inhibition, isozymes, allosteric enzymes.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2019). Biochemistry (9th ed.). W. H. Freeman.
2. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W. H. Freeman.
3. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.). Wiley.
4. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2018). Plant Physiology and Development (6th ed.). Sinauer Associates.
5. Hopkins, W. G., & Hüner, N. P. A. (2008). Introduction to Plant Physiology (4th ed.). Wiley.

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Part A - Introduction	
Name of Programme	**M.Sc. Botany**

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Semester	**III**		
Name of the Course	**Plant Anatomy & Reproduction**		
Course Code	**M24-BOT-302**		
Course Type	**CC-10**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand meristem classification, permanent and complex tissues, vascular bundles, and monocot and dicot stem and root anatomy. CLO2. Explore monocot and dicot leaf anatomy, secondary growth, types of wood, and anomalous secondary growth. CLO3. Examine polarity, patterning, genetic basis of embryogenesis, origin and differentiation of tissues, SAM and RAM maintenance, and vascular cambium. CLO4. Understand the structure of male and female gametophyte in plants, endosperm types and development.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Meristem classification, permanent tissues, complex tissues (xylem and phloem), secretory tissues, epidermal tissue system, types of vascular	15

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	bundles, anatomy of monocotyledonous and dicotyledonous stems and roots, root-stem transition.	
II	Anatomy of monocotyledonous and dicotyledonous leaves, secondary growth (tissues and mechanism involved), types of wood (storied and non-storied, ray structure, tyloses, canals), anomalous secondary growth with examples.	15
III	Origins of polarity, patterning during embryogenesis, position dependent mechanisms, genetic basis of embryogenesis, mutant analysis, role of phytohormones, radial patterning, origin of epidermis, procambial precursors, SAM and RAM differentiation and maintenance, vascular cambium.	15
IV	Male gametophyte, microsporogenesis, female gametophyte, megasporogenesis, pollination, pollen-pistil interaction, fertilization, endosperm development and types, polyembryony and apomixis.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Esau, K. (2006). Plant Anatomy (3rd ed.). John Wiley & Sons.
2. Esau, M. (2019). Plant Anatomy. Springer.
3. Esau, M. (2005). Introduction to Plant Anatomy (Rev. ed.). John Wiley & Sons.
4. Went, F. W. (1970). Plant Embryology (2nd ed.). Van Nostrand Reinhold.
5. Gerstel, S. A., & Waller, D. G. (2000). Plant Embryology: A Morphological Approach. Oxford University Press.

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Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**III**

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Name of the Course	**Plant Biotechnology**		
Course Code	**M24-BOT-303**		
Course Type	**DEC-1**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CO1. The students will have a better understanding of various tools and techniques of genetic engineering. CO2. During the course students will gain in depth knowledge about different methods for genetic transformation of plants. CO3. The students will acquire understanding of production of transgenic plants for biotic and abiotic stress resistance, male sterility and edible vaccines. CO4. During the course students will gain in depth knowledge about gene cloning methods, PCR and fermentation technology.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. Techniques used in recombinant DNA Technology: Gel Electrophoresis, PFGE, Southern, Northern and Western blotting, Dot blots, Chemical synthesis of genes, DNA chip technology. 2. Isolation of genes, Sequencing of genes: Maxam & Gilbert method, Sanger's method and next-generation sequencing technologies, Brief	15

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	account of proteomics and genomics.	
II	1. DNA cloning methods, using vectors (Plasmids, phages, cosmids, phagemids, transposons, artificial chromosomes, BAC, YAC, MAC), cloning in bacteria and eukaryotes, genomic and cDNA libraries. 2. Gene amplification by PCR: different types, DNA fingerprinting, molecular probes: general features and applications.	15
III	1. Gene transfer methods in plants: plasmid mediated, electroporation, cation precipitation, liposomes, microinjection and particles gun technology, transgene expression. 2. Transgenic plants: over expression and RNAi with examples of improved crops, current status in India. 3. Genome editing: Types and examples of improved crops, current status in India.	15
IV	1. Yeast and algal biomass as source of single cell protein, oils and vitamins, microbial fermentation technology in the food industry, strain improvement, bioreactor types, media for fermentation, fermented products (bread, cheese, ethanol, beer, wine, distilled spirits, vinegar, organic acids, antibiotics). 2. Plant and microbial biopesticides, bioremediation and phytoremediation.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Chawla, H. S. (2017). Plant Biotechnology: Principles and Applications (2nd ed.).
2. Stewart Jr, C. N. (2018). Plant Biotechnology and Genetics: Principles, Techniques, and Applications.
3. Khanna, H. K., & Raina, S. K. (2017). Principles of Plant Biotechnology.
4. Smith, J., & Hood, E. E. (2016). Plant Biotechnology: The Genetic Manipulation of Plants (2nd ed.).
5. Altman, A. (Ed.). (2012). Plant Biotechnology and Agriculture: Prospects for the 21st Century.
6. Brown, T.A. (2016) Gene cloning and DNA analysis an introduction, 7th edition, John Wiley publishing.

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Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**III**		
Name of the Course	**Plant Cell & Signalling**		
Course Code	**M24-BOT-304**		
Course Type	**DEC-1**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Students will understand the principles of cell theory, cellular evolution, eukaryotic cells, and understand the structures and functions of the cell wall, plasma membrane, and ribosomes in eukaryotes. CLO2. Students will get acquainted with the endoplasmic reticulum's structure and function, protein transport processes, the Golgi complex, vesicle fusion, and the structure and enzyme composition of lysosomes, including the autophagy pathway. CLO3. Learners will examine the structure, types, and functions of vacuoles, the structure and protein targeting in mitochondria and plastids, and the structure and function of peroxisomes. CLO4. Learners will develop an in-depth understanding the nucleus, including the nuclear envelope, matrix, NPC, and nucleolus, as well as the cytoskeleton, plasmodesmata communication, and cell signalling mechanisms involving receptors, primary and secondary messengers, and two-component signalling systems.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

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Part B- Contents of the Course		
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.		
Unit	**Topics**	**Contact Hours**
I	Cell theory, cellular evolution, eukaryotic cells, plant cell wall (structure and functions), plasma membrane (structure, motion of lipids, membrane proteins and transport across membrane), plasma membrane-cell wall continuum, ribosome, chlororibosome and mitoribosome.	15
II	Endoplasmic reticulum (structure, function, N-linked glycosylation, protein transport across ER membrane up to cis-golgi), golgi complex (structure, protein transport through cisternae), vesicle fusion, signalling and events of autophagy pathway in plants.	15
III	Vacuole (structure, types and functions), mitochondria (structure and targeting of mitochondrial proteins), plastids (structure, types and targeting of chloroplast proteins), peroxisome (structure and function).	15
IV	Nucleus (nuclear envelope, matrix, NPC, transport through NPC, nucleolus), cytoskeleton (microtubules and actin filaments), communication through the plasmodesmata, cell signalling (receptors, primary messengers, secondary messengers, chloroplast-nuclear crosstalk)	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular biology of the cell* (7th ed.). Garland Science.
2. Lim, W. A., Mayer, B. J., & Pawson, A. (2014). *Cell signaling* (1st ed.). Garland Science.
3. Karp, G. (2018). *Karp's cell and molecular biology: Concepts and experiments* (9th ed.).

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Wiley.
4. Hardin, J., Bertoni, G., & Kleinsmith, L. J. (2017). *Becker's world of the cell* (9th ed.). Pearson.

Session: 2025-26			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**III**		
Name of the Course	**Applied Mycology**		
Course Code	**M24-BOT-305**		
Course Type	**DEC-1**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO 1: Production of Valuable microbial products. CLO 2: Role of Fungi as biofertilisers and biocontrol agents. CLO 3: Techniques used for maintenance of fungal cultures. CLO 4: Commercial production of mushrooms.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.			

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Unit	Topics	Contact Hours
I	Primary metabolites production by fungi: industrial alcohol, organic acid, beer. Secondary metabolites production by fungi: Antibiotics, steroid transformation, enzymes, amino acids, growth regulators, vitamins.	15
II	Fungi as biofertilizers: Endomycorrhizae and ectomycorrhizae. Fungi as biocontrol of plant pathogens and weeds. Biodeterioration of materials: Paper, painted surface, wood. Role of fungi in biogeochemical cycle.	15
III	Food processing by fungi: Bread, cheese, oriental food and baker's yeast. Fungal sources of health food: Single cell protein, edible mushrooms. Spoilage of food and fungal toxicity.	15
IV	Culturing and preservation of fungi: isolation of fungi, culturing of fungi, establishing a pure culture, aseptic technique, maintenance of culture collection, culture collection and identification centres. Common culture media and sterilization techniques.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Deacon, J. W. (2013). Fungal Biology (5th ed.). John Wiley & Sons.
2. Gadd, G. M. (2007). Fungi in Biogeochemical Cycles (2nd ed.). Cambridge University Press.
3. Moore-Landecker, E. (2009). Fundamentals of the Fungi (4th ed.). Prentice
4. Hall. Dighton, J., White, J. F., & Oudemans, P. (2005). The Fungal Community: Its Organization and Role in the Ecosystem (3rd ed.). CRC Press.
5. Sutton, B. C. (2012). The Fungi: An Advanced Treatise (2nd ed., Vol.)

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Session: 2025-26			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**III**		
Name of the Course	**Plant Growth Regulators**		
Course Code	**M24-BOT-306**		
Course Type	**DEC-1**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand the biosynthesis, transport, mechanisms, and agricultural applications of auxins, gibberellins, and cytokinins, including their roles in growth, development, and stress responses. CLO2. Study the biosynthesis, transport, mechanisms, and agricultural applications of abscisic acid, ethylene, and strigolactones, focusing on their roles in growth, development, and stress responses. CLO3. Explore the biosynthesis, transport, mechanisms, and agricultural applications of jasmonates, salicylic acid, and brassinosteroids, and their roles in growth, development, and stress responses. CLO4. Learn about novel phyto regulators, including phytomelatonin and peptide hormones, their biosynthesis, transport, mechanisms, and roles in hormonal crosstalk during growth, development, and stress responses.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

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Part B- Contents of the Course		
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.		
Unit	**Topics**	**Contact Hours**
I	Biosynthesis, transport, uses and molecular mechanisms of auxins, gibberellins and cytokinins, recent advances and applications in agriculture, role in growth, development and stress responses.	15
II	Biosynthesis, transport, uses and molecular mechanisms of abscisic acid, ethylene and strigolactones, recent advances and applications in agriculture, role in growth, development and stress responses.	15
III	Biosynthesis, transport, uses and molecular mechanisms of jasmonates, salicylic acid and brassinosteroids, recent advances and applications in agriculture, role in growth, development and stress responses.	15
IV	Novel classes of phytoregulators, biosynthesis, transport, uses and molecular mechanisms of phytomelatonin and peptide hormones, hormonal crosstalk during growth, development and stress responses.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2021). *Plant physiology and development* (7th ed.). Oxford University Press.
2. Mohr, H., Schopfer, P., & Wollenweber, A. (2019). *Principles of plant physiology* (5th ed.). Springer.
3. Salisbury, F. B., & Ross, C. W. (2020). *Plant physiology* (6th ed.). Brooks/Cole Pub Co.
4. Mohr, H., Schopfer, P., & Wollenweber, A. (2018). *Plant physiology* (4th ed.). Springer.

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Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**III**		
Name of the Course	**Restoration Ecology**		
Course Code	**M24-BOT-307**		
Course Type	**DEC-2**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand terms, definitions, and strategies of ecological restoration, including natural recovery, active restoration, rehabilitation, and the impacts of disturbances on ecosystems. CLO2. Learn methods for rehabilitating salt-affected soils, preventing invasive species, managing habitat fragmentation, ensuring ecosystem stability, and mitigating climate change through biological carbon sequestration. CLO3. Explore sustainable forestry management, agroforestry, biotechnological restoration tools, and conducting environmental impact and risk assessments. CLO4. Gain knowledge on the degradation and restoration of forest, grassland, and aquatic ecosystems, adaptive wetland restoration, wastewater recycling, waste management, reclamation of mining sites, bioremediation, and phytoremediation.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

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Part B- Contents of the Course		
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.		
Unit	**Topics**	**Contact Hours**
I	1. Restoration-Terms and definitions, Importance of ecological restoration: strategies of Restoration- Natural recovery, active restoration, rehabilitation. 2. Restoration plan and rehabilitation measures. 3. Natural and anthropogenic disturbances: Characteristics and sources, effects on structural and functioning of terrestrial and aquatic ecosystems.	15
II	1. Rehabilitation of salt affected soils. 2. Prevention and mitigation of invasive species; Habitat fragmentation. 3. Ecosystem stability: Structural and functional stability. 4. Climate change mitigation and Biological carbon sequestration.	15
III	1. Sustainable forestry management and agroforestry. 2. Biotechnological Tools of Restoration. 3. Environmental impact and risk assessment.	15
IV	1. Degradation and Restoration of forest and grassland ecosystems. 2. Degradation and restoration of aquatic resources: River corridors, wetlands and lakes 3. Adaptive restoration of wetlands; Waste water recycling and waste management. 4. Reclamation of mining sites, Bioremediation and Phytoremediation.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

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Part C-Learning Resources
Recommended Books/e-resources/LMS: 1. Botkin, D.B. and E.A. Keller (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York. 2. Manahan, S.E. 2000. Environmental Chemistry. Seventh Edition. Lewis Publishers, New York 3. Pierzynski, G.M., Sims, J.T. and Vance, G.F. 2000. Soils and Environmental Quality. Second Edition. CRC press, New York. 4. Singh,J.S., Singh,S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi. 5. Packard, S. And Mutel C.F. eds. (1997). The Tallgrass Restoration Handbook, Island Press, Washington, DC. 6. Jakhar, S. (2024). Fundamentals of Ecology. TechSar Pvt. Ltd, New Delhi.

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Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**III**		
Name of the Course	**Biophysical & Biochemical Techniques**		
Course Code	**M24-BOT-308**		
Course Type	**DEC-2**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Master various microscopic techniques and staining methods including light, phase contrast, fluorescence, and electron microscopy. CLO2. Understand centrifugation principles, types, and applications, including safety considerations. CLO3. Learn chromatographic techniques and spectrophotometry principles for molecular analysis. CLO4. Explore electrophoresis and mass spectrometry methods, along with immunotechniques and radioisotope techniques for detection and imaging.		
Credits	**Theory**	**Practical**	**Total**
	4	0	4
Teaching Hours per week	4	0	4

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Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	**100**
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. **Microscopic techniques**: Introduction; Light microscope; Phase contrast microscope; Fluorescence microscope; Electron microscope (EM) SEM, TEM and STEHM; Scanning probe microscopes; Different fixation and staining techniques. 2. **Centrifugation**: Principles of sedimentation; Types, care and safety aspects of centrifuges; Differential centrifugation; Density gradient centrifugation and their applications.	15
II	1. **Chromatographic techniques**: Theory of chromatography; Types of chromatography- Paper chromatography, Thin layer chromatography, Adsorption chromatography, Partition chromatography, Affinity chromatography, Ion exchange chromatography, HPLC and Size-exclusion chromatography. 2. **Spectrophotometery**: Colorimetery; UV and Visible spectrophotometery.	15
III	1. **Electrophoresis**: Principle; Agarose gel electrophoresis; Polyacrylamide gel electrophoresis; 2- Dimensional gel electrophoresis; Capillary electrophoresis; Microchip electrophoresis and Isoelectric focusing. 2. **Mass spectrometry:** Introduction; Theory; Mass spectrometer; Ionization of molecules; Mass analysers- MALDI; Detectors and Applications.	15
IV	1. **Immunotechniques**: Antibody generation; Detection of molecules using ELISA, RIA, Immunoprecipitation and Immunofluorescence microscopy; Detection of molecules in living cells. 2. **Radioisotope techniques**: Radioactive isotopes; Nature of radioactivity; Detection and measurement of different types of radioisotopes normally used in biology; Incorporation of radioisotopes in biological tissues and cells; Molecular imaging of radioactive	15

	material; Disposal of radioactive wastes and safety guidelines.	
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of Instrumental Analysis (7th ed.). Brooks Cole.
2. Wilson, K., & Walker, J. (2017). Biochemical Techniques (4th ed.). Garland Science.
3. Roberts, G. C. K., & Watts, A. (2016). Biophysical Techniques (2nd ed.). Oxford University Press.
4. Hames, B. D., & Hooper, N. M. (Eds.). (2017). Biochemical Methods (4th ed.). Elsevier.
5. Wilson, K., & Walker, J. (2018). Practical Biochemistry: Principles and Techniques (6th ed.). Cambridge University Press.

Session: 2025-26	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**III**
Name of the Course	**Plant Informatics**
Course Code	**M24-BOT-309**
Course Type	**DEC-2**
Level of the course	**500-599**
Pre-requisite for the course (if any)	**Nil**
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO 1: Students will understand the scope of bioinformatics, effectively utilize various biological databases, and proficiently retrieve and manage sequence data in FASTA format using plant genomic data.

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	CLO 2: Students will perform and interpret pairwise and multiple sequence alignments using appropriate algorithms and scoring matrices, assessing their biological significance using plant genomic data. CLO 3: Students will apply heuristic algorithms such as BLAST for database searches, utilize Markov models for sequence analysis, and predict protein motifs and domains using specialized databases of plants. CLO 4: Students will predict genes, promoters, and regulatory elements, analyze gene expression data, construct and interpret phylogenetic trees, and predict protein and RNA structures from freely available plant genomic data.

Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	**Topics**	**Contact Hours**
I	Introduction and scope of bioinformatics, biological databases (primary databases, secondary and specialized databases), advantages and disadvantages of biological databases, sequence retrieval from databases (NCBI, Phytozome, SOL Genomics, TAIR and other plant specific databases).	15
II	Sequence alignment, pairwise sequence alignment, sequence homology, sequence identity, sequence similarity, global and local alignment, alignment algorithms (dot matrix method and dynamic programming methods), scoring matrices, statistical significance of sequence alignment.	15

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III	Heuristic algorithms for performing database searches, types of BLAST, multiple sequence alignment, Markov and Hidden Markov Models, PSI BLAST, protein motif and domain prediction, motif and domain databases, plant protein family databases.	15
IV	Gene, promoter and regulatory element prediction programs for prokaryotes and eukaryotes (with reference to plant genomes), gene expression databases (data retrieval and processing from SOL Genomics, Phytozome), phylogenetic trees (concept and programmes), protein and RNA structure prediction.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Lesk, A. M. (2008). Introduction to Bioinformatics. Oxford University Press.
2. Choudhuri, S. (2014). Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools. Academic Press.
3. Edwards, D. (Ed.). (2016). Plant Bioinformatics: Methods and Protocols. Humana Press.
4. Rashidi, H. H., & Buehler, L. K. (2017). Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press.
5. Compeau, P., & Pevzner, P. (2014). Bioinformatics Algorithms: An Active Learning Approach. Active Learning Publishers.

Session: 2025-26	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**III**
Name of the Course	**Palaeobotany & Palynology**
Course Code	**M24-BOT-310**

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Course Type	**DEC-2**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand the processes, environments, and types of fossilization, as well as the principles of systematics, reconstruction, and nomenclature in paleobotany. CLO2. Grasp a clear picture of land plant evolution and early spore producing trees. CLO3. Explain the origin and evolution of flowering plants and coevolution of other organisms with plants. CLO4. Understand the importance of palynology in solving evolutionary problems.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Preservation of plants as fossils: Definition; taphonomy; environment for fossilization; modes of preservation; types; major rock types, rock cycle and rocks containing fossils; systematics, reconstruction and nomenclature. Geologic Time: Geologic timescale, relative vs. numerical age, physical and biological principles for defining relative and numerical age. Early Life: The origin of earth, earliest environment, theories on origin of life, evidences for the origin of life - prokaryotes, evolution of eukaryotes and fossil records, diversified life - algae and fungi.	15

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II	Colonization of land by plants: Geologic time, environment, vegetative and reproductive adaptations to land dwelling, fossil evidences - transitional plants with land adaptive features, early non vascular land plants (bryophytes), early vascular land plants (pteridophytes). Early vascular plants to early spore producing trees (arborescent pteridophytes & progymnosperms): Geologic time, environment, advancement in plant adaptive features for land dwelling with fossil evidences. Early spore producing trees to early seed producing trees (gymnosperms): From isospores to free sporing heterospores, origin of ovule, hydrasperman reproduction with fossil evidences.	15
III	Origin and evolution of flowering plants (angiosperms): Geologic time, evolutionary trends - angiosperm derived characteristics, fossil evidences for early flowering plants, place of origin, radiation, phylogeny. Aspects and Appraisal of Palaeobotany: Palaeobotanical study in exploring mysteries in the living planet; origin, evolution, diversification and extinction of species; plant-animal interaction and coevolution; plate movement, geological age and correlation of strata; palaeogeogrpahy, palaeoclimate; fossil fuel.	15
IV	Spore-pollen morphology: units, polarity, symmetry, shape, size, aperture; NPC system for numerical expression of apertural details; evolution of aperture types. Pollen wall and extraexinous wall materials: Sporoderm stratification and sculptures; LO- analysis; sporopollenin; pollen wall development; Ubisch body; pollen connecting threads, perine, pollen-kit. Pollen grains adaptation: Pollen grains adaptation in different habitats and pollination types; pollen wall adaptation and significance; Hermomegathic mechanism. Pollen limitation and plant diversification: Definition; ecological and evolutionary relevance.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

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Part C-Learning Resources
Recommended Books/e-resources/LMS: 1. Taylor, T. N., Taylor, E. L., & Krings, M. (2009). *Paleobotany: The Biology and Evolution of Fossil Plants* (2nd ed.). Academic Press. 2. Traverse, A. (2007). *Paleopalynology* (2nd ed.). Springer. 3. Jansonius, J., & McGregor, D. C. (Eds.). (2021). *Palynology: Principles and Applications* (Vol. 1-3). AASP Foundation. 4. Scott, A. C., & Stea, R. R. (2019). *Fire in the Earth System* (1st ed.). Wiley. 5. Harley, M. M., Morton, C. M., & Blackmore, S. (Eds.). (2000). *Pollen and Spores: Morphology and Biology* (1st ed.). Royal Botanic Gardens, Kew.

Session: 2025-26			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**III**		
Name of the Course	**Practical based on M24-BOT-301 & M24-BOT-302**		
Course Code	**M24-BOT-311**		
Course Type	**PC-5**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	Get acquainted with the practical aspects of natural resources, biodiversity and molecular genetics.		
Credits	**Theory**	**Practical**	**Total**
	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 Time		6 hours	

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Part B- Contents of the Course	
Practicals	**Contact Hours**
List of practicals **M24-BOT-301: Plant Physiology & Biochemistry** 1. To find out the water potential of potato tuber by the weight method. 2. To find out the osmotic pressure of cell sap by plasmolytic method. 3. To find out the relative turgidity and saturation deficit of leaves. 4. To investigate the phytochemical constituents of given plant sample. 5. Estimation of ascorbic acid by iodometric titration. 6. To study plant pigments with the help of paper chromatography. 7. To study the level of chlorophyll in leaves of plants. 8. Qualitative test for organic acids. 9. Estimation of enzymatic activity from given sample (different enzymes). 10. Determination of thermal death point. **M24-BOT-302: Plant Anatomy & Reproduction** 11. Morpho-anatomical study of secondary growth in *Achyranthes* stem. 12. Morpho-anatomical study of secondary growth in *Amaranthes stem* 13. Morpho-anatomical study of secondary growth in *Nyctanthes* stem. 14. Morpho-anatomical study of secondary growth in *Bougainvillea.* 15. Morpho-anatomical study of secondary growth in *Tecoma.* 16. Morpho-anatomical study of secondary growth in *Boerhaavia.* 17. Morpho-anatomical study of secondary growth in *Dracaena.* 18. Morpho-anatomical study of secondary growth in *Chenopodium.* 19. To study the structure of endothecium and obturator through permanent slide. 20. To study the structure and type of ovule in the given plant sample. 21. To study the structure of anther of the given plant sample. 22. To study placentation in Angiosperms by cutting a T.S. or L.S. of the ovary of given flower sample. 23. To study the embryo of a given dicot and monocot sample. 24. To study protandry, protogyny and heterostyly in different plant samples. 25. To test the viability or germination of seeds with the help of tetrazolium salt. *Other experiments relevant to the course.	**120**

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and	
• Seminar/presentation/assignment/quiz/class test etc.:	10		

• Mid-Term Exam:	15	execution of the practical

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2018). Plant Physiology and Development (6th ed.). Sinauer Associates.
2. Hopkins, W. G., & Hüner, N. P. A. (2008). Introduction to Plant Physiology (4th ed.). Wiley.
3. Esau, M. (2005). Introduction to Plant Anatomy (Rev. ed.). John Wiley & Sons.
4. Went, F. W. (1970). Plant Embryology (2nd ed.). Van Nostrand Reinhold.

Session: 2025-26			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**III**		
Name of the Course	**Practical based on M24-BOT-303/304/305/306 & M24-BOT-307/308/309/310**		
Course Code	**M24-BOT-312**		
Course Type	**PC-6**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	Get acquainted with the practical aspects of plant biotechnology/plant cell & signalling/seed science & technology and restoration ecology/biochemical & biophysical techniques/plant informatics.		
Credits	**Theory**	**Practical**	**Total**
	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 Time		6 hours	

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Part B- Contents of the Course	
Practicals	**Contact Hours**
List of practicals **M24-BOT-303: Plant Biotechnology** 1. To study plant tissue culture tools and practices. 2. To prepare Murashige and Skoog (MS) basal medium. 3. To isolate *Rhizobium* species from root nodules of a leguminous plant. 4. To estimate the acid value of unsaturated fat samples. 5. To determine the quality of the milk samples by using methylene blue reductase test. 6. To prepare assembly for SDS-gel electrophoresis. 7. Plant genomic DNA isolation. 8. Plasmid DNA isolation. 9. To inoculate the leaf and intermodal segments in MS basal medium. 10. Sterilization of explants. **M24-BOT-304: Plant cell & signaling** 1. To quantify cellulose, hemicellulose, and lignin in plant tissues. 2. To study the effect of cellulase and pectinase on plant cell walls. 3. To study lignin distribution in plant tissues. 4. To measure the activity of mitochondrial enzymes like succinate dehydrogenase (SDH). 5. To isolate chloroplasts from plant leaves. 6. To observe chloroplast movement (photorelocation) within plant cells in response to light. 7. To stain vacuoles and observe their structure and distribution in plant cells. 8. To study mitosis from plant cells. 9. To study meiosis from plant cells. 10. DNA, RNA and protein extraction from plant tissue. **M24-BOT-305: Seed Science & Technology** 1. To study the external and internal structures of monocot and dicot seeds. 2. Preparation of seed albums and identification. 3. To study the kinetics of seed imbibition and solute leakage. 4. To study seed invigoration and priming treatments. 5. Study of study of orthodox, intermediary and recalcitrant seeds. 6. Identification of weed and other crop seeds as per specific crops. 7. Physical purity analysis of samples of different crops. 8. Estimation of seed moisture content. 9. Viability testing by tetrazolium test. 10. To study different seed treatment methods.	**120**

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M24-BOT-306: Plant Growth Regulators

1. To demonstrate the role of auxin in phototropism.
2. To study the effect of auxin on root formation in cuttings.
3. To observe the effect of gibberellin on seed germination.
4. To study the effect of gibberellin on stem elongation in plants.
5. To observe the effect of cytokinin on delaying leaf senescence.
6. To observe the effect of cytokinins on root growth.
7. To observe the effect of abscisic acid on seed germination and dormancy.
8. To study the effect of abscisic acid on stomatal closure.
9. To examine the effect of abscisic acid on plant water loss under drought conditions.
10. To observe the effect of ethylene on fruit ripening.
11. To observe the triple response of seedlings to ethylene.
12. To examine the effect of salicylic acid on plant tolerance to abiotic stress (e.g., drought or salt stress).

M24-BOT-307: Restoration Ecology

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

M24-BOT-308: Biophysical & Biochemical Techniques

1. Isolation and purification of genomic DNA from plants.
2. Isolation and purification of plasmid DNA.
3. Agarose gel electrophoresis of chromosomal and plasmid DNA
4. Isolation and purification of RNA from plants.
5. Agarose gel electrophoresis of RNA.
6. Isolation of total plant protein.
7. Quantification of total protein by standard protocols.
8. Polyacrylamide gel electrophoresis of plant total protein.
9. Isolation of sRNA from total RNA of samples.
10. Polyacrylamide gel electrophoresis of sRNA.

M24-BOT-309: Plant Informatics

1. To study bioinformatics resources: NCBI, EBI, DDBJ, RCSB, ExPASy.
2. To study Database search engines: Entrez, DBGET
3. To study Open access bibliographic resource and literature databases: PubMed,

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BioMed Central, CiteXplore, Public Library of Sciences (PloS).

4. To study bioinformatics resources at the species level: ICTV, Viral genome at NCBI, AVIS
5. To study sequence databases:
   a) Nucleic acid sequence databases: GenBank, EMBL, DDBJ
   b) Protein sequence databases: Uniptot-KB, SWISS-PROT, TrEMBL, UniPacr
   c) Genome databases at NCBI, TIGR, EBI, SANGER
6. To study structure databases: PDB, NDB, ChemBank, PubChem
7. To study sequence file formats: GenBank, FASTA
8. To retrieve the gene from Genbank and to save the sequence in FASTA format.
9. To retrieve the protein from Genbank and to save the sequence in FASTA format.
10. To find the similarity of sequence for the given nucleotide or protein sequence.

M24-BOT-310: Palaeobotany and Palynology

1. To understand the formation of coal and its relationship to ancient plant life.
2. To simulate the process of fossilization in plants (impression).
3. Anatomical study of fossil sections.
4. To collect and observe pollen from different plant species.
5. To observe the process of pollen germination.
6. To create and study spore prints from ferns.
7. To collect airborne pollen and analyse its diversity.
8. To test the viability of pollen grains.
9. Comparative morphology od spores and pollen from different species.
10. To extract and identify pollen grains from soil samples.

*Other experiments relevant to the course.

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Chawla, H. S. (2017). Plant Biotechnology: Principles and Applications (2nd ed.).
2. Stewart Jr, C. N. (2018). Plant Biotechnology and Genetics: Principles, Techniques, and Applications.
3. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular biology of the cell* (7th ed.). Garland Science.
4. Lim, W. A., Mayer, B. J., & Pawson, A. (2014). *Cell signaling* (1st ed.). Garland Science.
5. McDonald, M. B., & Copeland, L. O. (2019). Seed Production: Principles and

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Practices (2nd ed.). CABI.
6. Smith, R. D., & Dickson, M. H. (2018). Seed Technology and Its Biological Basis (2nd ed.). CRC Press.
7. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2021). *Plant physiology and development* (7th ed.). Oxford University Press.
8. Mohr, H., Schopfer, P., & Wollenweber, A. (2019). *Principles of plant physiology* (5th ed.). Springer.
9. Packard, S. And Mutel C.F. eds. (1997). The Tallgrass Restoration Handbook, Island Press, Washington, DC.
10. Jakhar, S. (2024). Fundamentals of Ecology. TechSar Pvt. Ltd, New Delhi.
11. Hames, B. D., & Hooper, N. M. (Eds.). (2017). Biochemical Methods (4th ed.). Elsevier.
12. Wilson, K., & Walker, J. (2018). Practical Biochemistry: Principles and Techniques (6th ed.). Cambridge University Press.
13. Choudhuri, S. (2014). Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools. Academic Press.
14. Edwards, D. (Ed.). (2016). Plant Bioinformatics: Methods and Protocols. Humana Press.
15. Traverse, A. (2007). *Paleopalynology* (2nd ed.). Springer.
16. Jansonius, J., & McGregor, D. C. (Eds.). (2021). *Palynology: Principles and Applications* (Vol. 1-3). AASP Foundation.

Session: 2025-26	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**III**
Name of the Course	**Plants & Humans**
Course Code	**M24-OEC-304**
Course Type	**OEC**
Level of the course	**500-599**
Pre-requisite for the course (if any)	**Nil**
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand the origin of agriculture, centres of origin for common crop plants, and the significance of minor cereals, major cereals, pseudocereals, pulses, spices, and condiments. CLO2. Learn about the importance of medicinal plants, traditional knowledge of specific medicinal plants, and a general account of psychoactive plants. CLO3. Explore the nutritive and medicinal value of certain fruits and vegetables, beverages, common ornamental plants, and food adulterants.

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	CLO4. Gain knowledge about common timber-yielding plants, minor forest products, and a general account of fibres, dyes, tannins, gums, resins, and plant-derived insecticides like pyrethrum and rotenone.		
Credits	**Theory**	**Practical**	**Total**
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. Plants and Civilization: Origin of agriculture 2. Origin crop plants: Idea about center of origin of common crop plants 3. Minor Cereals, Major cereals Pseudocereals and pulses 4. Spices and condiments (Saffron, Clove, Cardamom, Ginger, Turmeric, Cinnamon, Capsicums, Asafetida, Coriander, Fennel, Fenugreek)	7
II	1. Medicinal plants: Importance of medicinal plants – role in human health care 2. Traditional knowledge and utility of some common medicinal plants- Sarpagandha, Isabgol, Vasaka, Neem, Bhringraj, Amla, Harrad, Bahera, Arjun, Punarnava, Brahmi, Kasondi, Ghritkumari, Quinine and Eucalyptus 3. Psychoactive plants – general account and classification	8
III	1. Nutritive and medicinal value of some fruits and vegetables (Guava, Sapota, Orange, Mango, Banana, Lemon, Pomegranate, Moringa, Cabbage) 2. Beverages (Coffee, Tea, Chocolate, Cola) Common ornamental plants Common food adulterants	8
IV	1. Common timber yielding plants and minor forest products	7

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	2. General account of fibres, dyes, tannins, gums and resins 3. Insecticides from plants Pyrethrum and Rotenone	
	Total Contact Hours	30

Suggested Evaluation Methods			
Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**15**	➢ **Theory:**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	4		
• Mid-Term Exam:	7		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi. Hill, A.F. 1952. Economic Botany (2nd Ed.) McGraw Hill, New York.
2. Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.
3. Simmonds, N.W. 1976. Evolution of Crop Plants Longman, London, New York.
4. Samba Murthy, AVS and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd., Delhi
5. Schery, R.W. 1972. Plants for Man. Prentice Hall. Englewood Cliffs, N.J. USA
6. Simpson B. B. M. C. Ogorzaly 2001. Economic botany: plants of our world, 3rd ed. McGraw-Hill, New York, New York, USA.

Session: 2025-26	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**IV**
Name of the Course	**Physiology of Plant Growth & Development**
Course Code	**M24-BOT-401**
Course Type	**CC-11**
Level of the course	**500-599**
Pre-requisite for the course (if any)	**Nil**
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand growth concepts, curves, analysis, phases of development, and seed germination and dormancy, including the factors and regulators affecting

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	them. CLO2. Learn about the biosynthesis, mechanisms, and uses of plant growth regulators and the physiological responses of plants to abiotic and biotic stresses. CLO3. Explore the physiological and biochemical changes in senescence and abscission, programmed cell death, tropisms, and the roles of hormones and receptors. CLO4. Gain knowledge on sensory photobiology, the flowering process, including photoperiodism, circadian rhythms, and the molecular basis of flowering and vernalization.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. Plant Growth and Development: Growth concepts, curves and analysis, phases of development. 2. Germination and Dormancy of seeds: Phases of germination, mobilisation of seed reserves, factors affecting dormancy and its regulation by plant growth regulators and environmental factors, release of dormancy.	15
II	1. Plant Growth Regulators: Biosynthesis, mechanism of action and uses of auxins, gibberellins, cytokinins, ethylene, abscisic acid. 2. Stress Physiology: Physiological responses of plants to abiotic and biotic stresses, Primary and secondary messengers in stress signalling, crosstalk mechanisms between biotic and abiotic stress.	15
III	1. Senescence and Abscission: Physiological and biochemical changes	15

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	associated with senescence and abscission, programmed cell death, apoptosis and autophagy, phases of leaf senescence and abscission, whole plant senescence. 2. Tropisms: Phototropism, nature of receptors, phototropin structure and mechanism of action, role of hormones, geotropism and nastism.	
IV	1. Sensory Photobiology: Structure, regulation and mechanism of action of photoreceptors (phytochromes and cryptochromes). 2. The Flowering Process: Concepts of floral evocation, circadian rhythms, photoperiodism, photoperiodic response category of plants, importance of dark periods, integration of circadian clock with photoperiodism. 3. Molecular basis of flowering (signal perception to flowering, meristem identity and organ identity), florigen concept, chemical control of flowering, role of vernalization.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2020). Plant Physiology and Development (7th ed.). Sinauer Associates.
2. Hopkins, W. G., & Hüner, N. P. A. (2014). Introduction to Plant Physiology (4th ed.). Wiley.
3. Salisbury, F. B., & Ross, C. W. (2019). Plant Physiology (6th ed.). Cengage Learning.
4. Taiz, L., & Zeiger, E. (2014). Plant Physiology (6th ed.). Sinauer Associates.
5. Lambers, H., Chapin, F. S., & Pons, T. L. (2008). Plant Physiological Ecology (2nd ed.). Springer.

Session: 2025-26	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**IV**
Name of the Course	**Plant Taxonomy & Economic Botany**

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Course Code	**M24-BOT-402**		
Course Type	**CC-12**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Students will have a comprehensive understanding of history and evolution of taxonomy. They will be well acquainted with classification systems. CLO2. Students will be able to understand concepts of botanical nomenclature and phylogeny. CLO3. Students will develop a detailed understanding of different monocot families. CLO4. Students will develop a detailed understanding of different dicot families.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	History of taxonomy, taxonomy and systematics, evolution of classification systems, systems of classifications with merits and demerits [Bentham & Hooker (1862-1883) and APG IV (2016)], ICN- principles, herbaria and botanical gardens.	15
II	Botanical nomenclature (detailed concepts), taxonomic evidence, dichotomous keys, phenetics, numerical taxonomy, cladistics, monophyletic, polyphyletic and paraphyletic groups.	15

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III	Diagnostic features, systematic position and economic importance of important plants of the following monocot families: Alismataceae, Poaceae, Cyperaceae, Arecaceae, Liliaceae, Musaceae, Zingiberaceae, Cannaceae, Iridaceae and Orchidaceae.	15
IV	Diagnostic features, systematic position and economic importance of important plants of the following dicot families: Nymphaeaceae, Magnoliaceae, Brassicaceae, Leguminosae (subfamilies), Malvaceae, Apiaceae, Lamiaceae, Solanaceae, Cucurbitaceae and Asteraceae.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row Publishers Inc. Lawrence, G.H.M. 1951. Taxonomy of vascular plants. The Macmillan C., New York.
2. Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi. Hill, A.F. 1952.
3. Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.
4. Simpson, M. G. (2019). *Plant Systematics* (3rd ed.). Academic Press.
5. Heywood, V. H., Brummitt, R. K., Culham, A., & Seberg, O. (2007). *Flowering Plant Families of the World*. Royal Botanic Gardens, Kew.

Session: 2025-26	
Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**IV**
Name of the Course	**Phytochemistry & Pharmacognosy**
Course Code	**M24-BOT-403**
Course Type	**DEC-3**

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Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand protein and non-protein amino acids, protein structure and sequencing, special forms of DNA, and RNA world hypothesis, including isolation and purification techniques. CLO2. Learn about carbohydrates, including their classification, structure, properties, types, and the roles of water-soluble and fat-soluble vitamins. CLO3. Explore pharmacognosy, the classification and evaluation of crude drugs, and the structure and classification of secondary metabolites. CLO4. Gain knowledge on source plants, parts used, and uses of various bioactive compounds, along with commonly used extraction methods.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Protein and non-protein amino acids, Ramachandran plot, protein (levels of organisation), protein sequencing and assays, protein isolation and purification. Special forms of DNA (triplex and G-quadruplex), DNA denaturation and quantification, supercoiling, DNA isolation and purification. RNA world hypothesis, RNA stability and thermodynamics, RNA isolation and purification.	15

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II	Carbohydrates (classification, structure and optical properties), reducing and non-reducing sugars, monosaccharide derivatives (sugar alcohols, sugar acids, glycosides and amino sugars), disaccharides (glycosidic bond with examples and sucrose hydrolysis), polysaccharides (homo and hetero), glycoproteins. Water soluble and fat soluble vitamins (biosynthetic precursors and roles).	15
III	Pharmacognosy and its importance in modern medicine, crude drugs, classification of drugs (chemical and pharmacological), drug evaluation (organoleptic, microscopic, chemical, physical and biological), classification and structure of secondary metabolites (terpenes, phenolics and N-containing).	15
IV	Source plants (one example), parts used and uses of solasodin, diosgenin, digitoxin, catechin, gingerol, curcuminoids, paclitaxel, quinine, atropine. pilocarpine, strychnine, reserpine, vinblastine, sennoside and capsaicin, commonly used methods of extraction.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2022). *Biochemistry* (10th ed.). W. H. Freeman.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2020). *Fundamentals of biochemistry: Life at the molecular level* (6th ed.). Wiley.
3. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2021). *Lehninger principles of biochemistry* (8th ed.). W. H. Freeman.
4. Evans, W. C. (2020). *Trease and Evans' pharmacognosy* (19th ed.). Elsevier.
5. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2019). *Pharmacognosy* (56th ed.). Nirali Prakashan.

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Part A - Introduction	
Name of Programme	**M.Sc. Botany**

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Semester	**IV**		
Name of the Course	**Plant Diseases**		
Course Code	**M24-BOT-404**		
Course Type	**DEC-3**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Students will understand the principles of cell theory, cellular evolution, eukaryotic cells, and understand the structures and functions of the cell wall, plasma membrane, and ribosomes in eukaryotes. CLO2. Students will get acquainted with the endoplasmic reticulum's structure and function, protein transport processes, the Golgi complex, vesicle fusion, and the structure and enzyme composition of lysosomes, including the autophagy pathway. CLO3. Learners will examine the structure, types, and functions of vacuoles, the structure and protein targeting in mitochondria and plastids, and the structure and function of peroxisomes. CLO4. Learners will develop an in-depth understanding the nucleus, including the nuclear envelope, matrix, NPC, and nucleolus, as well as the cytoskeleton, plasmodesmata communication, and cell signalling mechanisms involving receptors, primary and secondary messengers, and two-component signalling systems.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire			

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syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Disease, pathogen (classification based on virulence), host (classification based on disease symptoms), terminologies used in plant pathology, levels of parasitism, disease cycles, disease triangle, symptoms associated with plant diseases, quarantine, disease forecasting.	15
II	Epidemiology and disease forecasting, diagnosis, prophylaxis (exclusion, eradication and direct protection), immunisation (cross-protection and induced resistance), biological control measures, IDM/IPM, disease classification (based on location, spread and causal agents), Koch's postulates.	15
III	Disease cycle of selected plant diseases and control measures (brown spot of rice, rust of wheat, late blight of potato, powdery mildew, white rust of crucifers, red rot of sugarcane, bacterial blight of rice, citrus canker, tungro disease of rice, leaf curl disease and algal leaf spot).	15
IV	Breeding and biotechnological tools for disease resistance (introgression of resistance alleles, overexpression, RNAi, genome editing), molecular mechanism of plant-pathogen interaction (MAMP to HR), PR proteins, phytoalexins and ROS in plant defence/susceptibility.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Agrios, G. N. (2022). *Plant pathology* (6th ed.). Academic Press.
2. Brasier, C. M., & Buck, K. W. (2015). *Fungal pathology: An introduction* (2nd ed.). Wiley-Blackwell.
3. Lucas, J. A. (2019). *Plant pathology and plant pathogens* (5th ed.). John Wiley & Sons.
4. Gullino, M. L., Bottex, B., & Fletcher, J. (Eds.). (2016). *Integrated pest and disease management in greenhouse crops* (2nd ed.). Springer Science & Business Media.
5. Schumann, G. L., & D'Arcy, C. J. (2017). *Essential plant pathology* (3rd ed.). American

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Phytopathological Society.

Session: 2025-26			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**IV**		
Name of the Course	**Plant Tissue Culture & Crop Improvement**		
Course Code	**M24-BOT-405**		
Course Type	**DEC-3**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand the genetic basis of plant breeding, self and cross fertilisation, male sterility, and germplasm conservation. CLO2. Learn breeding procedures for self-pollinated, cross-pollinated, and vegetatively propagated crops, and explore heterosis, inbreeding depression, and mutation breeding. CLO3. Study totipotency, somatic embryogenesis, synthetic seeds, callus cultures, cell suspensions, and protoplast fusion methods. CLO4. Explore biotechnological tools for crop improvement, gene overexpression and knockdown, plant expression vectors, genome editing, and transgenic crops in India.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		
Part B- Contents of the Course			

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Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Cellular differentiation, totipotency, callus induction, organogenesis and embryogenesis, production of synthetic seeds, protoplast isolation and culture, somatic hybridization, hybrids and cybrids, haploid production (anther, pollen and ovule culture), production of polyploids.	15
II	Meristem cultures and virus free plants, cell suspension cultures, somaclonal variations and isolation of useful mutants for genotype improvement, bioreactors for plant cell cultures and secondary metabolite production, edible vaccines, current scenario of tissue culture in India.	15
III	Plant breeding: History, objectives, overview of mating systems Population breeding-mass selection and ear-to-row methods; Breeding methods in asexually/clonally propagated crops, clonal selection. Transgressive breeding. Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses. Self-incompatibility and male sterility. Plant breeders' rights and regulations for plant variety protection and farmers rights.	15
IV	Biotechnological tools for crop improvement, overexpression and knockdown of candidate genes, plant expression vectors, genome editing, status of genome editing in India, case studies of crops released through transgenic and genome editing approaches.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Principles of Plant Breeding - R.W. Allard. John Willey and sons Inc., New York.

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2. Plant Tissue Culture: Theory and Practice By S. S. Bhojwani and M. K. Razdan Elsevier Publishers.
3. Plant Cell and Tissue Culture Edited by Indra K. Vasil and Trevor A. Thorpe, Kluwer Academic Publishers.
4. Methods in Plant Molecular Biology and Biotechnology by B.R. Glick, 2014.
5. Plant Biotechnology-The genetic manipulation of plants, Second Edition by Adrian Slater, Nigel Scott, and Mark Fowler, 2008.

Session: 2025-26			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**IV**		
Name of the Course	**Physiology of Stress in Plants**		
Course Code	**M24-BOT-406**		
Course Type	**DEC-3**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand how plants utilise mechanical barriers, secondary metabolites, inducible defenses, and signalling pathways to defend against insect herbivores and store toxic compounds. CLO2. Explore how plants detect pathogenic signatures and employ immune responses, including MAMPs, PTI, ETI, and RNA-mediated defences, against a variety of pathogens. CLO3. Examine the trade-off between reproductive and vegetative growth in plants and their strategies for acclimation and adaptation to environmental stresses like water, salinity, and temperature extremes. CLO4. Investigate how plants sense and respond to abiotic stress through early sensors, hormone signalling, ROS signalling, and mechanisms like osmotic adjustment and stomatal regulation.		
Credits	**Theory**	**Practical**	**Total**
	4	0	4
Teaching Hours per week	4	0	4

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Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	**100**
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Beneficial and harmful plant-microbe interactions, mechanical barriers as first line of defence, secondary metabolites in defence, specialised structures for storing toxic compounds in plants, inducible defence responses to insect herbivores, role of hormones, calcium signalling and MAPK pathway in herbivory, systemin signaling pathway, GLR in long distance signalling, role of volatiles.	15
II	Pathogenic signatures, MAMPs, PTI, ETI, NBS-LRR receptors, phytoalexins, PR proteins, NPR, RNAi and sRNA mediated defence, defence against nematodes, defence against viruses, role of UPS, autophagy and other defence pathways.	15
III	Trade-off between reproductive and vegetative development, acclimation and adaptation, environmental factors and their impact on plants (water, ozone, salinity, light, cold, heat, UV, etc), ABA dependent and independent pathways, role of calcium and heat shock proteins.	15
IV	Stress sensing mechanisms, early acting sensors, interaction of signalling pathways during abiotic stress, role of hormones, regulons in acclimation, role of chloroplast genes in light stress, ROS signalling, osmotic adjustment mechanisms, stomatal regulation mechanism during stress.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		

• Mid-Term Exam:	15

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2021). *Plant physiology and development* (7th ed.). Sinauer Associates, Inc.
2. Mohr, H., Schopfer, P., & Wollenweber, A. (2019). *Principles of plant physiology* (5th ed.). Springer.
3. Salisbury, F. B., & Ross, C. W. (2020). *Plant physiology* (6th ed.). Brooks/Cole Pub Co.
4. Mohr, H., Schopfer, P., & Wollenweber, A. (2018). *Plant physiology* (4th ed.). Springer.

Session: 2025-26			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**IV**		
Name of the Course	**Biodiversity Conservation**		
Course Code	**M24-BOT-407**		
Course Type	**DEC-4**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Students will become aware and understand the concept and significance of different conventions and Protected Area Networks in relation to conservation of Biodiversity. CLO2. Students will be able to develop their own conservation values and ethics and appreciate the importance of biodiversity services. CLO3. Students will be able to develop the skills necessary to work efficiently in areas like conservation, EIA, environment management and monitoring. CLO4. After completion of the course, the student be able to formulate one's own scientific and realistic approach towards Conservation Biology.		
Credits	**Theory**	**Practical**	**Total**
	4	0	4
Teaching Hours per week	4	0	4

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Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	**100**
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	1. Introduction to conservation biology: state of our planet, rise of conservation biology, biodiversity concepts and measurement. 2. Principles, characteristics and importance of conservation biology Conservation values and ethics, Role of species in conservation	15
II	1. Global biodiversity I: Patterns and Processes 2. Global biodiversity II: Losses, Pattern of species vulnerability, Habitat fragmentation and degradation, Synergistic interactions 3. Biodiversity and ecosystem services and functioning.	15
III	1. Biodiversity of wetlands, mangroves and coral reefs- A general account. 2. Biosphere reserves and RAMSAR sites in India, Protected Area Networks and their functions, The Design of Conservation Reserves. 3. Major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, GOI-UNDP Sea turtle project, Project Elephant and crocodile conservation, and Biosphere Reserves)	15
IV	1. Importance of genetic resources and conservation of crop genetic resources 2. International and National efforts to conserve biodiversity: Convention on biological diversity, CITES, Ramsar convention; National Biodiversity strategy 3. Role of remote sensing and GIS and biodiversity conservation	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**

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• Class Participation:	5	Written Examination
• Seminar/presentation/assignment/quiz/class test etc.:	10	
• Mid-Term Exam:	15	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Huston, M.A. 1994. Biological Diversity: The Coexistence of Species on Changing Landscapes. Cambridge University Press, Cambridge.
2. Peter H. Raven, P.H. and Berg, L. R. Berg. 2005. Environment, 5th Edition. John Wiley & Sons Inc., New York.
3. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
4. Soule, M.E. (ed.) (1986) : Conservation Biology. The Science of Scarcity and Diversity. Sinaur Associates, Inc., Sunderland, Massachusetts.
5. Turner, M.G., Gadner, R.H. and O, Neill, R.V. 2001. Landscape Ecology: In theory and Practice, Pattern and Processes. Springer Verlag, New York.
6. Jakhar, S. (2024). Fundamentals of Ecology. TechSar Pvt. Ltd, New Delhi.

Session: 2025-26			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**IV**		
Name of the Course	**Advanced Phycology**		
Course Code	**M24-BOT-408**		
Course Type	**DEC-4**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO 1: Understand algal growth dynamics, eutrophication impact, and India's phycological research history. CLO 2: Analyze algae's effects, biodiversity, and adaptation mechanisms. CLO 3: Comprehend photosynthetic organization, algal applications, and commercial potential. CLO 4: Examine genomics, proteomics, isolation methods, genetic manipulation, and algal evolution.		
Credits	**Theory**	**Practical**	**Total**

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	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Dynamics of algal growth and blooms, eutrophication and its impact, centers of phycological research in India, mineral nutrition in algae, algal culture, growth and measurement techniques, nutrient regulated growth.	15
II	Impact of algae on water supply, monuments, bio-fouling of ships, etc., biodiversity of algae in unusual habitats, paddy field algal flora, impact and kinetics of heavy metal uptake in algae, mechanisms of adaptation against tolerance to toxicants, pesticides and salt.	15
III	Photosynthetic membrane organization, oxygenic & anoxygenic photosynthesis in algae and cyanobacteria, heterocyst, algal flora for the treatment of wastewaters, concept of algalization and biofertilizers, commercial potentials of algae and algal products.	15
IV	Recent trends in genomics and proteomics research in algae; sequenced algal genomes, DNA, RNA and protein isolation methods in algae, genetic manipulation in algae (procedures, advantages and challenges), algal evolution based on molecular evidences.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	

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• Seminar/presentation/assignment/quiz/class test etc.:	10
• Mid-Term Exam:	15

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Grant, W. D. (2020). Introduction to Phycology (4th ed.). Cambridge University Press.
2. Barsanti, L., & Gualtieri, P. (2014). Algae: Anatomy, Biochemistry, and Biotechnology (2nd ed.). CRC Press.
3. van den Hoek, C., Mann, D. G., & Jahns, H. M. (2015). Algae: An Introduction to Phycology (4th ed.). Cambridge University Press.
4. Whitton, B. A., & Potts, M. (2002). The Ecology of Cyanobacteria: Their Diversity in Time and Space (2nd ed.). Springer.
5. Mouritsen, O. G., & Mouritsen, J. D. (2019). Seaweeds: Edible, Available, and Sustainable (2nd ed.). University of Chicago Press.

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Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**IV**
Name of the Course	**Plant Photobiology**
Course Code	**M24-BOT-409**
Course Type	**DEC-4**
Level of the course	**500-599**
Pre-requisite for the course (if any)	**Nil**
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO 1: Students will understand light characteristics and plant photoreceptors, including phytochrome and cryptochrome structures and functions. CLO 2: Students will learn about circadian rhythm control by ZEITLUPE and the roles of phototropins and UVR8 in plant responses to light. CLO 3: Students will explore light-hormone interactions in plant growth, development, and stress responses, focusing on phototropism and photomorphogenesis. CLO 4: Students will gain knowledge of key experiments and concepts in photosynthesis, including photosystems, the Z-scheme, and various photosynthetic pathways.

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Credits	Theory	Practical	Total
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Characteristics of light, plant photoreceptors and its classification, phytochrome structure and action potential, phytochrome responses (VLFR, LFR, HIR), phytochrome signalling pathways (gene regulation by PIFs, COP regulation), blue light kinetics, cryptochrome structure and action potential, CRY-COP interaction.	15
II	Control of circadian rhythm by ZEITLUPE, phototropins structure and action potential, role of phototropins in chloroplast movement and stomatal opening, UVR8 structure and action potential, responses to UV radiation and molecular mechanism of UVR8 function.	15
III	Light-hormone interplay in phototropism, photomorphogenesis, chlorophyll biosynthesis, defence and development, molecular mechanism of shade avoidance, role of yellow and green light in growth, development, shade avoidance and stress responses, mechanisms of sensing and responding to light stress in plants.	15
IV	Key experiments in understanding photosynthesis, antenna system, photosystems, Z-scheme, repair and regulation of photosynthetic machinery, genetics, assemble and evolution of photosynthetic systems, C3 cycle, RuBisCO regulation, phototrespiration, C4, CAM and SAM photosynthesis.	15
	Total Contact Hours	60

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Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2023). *Plant physiology and development* (7th ed.). Sinauer Associates.
2. Mohr, H., & Schopfer, P. (2020). *Plant physiology* (2nd ed.). Springer.
3. Kochhar, S. L., & Gujral, S. K. (2020). *Plant physiology: Theory and applications* (2nd ed.). Cambridge University Press.
4. Nobel, P. S. (2020). *Physicochemical and environmental plant physiology* (5th ed.). Academic Press.
5. Pessarakli, M. (Ed.). (2024). *Handbook of plant and crop physiology* (4th ed.). CRC Press (Routledge).

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Part A - Introduction

Name of Programme	**M.Sc. Botany**
Semester	**IV**
Name of the Course	**Seed Science & Technology**
Course Code	**M24-BOT-410**
Course Type	**DEC-4**
Level of the course	**500-599**
Pre-requisite for the course (if any)	**Nil**
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO 1: Understand the principles and practices of seed production, including hybrid seed techniques and the role of seed industry stakeholders in India. CLO 2: Learn the objectives and procedures of seed quality control, including seed testing methods and standards, as well as the importance of moisture content and purity standards. CLO 3: Explore the factors affecting seed viability, vigour, and longevity, along with the physiological

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	basis of seed vigour and its impact on crop performance. CLO 4: Gain insights into seed certification regulations, seed processing principles, and the operation of seed processing machinery, essential for maintaining seed quality and standards.		
Credits	**Theory**	**Practical**	**Total**
	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 Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Seed production: seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, agro climatic requirements and their influence on quality seed production, certification standards, use of male sterility and self-incompatibility and CHA in hybrid seed production, seed village concept; seed production agencies, seed industry and custom seed production in India.	15
II	Seed quality: objectives, concept and components and their role in seed quality control, instruments, devices and tools used in seed testing, ISTA and its role in seed testing, procedure of seed sampling, sampling intensity, methods of preparing composite and submitted samples, sub-sampling techniques, dispatch, receipt and registration of submitted sample in the laboratory, prescribed seed purity standards, importance of moisture content, equilibrium moisture content, methods of seed germination testing.	15
III	Seed viability and longevity, pre and post-harvest factors affecting seed viability, seed ageing, physiology of seed deterioration, lipid peroxidation and other viability theories, means to prolong seed viability, mechanism of	15

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	desiccation sensitivity and recalcitrance with respect to seed longevity, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield.	
IV	Central Seed Certification Board (CSCB), the Seed Act (1966), Seed Rules (1968), New Seed Bill-2004, Indian Minimum Seed Certification Standards (I.M.S.C.S), principles of seed processing, functions of scalper debearder, scarifier, huller, seed cleaner, grader, screen cleaners, specific gravity separator, indented cylinder, velvet-spiral-disc separators, colour sorter, delinting machines; seed blending.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. ISTA. (2019). ISTA Handbook on Seedling Evaluation (3rd ed.). International Seed Testing Association.
2. Basra, A. S. (2017). Seed Science and Technology (3rd ed.). CRC Press.
3. McDonald, M. B., & Copeland, L. O. (2019). Seed Production: Principles and Practices (2nd ed.). CABI.
4. Smith, R. D., & Dickson, M. H. (2018). Seed Technology and Its Biological Basis (2nd ed.). CRC Press.
5. Vanangamudi, K., & Swaminathan, M. S. (2016). Seed Science and Technology: Theory and Practice (4th ed.). Agrobios Publications.

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Part A - Introduction	
Name of Programme	**M.Sc. Botany**
Semester	**IV**
Name of the Course	**Practical based on M24-BOT-401 & M24-BOT-402**
Course Code	**M24-BOT-411**
Course Type	**PC-7**

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Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	Get acquainted with the practical aspects of plant physiology, biochemistry, anatomy and reproduction.		
Credits	Theory	Practical	Total
	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 Time		6 hours	

Part B- Contents of the Course

Practicals	Contact hours
List of practicals **M24-BOT-401: Physiology of Plant Growth & Development** 1. Estimation of carbohydrate by Anthrone method. 2. To detect the presence of reducing and non-reducing sugar in a given sample. 3. Identification of specific sugars in a given sample. 4. Comparative study of chlorophyll content from fresh leaves and senescent leaves of plant by Arnon's method. 5. To study the process of etiolation in the laboratory. 6. To study the action of Ethylene hormone on fruit ripening. 7. Qualitative analysis of plant secondary metabolites of given leaf sample. 8. To separate different types of sugar by paper chromatography. 9. Quantitive test for organic acids. 10. Estimation of catalase activity. 11. Estimation of peroxidase activity. **M24-BOT-402: Plant Taxonomy & Economic Botany** 12. To study floral characteristics and identifying features of members of family Poaceae. 13. To study floral characteristics and identifying features of members of family Liliaceae. 14. To study floral characteristics and identifying features of members of family Musaceae. 15. To study floral characteristics and identifying features of members of family	**120**

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Cannaceae. 16. To study floral characteristics and identifying features of members of family Magnoliaceae. 17. To study floral characteristics and identifying features of members of family Brassicaceae. 18. To study floral characteristics and identifying features of members of family Leguminosae. 19. To study floral characteristics and identifying features of members of family Apiaceae. 20. To study floral characteristics and identifying features of members of family Solanaceae. 21. To study floral characteristics and identifying features of members of family Cucurbitaceae. 22. To study floral characteristics and identifying features of members of family Asteraceae. 23. Construction of Indented and Bracketed keys for the given material. 24. Training in using floras and herbaria for identification of specimens described in the class. *Other experiments relevant to the course.	

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2020). Plant Physiology and Development (7th ed.). Sinauer Associates.
2. Hopkins, W. G., & Hüner, N. P. A. (2014). Introduction to Plant Physiology (4th ed.). Wiley.
3. Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi. Hill, A.F. 1952.
4. Simpson, M. G. (2019). *Plant Systematics* (3rd ed.). Academic Press.

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Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**IV**		
Name of the Course	**Practical based on M24-BOT-403/404/405/406 & M24-BOT-407/408/409/410**		
Course Code	**M24-BOT-412**		
Course Type	**PC-8**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	Get acquainted with the practical aspects of phytochemistry & pharmacognosy/ plant diseases/ advanced phycology & conservation biology/crop improvement/plant photobiology.		
Credits	**Theory**	**Practical**	**Total**
	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 Time		6 hours	

Part B- Contents of the Course	
Practicals	**Contact hours**
List of practicals **M24-BOT-403: Phytochemistry & Pharmacognosy** 1. Comparative analysis of pigments from different plant species. 2. To extract essential oils from aromatic plant material. 3. To test the antioxidant activity of plant extracts. 4. To detect the presence of tannins in plant extracts. 5. To detect the presence of alkaloids in plant extracts. 6. To extract bioactive compounds from plant material using different solvents. 7. To quantify the total phenolic content in plant extracts. 8. Microscopic evaluation of common drugs to determine their purity.	**120**

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9. Identification of starch grains in different powdered drugs.
10. Identification of unorganized drug gelatin by studying physical and chemical characters.

M24-BOT-404: Plant Diseases

1. Prepare PDA medium.
2. Prepare CDA medium.
3. Prepare YEMA medium.
4. Prepare carrot agar medium.
5. Prepare nutrient agar medium.
6. Isolate *Rhizobium* from leguminous plants.
7. To check the quality of milk sample by methylene blue reductase test.
8. Gram staining of bacteria.
9. Isolate the aquatic fungi from Brahma Sarovar Lake.
10. Study *Rhizobium* as biofertilizer.
11. Calibrate the ocular micrometer with stage micrometer.
12. Isolate the seed mycoflora from seeds.

M24-BOT-405: Plant Tissue Culture & Crop Improvement

1. To estimate the acid value of saturated fat samples.
2. To isolate casein proteins from the given milk sample.
3. To inoculate Albizia seeds on slants of MS medium.
4. Production of wine from the fruit juice of grapes by fermentation process using yeast.
5. To prepare synthetic seeds by encapsulating citrus embryos in calcium alginate beads.
6. To study the release of aldoses and ketoses by breakdown of sugar in cane juice and apple juice and detection of ketose formation by resorcinol method.
7. To study the enzymatic conversion of non-reducing sugar to reducing sugar with the help of enzyme invertase.
8. To isolate the protoplasts from given plant sample.
9. Wine production from grapes juice.
10. Isolation of total plant protein from given sample.
11. To study male sterility and in vitro germination of pollen grains.
12. To study the floral morphology of pollen grains.

M24-BOT-406: Physiology of Stress in Plants

1. To observe the effects of water deficiency on plants.
2. To study the impact of salinity stress on plant growth.
3. To examine the response of plants to high temperatures.
4. To investigate the effects of low temperatures on plants.
5. To assess the response of plants to oxidative stress.
6. To study the impact of heavy metal toxicity on plants.
7. To observe the effects of nutrient deficiency on plant growth and development.
8. To investigate the response of plants to waterlogging or flooding.
9. To study the effects of UV-B radiation on plants.
10. To investigate plant responses to herbivore feeding damage.

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11. To examine plant responses to interspecific or intraspecific competition.
12. To investigate the effects of allelochemicals on plant growth and physiology.

M24-BOT-407: Biodiversity Conservation

1. To determine the Calcium content of soil samples using titration method.
2. To estimate available N_2 in a given soil sample.
3. To determine the role of CO_2 evolution from the given soil sample.
4. To determine the total nitrogen content of a given leaf sample using Kelplus nitrogen analyzer.
5. To calculate the phosphorous content of the given soil sample.
6. To determine the organic carbon content of the given manure sample.
7. To interpret the Annual Forest report with reference to Haryana.
8. To estimate the sodium and potassium content of soil and water samples using flame photometry.
9. To study the Biosphere reserves of India.
10. Field study of wetland ecosystem and its importance.

M24-BOT-408: Advanced Phycology

1. To optimize growth conditions for selected algal strains.
2. To estimate the lipid content of selected algal species.
3. To assess the efficiency of algae in removing nutrients from wastewater.
4. To study the physiological responses of algae to environmental stressors.
5. To investigate the dynamics of algal communities in aquatic ecosystems.
6. To assess the allelopathic effects of algae on other organisms.
7. To extract and analyze pigments from algae.
8. To investigate the effect of pH on algal growth and physiology.
9. To investigate symbiotic relationships between algae and other organisms (coralloid root sections).
10. To study the process of algal biofouling on submerged surfaces.

M24-BOT-409: Plant Photobiology

1. To investigate how different wavelengths of light affect plant growth.
2. To observe phototropism in seedlings.
3. To investigate the influence of light on seed germination.
4. To observe photomorphogenic responses in seedlings exposed to different light qualities.
5. To measure the influence of light intensity on photosynthetic activity (oxygen evolution method).
6. To study the impact of light quality on pigment synthesis.
7. To examine how light quality influences plant architecture and canopy structure.
8. To determine the effect of light of stomatal movement.
9. To investigate the influence of light quality on leaf senescence.
10. To investigate shade avoidance response in plants.

M24-BOT-410: Applied Mycology

1. To prepare potato-dextrose agar medium.
2. To prepare CDA medium and prepare plates of CDA medium.

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3. To prepare PDA slants. 4. To prepare solid, liquid and semi-solid PDA medium. 5. Investigation for best media for fungal growth at different temperatures. 6. Quantify the air-borne fungi from different locations. 7. To prove Koch's postulates for fungal pathogen. 8. To prepare wine from grapes juice by fermentation using yeast. 9. Gram staining of bacteria. 10. To calibrate the ocular micrometer with stage micrometer. 11. To prepare nutrient agar medium. 12. Isolation of fungal pathogen *Alternaria* from infected leaves of *Spinacia oleracea.* *Other experiments relevant to the course.	

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Voet, D., Voet, J. G., & Pratt, C. W. (2020). *Fundamentals of biochemistry: Life at the molecular level* (6th ed.). Wiley.
2. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2021). *Lehninger principles of biochemistry* (8th ed.). W. H. Freeman.
3. Agrios, G. N. (2022). *Plant pathology* (6th ed.). Academic Press.
4. Brasier, C. M., & Buck, K. W. (2015). *Fungal pathology: An introduction* (2nd ed.). Wiley-Blackwell.
5. Grant, W. D. (2020). Introduction to Phycology (4th ed.). Cambridge University Press.
6. Barsanti, L., & Gualtieri, P. (2014). Algae: Anatomy, Biochemistry, and Biotechnology (2nd ed.). CRC Press.
7. Peter H. Raven, P.H. and Berg, L. R. Berg. 2005. Environment, 5th Edition. John Wiley & Sons Inc., New York.
8. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
9. Plant Tissue Culture: Theory and Practice By S. S. Bhojwani and M. K. Razdan Elsevier Publishers.
10. Plant Cell and Tissue Culture Edited by Indra K. Vasil and Trevor A. Thorpe, Kluwer Academic Publishers.
11. Moore-Landecker, E. (2009). Fundamentals of the Fungi (4th ed.). Prentice
12. Hall. Dighton, J., White, J. F., & Oudemans, P. (2005). The Fungal Community: Its Organization and Role in the Ecosystem (3rd ed.). CRC Press.

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Session: 2025-26			
Part A - Introduction			
Name of Programme	**M.Sc. Botany**		
Semester	**IV**		
Name of the Course	**Processing of Fruits & Vegetables**		
Course Code	**M24-BOT-413**		
Course Type	**EEC**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**Nil**		
Course Learning Outcomes (CLOs): After completing this course, the learner will be able to:	CLO1. Understand and apply post-harvest handling techniques and treatments to retain the quality of horticultural crops, including fruit ripening and ethylene management. CLO2. Evaluate and implement various storage methods to prevent contamination and spoilage of fresh and processed horticultural products. CLO3. Apply principles and methods of preservation and processing to fruits and vegetables, ensuring effective use of food additives, minimal processing, and appropriate packaging techniques. CLO4. Comprehend and adhere to quality management standards and food laws, including ISO/BIS, PFA, AGMARK, HACCP, and Codex alimentarius, ensuring compliance in food production and processing.		
Credits	**Theory**	**Practical**	**Total**
	1	1	2
Teaching Hours per week	1	2	3
Internal Assessment Marks	10	5	15
End Term Exam Marks	20	15	35
Max. Marks	30	20	**50**
Examination Time	3 hours	3 hours	
Part B- Contents of the Course			
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each			

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unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Post-harvest handling (harvesting, sorting, grading and packing and transportation) of fruits, vegetables and flowers, post-harvest treatments (pre cooling, hot water, hot air and vapour heat, fungicide & biologically safe chemicals, irradiation, curing, pulsing etc.) for quality retention of horticultural crops, fruit ripening and ethylene management.	4
II	On farm storage (evaporative cooled stores, ventilated storage, pit storage etc.), refrigerated storage, controlled / modified atmosphere storage, hypobaric, hyperbaric storage. Contamination and spoilage of fresh fruits, vegetables and processed products.	4
III	Principles and methods of preservation, processing of fruits and vegetables (canning, drying and dehydration, fruit beverages and juice concentrates, sugar based products, tomato products, fermented products, value added products etc.), food additives, minimal processing, packaging techniques and storage system for processed products.	4
IV	Importance of quality, quality management standards, ISO/BIS, PFA, AGMARK, HACCP, Codex alimentarius, total quality management (TQM), food standards (FPO, PFA etc.), food laws and regulations.	3
	Total Contact Hours	15

Practical	Contact hours
List of practicals 1. To determine the impact of blanching on color retention in vegetables. 2. To optimize drying parameters for preserving fruits or vegetables. 3. To compare the effect of different preservation methods on nutrient retention in fruits and vegetables. 4. To investigate enzymatic browning in fruits and evaluate methods to prevent it. 5. To assess the impact of processing methods on the texture of fruits and vegetables. 6. To ferment vegetables and study the effects on flavor and preservation. 7. To optimize the formulation of jams or jellies using different fruits and additives. 8. To investigate the effect of different cooking methods on nutrient loss in vegetables. 9. To optimize the extraction of juice from fruits. 10. Pickling of vegetables for long term storage. *Other experiments relevant to the course.	**30**

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Suggested Evaluation Methods			
Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**10**	➢ **Theory:**	**20**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	-		
• Mid-Term Exam:	6		
➢ **Practicum**	**5**	➢ **Practicum**	**15**
• Class Participation:	-	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/presentation/assignment/quiz/class test etc.:	5		
• Mid-Term Exam:	-		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Hui, Y.H. (2008). Handbook of fruit and vegetable processing. Wiley India Pvt. Ltd., New Delhi.
2. Sharma, S.K. (2010). Postharvest management and processing of fruits and vegetables. New India Publishing Agency, New Delhi.
3. Sharma, S.K. and Nautiyal, M.C. (2009). Postharvest technology of horticultural crops. New India Publishing Agency, New Delhi.
4. Wills, R.B.H, McGlasson, W.S, Graham, D. and Joyce, D.C. (2009). Postharvest: An introduction to the physiology and handling of fruits, vegetables and ornamentals. CABI International, Cambridge, USA.

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