

KASHI NARESH UNIVERSITY, BHADOHI

(National Education Policy-2020) Syllabus of Botany (w.e.f. Academic Session 2026-2027) For M.Sc.

Approved by
Board of Studies
Department of Botany
Faculty of Science
Kashi Naresh University
Bhadohi



Convenor/Head
Department of Botany
Kashi Naresh University, Bhadohi



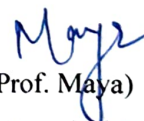
Dean
Faculty of Science
Kashi Naresh University, Bhadohi



(Dr. Ranjit Singh)
Member, Board of Studies
Department of Botany
Kashi Naresh University, Bhadohi



(Dr. Saumya Mishra)
Member, Board of Studies
Department of Botany
Kashi Naresh University, Bhadohi



(Prof. Maya)
Member, Board of Studies
Department of Botany
Dr. S. P. M. Govt. Degree College, Bhadohi



(Dr. Ravindra Kumar Pandey)
Member, Board of Studies
S.P. M. Govt. Degree College, Bhadohi



(Dr. Suman Gupta)
Member, Board of Studies
K.P.M. Govt. Girls Degree College, Aurai, Bhadohi

SEMESTER-WISE STRUCTURE OF SYLLABUS

M.Sc. (BOTANY) PREVIOUS YEAR

FIRST SEMESTER			
PAPER	DESCRIPTION	MARKS	Credit
PAPER I (BOT101T)	MICROBIOLOGY, PLANT VIROLOGY & BACTERIOLOGY	100 (75+25)	4
PAPER II (BOT102T)	MYCOLOGY	100(75+25)	4
PAPER III (BOT103T)	PHYCOLOGY AND LICHENS	100(75+25)	4
PAPER IV (BOT104T)	BRYOPHYTES	100(75+25)	4
PAPER V (BOT105P)	(BASED ON PAPER 101-104)	100(75+25)	4

SECOND SEMESTER			
PAPER	DESCRIPTION	MARKS	Credit
PAPER I (BOT201T)	PTERIDOPHYTES	100(75+25)	4
PAPER II (BOT202T)	GYMNOSPERMS AND PALAEOBOTANY	100(75+25)	4
PAPER III (BOT203T)	ANGIOSPERMS : TAXONOMY, MORPHOLOGY AND ECONOMIC BOTANY	100(75+25)	4
PAPER IV (BOT204T)	ANATOMY, EMBRYOLOGY AND MORPHOGENESIS	100(75+25)	4
PAPER V (BOT205P)	(BASED ON PAPER 201-204)	100(75+25)	4

M.Sc. (BOTANY) FINAL YEAR

THIRD SEMESTER			
PAPER	DESCRIPTION	MARKS	Credit
PAPER I (BOT301)	PLANT PHYSIOLOGY AND BIOCHEMISTRY	100(75+25)	4
PAPER II (BOT302)	GENETICS, PLANT BREEDING AND BIOSTATISTICS	100(75+25)	4
PAPER III (BOT303)	ECOLOGY, PLANT-SOIL RELATIONSHIP	100(75+25)	4
PAPER IV (BOT304P)	(BASED ON PAPER 301-303)	100(75+25)	4
RESEARCH (BOT404R)	DISSERTATION/RESEARCH PROJECT/FIELD SURVEY/EXCURSION	100	4

FOURTH SEMESTER			
PAPER	DESCRIPTION	MARKS	Credit
PAPER I (BOT401T)	CELL AND MOLECULAR BIOLOGY	100(75+25)	4
PAPER II (BOT402T)	PLANT BIOTECHNOLOGY	100(75+25)	4
PAPER III (BOT403T) SPECIAL PAPER IIIA(BOT403TA) III-B(BOT403TB) III-C(BOT403TC)	SPECIAL PAPERS (ANYONE OF THESE): ENVIRONMENT BOTANY PLANT PATHOLOGY ADVANCED PLANT PHYSIOLOGY	100(75+25)	4
PAPER IV (BOT404P)	(BASED ON PAPER I, II & III, (PAPER401-402-403) (A/B/C)	100(75+25)	4
RESEARCH (BOT405R)	DISSERTATION/RESEARCH PROJECT/FIELD SURVEY/EXCURSION	100	4

*Research Projects include industrial training/internship/survey work etc. (100 Marks) for both IIIrd and IVth Semester.

Note:-External Assesment- Written Examination (75 Marks), Internal Assesment- (25 Marks) : for every Theory & Practical Papers.

Handwritten signatures and initials in blue ink.

PG in Botany	
Subject prerequisites: 1. To study PG in Botany, a student must have had the degree of B.Sc in Botany. 2. Keen interest in plants and plant-related research, Potential in mathematics, biology and chemistry 3. Skills and aptitude for scientific study and research 4. Creativity and good comprehension while working on scientific procedures and research 5. Computer aptitude. COURSE INTRODUCTION The M.Sc. Botany programme is designed to provide advanced knowledge and practical understanding of plant sciences with special emphasis on microbial diversity, plant taxonomy, ecology, genetics, biotechnology, physiology, biochemistry, environmental biology and plant pathology. The programme integrates classical and modern aspects of botany to develop scientific temperament, analytical skills, laboratory competency and research aptitude among students. It emphasizes theoretical concepts along with practical training in microscopy, molecular techniques, tissue culture, ecological analysis, plant identification and experimental methods. The curriculum also focuses on biodiversity conservation, sustainable utilization of plant resources, environmental management and recent advances in biological sciences to prepare students for higher research, teaching, industry and allied professional fields.	
PO1	Develop comprehensive knowledge of microbial diversity, algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms along with taxonomy, palaeobotany, structural botany and ecology. Students acquire understanding of plant diversity, evolutionary relationships, biodiversity conservation and environmental management while also gaining practical skills in microbial techniques, herbarium preparation, plant identification, anatomical studies and ecological analysis.
PO2	Advanced understanding of plant cell biology, molecular genetics, biotechnology, plant physiology, biochemistry, environmental botany and plant pathology. Students develop knowledge of modern molecular and biotechnological techniques, plant metabolism, stress physiology, environmental conservation and disease management along with practical competency in cytology, tissue culture, molecular analysis, biochemical estimations, physiological experiments and plant pathology techniques for research and professional applications.
Programme Specific Outcome PG in Botany (Two Year Programme) Students completing the M.Sc. Botany PG programme gain advanced theoretical knowledge and practical skills in plant sciences, microbiology, biotechnology, ecology, genetics, physiology, taxonomy and plant pathology. The course develops laboratory competence, field study techniques, scientific observation, analytical thinking and research aptitude. Students become skilled in modern biological techniques such as tissue culture, molecular analysis, microbial culturing, ecological assessment and plant identification. The programme also enhances understanding of biodiversity conservation, environmental management and sustainable utilization of plant resources, preparing students for careers in teaching, research, biotechnology industries, environmental organizations, agriculture, forestry and higher academic studies such as Ph.D. and competitive examinations.	

M.Sc. SEMESTER-I

25/11/2020

Programme/Class: 2 Year PG degree	Year: I	Semester: I Paper-I
Subject: Botany		
Course Code: BOT401T	Course Title: MICROBIOLOGY,PLANT VIROLOGY & BACTERIOLOGY	
Course Outcome: After successful completion of the course, students will understand the classification, structure, transmission, detection, and control of plant viruses, viroids, and bacteria; explain bacterial genetics, metabolism, and antibiotics; and develop practical knowledge of microbial diversity and modern microbiological techniques.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Plant virus classification, structure, transmission, detection Nomenclature and classification of plant viruses, Range of plant virus particle and its genomic organization, Nature of plant viruses, Morphological, anatomical, and biochemical changes in virus infected plants, Transmission of plant viruses and their relationship with vectors, Purification and electron microscopy of viruses, Virus detection by serological and nucleic acid hybridization methods.	15
II	Plant virus replication, sub-viral pathogens, and techniques Infection and replication of plant viruses, Modern methods of plant virus disease control, Structure, replication and pathogenicity of viroids, Structure and replication of viruses infecting bacteria, MLO structure and multiplication.	15
III	Bacteria – History, classification, structure and genetics History of microbiology, Classification of Bacteria and Archaeobacteria based on Bergey’s Manual of Systematic Bacteriology, Bacterial cell structure, function of cell components, Bacterial genome structure, replication, expression and recombination and plasmids.	15







IV	Bacterial metabolism, microbiological applications Bacterial nutrition and metabolism, including Nitrogen fixation, Antibiotics and their mode of action, Decomposition of organic matter in soil, cycling of essential elements in nature, biofertilizers, Microorganisms in food processing-Cheese, butter, milk, bread, Microorganisms in relation to biotechnology: Production of alcohol, beverages, organic acid, vitamins and enzymes. Water-borne pathogenic microbes, role of microorganism in sewage disposal.	15
Suggested Readings 1. Prescott's Microbiology by Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton – for fundamentals of microbiology, bacterial structure, metabolism, genetics, and antibiotics. 2. Microbiology by Michael J. Pelczar, E. C. S. Chan and Noel R. Krieg – comprehensive reference for bacterial diversity and microbial physiology. 3. Plant Virology by Roger Hull – detailed account of plant viruses, viroids, transmission, diagnosis, and control methods. 4. Introduction to Modern Virology by Nigel Dimmock, Andrew Easton and Keith Leppard – useful for virus structure, replication, and pathogenicity. 5. Bergey's Manual of Systematic Bacteriology edited by George M. Garrity – standard reference for bacterial and archaeal classification. 6. Introductory Mycology by C. J. Alexopoulos, Charles W. Mims and M. Blackwell – authoritative text on fungal classification, thallus organization, and reproduction. 7. The Fungi by Ainsworth and Bisby – important reference for fungal diversity and taxonomy. 8. Textbook of Fungi by B. P. Pandey – useful for Indian university curricula and fungal genera studies. 9. Plant Pathology by George N. Agrios – standard text for fungal diseases, pathogen interactions, and disease management. 10. Microbial Diversity by D. P. Dubey and D. K. Maheshwari – covers microbial diversity, ecology, and applied microbiology.		

Programme/Class: 2 Year PG degree		Year: I	Semester: I Paper-II
Subject: Botany			
Course Code: BOT102T		Course Title: MYCOLOGY	
Course Outcome: After successful completion of this course, students will be able to explain the classification, structure, nutrition, reproduction, and diversity of fungi; describe fungal genetics, ecology, isolation and culturing techniques; evaluate the economic importance of fungi in agriculture, industry, and medicine; and identify major fungal groups and representative genera based on their morphology, life cycles, and significance.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic		No. of Lectures (60 hrs)
I	Status of fungi, Principle of important system of classification of fungi up to the rank of classes, Detailed fungal Classification of Alexopoulos and Mims. Thallus organization, phylogeny and cell structure, Mode of nutrition of fungi and their physical and chemical requirement for growth, Reproduction, hormonal mechanism of sexual reproduction.		15
II	Heterosis, parasexuality, heterothallism. Methods of isolation and culturing of fungi. Fossil fungi, Mycorrhizae, Fungi as a biocontrol agent. Economic importance of fungi- Utilization of fungi by man as food, in food processing, in production of organic acid, vitamins and enzymes. Harmful activities: Deterioration of material by fungi, fungi as an agent of plant and human diseases		15
III	Characteristic features, systematic position, thallus organization, reproduction, phylogeny and interrelationships of the principal classes of fungi with special reference to following genera: ➤ Myxomycota: ● Myxomycetes- <i>Stemonitis</i> . ● Plasmodiophormycetes- <i>Plasmodiophora</i> . ➤ Eumycota: ▪ Mastigomycotina: ● Chytridiomycetes- <i>Synchytrium</i> , <i>Allomyces</i> . ● Oomycetes- <i>Saprolegnia</i> , <i>Achlya</i> , <i>Phytophthora</i> , <i>Pythium</i> , <i>Peronospora</i> , <i>Sclerospora</i> .		15







	➤ Zygomycotina: ● Zygomycetes: <i>Pilobolus</i>, <i>Entomophthora</i>, <i>Choanophora</i>.	
IV	➤ Ascomycotina: Ascomycetes: <i>Yeasts</i>, <i>Taphrina</i>, <i>Penicillium</i>, <i>Protomyces</i>, <i>Erysiphe</i>, <i>Phyllactinia</i>, <i>Uncinula</i>, <i>Xylaria</i>, <i>Claviceps</i>, <i>Morchella</i>. ➤ Basidiomycotina: Basidiomycetes: <i>Puccinia</i>, <i>Uromyces</i>, <i>Melampsora</i>, <i>Ustilago</i>, <i>Lycoperdon</i>, <i>Geaster</i>, <i>Cyathus</i>. ➤ Deuteromycotina: Deuteromycetes: <i>Fusarium</i>, <i>Colletotrichum</i>, <i>Helminthosporium</i>, <i>Alternaria</i>, <i>Cercospora</i>, <i>Rhizoctonia</i>	15
Suggested Readings 1. Alexopoulos, C.J., Mims, C.W. & Blackwell, M. (1996). Introductory Mycology (4th Ed.). John Wiley & Sons. 2. Webster, J. & Weber, R.W.S. (2007). Introduction to Fungi (3rd Ed.). Cambridge University Press. 3. Deacon, J.W. (2006). Fungal Biology (4th Ed.). Blackwell Publishing. 4. Carlile, M.J., Watkinson, S.C. & Gooday, G.W. (2001). The Fungi (2nd Ed.). Academic Press. 5. Mehrotra, R.S. & Aneja, K.R. (1990). An Introduction to Mycology. New Age International Publishers. 6. Agrios, G.N. (2005). Plant Pathology (5th Ed.). Elsevier Academic Press. 7. Aneja, K.R. (2012). Experiments in Microbiology, Plant Pathology and Biotechnology (4th Ed.). New Age International Publishers. 8. Vashishta, B.R., Sinha, A.K. & Singh, V.P. Botany for Degree Students: Fungi. S. Chand & Company Ltd. 9. Pandey, B.P. College Botany, Volume II. S. Chand & Company Ltd. 10. Dube, H.C. An Introduction to Fungi. Scientific Publishers.		







Programme/Class: 2 Year PG degree	Year: I	Semester: I Paper-III
Subject: Botany		
Course Code: BOT103T	Course Title: PHYCOLOGY AND LICHENS	
Course Outcome: After successful completion of this course, students will understand the classification, diversity, morphology, pigmentation, reproduction, life cycles, and economic importance of algae and lichens, develop knowledge of the systematic position and characteristic features of major algal groups, and acquire practical skills in the isolation and culture of algae and the study of lichen biology and applications.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Study of important systems of classifications, criteria used in algal classifications including recent trends up to order. Range of thallus structure and organization. Algal Pigment. Nature of reserved food products. Reproductive diversity, life history patterns and alternation of generations. Economic and environmental aspects of algae.	15
II	Characteristics features, systematic position, thallus organization, reproduction, phylogeny and interrelationships of the principal classes of algae with special reference to- Cyanophyceae: <i>Microcystis, Oscillatoria, Lyngbya, Gloeotrichia, Stigonema</i> . Chlorophyceae: <i>Pandorina, Eudorina, Chlorella, Hydrodictyon, Scenedesmus, Microspora, Enteromorpha, Ulva, Sphaeroplea. Cladophora, Stigeoclonium, Fritschiella, Zygnema</i> Draparnaldiopsis, <i>Odeogonium, Bulbochaete, Mougeotia, Caulerpa, Valonia, Chara, Nitella</i> . Xanthophyceae: <i>Botrydium</i> . Bacillariophyceae: <i>Navicula, Melosira</i>	15
III	Phaeophyceae: <i>Ectocarpus, Dictyota, Laminaria, Fucus</i> . Rhodophyceae: <i>Batrachospermum, Gelidium, Gracilaria, Polysiphonia</i>	15

IV	Lichens A general account of lichens and Its symbionts, thallus structure, reproduction, physiology, classification and distribution. Chemistry of lichens, Isolation of symbionts and synthesis of thallus. Economic importance of lichens. Culture Techniques: Isolation and culture of algal groups.	15
----	---	----

Suggested Readings

1. Lee, R.E. (2018). *Phycology* (5th Edition). Cambridge University Press.
2. Barsanti, L., & Gualtieri, P. (2014). *Algae: Anatomy, Biochemistry and Biotechnology* (2nd Edition). CRC Press.
3. Fritsch, F.E. (1945). *The Structure and Reproduction of the Algae* (Vols. I & II). Cambridge University Press.
4. Sharma, O.P. (2011). *Textbook of Algae*. McGraw Hill Education (India).
5. Kumar, H.D. (1999). *Introductory Phycology*. Affiliated East-West Press Pvt. Ltd., New Delhi.
6. Sahoo, D. (2000). *Farming the Ocean: Seaweed Cultivation and Utilization*. Aravali International Publishers, New Delhi.
7. Nash, T.H. (Ed.) (2008). *Lichen Biology* (2nd Edition). Cambridge University Press.
8. Awasthi, D.D. (2007). *A Compendium of the Macrolichens from India, Nepal and Sri Lanka*. Bishen Singh Mahendra Pal Singh, Dehradun.
9. Singh, S.K., & Srivastava, S. (2022). *A Textbook of Algae*. OM Publications, New Delhi.
10. Khattar, J.I.S., Singh, D.P., & Kaur, G. (2018). *Algal Biology and Biotechnology*. I.K. International Publishing House.

Programme/Class: 2 Year PG degree	Year: I	Semester: I Paper-IV
Subject: Botany		
Course Code: BOT104T	Course Title: BRYOPHYTA	
Course Outcome: After successful completion of this course, students will understand the diversity, classification, ecology, physiology, reproduction, evolution, and economic importance of bryophytes, develop knowledge of the morphology, anatomy, life cycles, phylogeny, and geographical distribution of major bryophyte groups, and appreciate their ecological significance, environmental applications, and evolutionary relationships.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)

I	General characteristics, lifecycle and broad outline classification of bryophytes. Ecology, Physiology and Reproductive biology of Bryophytes. Geographical distribution of bryophytes with special reference to India. Bryophytes as indicators of mineral enrichment and environmental pollution. Economic importance of bryophytes. Peristome structure and its significance in the classification of mosses. Evolution of sporophyte in bryophyte.	15
II	Characteristic features, classification, range of gametophytic and sporophytic organization (morphology, anatomy and their distribution in India) of the principal classes of bryophytes with special reference to following genera: MUSCI: <i>Sphagnum</i> , <i>Polytrichum</i>	15
III	HEPATICAE: <i>Takakia</i> , <i>Calobryum</i> , <i>Porella</i> , <i>Plagiochasma</i>	15
IV	ANTHOCEROTAE: <i>Anthoceros</i> , <i>Notothylas</i> , <i>Dendroceros</i> . Origin, evolution, fossil history, phylogeny of principal classes: Hepaticae, Anthocerotae and Musci.	15

Suggested Readings

1. Sharma, O.P. (2012). *Bryophyta*. McGraw Hill Education (India), New Delhi.
2. Vashishta, B.R., Sinha, A.K. & Kumar, A. (2020). *Botany for Degree Students: Bryophyta*. S. Chand Publishing, New Delhi.
3. Shaw, A.J. & Goffinet, B. (Eds.) (2022). *Bryophyte Biology* (3rd Edition). Cambridge University Press.
4. Vanderpoorten, A. & Goffinet, B. (2009). *Introduction to Bryophytes*. Cambridge University Press.
5. Singh, S.K. & Srivastava, S. (2022). *A Textbook of Bryophyta*. OM Publications, New Delhi.
6. Rashid, A. (1998). *An Introduction to Bryophyta*. Vikas Publishing House, New Delhi.
7. Parihar, N.S. (1991). *Bryophyta*. Central Book Depot, Allahabad.
8. Kumar, H.D. (2011). *Introductory Bryology*. Affiliated East-West Press Pvt. Ltd., New Delhi.
9. Puri, P. (1981). *Bryophytes: Morphology, Growth and Differentiation*. Atma Ram & Sons, Delhi.
10. Singh, D.K., Singh, D. & Kumar, S. (2021). *Bryophytes of India: An Annotated Checklist*. Botanical Survey of India, Kolkata.

Handwritten signatures and initials: RSN, wh, S, Mayr, CS

Programme/Class: 2 Year PG degree		Year: I	Semester: I Paper-V
Subject: Botany			
Course Code: BOT105P		Course Title: Practical	
Course Outcome: After successful completion of this practical course, students will acquire hands-on skills in microbial, fungal, algal, lichen, and bryophyte identification, isolation, culture, staining, sterilization, and microscopy techniques, develop proficiency in laboratory practices, and apply these techniques for the study of biodiversity, plant–microbe interactions, and environmental microbiology.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			
Unit	Topic		No. of Lectures (60 hrs)
I	1. Preparation of Nutrient media (NAM, LB, PDA) and sterilization technique 2. Gram's staining and Antibiotic susceptibility test of bacteria 3. Inoculation techniques for growth of bacterial population 4. Isolation of microorganisms from different natural sources- soil, water and sewage 5. Bacteriological examination of water, milk and milk product 6. Identification of symbiotic bacteroids of Rhizobia 7. Symptomatology, mechanical and vector transmission of virus		15
II	1.Study of following genera of fungi, <i>Synchytrium</i> , <i>Saprolegnia</i> , <i>Phytophthora</i> , <i>Pythium</i> , <i>Peronospora</i> , <i>Sclerospora</i> , <i>Yeast</i> , <i>Taphrina</i> , <i>Penicillium</i> , <i>Protomyces</i> , <i>Erysiphae</i> , <i>Phyllactinia</i> , <i>Puccinia</i> , <i>Melampsora</i> , <i>Ustilago</i> , <i>Fusarium</i> , <i>Colletotrichum</i> , <i>Heminthosporium</i> , <i>Alternaria</i> , <i>Cercospora</i> , <i>Rhizoctania</i> 2.Isolation and culture of fungi		15
III	1. Study of following genera Chlorophyceae-, <i>Chlorella</i> , <i>Hydrodictyon</i> , <i>Enteromorpha</i> , <i>Ulva</i> , <i>Sphaeroplea</i> , <i>Cladophora</i> , <i>Stigeoclonium</i> , <i>Pithphora</i> , <i>Fritschiella</i> , <i>Zygonema</i> , <i>Draparnaldiopsis</i> , <i>Oedogonium</i> , <i>Bulbocheate</i> , <i>Mougeotia</i> Cyanophyceae- <i>Microcystis</i> , <i>Lyngbya</i> , <i>Gleotrichia</i> , <i>Stigonema</i> Xanthophyceae- <i>Botrydium</i> Bacillariophyceae- <i>Navicula</i> Phaeophyceae- <i>Ectocarpus</i> , <i>Dictyota</i> , <i>Laminaria</i> Rhodophyceae- <i>Batrachospermum</i> , <i>Gelidium</i> , <i>Polysiphonia</i>		15

	2. External morphology and preparation of slides of Lichen	
IV	Study and Identification of following genera with suitable preparation <i>Sphagnum</i> , <i>Polytrichum</i> , <i>Takakia</i> , <i>Calobryum</i> , <i>Porella</i> , <i>Plagiochasma</i> , <i>Anthoceros</i> , <i>Notothylas</i> , <i>Dendroceros</i> .	15
Suggested Readings 1. Aneja, K.R. (2023). <i>Experiments in Microbiology, Plant Pathology and Biotechnology</i> (5th Edition). New Age International Publishers, New Delhi. 2. Cappuccino, J.G. & Welsh, C.T. (2020). <i>Microbiology: A Laboratory Manual</i> (12th Edition). Pearson Education. 3. Dubey, R.C. & Maheshwari, D.K. (2022). <i>Practical Microbiology</i>. S. Chand Publishing, New Delhi. 4. Sharma, O.P. (2017). <i>Practical Botany: Microbiology, Mycology and Plant Pathology</i>. McGraw Hill Education (India). 5. Singh, S.K. & Srivastava, S. (2022). <i>Laboratory Manual of Microbiology and Plant Pathology</i>. OM Publications, New Delhi. 6. Aneja, K.R. (2020). <i>A Textbook of Mycology and Plant Pathology</i>. New Age International Publishers. 7. Lee, R.E. (2018). <i>Phycology</i> (5th Edition). Cambridge University Press. 8. Shaw, A.J. & Goffinet, B. (Eds.) (2022). <i>Bryophyte Biology</i> (3rd Edition). Cambridge University Press. 9. Sharma, O.P. (2012). <i>Bryophyta</i>. McGraw Hill Education (India), New Delhi. 10. Vashishta, B.R., Sinha, A.K. & Kumar, A. (2020). <i>Botany for Degree Students: Algae, Fungi, Lichens and Bryophyta</i>. S. Chand Publishing, New Delhi.		







M.Sc. SEMESTER-II

RSR wh E Mayr CS

Programme/Class: 2 Year PG degree		Year: I	Semester: II Paper-I
Subject: Botany			
Course Code: BOT201T		Course Title: PTERIDOPHYTES	
Course Outcome: After successful completion of this course, students will understand the origin, evolution, classification, diversity, morphology, reproduction, and phylogeny of pteridophytes, develop knowledge of major fossil and living groups, and appreciate the evolutionary significance of heterospory, seed habit, telome theory, stelar evolution, and fern development.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic		No. of Lectures (60 hrs)
I	Pteridophytes: Distribution of ferns, Origin and evolution of pteridophytes. Telome theory and evolution of stelar system. Heterospory and seed habit. Apogamy and Apospory. Physiology of germination of spores and development of fern prothallus.		15
II	Classification, distribution, morphology, life history and phylogeny of the following classes with special reference to following genera: Rhyniopsida- <i>Rhynia</i> , <i>Horneophyton</i> . Psilotopsida- <i>Psilotum</i> Lycopside: <i>Selaginella</i> - <i>Selaginella</i> . Lepidodendrales- <i>Lepidodendron</i> Isoetales- <i>Isoetes</i> . Equisetopsida: <i>Sphenophyllales</i> - <i>Sphenophyllum</i> . <i>Calamitales</i> - <i>Calamites</i> .		15
III	Primofilices: <i>Zygopteridales</i> - <i>Botryopteris</i> . <i>Cladolyales</i> - <i>Cladoxylon</i> . Filicopsida <i>Eusporangiatae</i> : <i>Ophioglossales</i> - <i>Ophioglossum</i> . <i>Protoleptosporangiatae</i> : <i>Osmundales</i> - <i>Osmunda</i>		15
IV	<i>Leptosporangiatae</i> : <i>Schizaeales</i> - <i>Lygodium</i> . <i>Pteridales</i> - <i>Pteris</i> , <i>Adiantum</i> . <i>Dicksoniales</i> - <i>Pteridium</i> . <i>Hymenophyllales</i> - <i>Hymenophyllum</i> . <i>Gleicheniales</i> - <i>Gleichenia</i> . <i>Cyathea</i> - <i>Cyathea</i> . <i>Marsileales</i> - <i>Marsilea</i> .		15

	Salviniales–Azolla	
Suggested Readings - Sharma, O.P. (2012). <i>Pteridophyta</i>. McGraw Hill Education (India), New Delhi. - Vashishta, B.R., Sinha, A.K. & Kumar, A. (2020). <i>Botany for Degree Students: Pteridophyta</i>. S. Chand Publishing, New Delhi. - Singh, V., Pande, P.C. & Jain, D.K. (2021). <i>A Textbook of Botany: Pteridophytes</i>. Rastogi Publications, Meerut. - Singh, S.K. & Srivastava, S. (2022). <i>A Textbook of Pteridophyta</i>. OM Publications, New Delhi. - Rashid, A. (1999). <i>An Introduction to Pteridophyta</i>. Vikas Publishing House, New Delhi. - Parihar, N.S. (1996). <i>The Biology and Morphology of Pteridophytes</i>. Central Book Depot, Allahabad. - Gifford, E.M. & Foster, A.S. (1989). <i>Morphology and Evolution of Vascular Plants</i> (3rd Edition). W.H. Freeman & Company. - Sundue, M.A. & Ranker, T.A. (Eds.) (2024). <i>Ferns and Lycophytes: A Global Perspective</i>. Academic Press. - Taylor, T.N., Taylor, E.L. & Krings, M. (2009). <i>Paleobotany: The Biology and Evolution of Fossil Plants</i> (2nd Edition). Academic Press. - Pichi Sermolli, R.E.G. (1977). <i>Tentamen Pteridophytorum Genera</i>. Webbia (a classic reference for pteridophyte classification).		

Programme/Class: 2 Year PG degree	Year: I	Semester: II Paper-II
Subject: Botany		
Course Code: BOT202T	Course Title: GYMNOSPERMS AND PALAEOBOTANY	
Course Outcome: After successful completion of this course, students will be able to understand the classification, diversity, evolution, morphology, anatomy, life history, and economic importance of gymnosperms, explain the phylogenetic relationships of major living and fossil groups, and acquire knowledge of fossil preservation, palaeobotanical techniques, Indian fossil floras, continental drift, and the applications of palaeobotany in carbon dating, coal, petroleum exploration, and palynology.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	General characteristics of Gymnosperms. Classification of Gymnosperms Distribution of Gymnosperms with special reference to India. Economic importance of Gymnosperms Origin and evolutionary tendencies in Gymnosperm.	15
II	A study of their morphology, structure, life history, Interrelationship and phylogeny of the following classes with special reference to the following genera:	15



	Cycadopsida Pteridospermales: <i>Glossopteris</i> . Cycadales: <i>Zamia</i> . Cycadeoideales (Bennettitales): <i>Williamsonia</i> , <i>Cycadeoidea</i> (Bennittites). Pentoxylales: with special reference to <i>Pentoxylon</i> .	
III	Coniferopsida Cordaitales: <i>Cordaitea</i> . Ginkgoales: <i>Ginkgo</i> Coniferales: <i>Araucaria</i> , <i>Cryptomeria</i> , <i>Cupressus</i> , <i>Thuja</i> . Taxales: <i>Taxus</i>	15
IV	Gnetopsida Ephedrales: <i>Ephedra</i> Gnetales: <i>Gnetum</i> Welwitschiales: <i>Welwitschia</i> Types of Fossils, their methods of preservation and methods of study. Applied Palaeobotany: Carbon dating, palaeobotany of coal and petroleum/palynology. Study of Indian Fossil Flora: Gondwana Flora, The Rajmahal Flora, Deccan Intertrappean Flora. Theory of continental drift.	15
Suggested Readings 1. Bhatnagar, S.P. & Moitra, A. – <i>Gymnosperms</i> . New Age International Publishers, New Delhi. 2. Singh, V., Pande, P.C. & Jain, D.K. – <i>A Textbook of Botany</i> . Rastogi Publications, Meerut. 3. Shukla, A.C. & Mishra, S.P. – <i>Gymnosperms</i> . Vikas Publishing House, New Delhi. 4. Sundara Rajan, S. – <i>Introduction to Palaeobotany</i> . Anmol Publications, New Delhi. 5. Bierhorst, D.W. – <i>Morphology of Vascular Plants</i> . Macmillan Publishing Company. 6. Sporne, K.R. – <i>The Morphology of Gymnosperms</i> . Hutchinson University Library. 7. Coulter, J.M. & Chamberlain, C.J. – <i>Morphology of Gymnosperms</i> . Central Book Depot. 8. Stewart, W.N. & Rothwell, G.W. – <i>Paleobotany and the Evolution of Plants</i> . Cambridge University Press. 9. Taylor, T.N., Taylor, E.L. & Krings, M. – <i>Paleobotany: The Biology and Evolution of Fossil Plants</i> . Academic Press. 10. Vashishta, P.C., Sinha, A.K. & Kumar, A. – <i>Botany for Degree Students: Gymnosperms</i> . S. Chand Publishing.		

Programme/Class: 2 Year PG degree	Year: I	Semester: II Paper-III
Subject: Botany		
Course Code: BOT203T	Course Title: ANGIOSPERMS: PLANT TAXONOMY, MORPHOLOGY AND ECONOMIC BOTANY	
Course Outcome: After successful completion of this course, students will be able to understand the principles and modern approaches of plant taxonomy, apply the rules of botanical nomenclature, identify major angiosperm families using diagnostic characters, demonstrate knowledge of herbarium and field techniques, explain the role of botanical institutions and economic plants, and interpret the morphology, phylogeny, and evolutionary relationships of flowering plants.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	



Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Taxonomy: A general account History of plant taxonomy. Systems of Classification: History, outlines, basis, merits and demerits of following classifications- ● Bentham and Hooker ● Hutchinson ● Takhtajan ● Cornquist ICBN (History, Principles and Application.)	15
II	Field and herbarium techniques. Herbaria and Botanical Gardens of India and World. Organization and activities of BSI. Taxonomy as a synthetic discipline, Modern trends of taxonomy: Morphology, Cytology, Nucleic Acid Hybridization, Chemotaxonomy, numerical taxonomy and serotaxonomy.	15
III	General knowledge of the distinguishing features of the following families with special reference to best flora: Dicots: Ranunculaceae, Caryophyllaceae, Capparaceae, Tiliaceae, Fabaceae, Mimosaceae, Caesalpiniaceae, Rosaceae, Apiaceae, Amaranathaceae, Asclepiadaceae, Rubiaceae, Asteraceae, Acanthaceae, Verbenaceae, Lamiaceae, Scrophulariaceae, Polygonaceae, Euphorbiaceae, Moraceae. Monocots: Cyperaceae, Poaceae, Lilaceae, Orchidaceae, Arecaceae, Commelinaceae, Zingiberaceae.	15
IV	Economic botany: Scope of economic botany, study of economically important plants and plant products. Forest Products (Wood Timber and Lumber. b) Resins, gum, tanning, material and cork c) Rubber and other latex products. Textile plants and products: A general account Fumitories and masticatories: A general account Narcotics and insecticide as plant products. Morphology: Phylogeny and interrelationship of Angiosperm. Morphology of flower with special reference to the morphology of carpel and inferior ovary.	15







Suggested Readings

1. Singh, Gurcharan – *Plant Systematics: Theory and Practice*. Oxford & IBH Publishing Co., New Delhi.
2. Sharma, O.P. – *Plant Taxonomy*. McGraw Hill Education (India).
3. Pandey, B.P. – *Taxonomy of Angiosperms*. S. Chand Publishing, New Delhi.
4. Jain, S.K. & Rao, R.R. – *A Handbook of Field and Herbarium Methods*. Today & Tomorrow's Printers and Publishers, New Delhi.
5. Shukla, P. & Mishra, S.P. – *Economic Botany*. Vikas Publishing House, New Delhi.
6. Vashishta, P.C. – *Taxonomy of Angiosperms*. S. Chand Publishing, New Delhi.
7. Lawrence, G.H.M. – *Taxonomy of Vascular Plants*. Scientific Publishers.
8. Stace, C.A. – *Plant Taxonomy and Biosystematics*. Cambridge University Press.
9. Cronquist, A. – *An Integrated System of Classification of Flowering Plants*. Columbia University Press.
10. Simpson, M.G. – *Plant Systematics*. Academic Press.

RSR wh S Mayr CS

Programme/Class: 2 Year PG degree		Year: I	Semester: II Paper-IV
Subject: Botany			
Course Code: BOT204T		Course Title: ANATOMY, EMBRYOLOGY AND MORPHOGENESIS	
Course Outcome: After successful completion of this course, students will be able to explain the developmental anatomy of plants, including meristem organization, secondary growth, wood structure, reproductive biology, embryogenesis, and morphogenesis, and interpret the significance of plant developmental processes, anatomy, embryology, and polarity in evolution, taxonomy, and plant growth.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic		No. of Lectures (60 hrs)
I	Shoot development: Organization of shoot apical meristem (SAM), Leaf (Marginal meristem). The cambium, its derivative tissues, differentiation of secondary phloem and xylem. Structure of woods in relation to its weight, strength, durability and taxonomic significance. Anomalous secondary growth in roots and stems. Cork cambium and its derivatives.		15
II	Abscission layers. Origin of lateral and adventitious roots, root-stem transition. Anatomy in relation to taxonomy. Structure of microsporangium, microsporogenesis and development to female gametophyte. Structure of ovule, megasporogenesis and development to female gametophyte. Pollen-Pistil interaction. Fertilization and its control.		15
III	Endosperm: Development, types, haustoria, ruminant endosperm, xenia, meta-xenia. Embryogenesis in dicot and monocot. Apomixis, causes and significance. Parthenocarpy. Polyembryony and its induction. Embryology in relation to taxonomy		15

IV	Polarity: Polarity in isolated cells, plasmodia and coenocytes. Expression of polarity in external and internal structure of plants. Role of polarity in developmental pattern. Correlation: Physiological and genetically correlations. Symmetry: Inorganic and organic symmetries. Radial, bilateral and dorsiventral symmetries in plant body. Development of symmetry. Morphogenesis in <i>Acetabularia</i>.	15
Suggested Readings 1. Bhojwani, S. S., & Bhatnagar, S. P. (2015). <i>The Embryology of Angiosperms</i> (5th ed.). Vikas Publishing House Pvt. Ltd., New Delhi. 2. Esau, K. (1977). <i>Anatomy of Seed Plants</i> (2nd ed.). John Wiley & Sons, New York. 3. Fahn, A. (1990). <i>Plant Anatomy</i> (4th ed.). Pergamon Press, Oxford. 4. Pandey, B. P. (2010). <i>Plant Anatomy</i>. S. Chand & Company Ltd., New Delhi. 5. Maheshwari, P. (1950). <i>An Introduction to the Embryology of Angiosperms</i>. McGraw-Hill Book Company, New York. 6. Johri, B. M. (Ed.). (1984). <i>Embryology of Angiosperms</i>. Springer-Verlag, Berlin. 7. Beck, C. B. (2010). <i>An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century</i> (2nd ed.). Cambridge University Press, Cambridge. 8. Mauseth, J. D. (2014). <i>Botany: An Introduction to Plant Biology</i> (5th ed.). Jones & Bartlett Learning, Burlington. 9. Eames, A. J., & MacDaniels, L. H. (1947). <i>An Introduction to Plant Anatomy</i> (2nd ed.). McGraw-Hill Book Company, New York. 10. Raghavan, V. (2000). <i>Developmental Biology of Flowering Plants</i>. Springer-Verlag, New York.		

Programme/Class: 2 Year PG degree	Year: I	Semester: II Paper-IV
Subject: Botany		
Course Code: BOT203T	Course Title: ANGIOSPERMS: TAXONOMY, MORPHOLOGY AND ECONOMIC BOTANY	
Course Outcome: After successful completion of this course, students will be able to explain the principles, history and modern concepts of plant taxonomy; compare different systems of angiosperm classification and apply the rules of botanical nomenclature; demonstrate knowledge of herbarium techniques, botanical gardens and the role of the Botanical Survey of India; identify and classify major angiosperm families based on diagnostic morphological characters; interpret the phylogeny and floral morphology of angiosperms with special reference to the carpel and inferior ovary; and evaluate the economic importance of flowering plants and their products in forestry, agriculture, medicine and industry.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

Unit	Topic	No. of Lectures (60 hrs)
I	Taxonomy: A general account History of plant taxonomy. Systems of Classification: History, outlines, basis, merits and demerits of following classifications- ● Bentham and Hooker ● Hutchinson ● Takhtajan ● Cornquist ICBN (History, Principles and Application.)	15
II	Field and herbarium techniques. Herbaria and Botanical Gardens of India and World. Organization and activities of BSI. Taxonomy as a synthetic discipline, Modern trends of taxonomy: Morphology, Cytology, Nucleic Acid Hybridization, Chemotaxonomy, numerical taxonomy and serotaxonomy.	15
III	General knowledge of the distinguishing features of the following families with special reference to best flora: Dicots: Ranunculaceae, Caryophyllaceae, Capparaceae, Tiliaceae, Fabaceae, Mimosaceae, Caesalpiniaceae, Rosaceae, Apiaceae, Amaranthaceae, Asclepiadaceae, Rubiaceae, Asteraceae, Acanthaceae, Verbenaceae, Lamiaceae, Scrophulariaceae, Polygonaceae, Euphorbiaceae, Moraceae. Monocots: Cyperaceae, Poaceae, Lilaceae, Orchidaceae, Arecaceae, Commelinaceae, Zingiberaceae.	15
IV	Economic botany: Scope of economic botany, study of economically important plants and plant products. Forest Products (Wood Timber and Lumber. b) Resins, gum, tanning, material and cork c) Rubber and other latex products. Textile plants and products: A general account Fumitories and masticatories: A general account Narcotics and insecticide as plant products. Morphology: Phylogeny and interrelationship of Angiosperm. Morphology of flower with special reference to the morphology of carpel and inferior ovary.	15

Suggested Readings

1. Singh, G. (2021). *Plant Systematics: Theory and Practice* (4th Ed.). CRC Press.
2. Simpson, M. G. (2019). *Plant Systematics* (3rd Ed.). Academic Press.
3. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F. & Donoghue, M. J. (2016). *Plant Systematics: A Phylogenetic Approach* (4th Ed.). Sinauer Associates.
4. Pandey, B. P. (Latest Edition). *Taxonomy of Angiosperms*. S. Chand & Company.
5. Sharma, O. P. (Latest Edition). *Plant Taxonomy*. McGraw Hill Education.
6. Singh, V., Pandey, P. C. & Jain, D. K. (Latest Edition). *A Textbook of Botany: Angiosperms*. Rastogi Publications.
7. Bendre, A. M. & Kumar, A. (Latest Edition). *A Textbook of Botany: Angiosperms*. Rastogi

Handwritten signatures and initials in blue ink.

- Publications.
8. Kochhar, S. L. (Latest Edition). *Economic Botany in the Tropics*. Macmillan India.
 9. Hill, A. F. (Latest Indian Reprint). *Economic Botany: A Textbook of Useful Plants and Plant Products*. McGraw-Hill.
 10. Lawrence, G. H. M. (Latest Indian Reprint). *Taxonomy of Vascular Plants*. Scientific Publishers/Associated Press.

Programme/Class: 2 Year PG degree		Year: I	Semester: II Paper-V
Subject: Botany			
Course Code: BOT205P		Course Title: Practical	
Course Outcome: After successful completion of this practical course, students will be able to identify and describe pteridophytes, gymnosperms, fossils, and angiosperms using morphological and anatomical characters, prepare and preserve herbarium specimens and permanent slides, perform sectioning, staining, pollen germination, and embryological techniques, and apply taxonomic keys and practical skills for plant identification, classification, and botanical research.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			
Unit	Topic		No. of Lectures (60 hrs)
I	Pteridophytes Monographic study of the sporophyte body of the following: <i>Cladoxylon, Selaginella, Lepidodendron, Isoetes, Sphenophyllum, Calamites, Botryopteris, Hymenophyllum, Ophioglossum, Osmunda, Lygodium, Pteris, Adiantum, Pteridium, Gleichenia, Cyathea, Marsilea, Azolla</i>		15
II	Gymnosperms and Palaeobotany A study of representative types: <i>Zamia, Ginkgo, Araucaria, Cryptomeria, Thuja, Taxus, Ephedra, Gnetum, Cupressus</i> of fossils and fossils slides		15
III	Angiosperms, Taxonomy, Morphology and Economic Botany		

Handwritten signatures and initials: RSN, wh, S, Mayr, CS

	1. Description of local plant in semi technical language 2. Identification of Angiospermic plants up to the level of family 3. Identification of Angiospermic plants of known family up to the level of genus and species with the help of flora Note: - Students have to collect and submit at least 100 plants properly pressed and mounted on Herbarium sheets by excursion	15
IV	Anatomy, Embryology and Morphogenesis 1. Study of the plants and its parts (root, stem and leaves) by sectioning and staining 2. Prepare of smear for the study of gametophyte 3. Micro- dissection techniques for embryo and embryo sac 4. Elementary techniques for pollen germination 5. Study for various stages in reproduction from permanent slides, pre and post fertilization in embryo sac 6. Preparation of permanent slides.	15

Suggested Readings

1. Bhatnagar, S. P., & Moitra, A. (2018). *Gymnosperms*. New Age International Publishers, New Delhi.
2. Singh, G. (2019). *Plant Systematics: Theory and Practice* (3rd ed.). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Jain, S. K., & Rao, R. R. (1977). *A Handbook of Field and Herbarium Methods*. Today & Tomorrow's Printers and Publishers, New Delhi.
4. Pandey, B. P. (2014). *Plant Anatomy*. S. Chand & Company Pvt. Ltd., New Delhi.
5. Bhojwani, S. S., & Bhatnagar, S. P. (2015). *The Embryology of Angiosperms* (5th ed.). Vikas Publishing House Pvt. Ltd., New Delhi.
6. Vashishta, P. C., Sinha, A. K., & Kumar, A. (2017). *Botany for Degree Students: Pteridophyta*. S. Chand & Company Pvt. Ltd., New Delhi.
7. Esau, K. (1977). *Anatomy of Seed Plants* (2nd ed.). John Wiley & Sons, New York.
8. Fahn, A. (1990). *Plant Anatomy* (4th ed.). Pergamon Press, Oxford.
9. Stewart, W. N., & Rothwell, G. W. (1993). *Paleobotany and the Evolution of Plants* (2nd ed.). Cambridge University Press, Cambridge.
10. Simpson, M. G. (2019). *Plant Systematics* (3rd ed.). Academic Press, London.

Handwritten signatures: RSN, wh, S, Mayr, CS

M.Sc. SEMESTER-III

RSR wh E Mayr CS

Programme/Class: 2 Year PG Degree		Year: II	Semester: III Paper-I
Subject: Botany			
Course Code: BOT301T		Course Title: PLANT PHYSIOLOGY AND BIOCHEMISTRY	
Course Outcome: After successful completion of this course, students will be able to explain the physiological and biochemical processes governing plant growth and development, including water relations, mineral nutrition, photosynthesis, respiration, growth regulation, stress physiology, and flowering, and demonstrate an understanding of the structure, function, metabolism, and biosynthesis of proteins, carbohydrates, lipids, nucleic acids, and enzymes with their applications in plant biology and biotechnology.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic		No. of Lectures (60 hrs)
I	Plant Water relations: ➤ Osmosis, osmotic potential, water potential. ➤ Mechanism of water absorption, root pressure, phloem loading and unloading. ➤ Transpiration mechanism and its regulation. Mineral Nutrition: ➤ Micro and Macro elements, Role and deficiency effects of essential nutrient elements. ➤ Stress physiology: Plant responses to abiotic stress, Stress proteins (HSP, LEA); Water deficit and drought, heat, chilling and freezing, salinity, light and anoxia stress. Growth regulators: ➤ Auxin, Cytokinin, Gibberellin, Ethylene. Flowering: ➤ Florigen concept, circadian rhythms, photoperiodism and its regulation. ➤ Vernalization, phytochrome and its functions. ➤ Abscission, dormancy, seed germination and senescence.		15
II	Photosynthesis: ➤ Organization of photosynthetic apparatus, pigments, absorption spectra, action spectra and light harvesting complexes. ➤ Mechanism of electron transport-structure and functions of components of Photosystem I and Photosystem II, Photophosphorylation. ➤ Proton transport and ATP synthesis in chloroplast - ATP synthetase. ➤ Carbon assimilation: Calvin cycle, C4 cycle and their regulation, CAM		15

	pathway, photorespiration and its regulation, Factors affecting photosynthesis. Respiration: ➤ Aerobic and anaerobic respiration Glycolysis, Krebs' Cycle and their regulation, substrate level phosphorylation, Electron Transport System and ATP Synthesis. ➤ Pentose Phosphate Pathway and factors affecting respiration.	
III	Amino acids, Peptides and Proteins: ➤ Biosynthesis of amino acid. ➤ Chemical and enzymatic hydrolysis of protein to peptides, amino acid sequencing. ➤ Secondary structure of proteins forces responsible for holding secondary structure α-helix and β-sheet. Super secondary structure, tertiary and Quaternary structure of proteins. ➤ Denaturation, degradation and renaturation of proteins. Carbohydrates: ➤ Structure, Function and Metabolism of Carbohydrates Lipid metabolism: ➤ Synthesis of fatty acids and their degradation.	15
IV	Nucleic Acid ➤ Biosynthesis of nucleotides. ➤ Denaturation, degradation and renaturation of nucleic acids. Enzymes: ➤ General aspects, nomenclature and classification. ➤ Mode of action, active sites, reversible and irreversible enzyme inhibition. ➤ Enzyme kinetics and Michaelis-Menten equation. ➤ Factors affecting enzymatic reactions. ➤ Structure and function of co-enzymes, Isozyme, abzymes.	15
Suggested Readings 1. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). <i>Biochemistry and Molecular Biology of Plants</i> (2nd ed.). John Wiley & Sons, Chichester. 2. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2018). <i>Plant Physiology and Development</i> (7th ed.). Oxford University Press, New York. 3. Salisbury, F. B., & Ross, C. W. (1992). <i>Plant Physiology</i> (4th ed.). Wadsworth Publishing Company, Belmont. 4. Hopkins, W. G., & Hüner, N. P. A. (2009). <i>Introduction to Plant Physiology</i> (4th ed.). John Wiley & Sons, Hoboken. 5. Jain, V. K. (2017). <i>Fundamentals of Plant Physiology</i> (18th ed.). S. Chand & Company Pvt. Ltd., New Delhi. 6. Verma, V. (2019). <i>Textbook of Plant Physiology</i>. Ane Books Pvt. Ltd., New Delhi. 7. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2021). <i>Lehninger Principles of Biochemistry</i> (8th ed.). W. H. Freeman & Company, New York. 8. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2019). <i>Biochemistry</i> (9th ed.). W. H. Freeman & Company, New York. 9. Voet, D., Voet, J. G., & Pratt, C. W. (2019). <i>Fundamentals of Biochemistry: Life at the Molecular Level</i> (6th ed.). John Wiley & Sons, Hoboken. 10. Pandey, S. N., & Sinha, B. K. (2014). <i>Plant Physiology</i>. Vikas Publishing House Pvt. Ltd., New Delhi.		



Programme/Class: 2 Year PG Degree		Year: II	Semester: III Paper-II
Subject: Botany			
Course Code: BOT302T		Course Title: GENETICS, PLANT BREEDING AND BIOSTATISTICS	
Course Outcome: After successful completion of this course, students will be able to explain the principles of classical and molecular genetics, chromosome structure and inheritance, population genetics, mutation, recombination, and gene mapping, apply plant breeding techniques for crop improvement, and use biostatistical tools to analyze, interpret, and validate biological data for research and decision-making.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic		No. of Lectures (60 hrs)
I	➤ Principles of Mendelian inheritance and Interaction of genes: Complementary, epistasis, Inhibitory, Duplicate, Polymeric, Lethal genes. ➤ Cytoplasmic inheritance involving chloroplast (Mirabilis jalapa, Zea mays), ➤ Population genetics: Gene and genotype frequencies, Hardy-Weinberg Law, ➤ Structural changes in chromosomes: Origin, meiosis and breeding behavior of duplication, deficiency, inversion and translocation heterozygotes. Cytological consequences of crossing over in Inversion and translocation heterozygotes Genetics of structural heterozygotes, complex translocation heterozygotes,		15
II	➤ Numerical Changes in chromosomes: aneuploidy and euploidy, cytology and genetics, their role in crop improvement. ➤ Recombination and Linkage:-Gene mapping in Fungi Neurospora. ➤ Sex Determination in plants, mutation, DNA damage and repair mechanism, transposable elements in prokaryotes and eukaryotes and its mechanism.		15
III	➤ Introduction to plant breeding; Domestication; plant introduction and acclimatization, kinds of germplasm, Methods of selection and		



	hybridization; Techniques of selfing and crossing. ➤ Cytoplasmic male-sterility; Heterosis and hybrid seed production; Mutant breeding; ➤ Polyploidy in plant breeding; Breeding for nutritional quality.	15
IV	➤ Relevance of biostatistics to biological interpretation, elementary idea of probability, combination and permutations, continuous and discontinuous variables; ➤ Measures of central tendency: Mean, Median and Mode; Measures of dispersion: Standard deviation, Standard error, Mean deviation. Significance of Chi-Square, t-test, analysis of variance, Correlation and regression.	15
Suggested Readings 1. Acquaah, G. (2020). <i>Principles of Plant Genetics and Breeding</i> (3rd ed.). Wiley-Blackwell, Hoboken. 2. Allard, R. W. (1999). <i>Principles of Plant Breeding</i> (2nd ed.). John Wiley & Sons, New York. 3. Singh, B. D. (2021). <i>Plant Breeding: Principles and Methods</i> (12th ed.). Kalyani Publishers, Ludhiana. 4. Singh, B. D. (2021). <i>Genetics</i> (5th ed.). Kalyani Publishers, Ludhiana. 5. Poehlman, J. M., & Sleper, D. A. (1995). <i>Breeding Field Crops</i> (4th ed.). Iowa State University Press, Ames. 6. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2008). <i>Principles of Genetics</i> (8th ed.). John Wiley & Sons, New York. 7. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2019). <i>Concepts of Genetics</i> (12th ed.). Pearson Education, New York. 8. Gupta, P. K. (2019). <i>Genetics</i> (6th ed.). Rastogi Publications, Meerut. 9. Panse, V. G., & Sukhatme, P. V. (1985). <i>Statistical Methods for Agricultural Workers</i> (4th ed.). Indian Council of Agricultural Research, New Delhi. 10. Gomez, K. A., & Gomez, A. A. (1984). <i>Statistical Procedures for Agricultural Research</i> (2nd ed.). John Wiley & Sons, New York.		

Programme/Class: 2 Year PG degree	Year: II	Semester: III Paper-III
Subject: Botany		
Course Code: BOT303T	Course Title: ECOLOGY, PLANT- SOIL RELATIONSHIP	
Course Outcome: After successful completion of this course, students will be able to explain the principles of plant ecology, ecosystem structure and functioning, plant–soil relationships, biodiversity and its conservation, ecological adaptations, environmental pollution, and soil properties, and apply ecological concepts to the sustainable management, conservation, and restoration of natural resources and ecosystems.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

Unit	Topic	No. of Lectures (60 hrs)
I	➤ Plant Ecology and its scope. ➤ Auto-ecological studies, gene ecology with emphasis on Indian work ➤ Plant communities: characteristics and its classification. ➤ Life-forms and biological spectrum. ➤ Plant community dynamics and development: succession and climax. ➤ Study of plant communities (Analytical and Synthetic characters) ➤ Population ecology. Ecological niche.	15
II	➤ Study of different types of ecosystems. ➤ Ecological energetic. ➤ Biogeochemical cycles of nutrients in ecosystem. ➤ Production ecology, measurement of primary productivity. ➤ Ecological adaptation of plants in different ecosystems.	15
III	➤ Biodiversity and its conservation: ➤ Introduction to Biodiversity. ➤ Levels of Biodiversity: Genetic species community and Ecosystem. ➤ Megadiversity Zones and Hotspots. ➤ Threats to Biodiversity: Causes of Biodiversity loss species extension. ➤ Red Data Book. IUCN threat categories. ➤ Strategies for Biodiversity conservation: Principles of Biodiversity ➤ conservation in- situ and ex-situ conservation strategies.	15
IV	➤ Environmental pollution and its consequences. ➤ Soil properties in relation to plant growth: Physical texture, density, porosity, permeability. ➤ Soil water, energy concept of soil, water, soil water quantities and their measurement. ➤ Soil: Its origin and development. ➤ Process of soil formation and soil profile. ➤ Soil erosion: its causes and effects on environment. ➤ Methods of soil conservation.	15

Suggested Readings

1. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of Ecology* (5th ed.). Brooks/Cole Publishing, Belmont.
2. Krebs, C. J. (2016). *Ecology: The Experimental Analysis of Distribution and Abundance* (7th ed.). Pearson Education, New York.
3. Sharma, P. D. (2022). *Ecology and Environment* (14th ed.). Rastogi Publications, Meerut.
4. Ambasht, R. S., & Ambasht, N. K. (2019). *A Textbook of Plant Ecology* (16th ed.). CBS Publishers & Distributors Pvt. Ltd., New Delhi.
5. Singh, J. S., Singh, S. P., & Gupta, S. R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand & Company Pvt. Ltd., New Delhi.

Handwritten signatures and initials: RSN, wh, S, Mayr, CS

6. Kormondy, E. J., & Brown, D. E. (1998). *Fundamentals of Human Ecology*. Prentice Hall, New Delhi.
7. Brady, N. C., & Weil, R. R. (2017). *The Nature and Properties of Soils* (15th ed.). Pearson Education, New York.
8. Raven, P. H., Evert, R. F., & Eichhorn, S. E. (2013). *Biology of Plants* (8th ed.). W. H. Freeman & Company, New York.
9. Begon, M., Townsend, C. R., & Harper, J. L. (2006). *Ecology: From Individuals to Ecosystems* (4th ed.). Blackwell Publishing, Oxford.
10. Singh, G., & Singh, J. S. (1992). *Forest Vegetation of the Himalaya*. Gyanodaya Prakashan, Nainital.

Programme/Class: 2 Year PG degree		Year: II	Semester: III Paper-IV
Subject: Botany			
Course Code: BOT304P		Course Title: Practical	
Course Outcome: After successful completion of this practical course, students will be able to perform experiments related to plant physiology, biochemistry, genetics, plant breeding, biostatistics, ecology, and plant–soil relationships, analyze and interpret experimental data using appropriate statistical methods, apply cytological and ecological techniques, and develop practical skills in laboratory and field investigations for plant science research.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			
Unit	Topic		No. of Lectures (60 hrs)
I	1. To determine the Osmotic pressure of vacuolar sap of Rhen discolor er Tradescantia leaves by plasmolytic method (50% plasmolysis) 2. To determine the diffusion pressure deficit (water potential) of potato tuber tissue by weighing method 3. To determine the structure, size and frequency of stomata in mesophytic and xerophytic leaves 4. To determine the rate of transpiration of plant by Potometer method 5. To determine the rate of transpiration by Cobalt Chloride paper method and to calculate transpiration index (TI). Transpiration efficiency (TE) of various leaves 6. To measure the rate of photosynthesis in aquatic plants by Willmotts bubble counting method 7. To study the effect of i. Co2 ii. Light quality and intensity on the rate of		15

	photosynthesis. 8. To extract the major plant pigments from leaves by different solubility method.	
II	1. To separate the major plant pigments by Paper chromatography and to calculate Rf values of the pigment. 2. To extract the free amino acid from germinating seed of mung bean/ black gram and separate them by two-dimensional paper chromatography 3. To determine the Rf values of a given mixture of amino acids using Paper chromatography 4. To measure the activity of enzyme catalase and to study the effect of (i) Substrate concentration and (ii) pH on enzyme activity 5. To extract proteins from germinating seeds of moong bean/ black gram and to estimate them by the Biuret test 7. To extract and test the presence of Reducing sugar by Benedict's test 8. Effect of enzyme concentration on the activity of Urease	15
III	1. Chromosomal Technique - Pretreatment, fixation, staining techniques- Acetocarmine Fuelgen, Banding Technique-G Banding 2. Karyotypic studies-Preparation of mitotic metaphase plates and to draw Camera Lucida drawing of chromosome and study of chromosome morphology ,Calculation of arm ratios, chromosome formula and symmetry of karyotype, preparation of idiograms and drawing photograph 3. Emasculation Techniques 4. Statistic analysis of seed samples and applying suitable statistical test for interpretation as desired 5. Numerical problem and design	15
IV	1. Autecology observations on selected plant species 2. Study of the vegetation by i. Transect method ii. Quadret method iii. Point method 3. Study of the environmental factors i. Climatic factors and their measurement ii. Edaphic factors, mineral composition of soil, pH, soil profile, moisture content, nitrate, calcium, carbonate iii. Water Analysis 4. Ecological anatomy of hydrophytes, halophytes and xerophytes 5. To measure the photosynthetic rate (A) and the specific leaf area of five tree species and observe relation between them.	15



Suggested Readings 1. Sadasivam, S., & Manickam, A. (2008). <i>Biochemical Methods</i> (3rd ed.). New Age International Publishers, New Delhi. 2. Plummer, D. T. (1988). <i>An Introduction to Practical Biochemistry</i> (3rd ed.). Tata McGraw-Hill Publishing Company Ltd., New Delhi. 3. Jain, V. K. (2017). <i>Fundamentals of Plant Physiology</i> . S. Chand & Company Pvt. Ltd., New Delhi. 4. Gupta, P. K. (2019). <i>Cytology, Genetics and Plant Breeding</i> . Rastogi Publications, Meerut. 5. Singh, B. D. (2021). <i>Genetics</i> . Kalyani Publishers, Ludhiana. 6. Panse, V. G., & Sukhatme, P. V. (1985). <i>Statistical Methods for Agricultural Workers</i> (4th ed.). Indian Council of Agricultural Research, New Delhi. 7. Gomez, K. A., & Gomez, A. A. (1984). <i>Statistical Procedures for Agricultural Research</i> (2nd ed.). John Wiley & Sons, New York. 8. Ambasht, R. S., & Ambasht, N. K. (2019). <i>A Textbook of Plant Ecology</i> (16th ed.). CBS Publishers & Distributors Pvt. Ltd., New Delhi. 9. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2014). <i>Fundamentals of Analytical Chemistry</i> (9th ed.). Cengage Learning, Boston. 10. Sawhney, S. K., & Singh, R. (2015). <i>Introductory Practical Biochemistry</i> . Narosa Publishing House, New Delhi.		
Programme/Class: 2 Year PG degree	Year: II	Semester: III Paper-V
Subject: Botany		
Course Code: BOT305R	Course Title: Dissertation/Research Project/Field Survey/Excursion	
Course Outcome: After successful completion of this course, students will be able to identify and formulate research problems, conduct field surveys and laboratory investigations using appropriate scientific methods, collect, analyze and interpret biological data, prepare technical reports and dissertations following scientific writing standards, and effectively communicate research findings through oral presentations while demonstrating ethical and professional practices in botanical research.		
Credits: 4	Core Compulsory	
Max. Marks: 100	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 2-0-2		
Unit	Topic	No. of Lectures (60 hrs)
I	Research Planning and Literature Review: Identification of research problem; review of literature; formulation of objectives and hypotheses; research ethics; preparation of research proposal; sampling techniques; field and laboratory safety.	30
II	Field Survey / Experimental Work: Field survey and ecological observations; collection and preservation of plant specimens; herbarium techniques; experimental design; laboratory investigations; maintenance of field and laboratory records; use of	30



	GPS, digital documentation and statistical software wherever applicable.	
--	--	--

M.Sc. SEMESTER-IV

Handwritten signatures: RSN, wh, S, Mayr, CS

25th Jan 2020

Programme/Class: 2 Year PG degree		Year: II	Semester: IV Paper-I
Subject: Botany			
Course Code: BOT401T		Course Title: CELL & MOLECULAR BIOLOGY	
Course Outcome: After successful completion of this course, students will be able to explain the structure and function of cells and cellular organelles, membrane transport, cell cycle regulation, genome organization, chromosome architecture, nucleic acid structure and function, DNA replication, transcription, translation, gene regulation and molecular mechanisms governing cellular processes, and apply these concepts in molecular biology, genetics, biotechnology, and plant science research.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic		No. of Lectures (60 hrs)
I	Cell structure & function: ➤ Cell wall, Plasma membrane and their structural models and functions; Cell organelles. ➤ Active and Passive uptake of ions facilitated diffusion, primary and secondary active transport, ion carriers, channel proteins and pumps (Na/K⁺ and Ca²⁺ pumps). ➤ Membrane transport proteins: Plasma membrane H-ATPase, vacuolar H-ATPase ➤ Organization of microtubules & microfilaments. ➤ Cell Division, Cell Cycle, Mitosis and Meiosis, Control of cell division. ➤ Cell cycle check points, Apoptosis and Programmed Cell Death (PCD) in plants. ➤ Cell Signaling		15
II	➤ Genome Basic concept and organization. ➤ Chromosome structure, nucleosome, solenoid and packaging of DNA, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes. euchromatin and heterochromatin, karyotype analysis, banding patterns. ➤ Specialized chromosomes. Polytene chromosomes, lampbrush chromosomes ➤ Nuclear DNA content, C-value paradox. ➤ Structure and Properties of Nucleic acids: Structure, chemical,		15

	physical and thermal properties of nucleic acids. ➤ Dissociation and reassociation kinetics of DNA, Cot curves, Cot values and its significance. ➤ Unique, moderately repetitive and highly repetitive DNA, conformation of nucleic acids (A, B, Z DNA, 1-RNA, m-RNA).	
III	➤ DNA amplification, molecular genetic maps, genome projects. ➤ Allele concept, multiple alleles, isoalleles, pseudoalleles. ➤ Genetic Code ➤ Gene Structure: Organization and structure of prokaryotic and eukaryotic genes; structure and role of promoters, exons, introns, terminators and enhancers. ➤ DNA Replication: Mechanism of prokaryotic and eukaryotic DNA replication, replication apparatus, origins of replication, priming and DNA polymerases. ➤ Transcription: RNA polymerases and their role, transcription apparatus, transcription in prokaryotes and eukaryotes, initiation, elongation and termination, RNA processing. reverse transcription, ribonucleoproteins.	15
IV	Regulation of Transcription in prokaryotes and eukaryotes: Operon concept (Lac, Tryptophan, cAMP) positive and negative regulation of prokaryotic genes, eukaryotic transcription factors. Transcriptional and translational control. Translation in prokaryotes and eukaryotes	15
Suggested Readings 1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). <i>Molecular Biology of the Cell</i> (7th ed.). Garland Science, New York. 2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). <i>Molecular Cell Biology</i> (9th ed.). W. H. Freeman & Company, New York. 3. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). <i>Molecular Biology of the Gene</i> (7th ed.). Pearson Education, Boston. 4. Lewin, B. (2017). <i>Lewin's Genes XII</i>. Jones & Bartlett Learning, Burlington. 5. Cooper, G. M., & Hausman, R. E. (2019). <i>The Cell: A Molecular Approach</i> (8th ed.). Oxford University Press, New York. 6. Karp, G. (2019). <i>Cell and Molecular Biology: Concepts and Experiments</i> (9th ed.). John Wiley & Sons, Hoboken. 7. De Robertis, E. D. P., & De Robertis, E. M. F. (2017). <i>Cell and Molecular Biology</i> (8th ed.). Lippincott Williams & Wilkins, Philadelphia. 8. Verma, P. S., & Agarwal, V. K. (2020). <i>Cell Biology, Genetics, Molecular Biology, Evolution and Ecology</i>. S. Chand & Company Pvt. Ltd., New Delhi. 9. Gupta, P. K. (2019). <i>Cell and Molecular Biology</i>. Rastogi Publications, Meerut. 10. Brown, T. A. (2023). <i>Genomes</i> (5th ed.). Garland Science, New York.		



Programme/Class: 2 Year PG degree	Year: II	Semester: IV Paper-II
Subject: Botany		
Course Code: BOT402T	Course Title: PLANT BIOTECHNOLOGY	
Course Outcome: After successful completion of this course, students will be able to explain the principles and applications of plant tissue culture, genetic engineering, recombinant DNA technology, molecular cloning, gene transfer, and transgenic plant development, and apply modern biotechnological tools for crop improvement, sustainable agriculture, environmental management, and industrial and medical applications.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Plant cell and tissue culture techniques: ➤ Plant Cell and Tissue culture: Introduction, history, scope, concept of cellular differentiation, totipotency. ➤ Culture media and laboratory requirements. ➤ Micropropagation-Organogenesis and embryogenesis. ➤ Endosperm and nucellus culture. ➤ Soma clonal variation---applications and reasons for generation ➤ Somatic hybridization–protoplast culture, regeneration and somatic hybridization, cybrids. ➤ Production and uses of haploids. ➤ Applications of plant tissue culture.	15
II	➤ Cloning vectors (plasmid and bacteriophage vectors, cosmids, BAC and YACs) and Enzymes (restriction endonucleases, polymerases, reverse	15



	transcriptase, alkaline phosphatase, polynucleotidekinase, Ligases, terminal transferases). ➤ DNA cloning, preparation of plasmid DNA, Restriction and electrophoresis, ligation.	
III	➤ Methods of direct and indirect gene transfer in plants, Agrobacterium, Ti and Ri plasmids, application of genetic engineering, transgenic plants for pest and disease resistance, abiotic stress tolerance, production of useful products. ➤ Principles and methods of Genetic Engineering, Gene libraries and cDNA libraries, Polymerase chain reaction, DNA fingerprinting, DNA Synthesis.	15
IV	DNA Sequencing, Southern blotting, RAPD, RFLP, Restriction mapping. Biotechnology and Human welfare ➤ Applications of genetically engineered bacteria in crop production and protection, biodegradation of xenobiotics and toxic wastes, production of chemicals, fuels and medicines. ➤ Biopesticides and integrated pest management, Biofertilizers, Organic farming. ➤ Restoration of degraded land–Development of stress tolerant plants, microbes for improving soil fertility.	15

Suggested Readings

1. Bhojwani, S. S., & Razdan, M. K. (2013). *Plant Tissue Culture: Theory and Practice* (Revised ed.). Elsevier, Amsterdam.
2. Chawla, H. S. (2009). *Introduction to Plant Biotechnology* (3rd ed.). Science Publishers, Enfield.
3. Slater, A., Scott, N. W., & Fowler, M. R. (2018). *Plant Biotechnology: The Genetic Manipulation of Plants* (3rd ed.). Oxford University Press, Oxford.
4. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2017). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (5th ed.). ASM Press, Washington, D.C.
5. Primrose, S. B., & Twyman, R. M. (2013). *Principles of Gene Manipulation and Genomics* (7th ed.). Wiley-Blackwell, Oxford.
6. Brown, T. A. (2021). *Gene Cloning and DNA Analysis: An Introduction* (8th ed.). Wiley-Blackwell, Oxford.
7. Gupta, P. K. (2017). *Elements of Biotechnology* (2nd ed.). Rastogi Publications, Meerut.
8. Dubey, R. C. (2014). *A Textbook of Biotechnology*. S. Chand & Company Pvt. Ltd., New Delhi.
9. Ignacimuthu, S. (2008). *Plant Biotechnology*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
10. Singh, B. D. (2020). *Biotechnology: Expanding Horizons* (5th ed.). Kalyani Publishers, Ludhiana.

Programme/Class: 2 Year PG Degree	Year: II	Semester: IV Paper-III
--------------------------------------	----------	---------------------------

[Handwritten signatures]

Subject: Botany		
Course Code: B0T403T(a)	Course Title: Environmental Botany	
Course Outcome: Students will develop understanding of environmental components, ecosystems, environmental pollution and their impact on living organisms. The course provides knowledge of water, air, radioactive and noise pollution, environmental management practices, waste treatment, soil conservation and pollution control strategies. Students will also gain awareness about biodiversity conservation, renewable energy resources, environmental laws, environmental education and phytogeographical distribution of vegetation with special reference to India.		
Credits: 4	Core Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lecturs (60 hrs)
I	➤ Introduction: Relation of man with environment, National and International effects on environmental problems, applied aspects of environmental Botany. ➤ Ecosystem: Classification, general idea of different ecosystems. ➤ Environment: concept of environment, environmental segments, Biosphere. ➤ Biodegradable substances: Classification of pesticides, A brief history of use of synthetic pesticides, ecological effects of pesticide pollution, Bio-accumulation and biomagnifications of pesticide.	15
II	➤ General idea about pollution, Pollutants. ➤ Water pollution: Physico-chemical and biological characteristics of polluted and drinking water. ➤ Air pollution :Air pollutants, PAN, Ozone, Ozone layer and Ozone hole ,Green house effects ; Consequences of climate change (global warming, Sea level rise). ➤ Radioactive pollution: General ideas about hazardous impacts of radiations and radioactive fallouts. ➤ Noise Pollution: General idea about various levels of noise pollution and human response.	15
III	Environmental management: Control of environmental pollution: ➤ Water management of aquatic ecosystem. ➤ Purification of water sewage treatment.	



	➤ Air methods for monitoring air pollutants air quality management and air pollution control device, role of plants in air pollution abatement. ➤ Soil conservation: Solid waste and their disposal, waste collection, reclamation and cycling processes. ➤ Radioactive waste treatment. Noise abatement	
IV	➤ Conservation: (Forest, Forestation, deforestation and social forestry). ➤ Renewable energy sources. ➤ Non – conventional energy sources. ➤ Environmental education in India , international summits and treaties related to environment. ➤ Control of environmental pollution through law. ➤ Phytogeography: Distribution patterns, barriers and Age area hypothesis, vegetation & floristic regions of India.	
Suggested Readings 1. Environmental Biology — Agarwal, K.C. <i>Environmental Biology</i>. Nidi Publishers. 2. Ecology and Environment — Sharma, P.D. <i>Ecology and Environment</i>. Rastogi Publications, Meerut. 3. Fundamentals of Ecology — Odum, E.P. <i>Fundamentals of Ecology</i>. Saunders College Publishing. 4. Concepts of Ecology — Kormondy, E.J. <i>Concepts of Ecology</i>. Prentice Hall of India. 5. Environmental Science — Cunningham, W.P. and Cunningham, M.A. <i>Principles of Environmental Science</i>. McGraw Hill. 6. Environmental Chemistry — De, A.K. <i>Environmental Chemistry</i>. New Age International Publishers. 7. Air Pollution — Rao, M.N. and Rao, H.V.N. <i>Air Pollution</i>. Tata McGraw Hill Publishing Company. 8. Environmental Pollution and Control — Trivedi, R.K. and Goel, P.K. <i>An Introduction to Air Pollution</i>. Techno Science Publications. 9. Biodiversity — Wilson, E.O. <i>Biodiversity</i>. National Academy Press. 10. Phytogeography — Good, R. <i>The Geography of Flowering Plants</i>. Longman Group Ltd. 11. Plant Geography — Chatterjee, S.P. <i>Plant Geography</i>. Central Book Depot. 12. Environmental Education — Asthana, D.K. and Asthana, M. <i>Environment: Problems and Solutions</i>. S. Chand & Company.		

Programme/Class: 2 Year PG Degree	Year: II	Semester: IV Paper-III
Subject: Botany		
Course Code: B0T403T(b)	Course Title: Plant Pathology	
Course Outcome: Students will acquire knowledge of the history, scope and classification of plant diseases along with symptoms, disease development and host–pathogen interactions. The course provides understanding of plant defence mechanisms, epidemiology, disease forecasting and various methods of disease management including integrated pest management. Students will also gain detailed knowledge of important fungal, bacterial, viral, nematode and phytoplasma diseases of crop plants, their etiology, symptoms, dissemination and control measures.		
Credits: 4	Core Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lecturs (60 hrs)
I	Historical development and present status of phytopathology. Classification of plant diseases General symptoms of plant diseases caused by fungi, bacteria and virus. Concept of disease, Koch’s postulates. Mode of infection and development of pathogen in plants. Role of enzymes and toxins in pathogenesis.	15
II	Defence mechanism in host, effect of infection on host physiology. Dissemination of phytopathogens, plant disease forecasting and management Principle methods of plant disease control: Regulatory, cultural and biological, physical, chemical methods, resistant varieties. Mycotoxins and storage diseases. Integrated pest management	15

III	Epidemiology, symptoms, etiology, perennation and control of following diseases: Diseases caused by Fungal Pathogens: Fruit and stem rot of papaya, Red rot of sugarcane, Damping off of seedling of crop plants, Downy mildew of bajra, crucifer and pea, Powdery mildew of barley and cucurbits, Rust of linseed, Cover and loose smut of barley, Wilt of Arhar, Leaf spot of crucifer, rice and turmeric, Blast of rice, Late blight of potato, Stem gall of coriander, Peach leaf curl, Tikka disease of groundnut	15
IV	Diseases caused by nematodes: • Ear cockle of wheat. • Root knot of vegetables. Abiotic/Non pathogenic diseases: • Black tip of mango. • Black heart of potato. Disease caused by plant bacteria: ➤ Citrus canker. ➤ Blight of rice. ➤ Tundu disease of wheat. ➤ Soft rot of carrot/onion. Disease caused by plant viruses: ➤ Mosaic of apple, papaya, tobacco and potato. ➤ Leaf curl of tobacco, chilly and tomato. ➤ Tungro of paddy. ➤ Yellow vein of mosaic. ➤ Bunchy top of banana. Disease caused by plant MLO: ➤ Sesame phyllody ➤ Little leaf of brinjal. - Grassy shoot of sugarcane	15

Suggested Readings

1. Plant Pathology — Agrios, G.N. *Plant Pathology*. Academic Press.
2. Introduction to Principles of Plant Pathology — Singh, R.S. *Introduction to Principles of Plant Pathology*. Oxford & IBH Publishing Co.
3. Plant Diseases — Rangaswami, G. and Mahadevan, A. *Diseases of Crop Plants in India*. Prentice Hall of India.
4. Essentials of Plant Pathology — Bilgrami, K.S. and Dube, H.C. *A Textbook of Modern Plant Pathology*. Vikas Publishing House.
5. Fundamentals of Plant Pathology — Sharma, P.D. *Plant Pathology*. Rastogi Publications.
6. Plant Pathology and Plant Pathogens — Lucas, J.A. *Plant Pathology and Plant Pathogens*. Blackwell Science.
7. Physiological Plant Pathology — Wood, R.K.S. *Physiological Plant Pathology*. Blackwell Scientific Publications.
8. Principles of Plant Infection — Walker, J.C. *Plant Pathology*. McGraw Hill Book Company.
9. Plant Virology — Matthews, R.E.F. *Plant Virology*. Academic Press.
10. Diseases of Field Crops — Butler, E.J. and Jones, S.G. *Plant Pathology*. Macmillan & Co.

Handwritten signatures: RSN, wh, S, Maye, CS

11. Integrated Pest Management — Dhaliwal, G.S. and Arora, R. *Integrated Pest Management: Concepts and Approaches*. Kalyani Publishers.
12. Plant Nematology — Sasser, J.N. and Freckman, D.W. *A World Perspective on Nematology*. Society of Nematologists.

Programme/Class: 2 Year PG Degree	Year: II	Semester: IV Paper-III
Subject: Botany		
Course Code: B0T403T(c)	Course Title: Advanced Plant Physiology	
Course Outcome: Students will develop advanced understanding of photosynthesis, respiration, nitrogen metabolism, lipid metabolism and plant energetics. The course provides detailed knowledge of biosynthesis and functions of secondary metabolites, vitamins and plant growth regulators. Students will gain insight into stress physiology, plant defence mechanisms, photobiology, phytochrome-mediated responses, circadian rhythms and the physiological and biochemical regulation of flowering and plant development.		
Credits: 4	Core Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lecturs (60 hrs)
I	➤ Photosynthesis and chemosynthesis: • Quantasomes, biosynthesis of chlorophylls, heme compounds, role and biosynthesis of accessory pigments, photo oxidation. • Biochemical pathways of conversion of solar energy into chemical energy and its utilization in CO₂ reduction cycle. • Efficient and inefficient plants, bacterial photosynthesis and its utility in nature. ➤ Organic acid metabolism: Succulents, CAM pathway and its significance. ➤ Plant Energetics : As controlled by photosynthesis, respiration and photorespiration ➤ Respiration: Biological oxidation of carbohydrates and interconversions of the products, terminal oxidation, electron transport, role of cytochromes and other heme compounds.	15

II	Nitrogen metabolism: Synthesis and activation of amino acids, transcription and translation of genetic code, the template. • Chemical regulation and biosynthesis of proteins and enzymes. • Biochemistry of biological nitrogen fixation and its significance. ➤ Phosphorus metabolism: Metabolism of phosphorylated compounds and their role. ➤ Lipid metabolism: Classification of fat and fatty Acids, biosynthesis and breakdown of fats and lipids, its significance. Unsaturated fatty acids. ➤ Vitamins : Water and fat-soluble vitamins, biochemical function of thiamine, riboflavin, nicotinic acid, pantothenic acid, pyridoxin, biotin, folic acid, vitamin B₁₂, ascorbic acid, vitamin A and vitamin D.	15
III	➤ Secondary metabolites : • Coumarins and lignins : Structure and synthesis. • Tannins : Distribution synthesis and function. • Flavonoids and water-soluble pigments: Synthesis and function. • Hallucinogens: Distribution, chemistry and function. • Alkaloids : Pyrrole, pyrrolidine, pyridine, polyacetyl isoquinoline, tropane and indole alkaloids - their distribution, synthesis and function. • Saponins and sapogenins : Sterols, steroids, steroidal alkaloids - their distribution, synthesis and function. Plant growth regulators: Natural and synthetic, biochemistry and physiological effects of auxins, gibberellins, cytokinins, brassinosteroids, jasmonic acid; salicylic acid, polyamines, morphactins and cyanogenic compounds	15
IV	➤ Stress physiology : Plant responses to biotic and abiotic stresses, mechanism of biotic and abiotic stress resistance, plant defence mechanisms against water stress, salinity stress, metal toxicity, freezing and heat stress and oxidative stress. ➤ Photobiology: Photoreceptors, Phytochrome : history, discovery, physiological properties, interaction between hormones, and phytochrome, role of different phytochromes in plant development and flowering, mechanism of phytochrome signal transduction. Cryptochromes and phototropins. Circadian rhythms in plants: Nature of oscillator, rhythmic outputs, entrainments (inputs) and adaptive significance ➤ Flower Initiation and Floral Expression	15



Suggested Readings

1. Plant Physiology — Taiz, L. and Zeiger, E. *Plant Physiology and Development*. Sinauer Associates.
2. Plant Physiology — Salisbury, F.B. and Ross, C.W. *Plant Physiology*. CBS Publishers & Distributors.
3. Introduction to Plant Physiology — Hopkins, W.G. and Hüner, N.P.A. *Introduction to Plant Physiology*. John Wiley & Sons.
4. Biochemistry and Molecular Biology of Plants — Buchanan, B.B., Gruissem, W. and Jones, R.L. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Biologists.
5. Plant Biochemistry — Bonner, J. and Varner, J.E. *Plant Biochemistry*. Academic Press.
6. Outlines of Biochemistry — Conn, E.E. and Stumpf, P.K. *Outlines of Biochemistry*. Wiley Eastern Ltd.
7. Biochemistry — Nelson, D.L. and Cox, M.M. *Lehninger Principles of Biochemistry*. W.H. Freeman & Company.
8. Stress Physiology in Crop Plants — Levitt, J. *Responses of Plants to Environmental Stresses*. Academic Press.
9. Photomorphogenesis in Plants — Kendrick, R.E. and Kronenberg, G.H.M. *Photomorphogenesis in Plants*. Kluwer Academic Publishers.
10. Plant Hormones — Davies, P.J. *Plant Hormones: Physiology, Biochemistry and Molecular Biology*. Kluwer Academic Publishers.
11. Secondary Metabolism in Plants — Harborne, J.B. *Introduction to Ecological Biochemistry*. Academic Press.
12. Plant Stress Biology — Hirt, H. and Shinozaki, K. *Plant Responses to Abiotic Stress*. Springer Verlag.

Programme/Class: 2 Year PG Degree		Year: II	Semester: IV Paper-IV
Subject: Botany			
Course Code: B0T404P		Course Title: Practical	
Course Outcome: After successful completion of this practical course, students will be able to perform advanced laboratory and field techniques in cell and molecular biology, plant biotechnology, environmental analysis, plant pathology, and plant physiology, prepare and analyze biological samples using modern instruments, culture plant tissues, identify plant diseases, assess soil and water quality, interpret experimental data, and develop research skills applicable to plant science, biotechnology, environmental monitoring, and sustainable agriculture.			
Credits: 4		Core Elective	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic		No. of Lecturs (60 hrs)

I	1. Preparation of squash for the study of mitosis 2. Preparation of squash for the study of meiosis 3. Preparation of various stains- Safranin, Fast green, Haematoxylin and carmine 4. Study of fixation of botanical materials 5. To study the use of ocular and stage micrometers for the measurement of pollen grains and stomata 6. To extract and to detect nucleic acid from cauliflower or any floral tissue: (i) DNA by Diphenylamine test, (ii) RNA by Orcinol test 7. Isolation and purification of DNA from various electrophoresis 8. Estimation of protein by Bradford reagent sample using Agarose gel 9. Use of spectrophotometer in biochemical estimations- chloroplastic pigments, proteins, carbohydrates etc. 10. Demonstration of instruments: Gel Electrophoresis, Microtome, pH meter, oven, incubator, autoclave and centrifuge	15
II	1. Preparation of MS (Murashige and Skoog) basal medium for tissue culture 2. Preparation of medium for regeneration of <i>Bryophyllum</i> 3. To prepare medium for Anther culture <i>Datura innoxia</i> using IAA, MS medium	15
III (a)	Physico chemical analysis of polluted water- colour, acidity, alkalinity, taste, turbidity, total solids, total dissolved solids, conductivity, hardness, pH, Biological oxygen demand, Dissolved oxygen, Chemical oxygen demand Biological examinations of polluted water- microscopic and culturing method (Density count) Physico chemical analysis of polluted soil, pH, Electric conductivity, soluble cations and anions, heavy metals (base deficiency) To analyse distribution pattern of selected species in an ecosystem To measure the photosynthetic rate (A) and the specific leaf area of five tree species and observe relation between them OR	30
III(b)	A study of symptomology, histopathology, and identification of pathogen of various fungal diseases : Fruit and stem rot of Papaya, Red rot of sugarcane, Damping off of seedling of crop plants, Downy mildew of bajra, crucifer and pea, Powdery mildew of barley and cucurbits, Rust of linseed Cover and loose smut of barley, Wilt of Arhar, Leaf spot of crucifer, rice and turmeric, Blast of rice, Late blight of potato, Peach leaf curl, Ergot of bajra, Tikka disease of ground nut A study of symptomology in bacterial (Citrus canker, Blight of rice, Tundu disease of	30

	wheat, Soft rot of carrot/ onion), viral (Mosaic of apple, papaya, tobacco and potato, Leaf curl of tobacco, chilly and tomato, Tungru of paddy, Yellow vein mosaic and Bunchy top of banana) and M.L.O. (Sesame phyllody, Little leaf of brinjal, and Grassy shoot of sugarcane) disease Preparation of culture media and sterilization Isolation of fungi and bacteria from diseases plant Inoculation experiment with fungal and bacterial plant pathogens Measurement of fungal spores Transmission experiments (mechanical and insect transmission) of plant virus Use of fungicides and plant protection appliances Field collection of 50 diseased plant specimens (fungal, viral and bacterial) OR	
III (c)	To extract the pigment from green leaf and to estimate quantitatively the percentage of Chl a, Chl b and total chlorophyll and the carotenoids spectrophotometrically Estimate the percentage of total free amino acids in any plant material spectrophotometrically by using Ninhydrin To estimate the amount of Total Nitrogen in dry leaves by Micro- Kjeldahl method To estimate total protein of fresh moong, bean seedlings by biuret reagent To estimate the percentage of soluble protein of fresh moong, bean seedling by Lowry's method To estimate the percentage of reducing sugar in any plant material by Somogy-Nelson's method To estimate the percentage of total soluble sugar in plant tissue using anthrone reagent To estimate ascorbic acid in plant tissue To measure the activity of amylase in germinating barley and moong seeds and to study the effect of : (1) substrate concentration, (2) pH, (3) Temperature, and (4) any Heavy metal on amylase activity To study the effect of any stress (temperature, water) on germination in barley seed To estimate the percentage of fatty acid in castor, bean, mustard by Soxhlet's extraction method To test the presence of fatty acid in castor seed To measure the activity of the enzyme nitrate reductase (NR) in the leaves of Vigna mungo and to study the effect of : (1) substrate concentration, and (2) pH, on enzyme activity To study the phenomenon of Apical Dominance in Coleus and Tulsi To study the phenomenon of Phototropism in plants To study the phenomenon of Geotropism in plants	30
Suggested Readings 1. Sadasivam, S., & Manickam, A. (2008). <i>Biochemical Methods</i> (3rd ed.). New Age International Publishers, New Delhi. 2. Plummer, D. T. (1988). <i>An Introduction to Practical Biochemistry</i> (3rd ed.). Tata McGraw-Hill Publishing Company Ltd., New Delhi. 3. Sawhney, S. K., & Singh, R. (2015). <i>Introductory Practical Biochemistry</i>. Narosa Publishing House, New Delhi. 4. Aneja, K. R. (2012). <i>Experiments in Microbiology, Plant Pathology and Biotechnology</i> (4th ed.). New Age International Publishers, New Delhi.		

5. Bhojwani, S. S., & Razdan, M. K. (2013). *Plant Tissue Culture: Theory and Practice* (Revised ed.). Elsevier, Amsterdam.
6. Dubey, R. C. (2014). *A Textbook of Biotechnology*. S. Chand & Company Pvt. Ltd., New Delhi.
7. Jain, S. K., & Rao, R. R. (1977). *A Handbook of Field and Herbarium Methods*. Today & Tomorrow's Printers and Publishers, New Delhi.
8. Rangaswami, G., & Mahadevan, A. (2006). *Diseases of Crop Plants in India* (4th ed.). Prentice Hall of India, New Delhi.
9. APHA. (2017). *Standard Methods for the Examination of Water and Wastewater* (23rd ed.). American Public Health Association, Washington, D.C.
10. Gupta, P. K. (2019). *Cell and Molecular Biology: Practical Manual*. Rastogi Publications, Meerut.

Programme/Class: 2 Year PG degree	Year: II	Semester: IV Paper-V
Subject: Botany		
Course Code: BOT405R	Course Title: Dissertation/Research Project/Field Survey/Excursion	
Course Outcome: After successful completion of this course, students will be able to identify and formulate research problems, conduct field surveys and laboratory investigations using appropriate scientific methods, collect, analyze and interpret biological data, prepare technical reports and dissertations following scientific writing standards and effectively communicate research findings through oral presentations while demonstrating ethical and professional practices in botanical research.		
Credits: 4	Core Compulsory	
Max. Marks: 100	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 2-0-2		
Unit	Topic	No. of Lectures (60 hrs)
I	Data Analysis and Scientific Writing: Data compilation and statistical analysis; preparation of tables, graphs and figures; interpretation of results; referencing and citation styles; preparation of dissertation/project report; plagiarism awareness and academic integrity.	30
II	Dissertation Presentation / Excursion Report: Submission of dissertation/project report/field survey report/excursion report; seminar presentation and viva-voce; documentation of observations, photographs and herbarium specimens; discussion of findings, conclusions and future scope of the study.	30