Institute of Science, Nagpur

(An Autonomous Institute of Govt. of Maharashtra)

DEPARTMENT OF BOTANY

CREDIT STRUCTURE, EVALUTION SCHEME, AND SYLLABUS OF TWO-YEAR MASTER OF SCIENCE DEGREE WITH A SEMESTER PATTERN IN BOTANY

M. Sc. I YEAR BOTANY

(FACULTY OF SCIENCE &TECHNOLOGY)

BASED ON DIRECTION 2 OF 2024 ISSUED BY THE INSTITUTE OF SCIENCE, NAGPUR AS PER NEP 2020

To be implemented from 2026-2027

M. Sc. BOTANY

Program Outcomes (POs)

After completing the M.Sc. Botany program, students will be able to:

PO1. Scientific Knowledge: Apply advanced concepts of plant sciences, including taxonomy, systematics, ecology, physiology, and molecular biology, to understand biodiversity and ecosystem functioning.

PO2. Research Skills: Design experiments, analyze data, and use modern tools (bioinformatics, molecular markers, microscopy) to investigate biological problems.

PO3. Critical Thinking: Evaluate scientific literature, interpret results, and develop logical arguments for solving complex biological questions.

PO4. Professional Competence: Demonstrate competence in laboratory techniques, fieldwork, herbarium preparation, and plant identification for academic, industrial, and applied careers.

PO5. Ethics & Sustainability: Uphold research ethics, environmental responsibility, and sustainable practices in plant sciences.

PO6. Communication Skills: Present scientific ideas effectively through reports, presentations, and publications, fostering outreach and employability.

PO7. Lifelong Learning: Engage in continuous learning and adapt to emerging areas such as biotechnology, conservation, and climate change studies.

Program Specific Outcomes (PSOs)

Graduates of M.Sc. Botany will specifically be able to:

PSO1. Algae & Fungi Expertise: Identify, classify, and analyze the biology, life cycles, and economic importance of algae and fungi, including their role in biofertilizers, industry, and pathology.

PSO2. Bryophytes & Pteridophytes: Understand evolutionary trends, fossil history, and ecological roles of bryophytes and pteridophytes, with hands-on field and lab identification.

PSO3. Plant Systematics: Apply taxonomic principles, dichotomous keys, and modern classification systems (APG, molecular tools) to identify gymnosperms and angiosperms.

PSO4. Phycology & Hydrobiology: Assess algal diversity, freshwater ecosystems, eutrophication, and bioremediation strategies, linking aquatic ecology with human impacts.

PSO5. Advanced Mycology & Pathology: Analyze fungal ultrastructure, genetics, ecology, and metabolites; diagnose plant diseases and apply biocontrol methods.

PSO6. Research Methodology: Formulate hypotheses, design experiments, apply statistical tools, and conduct ethical research in plant sciences.

PSO7. Applied Botany: Translate botanical knowledge into practical applications in agriculture, forestry, pharmaceuticals, and environmental management.

Teaching and Examination Schemes Two Year M.Sc. (of four semesters) program is as follows.

Table 1: M.Sc. Semester-I

Sr No	Course Category	Name of the course (Title of the Paper)		Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	**DSC**	Paper 1:- **CRYPTOGAMIC BOTANY**	M-BO511T	6.0	4	--	--	4	3	60	40	50
		Paper 2:- **GYMNOSPERMS & PLANT SYSTEMATICS**	M-BO512T		4	--	--	4	3	60	40	50
2	**DSE**	Elective:- **1) PHYCOLOGY AND HYDROBIOLOGY 2) ADVANCED MYCOLOGY AND APPLIED PLANT PATHOLOGY**	M-BO513TPH M-BO513TMP		4	--	--	4	3	60	40	50
3	**DSC /DSE**	**DSC LAB I : Practical - I** (Based on Paper 1 + Paper 2+ Elective)	M-BO514P		--	--	12	6	8 - 12	180	120	150
4	**RM**	**RESEARCH METHODOLOGY**	M-BO515TRM		4	--	--	4	3	60	40	50
TOTAL					**16**	**--**	**12**	**22**		**420**	**280**	**--**

Table 2: M.Sc. Semester-II

Sr No	Course Category	Name of the course (Title of the Paper)		Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
					Th	Tu	P					
1	**DSC**	Paper 1:- **CELL AND MOLECULAR BIOLOGY- I**	M-BO521T	6.0	4	--	--	4	3	60	40	50
		Paper 2:- **PLANT PHYSIOLOGY**	M-BO522T		4	--	--	4	3	60	40	50
2	**DSE**	Elective:- 3) **PHYTOCHEMISTRY** 4) **PALYNOLOGY**	M-BO523TPC M-BO523TPN		4	--	--	4	3	60	40	50
3	**DSC /DSE**	**DSC LAB I : Practical - II** (Based on Paper 1 + Paper 2+ Elective)	M-BO524P		--	--	12	6	8-12	180	120	150
4	**OJT/FP**	**INTERNSHIP / APPRENTICESHIP** (Related to DSC)	M-BO525P		--	--	8	4	--	--	200	100
TOTAL					**12**	**--**	**20**	**22**		**360**	**440**	**--**
Cumulative Credits for : PG Diploma in Major Subject Core = 28 Electives = 8 RM = 4 OJT / FP = 4 = 44												
Exit option: PG Diploma after First Year UG Degree :- Cumulative Credits required for PG Diploma (After First Year Degree) = 44												

Table 3: M.Sc. Semester-III

Sr No	Course Category	Name of the course (Title of the Paper)		Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	**DSC**	Paper 1:- **BIOCHEMISTRY AND METABOLISM**	M-BO631T	6.5	4	--	--	4	3	60	40	50
		Paper 2:- **CELL AND MOLECULAR BIOLOGY- II**	M-BO632T		4	--	--	4	3	60	40	50
2	**DSE**	Elective:- 5)**REPRODUCTIVE BIOLOGY OF ANGIOSPERMS** 6) **INHERITANCE BIOLOGY**	M-BO633TRB M-BO633TIB		4	--	--	4	3	60	40	50
3	**DSC /DSE**	**DSC LAB I : Practical - III** (Based on Paper 1 + Paper 2+ DSE)	M-BO634P		--	--	12	6	8-12	180	120	150
4	**RP**	**RESEARCH PROJECT / DISSERTATION** (Core)	M-BO635P		--	--	8	4	--	--	200	100
TOTAL					**12**	**--**	**20**	**22**		**360**	**440**	**--**

Table 4: M.Sc. Semester-IV

Sr No	Course Category	Name of the course (Title of the Paper)		Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	**DSC**	Paper 1:- **PLANT ECOLOGY**	M-BO641T	6.5	4	--	--	4	3	60	40	50
		Paper 2:- **PLANT BIOTECHNOLOGY AND PLANT BREEDING**	M-BO642T		4	--	--	4	3	60	40	50
2	**DSE**	Elective:- 7) **PALEOBOTANY** 8) **PLANT BIODIVERSITY AND CONSERVATION**	M-BO643TPB M-BO643TPC		4	--	--	4	3	60	40	50
3	**DSC /DSE**	**DSC LAB** (Based on Paper 1 + Paper 2+ Elective)	M-BO644P		--	--	8	4	8	120	80	100
4	**RP**	**RESEARCH PROJECT / DISSERTATION** (Core)	M-BO645P		--	--	12	6	--	--	300	150
TOTAL					**12**	**--**	**20**	**22**		**300**	**500**	**--**
Cumulative Credits for PG in Major Subject (Two Year PG Degree) = 54 Electives = 16 RM = 4 OJT / FP = 4 RP = 10								**88**				
Cumulative Credits required for PG in Major Subject (One Year PG Degree) = 44 **Cumulative Credits required for PG in Major Subject (Two Year PG Degree) = 88**												

Credit Specifications:

a. Theory/Tutorial Courses: One hour/credit/week (a minimum of 15 hours of teaching per credit is required in a semester.

b. Laboratory/Performance Based Courses: A minimum of 30 hours in laboratory or Performance Based activities is required in a semester. Performance based activities include Workshop based activities, internship, Apprenticeship; Field based learning, community engagement learning, etc.

c. Each semester will consist of at least 15 weeks of Academic Work equivalent to 90 actual teaching days.

Assessment:

Assessment Plan will consist of **Continuous Internal Evaluation (CIE) and End Semester Evaluation (ESE)** for each course/subject taken together.

(A) Continuous Internal Evaluation (CIE) will be based on

(a) Attendance of the student during a particular semester

(b) An assignment (min. two) based on curriculum to be assessed by the teacher concerned

(c) Subject wise class test (min. two) or activities conducted by the teacher concerned with proper rubrics.

(d) Expected classroom activities shall consist of **Group Discussion, Seminars, Power Point Presentations, Elocution, Debate, Role Play, Case Studies, Educational Games etc .** The teacher is expected to undertake a minimum of four of the aforesaid activity.

(e) The CIE marks will be communicated to the examination cell at the end of each semester, but before the semester end examinations / as instructed by the Examination Cell. These marks will be considered for the declaration of the results.

(f) The record of internal marks, evaluation & results should be maintained for a minimum period of three years by the respective department for verification by the competent authority.

(B) End Semester Evaluation (SEE)

(a) Pattern of Theory Question Paper of 60 marks

1. There will be four units in each paper.

2. Maximum marks for each theory paper will be 60.

3. Question paper will consist of five questions, each of 12 marks.

4. Four questions will be on four units with internal choice (One question on each unit).

5. Fifth question will be compulsory with questions from each of the four units having equal weightage and there will be no internal choice.

Standard of Passing

The scope of the course, percentage of passing in Theory and Project, and Internal Assessment will be governed as per the following rules:

1. To pass the Master of Science (M.Sc.) I, II, III and IV Semester Examinations, an examinee shall obtain not less than 40 % (Grade 4) marks in each theory course/paper, taking CIE & SEE together. Whereas, for practical/performance-based examinations an examinee shall obtain not less than 50 % marks in each practical, taking CIE & ESE together.
2. An examinee who is unsuccessful at the examination shall be eligible for admission to the subsequent examinations on payment of a fee prescribed for the examination together with the conditions of the ordinance in force from time to time.

M. SC. SEMESTER-I BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I CRYPTOGAMIC BOTANY
M-BO511T

Hours: 4Hours/Week **Marks: 60(SEE)+40(CIE)=100** **Credit: 4**

Course Objectives

- To study diversity and biology, life cycles, economic importance of various groups of algae and fungi
- To understand plant diseases, symptoms, histopathology, etiology, identification of plant diseases and host–pathogen interactions
- To Understanding general characters, ecology, fossil history, classification, various types of bryophytes, pteridophytes.
- Learn evolutionary trends of various orders of Bryophytes, Pteridophytes and their different organs
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Course Outcomes:

After completion of the course, the student will be able to

- Identify the structure, life cycles, economic importances of algae,
- Identify the structure of fungi and economic importance of fungi
- Learn various types of bryophytes, Pteridophytes characters for identification in lab and nature.
- Understand various types of fossils in bryophytes and Pteridophytes
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Unit 1: Phycology **15 Hrs**

1. General Characters of Algae, Algae in diversified habitats (terrestrial, freshwater, marine), Thallus organization, cell ultrastructure; reproduction (vegetative, asexual, sexual)
   F.E. Fritsch Classification of Algae, Criteria for classification of algae:pigments, reserved food, flagella.
2. Characteristic feature, range of vegetative structure, reproduction in each class Chlorophyceaes, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta
3. General account; ultrastructure, nutrition and reproduction, biology and economic importance; Cyanobacteria:*Microcystis, Lyngbya, Nostoc, Scytonema, Gloeotrichia* and *Stigonema*.
4. Useful and Harmful aspects of Algae, algal blooms, algal biofertilizers,

Unit II: Mycology **15 Hrs**

1. Comparative study, classification and evolutionary trends in the following: Myxomycota: Protist characters and general account with special reference to *Physarium* and *Plasmodiophora*
2. Eumycota: i. Oomycetes: *Saprolegnia*, *Synchytrium*, *Phytophthora*, *Peronospora*,
3. Zygomycetes: *Mucor*, *Rhizophus*, *Syncephalastrum, Cunninghamella*

4. Ascomycetes: *Saccharomyces, Phyllactinia, Chaetomium, Xylaria*
5. Basidiomycetes: *Melampsora, Puccinia, Ravenelia, Ustilago, Polyporus*.
6. Deuteromycetes: *Helminthosporium, Fusarium, Colletotrichum.*

Unit III: Bryophytes **15 Hrs**

1. General characters, distribution, classification, ecology of Bryophytes, fossil history of bryophytes,
2. Cytology of bryophytes, regeneration in bryophytes, evolution of sporophyte- Retrogressive and Progressive theory.
3. General account of- Hepaticopsida: Sphaerocarpels, Takakiales;
4. General Account : Anthocerotopsida: Anthocerotales;
5. General account: Bryopsida: Sphagnales, Polytrichales.

Unit IV: Pteridophytes **15 Hrs**

1. General characters, distribution, classification, evolution of stele, heterospory and seed habit, apospory and apogamy; Important contributions of Indian Pteridologists,
2. General account of Ryniopsida, Psilopsida, Lycopsida (protolepidodendrales, Lycopodiales, Selaginales, Isoetales).
3. General account and evolutionary trends of Sphenopsida (Hyeniales, Equisetales), Filicopsida (Ophioglossales, Filicales, Salvinales, Marsileales), Tracheophyta (Progymnospermosida).

Laboratory Course

1. Classification and type study of the following Algal classes:
   a. *Cyanobacteria: Microcystis, Lyngbya, Nostoc, Scytonema, Gloeotrichia* and *Stigonema*.
   b. Chlorophyta: *Pandorina, Eudorina, Stigeoclonium, Ulva,Chlorella, Scenedesmus, Caulerpa, Valonia, Acetabularia*;
   c. Xanthophyta :*Botrydium and Vaucheria*
   d. Phaeophyta: Ectocarpus, *Sargassum Padina, Dictyota*;
   e. Rhodophyta: *Gelidium, Gracilaria, Corallina, Polysiphonia*;
   f. Euglenophyta:*Euglena*,

2. Morphological Studies of Fungi (any 15 of the following)
   Stemonities, Perenospora, Phytopthora, Albugo, Mucor, Rhizopus, Yeast, Aspergillus,Penicillium, Chaetomium, Taphrina, Peziza, Erisyphe, Phyllactenia, Uncinula, Melamosora,Uromyces, Drechslera,Ravenallia, Ustilago, Polyporus, Morchella, Cyathus, Alternaria, Helminthosporium, Curvularia, Colletotrichum, Phoma, Plasmodiophora, Cercospora, Fusarium, Claviceps.

3. Bryophytes: Study of morphological and reproductive characters of representative members mentioned in the syllabus using cleared whole mount preparations, dissections and sections.
4. Pteridophytes: Study of fossil forms (specimens and permanent micropreparations).
5. Pteridophytes: Study of living forms: Morphological, anatomical and reproductive characters of the forms mentioned in the syllabus. Anatomical characters to be studied either by taking free hand sections (T.S./L.S.) and by observing the permanent micropreparations

6. Field study: Lake Visit for collection of Algae and Field visit for collection and studying fungal flora. Study of bryophytes and Pteridophytes in their natural habitats.
7. Botanical excursion outside the state is compulsory to study the Bryophytes and Pteridophytes in their natural conditions.

Suggested Readings:

1. Kumar HD (1988) Introductory Phycology. Affiliated East-West Press Ltd. New Delhi
2. Morris I (1986) Introduction to the Algae. Cambridge University Press, UK
3. Round FE 1986 The Biology of Algae. Cambridge University Press, UK
4. Ainsworth, G.C. and A.S.Sussman (eds). The Fungi, An advance Treatise Vol.I, II, III & IV Academic Press, New York.
5. Alexopoulos, C.J. (1962). Introductory Mycology John Wiley Eastern Pvt.Ltd.
6. Alexopoulos, C.J. and Mims C.W. (1979). Introductory Mycology 3rd Edition, John Wiley and Sons, Inc. Wiley, New York.
7. Alexopoulos, C.J., Mims and Black well (1996) 4th ed. John Wiley and Sons, Inc. Wiley, New York
8. Bessey, E.A. (1950) Morphology and Taxonomy of Fungi. The Blakiston co. Philadelphia.
9. Barnett, J.H. (1968) Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
10. Mehrotra, R.S. and K.R.Aneja (1998) An Introduction to Mycology, New Age Intermidiate Press.
11. Banks H.P. (1968) The early history of Land plants. In evolution and environment, ed. E.T.Drake. New Haven: Yale Univ. Press, pp, 73-107.
12. Banks H.P. (1970) Evolution and plants of past. (Belmont, California, Wadsworth).
13. Berrie, G. K. (1963). Cytology and Phylogeny of liverworts. Evolution 17, 347-357.
14. Bierhorst D.W (1971) Morphology of vascular plants, New York (Mac Millan)
15. Campbell, D. H. (1961). The evolution of the Land Plants (central Book Depot, Allahabad)
16. Cavers, F. (1910). The interrelationship of Bryophyta I-IV.New Phytologist.
17. Cavers, F. (1911). The interrelationship of Bryophyta VII-IX.New Phytologist.
18. Delevoryas T. (1962) Morphology and Evolution of fossil plants (Holt, Rinehart and Winston, New York)
19. Eames A.J (1936) Morphology of vascular plants, lower groups (McGraw Hill, New York).
20. Foster A.S.and E.M Gifford Jr. (1959) Comparative morphology of vascular plants Freeman, San Fransisco.
21. Grolle, R. (1963). Takakia in Himalayas, Ost. Bot. Zeitscher, 110:444-447.
22. Gupta K.M. (1962) Marsilea, Botanical monograph no. 2 (CSIR, New Delhi).
23. Ingold, C. T. (1939). Spores discharge in land plants (Oxford London)
24. Kashyap S.R. (1929). Liverworts of the western Himalayas and The Punjab Plain 1 (Chronica Botanica)
25. Kashyap S.R. (1933). Liverworts of the western Himalayas and The Punjab Plain 2(Chronica Botanica)
26. Lacey, W. A. (1969). Fossil Bryophytes.Biological Reviews, 44,189-205.
27. Parihar N. S. (1976). An introduction to Embryophyta, Bryophyta (Centaral Book House, Allahabad)

28. .Parihar N.S. (1977) The biology and morphology of the Pteridophytes (Central Book Depot, Allahabad).
29. Pichi-Sermolli REG (1959) Pteridophyta in vistas in botany, WB Turrill, ed. (Pergamon Press, London) pp 421-493.
30. Puri Prem (1985) Bryophytes-A broad perspective.
31. Ramanujam CGK (1992) Origin and evolution of lycopods Paleobotanist 41, 51-57.
32. Rashid A. (1982) (4th edn) An introduction to pteridophyta (Vikas Publ House Pvt Ltd.)
33. Schuster R. (1966). The Hepaticae and Anthocerotae of North America.East of the Hundredth meridian, Newyork (Colombia University Press).
34. Scott D.H. (1920-1923) Studies in fossil botany. (A & C Black London.)
35. Sharma O.P (1996) Textbook of pteridophyta (Mac Millan India Ltd, New Delhi)
36. Smith A. J. E. (1986). Bryophyte phylogeny fact or Fiction? Journal of Bryology, 14,83 89.
37. Smith G. M. (1955). Cryptogamic Botany-vol. 2 Bryophyta and Pteridophyta (McGraw Hill Book compony, Newyork)
38. Smith W.N. and G. W. Rothwell (1993). Paleobotany and the evolution of plants (Cambridge Univ. press)
39. Sporne K.R. (1962) The morphology of pteridophyta (Hutchinson Univ. Library, London)
40. Steil W.N. (1939) Apogamy, Apospory and Parthenogenesis in the pteridophyta, Bot. rev, 5, 433-453.
41. Steward W.N. (1983) Paleobotany and the evolution of plants. ed. New York, (Cambridge Univ. press)
42. Surange K.R and S. Chandra (1972) Fructification of Glossipteridae from India, Paleobotanist 21, 1-17. 40. Taylor T.N. (1988) the origin of land plants-Some answers more questions, Taxon, 37, 805
43. Udar Ram (1970) An introduction to bryophyte (Shashidhar malviya Prakashan, Lucknow)
44. Watson E.V. (1967) The structure and life of Bryophytes, 2nd ed, London, Hutchinson.

M. SC. SEMESTER-I BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-II GYMNOSPERMS & PLANT SYSTEMATICS
M-BO512T

Hours: 4Hours/Week Marks: 60(SEE)+40(CIE)=100 Credit: 4

Course Objectives:

1. The major features and evolutionary origins of vascular plant.
2. To study morphological, anatomical and reproductive features of Gymnosperm
3. Learn the origin of gymnosperms, classification, evolution, economic importance of gymnosperms
4. Identification of Angiospermic plants using dichotomous key.

Course outcomes:

After completion of the course, the student will be able to

1. Develop understanding of major patterns in the evolution of seed plants and plant diversity. including the principles of phylogenetic systematics
2. Learn skills required for effective identification of order, family, genus and species
3. Ability in communicating ideas for plant identification leading to pursue higher studies to get employability.

Unit 1: Gymnosperm (15 Hrs)

1. General account; distribution (living, Fossil); origin; systems of classification; economic importance.
2. Comparative morphology and evolutionary tendencies of:
   Pteridospermales- Lyginoptridaceae
   Cycadales- Cycadaceae; Fossil history (*Baenia, Nilssonia, Androstrobus*)
   Cycadeoidales- Williamsoniaceae, Cycadoeoidaceae
3. General account and relationships of- Cordaitales, Caytoniales, Glossopteridales, Pentoxylales,
4. Gnetales, Ginkgoales (*Ginkgo, Baiera, Trichopitys*); Coniferales (General characters, Embryogeny and phylogeny, evolution of ovuliferous scales, phylogeny); Taxales (*Taxus*, taxonomic position of taxales with respect to coniferales)

Unit 2 Angiosperms (15 Hrs)

1. Significance of plant systematic :Introduction to systematic ; Components of systematics: Classification, Identification, Nomenclature
2. Concept of species: Morphological, Biological, Phylogenetic
3. Taxonomic Hierarchy, Taxonomic categories (Species to Kingdom)
4. Botanical Nomenclature: Principles and rules of (ICBN), Ranks and names; principle of priority, binomial system, type method, author citation, valid publication,
5. Taxonomic tools: Herbarium, Floras, Monographs, Botanical gardens, Biochemical and Molecular techniques, Computers and GIS.

Unit 3 Taxonomy **(15 Hrs)**

1. Morphological characters in taxonomy, Anatomy, Palynology in taxonomy
2. Numerical taxonomy (Phenetics) , Cytotaxonomy, Chemotaxonomy, Palynology and Embryology in systematics
3. Systems of Classification : Major Contribution of Theophrastus, Linnaeus, Anderson, decandoll Bessey, Hutchinson and Cronquist
4. Types of Classification: Artificial, Natural and Phylogenetic classification. Bentham & Hooker system, Engler & Prantl system, Hutchinson system, Takhtajan system, Cronquist system
5. APG (Angiosperm Phylogeny Group) classification, Comparison of systems

Unit 4 Systematics **(15 Hrs)**

1. Systematic study, Diagnostic characters, floral formula, floral diagrams and economic importance of the following Dicotyledons families;
   a. Ranunculaceae, Papaveraceae, Brassicaceae
   b. Fabaceae subfamily: Caesalpinioideae, Mimosoideae Papilionoideae,
   c. Apiaceae, Cucurbitaceae, Euphorbiaceae, Asteraceae, Lamiaceae
2. Systematic study, Diagnostic characters, floral formula, floral diagrams and economic importance of the following Monocotyledons families;
   a. Orchidaceae,
   b. Palmae
   c. Poaceae

Lab Based on DSC II Plant Systematics

Suggested Laboratory Exercises

1. Study of vegetative and reproductive parts of: *Cycas, Zamia, Cedrus*, *Pinus, Cupressus, Cryptomeria, Taxodium, Podocarpus, Agathis, Thuja, Gnetum*, *Ephedra, Juniperus*, *Cephalotaxus, Taxus*. Permanent micropreparatious to be submitted by the students.
2. *Ginkgo*: Morphology to be studied from Museum specimens & anatomy from permanent slides only.
3. Study of important fossil gymnosperms from material and permanent slides.
4. Demonstration of herbarium techniques.
5. Study of vegetative and floral characters of following Dicot families (Description, ovary, floral Diagrams, floral formula and systematic position according to Bentham and Hooker system of classification)
   a. Rananculaceae,
   b. Papaveraceae
   c. Brassicaceae
   d. Fabaceae subfamily: Mimosoidae, Caesalpiniodeae, Papilionatae,
   e. Apiaceae,
   f. Cucurbitaceae,

g. Euphorbiaceae,
h. Asteraceae,
i. Lamiaceae

6. Study of vegetative and floral characters of following Monocot families (Description, ovary, floral Diagrams, floral formula and systematic position according to Bentham and Hooker system of classification)
   a. Orchidaceae,
   b. Palmae
   c. Poaceae
7. To study the variation in stamens and carpels.
8. To study Placentation types in various taxa.
9. Description of various species of a genus, location of key characters and preparation of keys at generic level.
10. Location of key charecters and use of keys at family level.
11. Description of specimens from representative, locally available Angiosperm families.
12. Field visits to ecologically different localities to study living gymnosperms.

Suggested Readings

1. Cronquist,A.(1981) An integrate system of classification of flowering Plants. Columbia Uni.Press. New york.
2. Takhtajan,A.(1969).Flowering Plants :Origin and Disposal (Tr.c.Jefferey) Olive . And Bot.Gard,62Bord. Edinbusgh.
3. Thorne,Robert F.(1975),Angiosperm Phylogeny and Geography.Ann.Missouri Bot.Gard.62: 362-367.
4. Heywood,VH.(ed)(1968) Modern Methods in Plant Taxonomy,A.P.,London and N.Y.
5. Singh,(2012).Plant systematic; Theory and Practice Oxford and IBH Pvt. Ltd.,New Delhi.3rd edition.
6. Jefferey,C. (1982).an introduction to Plant Taxonomy.Cmbridge University Press,Cambridge.
7. Maheshwari,J.K. (1963),Flora of Delhi, CSIR, New Delhi.
8. Takhtajan, A. L. 1997. Diversity and classification of Flowering Plants. Columbia University Press, New York.
9. Radford,A.E.(1986).Fundamentals of Plant Systematic.Harper and Row,New York.
10. Plant Taxonomy Saxena and saxena 7th evised edition, Pragati prakashan Meerut.
11. A text book of practical Botany Vol II,Bendre vol . II,Bendre,Kumar 7th edition, Rastogi Publication,Meerut.
12. Taxonomy of Angiosperm AVSS Sambamurty.,I K International Pvt. Ltd.,New Delhi
13. Systematic Botany (Angiosperms),Fourteenth Edition.Prof R.C. Mathur, Agra book store.
14. Stewart, W.N. and Rothwell G.W. (1993), Palaeobotany and the Evolution of Plants, Cambridge University Press.
15. Eames, A.J.(1974): Morphology of Vascular Plants-lower groups, Tata Mc-Graw Hill publishing Co., New Delhi.
16. Agashe, S.N. (1995), Palaeobotany, Oxford & IBH, New Delhi.

17. Biswas, C & Johri, B.N. (2004), The Gymnosperms, Narosa Publishing House, New Delhi.
18. Coulter J.M. & Chamberlain C.J.(1978): Morphology of Gymnosperms, Central Book Depot, Allahabad.
19. Kakkar, R.K.and Kakkar, B.R. (1995), The Gymnosperms (Fossils & Living), Central Publishing House, Allahabad.
20. Sharma O.P. (2002) Gymnosperms, Pragati Prakashan, Meerut.
21. Siddiqui, K.A. (2002) Elements of Palaeobotany, Kitab Mahal, Allahabad.
22. Bhatnagar, S.P. and Moitra A. (1996), Gymnosperms, New Age International Pvt. Ltd.,New Delhi.
23. http;www.theplantlist.org, http;www.tropicos.org, http//www.npgsweb.ars-grin.gov, http;//www.iapt-taxon.org

M. SC. SEMESTER-I BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-I PHYCOLOGY AND HYDROBIOLOGY
M-BO513TPH

Hours: 4Hours/Week **Marks: 60(SEE)+40(CIE)=100** **Credit: 4**

Course objectives: -

1. To understand the salient features and economic importance of algal diversity
2. To study the structure and reproduction of various genera mentioned in the field of lower plants.
3. To familiarize the salient features and economic importance of various algal groups
4. To Know Distribution and dynamics of freshwater bodies
5. To understand the impact of human activities on water bodies

Course outcome: -

By the end of this course, the students will be able to:

1. Students will understand the morphology and organization of the thallus and their role in medicine, industrial and food.
2. Students will understand the interrelationship of various algal groups
3. Understand the contributions of famous Indian phycologists and centers of Algal Research in India.
4. Study their ecological and economic importance
5. Understand Human impacts on lakes (e.g., water quality) and remediation strategies
6. Learn The role of aquatic ecosystem science in society

Unit-I (15 Hrs)

1. General account of Phycology, Contributions of Indian Phycologist,
2. Classification and general characters of Algae, Criteria for algal classification, F.E. Fritch classification of algae,
3. Diverse habitats of Algae, Range of thallus organization, Algal pigments and its significance in classification, ultra-structure of flagella, eyespot and pyrenoids.
4. Algal reproduction- (vegetative, asexual and sexual), life cycles and molecular phylogeny of algae.
5. Useful and harmful aspects of Algae -Algae as source of food for human, animal feed, SCP; Pharmaceuticals, biofuel, bio-ethanol, biofertilizers, industrial applications of algae.

Unit-II (15 Hrs)

1. General features, range of vegetative structure, reproduction, life cycle and phylogeny, brief knowledge of the following genera
2. Chlorophyta :Chlamydomonas, Hydrodictyon, Ulva, Cladophora, Pithophora, Chara
3. Xanthophyta :Botrydium and Vaucheria
4. Phaeophyta : Ectocarpus, Dictyota, Padina and Sargassum
5. Rhodophyta : Polysiphonia, Ceramium, Gelidium and Gracilaria

6. Cyanophyta : Anabaena, Spirulina, Oscillatoria and Lyngbya
7. General characteristic of the following divisions Bacillariophyta Cryptophyceae, Dinophyceae, Euglenophyceae and Chrysophyceae,

Unit-III (15 Hrs)

1. Scope and importance of Hydrobiology, Physical and chemical characteristics of water , freshwater environment
2. Aquatic Ecosystem Types: Lotic (running waters) , Lentic (stagnant waters) ecosystems (rivers, lakes, wetlands). Characteristics, Zonation
3. Freshwater Flora: Phytoplankton Diversity, periodicity and succession, vertical distribution, Nekton and benthos, Aquatic food chains and food webs, Primary productivity in aquatic ecosystems
4. Aquatic plants: Aquatic macrophyte structure, characteristics and adaptation, classification, zonation, seasonal variations,

Unit-IV (15 Hrs)

1. Eutrophication and algal blooms: Definition, factor responsible for water quality, use of algal blooms and their control measures. Bioluminescence.
2. Algae in waste water treatment, Bioindicators and Bio monitoring of water quality. Algae stabilization pond. Role of algae in CO2 sequestration, Bioremediation,
3. Sources of Nitrogen and its assimilation, importance and activity of biofertilizers, and Biological Nitrogen fixation. Symbiotic algae and their role in other plants.
4. Mass cultivation of algae, Microalgae Culturing techniques and photo bioreactor-based production;

Laboratory Exercises

1. Classification and type study of the following classes:
   Chlorophyta : Chlamydomonas, Hydrodictyon, Ulva, Cladophora, Pithophora, Chara and *Nitella*.
   Xanthophyta : *Botrydium* and *Vaucheria*
   Phaeophyta : *Ectocarpus*, *Dictyota, Padina* and *Sargassum*
   Rhodophyta : *Polysiphonia, Ceramium, Gelidium* and *Gracilaria*
   Cyanophyta : *Anabaena, Spirulina, Oscillatoria* and *Lyngbya*
2. Identification of phytoplankton collected from water body
3. Determination of physical characteristics and chemical characteristics of Water from polluted and unpolluted water body
4. Collection and identification of aquatic plants from different fresh water bodies
5. Separation of algal pigments by paper chromatography method
6. Estimation of primary productivity in fresh water bodies
7. Field visit to lotic and lentic water bodies.

Suggested Readings

1. Fritsch, F.E. 1979. The structure and Reproduction of Algae Vol. I & II. Bishan Singh,Mahendra Pal Singh, Dehradun. Delhi.651 pp.1999.
2. O.P. Sharma. 2011, Algae, TATA McGraw-Hill, India.
3. Prescott, G.W. 1984. Algae: A review, Bishan Singh, Mahendra Pal Singh. Dehradun.
4. Kumar, H.D. Introductory Phycology. 2nd Ed. Affiliated East-West Press, New
5. Morris, I. 1986. An introduction of Algae. Cambridge University Press U.K.
6. R. E. Lee. 2008.Phycology, 4th Ed. Cambridge University Press
7. V.J. Chapman. 2015. The algae, Springer
8. Pandey, S.N., S.P.Misra and P.S. Trivedi. 2002. A Textbook of Botany Volume II. Vikas Publishing House Pvt Ltd, New Delhi.
9. Sharma, O.P. 2008. Textbook of Algae, Tata McGraw Hill
10. Round, F.E.1986. The Biology of Algae. Cambridge University Press, Cambridge
11. Desikachary, T.V. (1984). Cyanophyta. ICAR, New Delhi.

Reynolds, C.S.2007. Ecology of Phytoplankton

M. SC. SEMESTER-I BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-II ADVANCED MYCOLOGY AND PLANT PATHOLOGY
M-BO513TMP

Hours: 4Hours/Week Marks: 60 (SEE) + 40 (CIE) = 100 Credits: 4

Course Objective: -

1. Students should understand ultrastructure of fungal cell, gain skills in fungal taxonomy, explore fungal ecology and master host-parasite relationship.

Course outcome: -

By the end of this course, the students will be able to:

1. Analyse fungal reproduction at molecular level.
2. Classify fungi using morphological characters and molecular markers.
3. Understanding phylogenetic methods of tree construction of fungal systematics.
4. Evaluate ecological role of fungi
5. Application of knowledge of fungal metabolites, their uses for human welfare.
6. Acknowledge major milestones in fungal systematics.
7. Diagnose crop diseases and control methods.

Unit-I Advanced Mycology (15Hrs)

- Ultrastructure of fungal cells (cell wall composition, chitin, glucans, mannoproteins).
- Molecular basis of fungal reproduction and development.
- Types of spores and dispersal mechanism.
- Fungal genetics: heterokaryosis, parasexual cycle, mating-type genes.
- Pathogenic fungi (Candida, Aspergillus)

1**Unit-II Molecular Systematics and Phylogeny (15Hrs)**

- Major Milestones in fungal taxonomy (Micheli, Gäumann, Ainsworth, Hawksworth, Kirk, AFTOL, Liu).
- Molecular markers in fungal phylogenetics: ITS, LSU, SSU, RPB1, RPB2, TEF1.
- Phylogenetic methods: DNA sequencing, PCR, phylogenetic tree construction.
- Current classification systems (Alexopoulos, Kirk et al., Index Fungorum, MycoBank).

Unit III – Fungal Ecology and Applied Mycology

- Mycorrhizal associations: AM fungi, ectomycorrhizae, ericoid, orchid mycorrhizae.
- Endophytic fungi and their ecological roles.

- Fungal interactions: parasitism, mutualism, antagonism.
- Role of fungi in biogeochemical cycles (carbon, nitrogen, phosphorus).
- Fungal enzymes: amylases, cellulases, ligninases, proteases, industrial applications.
- Fungal toxins and secondary metabolites (aflatoxins, ergot alkaloids).
- Antibiotics -Penicillin and Cephalosporin
- Organic acids -Critic acid, Gluconic acid, lactic acid, kojic acid, Itaconic acid.

Unit IV – Advanced Plant Pathology (15Hrs)

- Molecular basis of host-pathogen interactions.
- Pathogenesis-related proteins, elicitors, and defense signaling.
- Disease forecasting, epidemiology, and plant quarantine.
- Symptomology, histopathology, etiology and identification of diseases with reference to following fungal, bacterial and viral diseases (Paddy blast, wheat rust, bunt of wheat, smut of jowar, black arm of cotton, red rot of sugarcane, citrus canker, gummosis, leaf curl of papaya, potato blight.
- Biocontrol agents: *Trichoderma*, *Beauveria*, *Metarhizium*.

List of Books / References / Online Resources

1. Agrios, G.N. (2005) Plant Pathology, academic Press, INC, New York.
2. Alexopoulos, C.J., Mims and Black well (2007) Introductory Mycology, John Wiley and Sons, Inc. Wiley, New York
3. Kirk, P.M., Cannon, P.F., Minter, D.W., & Stalpers, J.A. (2008). Dictionary of the Fungi – 10th edn. CAB International.
4. AFTOL Project Reports (2002–2011)
5. Aneja, K.R. (1993) Experimental in Microbiology, Plant Pathology & Tissue Culture, Wiswa Prakashan, New Delhi.
6. Bessey, E.A. (1950) Morphology and Taxonomy of Fungi. The Blakiston co. Philadelphia.
7. Bilgrami, K.S. and H.C.Dube (1985) A text Book of Modern Plant Pathology, Vikas Publication House, New Delhi.
8. Mehrotra, R.S. (1989) Plant Pathology, Tata McGraw Hill.
9. Singh, R.S. (1994). Plant Pathology, Oxford & IBH publishing Co. New Delhi
10. Mehrotra, R.S. and K.R.Aneja (1998) An Introduction to Mycology, New Age Intermidiate Press.
11. Manoharachary, C. et al. (2016). Mycology and Microbiology, Scientific publishers, India
12. Thind, T.S. (1998) Diseases of field crops and their management, National Agricultural Technology, Information Centre, Ludhiana.

Suggested activity:
Seminar, Quiz, debate, Assignments, visit to a nearby Farm or forest site for collection of diseased plants, Field work, Study Projects, Models etc. are Part of Curriculum. Botanical Excursion (one short excursion is compulsory)

List of Practicals

1. Microscopic study of fungal cell wall (chitin, glucans, mannoproteins) using stains.
2. Demonstration of heterokaryosis and parasexual cycle in *Aspergillus* using photomicrographs.
3. Study of pathogenic fungi (*Aspergillus fumigatus*) using culture slides.
4. DNA extraction from fungi and PCR amplification of ITS/LSU regions.
5. Gel electrophoresis and phylogenetic tree construction (bioinformatics software).
6. Comparative taxonomy exercise: morphological vs molecular classification.
7. Isolation of mycorrhizal spores from soil and staining with trypan blue.
8. Endophyte isolation from *Vinca rosea*.
9. Enzyme assays of cellulase, ligninase and amylase.
10. Screening fungi for antimicrobial activity (disc diffusion or agar well diffusion method).
11. Demonstration of organic acid production (citric acid fermentation).
12. Pathogen isolation from diseased crop samples.
13. Koch's postulates demonstration with a model pathogen.
14. Screening fungi for antimicrobial activity (leaf histopathology *Albugo* or *Cercospora*).
15. Disease forecasting exercise using local crop disease data.
16. Study of plant diseases mentioned in theory.
17. A field visit for collection of specimens.

M. SC. SEMESTER-I BOTANY

PRACTICAL EXAMINATION

DSC AND DSE LAB

M-BO514P

Question paper

Time : 6-8 Hours **Max marks : 180**

1. One experiment from DSC Paper-1……. 20 Marks
2. One experiment from DSC Paper-1 ……10 Marks
3. One experiment from DSC Paper-2 ……20 Marks
4. One experiment from DSC Paper-2 ……10 Marks
5. One experiment from DSE ……...20 Marks
6. One experiment from DSE ……...10 Marks
7. Spotting: (5 marks for each spot) ……30 Marks

G. DSC Paper-1
H. DSC Paper-1
I. DSC Paper-2
J. DSC Paper-2
K. DSE
L. DSE

8. Viva-voce ……30 Marks
9. Record and excursion report (submission is compulsory) ……...30 Marks

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
30	30	30	30	**120**

M. SC. SEMESTER-I BOTANY
RESEARCH METHODOLOGY
M-BO515TRM

RM-Theory Hours: 4 Hours/Week Marks: 60 (SEE) + 40 (CIE) Credits: 4

Course objectives: To develop a strong foundation in scientific thinking, experimental design, and analytical reasoning, enabling students to transform botanical problems into well-structured research investigations.

Acquire proficiency in designing experiments, handling data, and applying statistical and computational tools in biological research.

Uphold high standards of research ethics, academic integrity, and responsible scientific communication.

Course outcomes:

- To train students in identifying research problems, formulating hypotheses, and defining objectives for scientific investigation.
- To familiarize students with various types of research designs and methodologies used in biological and botanical sciences.
- To develop skills in literature review, data collection methods, and scientific documentation.
- To provide knowledge of statistical tools and techniques used for analysis and interpretation of biological data.
- Promote scientific writing skills for thesis preparation, journal publication, and project reporting at national and international levels.

Unit I: Research basics and perception of research (15 Hrs.)

- Meaning, objectives, and characteristics of scientific research. Importance of research in plant sciences
- **Types of research**: basic, applied, exploratory, descriptive, experimental Scientific thinking and problem-solving approach in botany
- **Research problem**: Concept and statement of a research problem, Research gaps and problem prioritization. Techniques for problem identification
- **Hypothesis:** Meaning and importance of hypothesis in scientific research. Types of hypotheses: null, alternative, directional, non-directional. Hypothesis formulation.
- **Research objectives:** meaning, types, and significance. Difference between aims and objectives. Writing SMART objectives (Specific, Measurable, Achievable, Relevant, Time-bound)

Unit II: Literature Review (15 Hrs.)

- **Literature Review** Meaning and objectives of literature review, Steps in conducting a systematic literature review, Critical reading and analysis of research papers, Thematic and chronological

organization of literature, Citation management tools (basic introduction: Mendeley, Zotero), Avoiding plagiarism in literature review.

- **Types of scientific literature**: primary, secondary, and tertiary sources.
- **Sources of botanical information:** Journals (national and international), Books, monographs, floras; Online databases (Google Scholar, PubMed, Scopus – overview); Use of library resources and digital repositories, Techniques for effective literature search, Keywords, Boolean operators, and search strategies
- **Data collection:** Meaning and importance of data in research, Types of data: qualitative and quantitative, Primary and secondary data collection methods, Field data collection techniques, Laboratory data recording methods, Data quality, accuracy, and validation.

Unit III: Introduction to Biostatistics (15 Hrs.)

- Meaning and scope of statistics in biological sciences. Types of data: qualitative, quantitative, discrete, continuous; Scales of measurement: nominal, ordinal, interval, ratio.
- **Measures of central tendency**: Mean, median, mode
- **Measures of dispersion:** Range, variance, standard deviation Coefficient of variation
- **Graphical representation of data:** Bar diagrams, histograms, pie charts, frequency curves
- **Hypothesis testing:** concept and importance, Level of significance and confidence intervals, Chi-square test (goodness of fit and independence), t-test (paired and unpaired), ANOVA, Correlation and regression analysis (basic concepts).

Unit IV: Fundamentals of Scientific Writing (15 Hrs.)

- Importance of scientific communication in research, Characteristics of scientific writing: clarity, precision, objectivity.
- **Thesis and Dissertation Writing**: Structure of thesis/dissertation Formatting guidelines and institutional standards, Presentation of tables, figures, and appendices, Writing conclusions and future scope, Proofreading and editing techniques.
- **Research Paper Writing:** Structure of a research paper, Selection of appropriate journals, Impact factor, indexing, and journal quality indicators
- **Referencing, Citation, and Plagiarism Control:** Importance of citations in scientific writing. Referencing styles: APA, Harvard, Vancouver (overview); In-text citation methods
- **Use of reference management tools:** Mendeley; Zotero
- **Plagiarism**: types and consequences, Plagiarism detection tools (Turnitin, Grammarly – overview) Academic integrity and ethics in publishing

Reference:

1. Kothari, C.R. & Gaurav Garg (2019) Research Methodology: Methods and Techniques New Age International Publishers, New Delhi.
2. Ranjit Kumar (2018), Research Methodology: A Step-by-Step Guide for Beginners SAGE Publications.
3. Wayne C. Booth, Gregory G. Colomb & Joseph M. Williams (2016) The Craft of Research University of Chicago Press.

4. John W. Creswell & J. David Creswell (2018), Research Design: Qualitative, Quantitative and Mixed Methods Approaches, SAGE Publications.
5. Geoffrey Marczyk, David DeMatteo & David Festinger (2005), Essentials of Research Design and Methodology Wiley.
6. P.S. Narayana, D. Varalakshmi & T. Pullaiah (2016), Research Methodology in Plant Science Scientific Publishers.
7. V.P. Singh (2021), Research Methodology in Plant Sciences Scientific Publishers.
8. J. Jayaraman (1972), Techniques in Biology Higgin bothams, Chennai.
9. Zar, J.H. (1999), Biostatistical Analysis Prentice Hall.
10. Sokal, R.R. & Rohlf, F.J. (1995), Biometry: The Principles and Practice of Statistics in Biological Research
11. W.H. Freeman. Khan, I.A. & Khanum, A. (1994) Fundamentals of Biostatistics Vikas Publishing House.
12. Sree Ramulu, V.S. (1988) Thesis Writing Oxford & IBH Publishing. Connor & Peter
13. Woodford (1979) Writing Scientific Papers in English Pitman Publishing.
14. Carol Ellison (2010), McGraw-Hill's Concise Guide to Writing Research Papers McGraw-Hill.
15. Balagurusamy, E. Programming in BASIC / Introduction to Computers Tata McGraw-Hill.
16. Rastogi, S.C. et al. (2003) Bioinformatics: Concepts, Skills and Applications CBS Publishers.
17. Neuman, W.L. (2008) Social Research Methods: Qualitative and Quantitative Approaches Pearson Education.
18. Dooly, Moore & Vallejo (2017) Research Ethics Research-publishing.net.

M. SC. SEMESTER-II BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I CELL AND MOLECULAR BIOLOGY
M-BO521T

Hours: 4Hours/Week Marks: 60 (SEE) + 40 (CIE) = 100 Credits: 4

Course Objectives:

1.Understanding the structures and functions of the cell wall, plasma membrane and plasmodesmata

2. Understanding the structures and functions of cell organelles, cytoskeleton, nuclear envelope, and structure of DNA

3. Understanding various types of stresses and defense mechanisms in plants and apply this knowledge.

Course Outcomes:

After successful completion of the course the students will be able to

1. Know the cell wall & cellular organization of the eukaryotic and prokaryotic cells

2. Learn the cell cytoskeleton and its role

3. Learn and apply techniques of stress related problems in plants.

Unit-I Cell wall: (15 Hrs)

1.Structure; function; biogenesis and growth.

2. Plasma membrane: Membrane architecture (fluid mosaic model); sites for ATPases; membrane transport-ion carriers, channels, pumps and aquaporins; receptors. 3. Plasmodesmata: Structure, role in movement of molecules and macromolecules; comparison with gap junction.

Unit-II Cellular organelles (15 Hrs)

1. Ultra-structure and function of golgi complex, lysosomes, peroxisomes, endoplasmic reticulum, mitochondria, chloroplast and plant vacuoles.

2.Cell shape and motility: The cytoskeleton; organization and role of microfilaments, intermediate filaments and microtubules; motor movements, implications in cell division, flagellar & other movements.

Unit-III Nucleus (15 Hrs)

1. Nucleus: Ultrastructure, nuclear pores, nucleolus, DNA structure A, B and Z forms, replication in prokaryotic and eukaryotic cells, DNA replication proteins, damage and repair.

2. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA;

3. Types of RNA; Structure of tRNA.

Unit-IV Stress Physiology (15 Hrs)

1. Stress biology: Definition and classification of stress.

2. Biotic stress: Plant defence mechanism (passive and active); HR and SAR; modulation of plant metabolism in response to biotic stress: early and late response; production of ROS, induction of

enzymes; PR proteins; R-genes.
3. Abiotic stress: Effect of water, temperature, salt and light stress on plants; developmental and physiological mechanisms protecting plants against environmental extremes.

Suggested activity:
Seminar, Quiz, debate, Assignments, collection and preparation of different study Projects, Models etc. are Part of Curriculum.

Suggested readings :
1. Atherly, A.G., Griton, J.R. and Mc Donald, J. F. 1999.The Science of Genetics.Saunders College Pub. Fort Worth, USA
2. Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA.
3. Bush, H. Rothblum, L. 1982. Vol. X. The Cell Nucleus RDNA part A. Academic Press.
4. Dc, D. N. 2000 Plant cell vacuoles: An introduction. CSIRO Publication, Collingwood, Australia.
5.Fukui, K. and Nakayama, S. 1996. Plant Chromosomes: Laboratory Methods. CRS Press, Boca Raton, Florida.
6.Glick, B. R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Biotechnology.CRC Press, Boca Raton, Florida USA.
7.Goswami, H. K. 1986. Practical cytology – Applied Genetics and Biostatistics Himalaya Pub. House, Bombay.
8.Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Barlett Publishers, Boston, Massachusetts.
9.Hall, J.L. and Moore, A.L. 1983.Isolation of Membranes and Organelles from Plant Cells Academic Press, London, U.K.
10.Harris,N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.
11.Sharma, A.K. and Sharma, A. 1999. Plant Chromosomes: Analysis, Manipulation and Engineering. Har Academic Publishers, Australia.
12.Shaw, C.H. (Ed.), 1988. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.Techniques, 2nd edition. PAS, IRL Press at Oxford University Press, Oxford.

References: Online journals available on UGC V-SAT

Review Journals:
Annual Review of Plant Physiology and Molecular Biology
Biochemistry and Cell Biology
Cell Death and Differentiation
Cell Motility and the Cytoskeleton
Cellular Physiology and Biochemistry
Current Advances in Plant Sciences
European Journal of Cell Biology Journal of Cell Science
Nature Reviews: Molecular and Cell Biology
Protoplasma-An International Journal of Cell Biology

Trends in Cell Biology
Trends in Plant Sciences

13. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8Ed. B. I. Waverly Pvt. Ltd., New Delhi.
14. Jones R, Ougham H, Thomas H and Waaland S 2013 The Molecular life of plants. Wiley-Blackwell Publ., USA
15. Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.
16. Kleinsmith, L.J. and Kish, V.M. 1995 Principles of Cell and Molecular Biology (2ndEdi.)Harper Collins Coll. Publisher, New York, USA.
17. Krishnamurthy, K.V. 2000 Methods in Cell wall Cyto-chemistry. CRC Press, Boca Raton, Florida
18. Lodish, H., Berk, A. Zipursky, S. L. Matsudaira, P., Baltimore, D. and Dar nell, J. 2000 Molecular Cell Biology Edi. W.H. Freeman and Co., New York, USA
19. Russel, P. J. 1998 Genetics (5th Edi.) The Banjamin/ Cummings Publishing Com. Inc., USA
20. Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA
21. Taiz, L. and Zeiger, E. 1998: Plant Physiology. Sinaucr Associates, Inc., Publishers, Massachus, USA

Practicals

1. To study salivary gland chromosomes of Chironomas and Drosophila.
2. To isolate mitochondria and determine the activity of its marker enzyme SDH.
3. To isolate bacterial and plant DNA and quantify them by spectrophotometric method.
4. To demonstrate the semi-permeability of the plasma membrane.
5. To study the activity of Na/K ATPase.
6. To demonstrate different components of cytoskeleton in the suitable material.
7. To perform flagellar staining.
8. Isolation of DNA and preparation of Cot-curve.
9. Demonstration of vital structure and functions of cell
10. To study the activity of PAL in the seedlings challenged with elicitors.
11. To study the induction of antioxidant enzymes in the seedlings challenged with elicitors.
12. To study the effect of water stress on the seedling growth and its chlorophyll content.
13. To study the effect of temperature stress on the seedling growth and its chlorophyll content.
14. To study the effect of salt stress on the seedling growth and its chlorophyll content.

M. SC. SEMESTER-II BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-II PLANT PHYSIOLOGY
M-BO522T

Hours: 4 Hours/Week. Marks: 60(SEE) + 40(CIE) = 100. Credit: 4

Course Objectives:

Understanding basic concepts of photosynthesis & respiration.
Understanding basic concepts of sensory biology and solute transport.

Course Outcomes:

After completion of this course students will be able to:

1. Understand the mechanism of photosynthesis & respiration.
Understand concepts of solute transport inside plants.

Course Content

Unit-I: Photosynthesis & Respiration (15 Hrs)

Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO2 fixation-C3, C4 and CAM pathways.
Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

Unit-II: Nitrogen Metabolism & Plant Hormones (15 Hrs)

Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis.
Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

Unit-III: Sensory Photobiology & Solute Transport (15 Hrs)

Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.
Solute transport and photo assimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photo assimilates.

Unit-IV: Secondary Metabolites & Stress Physiology (15 Hrs)

Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.
Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses. Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

List of Books / References / Online Resources

1. Berg J.M., Tymoczko J.L., Stryer L. (2002) Biochemistry. 5th Ed. W.H. Freeman and Company, New York.
2. Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
3. Buchanan B.B, Gruissem W. and Jones R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
4. Concepts in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
5. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
6. Galston A.W. 1989. Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA.
7. Goodwin T.W., Mercer E.I. (1998) Introduction to Biochemistry. CBS Publishers, New Delhi.
8. Hopkins W.G. 1995. Introduction to Plant Physiology. John Wiley and Sons, Inc., New York, USA.
9. Lehninger A.C. 1987. Principles of Biochemistry, CBS Publishers and Distributors (Indian Reprint).
10. Lincoln Taiz and Eduardo Zeiger (2010) Plant Physiology, Fifth edition. Sinauer Associates, Inc. Publishers. Sunderland, USA.
11. Lodish H., Berk A., Zipursky S.L., Matsudaira P., Baltimore D. and Darnell J. 2000. Molecular Cell Biology. W.H. Freeman.
12. Metabolism (Second Edition) Longman, Essex, England.
13. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones. Springer-Verlag, New York, USA.
14. Nelson David and Cox Michael. (2007) Lehninger Principles of Biochemistry. W.H. Freeman.
15. Salisbury F.B. and Ross C.W. 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California, USA.
16. Davies, P.J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
17. Jordan, B.R. (2006). The Molecular Biology and Biotechnology of Flowering, 2nd Edition, CAB International, Oxfordshire, U.K.
18. Nelson, D.L. and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5th ed.). New York.
19. Buchanan, Gruissem and Jones. 2002. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
20. Annual Review of Plant Biology (formerly Annual Review of Plant Physiology and Plant Molecular Biology).
21. BASIC REFERENCES: Alberts et al., Molecular Biology of the Cell (parts related to plants); Salisbury and Ross, Plant Physiology; Taiz and Zeiger, Plant Physiology; Hopkins and Huner, Introduction to Plant Physiology.

M. SC. SEMESTER-II BOTANY
DISCIPLINE SPECIFIC COURSE (DSC) LAB
PLANT PHYSIOLOGY

Course Objectives:

1. Understand the mechanisms of water and mineral uptake and transport in plants, including hydraulic conductance and aquaporins.

Explore the evolutionary dynamics and diversity of photosynthesis across different organisms.

Analyze the processes involved in the light reaction and the Calvin cycle, including electron pathways and key enzymes.

Investigate the role of light in the activation of dark phase enzymes and the regulation of C4 and CAM photosynthesis.

Examine the translocation of photosynthates, including signaling mechanisms, phloem unloading, and the source-to-sink transition.

Course Outcomes:

1. Explain the physiological regulation of mineral homeostasis and adaptive strategies under different environmental conditions.
2. Describe the evolution and diversity of photosynthesis, including carbon-concentrating mechanisms and photo-protectant systems.
3. Analyze the light reaction and Calvin cycle, detailing the involvement of reaction centers and electron pathways.
4. Evaluate the regulation of dark phase enzymes and the mechanisms of C4 and CAM photosynthesis.
5. Discuss the evolutionary timeline and distribution of Rubisco, photorespiratory bypasses, and the potential for artificial photosynthesis.

List of Laboratory Exercises / Practicals

1) Demonstration of Bolting.

2) Demonstration of the Effect of Auxins on Rooting.

3) Demonstration of Root Respiration.

4) Demonstration of Suction Due to Transpiration.

5) To Determine the Osmotic Potential of Plant Cell Sap by Plasmolytic Method.

6) To Study the Effect of Two Environmental Factors (Light and Wind Velocity) on Transpiration by an Excised leaf.

7) To Determine the Stomatal Index and Stomatal Frequency in a Mesophyte and Xerophyte.

8) To Demonstrate Hill Reaction.

9) To Study the Effect of Light Intensity and Bicarbonate Concentration on O2 Evolution in Photosynthesis.

10) To study and quantify stomatal features (density, index & size) of leaves using Image J software.

11) To calculate total leaf area and the infected leaf area of given leaf sample using Image J software.

12) To evaluate Membrane stability index (MSI) of plant leaf tissues subjected to environmental

stress using electrolyte leakage method.

13) To study the role and localization of Statoliths in root cap cells in relation to gravitropism under different environmental conditions using histochemical staining technique.
14) To Compare the Rate of Respiration in any Two Parts of a Plant.
15) To Separate Amino Acids by Paper Chromatography.
16) Estimation of sodium and potassium in plant material by flame photometry.
17) Determination of Isoelectric point of Legumin.
18) Separation of amino acids or sugars from the phloem sap using paper chromatography or TLC.
19) Estimation of free fatty acids by Titration method.
20) Effect of various salts on the permeability of the plasma membrane.
21) To determine the rate of transpiration by Cobalt Chloride paper method and to calculate transpiration index (TI), Transpiration efficiency (TE) of various leaves.
22) Determination of Na+ & K+ ions using internal standard method.

M. SC. SEMESTER-II BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-I PHYTOCHEMISTRY
M-BO523TPC

Hours: 4Hours/Week **Marks: 60(SEE) + 40(CIE)=100** **Credit: 4**

Course objective: To promote advanced study of plant secondary metabolites and their applications for utilization of plant-derived chemical compounds for the benefit of science, society, and industry. Nurturing scientific temper and research aptitude in students to enable them to contribute to natural product research, drug discovery, sustainable utilization of plant resources, and development of plant-based industries.

Course outcome:

- Understand the basic principles of phytochemistry, including the classification, occurrence, and distribution of plant secondary metabolites.
- Gain knowledge of the major classes of phytochemicals such as alkaloids, terpenoids, flavonoids, phenolics, steroids, coumarins, and glycosides.
- Develop an understanding of the isolation, extraction, purification, and quantification techniques of phytochemicals using modern analytical methods.
- Learn the principles and applications of chromatographic and spectroscopic methods.
- Understand the role of phytochemicals in plant defence mechanisms, ecological interactions, and biological activity.
- Explore the industrial and pharmaceutical applications of phytochemicals in medicine, food, cosmetics, and nutraceuticals.

Unit I: (15 Hrs)

Introduction to Phytochemistry: Definition and scope of phytochemistry. Difference between primary and secondary metabolites. Importance of secondary metabolites in plants. Role of phytochemicals in plant survival and adaptation. Classification of Plant Secondary Metabolites

Major Classes of Phytochemicals: Definition, general properties, Biological and pharmacological importance of Alkaloids, Terpenoids, Flavonoids, Phenolic compounds, steroids and glycosides.

Unit II: (15 Hrs)

Extraction of Phytochemicals: Principles of extraction: solubility, polarity, and partition coefficient; Selection of solvents (polar and non-polar solvents)

Methods of extraction: Maceration**,** Percolation**,** Soxhlet extraction**,** Steam distillation (for volatile compounds)**,** Supercritical fluid extraction (basic concept)**;** Factors affecting extraction efficiency.

Isolation and Purification Techniques: Principle of separation of plant constituents**,** Liquid–liquid extraction**,** Precipitation methods**,** Fractionation techniques**,** Importance of purity in phytochemical studies.

Unit III: (15 Hrs)

Chromatographic Techniques: Principle and working and applications of Thin layer Chromatography (TLC), Column Chromatography, High Performance Liquid Chromatography (HPLC), Gas Chromatography (GC); Spectroscopic Techniques.

Quantification of Phytochemicals: Colorimetric and spectrophotometric methods.
Biological Activities of Phytochemicals: Antioxidant activity and free radical scavenging Anti-inflammatory, anticancer, and immunomodulatory properties**.** Antimicrobial and antiviral effects.

Unit IV: (15 Hrs)

Industrial Applications of Phytochemicals: Role in food industry: natural colorants, Flavors, preservatives**.** Use in textile and dye industries (natural dyes from plants)**.** Application in agriculture: biopesticides and growth regulators**.** Role in green chemistry and sustainable industries.
Pharmaceutical Applications: Plant-derived drugs and drug discovery**,** Importance of medicinal plants in traditional and modern medicine
Phytochemicals in Food, Cosmetics, and Nutraceuticals: Functional foods and health-promoting compounds**,** Antioxidants and dietary supplements**,** Use in cosmetics: anti-aging, skin protection, natural fragrances**,** Nutraceutical industry and health benefits of plant-based compounds.

Reference:

1. **Harborne, J.B. (1998)** *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis* Springer / Chapman & Hall
2. **Trease, G.E. & Evans, W.C. (latest edition)** *Pharmacognosy* Elsevier
3. **Cseke, L.J. et al. (2016)** *Natural Products from Plants* CRC Press
4. **Robbers, J.E., Speedie, M.K. & Tyler, V.E.** *Pharmacognosy and Pharmaco biotechnology*
5. **Brahmachari, G. (Ed.)** *Handbook of Natural Products* Wiley-VCH
6. **Cowan, M.M. (1999)** "Plant Products as Antimicrobial Agents" *Clinical Microbiology*
7. **Dewick, P.M. (2009)** *Medicinal Natural Products: A Biosynthetic Approach* Wiley
8. **Taiz, L., Zeiger, E. et al. (latest edition)** *Plant Physiology and Development* Sinauer / Oxford University Press
9. **Stryer, L. (latest edition)** *Biochemistry* W.H. Freeman

DISCIPLINE SPECIFIC ELECTIVE COURSE LABORATORY EXERCISE PHYTOCHEMISTRY

Laboratory Exercise

1. Study of Collection and processing of crude plant samples.
2. Study of different extraction processes and extractive values for different samples.
3. Separation of phytochemicals by Chromatography.
4. Qualitative phytochemical screening of plant extracts.
5. Quantitative spectrophotometric estimation of Phenols.
6. Quantitative spectrophotometric estimation of tannins.
7. Quantitative spectrophotometric estimation of flavonoids.
8. Quantitative spectrophotometric estimation of saponins.
9. Quantitative spectrophotometric estimation of alkaloids.
10. Study of Antioxidant activity of plant extracts.
11. Study of Antimicrobial activity of plant extracts.

Suggested activity: Seminar, Quiz, debate, Assignments, collection and preparation of different Medicinal plants, Study Projects, Models etc. are Part of Curriculum. Botanical Excursion (one short excursion is compulsory)

M. SC. SEMESTER-II BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-III PALYNOLOGY
M-BO523TPN

Hours: 4Hours/Week Marks: 60(SEE) + 40(CIE)=100 Credit: 4

Course objectives: - Understand the scope, principles, and significance of palynology and its interdisciplinary relevance in biological, environmental, geological, and forensic sciences.

Course outcome: -

By the end of this course, the students will be able to:

1. Acquire knowledge of pollen and spore morphology, wall structure, classification.
2. Develop practical skills in collection, processing, acetolysis, preservation, microscopy, and analysis of pollen and spore samples.
3. Understand the role of aeropalynology in monitoring airborne pollen and spores, allergy forecasting, and environmental health studies.
4. Study melissopalynology for honey characterization, identification of floral sources, and applications in apiculture.
5. Explore the applications of palaeopalynology in biostratigraphy, palaeoenvironmental reconstruction, climate studies, and fossil fuel exploration.
6. Understand the use of palynological evidence in forensic science, archaeology, medicine, pharmacology, and environmental monitoring.

Unit-I: Introduction to Palynology (15 Hrs)

Definition, scope, and history of palynology. Importance in taxonomy, ecology, agriculture and geology. Development of palynological studies in India.

Sampling Techniques:

A. Field Sampling: Collection of flowers and anthers for pollen studies,
Surface soil sampling, Lake and peat bog sediment sampling**,** Core sampling techniques. Marine and archaeological sampling methods

B. Air Sampling: Gravity sedimentation methods**,** Volumetric and gravimetric air samplers**,** Applications of Sampling in Palynology

Unit-II Pollen and Spore Morphology (15 Hrs)

Pollen wall structure and development: Pollen Wall Structure, Sporoderm organization, Exine and intine, Sporopollenin: structure and functions, Exine stratification and ornamentation, Exine ornamentation types. LO-analysis (Light Optical analysis), Ubisch bodies, Pollen wall proteins, Perine, pollen-kitt, viscin threads, pollen connecting threads, Pollen units: monad, dyad, tetrad, polyad, pollinia; Polarity, symmetry, size, and shape classes; NPC (Number–Position–Character) classification system.

Unit-III (15 Hrs)

Palynotaxonomy: Taxonomic significance of pollen characters, Pollen morphology in angiosperm classification, Evolutionary trends in pollen grains, Applications in plant systematics

Fossil and Geological Palynology: Fossil pollen and spores, Preservation and recovery techniques Palynomorphs: spores, pollen, dinoflagellates, acritarchs. Paleopalynology, Biostratigraphy, Paleoecological and paleoclimatic interpretations,

Forensic and Medical Palynology: Use of pollen evidence in criminal investigations, Tracking movement of objects and individuals, Diagnosis of allergic diseases, Pollen as indicators of environmental health**,** Medicinal and pharmaceutical applications

Unit-IV (15Hrs)

Aeropalynology: Airborne pollen and spores, Pollen allergy, Allergenic plants and fungal spores, Monitoring airborne pollen and spores. Pollen calendars and forecasting of allergy seasons and Plant infections**,** Aerobiological work in India

Melissopalynology: Study of pollen in honey, Identification of floral sources of honey, Bee forage analysis, Economic importance in apiculture, Importance in botany, apiculture, agriculture, and honey authentication**,** Types of honey: unifloral and multifloral honey

Reference:

1. Bhattacharya K., Majumdar M. and Gupta Bhattacharya S. (2006). A text book of Palynology.New Central Book Agency(P) Ltd.,Kolkata
2. Tilak S. T. 1989. Atlas of airborne pollen grains and fungal spores. Vaijayanti Prakashan, Aurangabad.
3. Tilak S T and Pande B N 1997. Aerobiology. Satyajeet Prakashan, Pune.Van Campo, M. 1967.
4. Wodehouse, R.P. 1935.Pollen Grains. McGraw Hill and Co. New York 106.
5. Tilak S.T. 1987 “Air monitoring practical Manual”, Vaijanti Prakashan, Aurangabad.
6. Tilak S.T. 2009. Aeromycology. Bharati Printing Press, Pune.
7. Nair, P K.K. 1965. Trends in the morphological evolution of pollen and
8. spores. Journs.Indian. Bot. Soc. XLIV (4):
9. Nair, P.K.K. 1965.Pollen morphology 'of some families of monochlamydeae, Bot. Notiser: 118(3) Lund,
10. Nair, P.K.K. 1966.Essentials of Palynology. Asia Publ. House, Bombay,
11. Nair, P.K.K-. 1970.Pollen morphology of Angiosperms. Scholar Publ. House, Lucknow,
12. Nair. P.K.K. 1965.Pollen Grains of Western Himalayan Plants.Asia Publ. House.
13. P. K. K (1970). Pollen morphology of angiosperms. Scholar, Lucknow.
14. Erdtman, G, (1956) "Lo-analysis" and "Welcker's rule". Sven Bot. Tidskr. 50:1-7.
15. Erdtman, G. 1945. Pollen Morphology and Plant Taxonomy IV Labiatae,

Verbenaceae, Avicenniaceae. Svensk Botanisk Tidskrift. 39(3)

16. Erdtman, G. (1966). Pollen morphology and plant taxonomy angiosperms hafner. New York.
17. Erdtman, G. (1969). Handbook of Palynology. Hafner, New York
18. Erdtman, G. 1943. An Introduction to Pollen Analysis. Chronica Botanica Co., Waltham, Mass. pp. 239,

19. Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy (An Introduction to Palynology-1, Angiosperms). Aimqvist, and Wicksell, Stockholm.
20. Afzelius, B.M. 1956 Electron-microscope investigation into exine stratification GranaPalynologica (N.S.) 1:2,
21. Agashe S. N. – Paleobotany (1997) – Plants of the past their evolution paleoenvironment and applications inexploration of Fossil.
22. 3. Agashe S. N. – Palynology and its Applications – Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

Suggested activity:
Seminar, Quiz, debate, Assignments, collection and preparation of different Pollen and spore slides, Study Projects, Models etc. are Part of Curriculum. Botanical Excursion (one short excursion is compulsory)

DISCIPLINE SPECIFIC ELECTIVE COURSE LABORATORY EXERCISE PALYNOLOGY

List of Practicals

1. Preparation of glycerine jelly.
2. To study the acetolysis method for exine ornamentation of pollen.
3. Study of instrumentation and different Air samplers in palynology.
4. To study pollen grains using different stains and observe their morphology from different angiosperm families.
5. To study different pollen units such as monads, dyads, tetrads, polyads, and pollinia.
6. To estimate pollen and spore abundance and diversity in environmental samples.
7. To identify and quantify airborne pollen and fungal spores from different atmospheric samples.
8. To detect amino acids, present in pollen grains using chromatography.
9. To compare biochemical constituents of pollen from different species.
10. To determine pollen production, viability and in vitro pollen germination of different Angiosperm families.
11. To identify pollen type present in honey and determine their floral origin.
12. To distinguish between unifloral and multifloral honey based on pollen spectra.
13. To identify pollen grains associated with archaeological materials.
14. To examine pollen evidence from different materials from crime scene for forensic investigations.

M. SC. SEMESTER-II BOTANY
PRACTICAL EXAMINATION
DSC AND DSE LAB

Time : 6-8 Hours **Max marks : 180**

1. One experiment from DSC Paper-1	20 Marks
2. One experiment from DSC Paper-1	10 Marks
3. One experiment from DSC Paper-2	20 Marks
4. One experiment from DSC Paper-2	10 Marks
5. One experiment from DSE	20 Marks
6. One experiment from DSE	10 Marks
7. Spotting: (5 marks for each spot)	30 Marks
G. DSC Paper-1	
H. DSC Paper-1	
I. DSC Paper-2	
J. DSC Paper-2	
K. DSE	
L. DSE	
8. Viva-voce	30 Marks
9. Record and excursion report (submission is compulsory)	30 Marks

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
30	30	30	30	**120**

Institute of Science, Nagpur

(An Autonomous Institute of Govt. of Maharashtra)

DEPARTMENT OF BOTANY

CREDIT STRUCTURE, EVALUTION SCHEME,

AND SYLLABUS OF TWO-YEAR MASTER OF SCIENCE DEGREE WITH A SEMESTER PATTERN IN BOTANY

M. Sc. II YEAR BOTANY

(FACULTY OF SCIENCE &TECHNOLOGY)

BASED ON DIRECTION 2 OF 2024 ISSUED BY THE INSTITUTE OF SCIENCE, NAGPUR AS PER NEP 2020

To be implemented from 2027-2028

Table 1: M.Sc. Semester-III

Sr No	Course Category	Name of the course (Title of the Paper)		Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
					Th	Tu	P					
1	**DSC**	Paper 1:- **BIOCHEMISTRY AND METABOLISM**	M-BO631T	6.5	4	--	--	4	3	60	40	50
		Paper 2:- **CELL AND MOLECULAR BIOLOGY- II**	M-BO632T		4	--	--	4	3	60	40	50
2	**DSE**	Elective:- 5)**REPRODUCTIVE BIOLOGY OF ANGIOSPERMS** 6) **INHERITANCE BIOLOGY**	M-BO633TRB M-BO633TIB		4	--	--	4	3	60	40	50
3	**DSC /DSE**	**DSC LAB I : Practical - III** (Based on Paper 1 + Paper 2+ DSE)	M-BO634P		--	--	12	6	8-12	180	120	150
4	**RP**	**RESEARCH PROJECT / DISSERTATION** (Core)	M-BO635P		--	--	8	4	--	--	200	100
TOTAL					**12**	**--**	**20**	**22**		**360**	**440**	**--**

Table 2: M.Sc. Semester-IV

Sr No	Course Category	Name of the course (Title of the Paper)		Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
					Th	Tu	P					
1	**DSC**	Paper 1:- **PLANT ECOLOGY**	M-BO641T	6.5	4	--	--	4	3	60	40	50
		Paper 2:- **PLANT BIOTECHNOLOGY AND PLANT BREEDING**	M-BO642T		4	--	--	4	3	60	40	50
2	**DSE**	Elective:- 7) **PALEOBOTANY** 8) **PLANT BIODIVERSITY AND CONSERVATION**	M-BO643TPB M-BO643TPC		4	--	--	4	3	60	40	50
3	**DSC /DSE**	**DSC LAB** (Based on Paper 1 + Paper 2+ Elective)	M-BO644P		--	--	8	4	8	120	80	100
4	**RP**	**RESEARCH PROJECT / DISSERTATION** (Core)	M-BO645P		--	--	12	6	--	--	300	150
TOTAL					**12**	**--**	**20**	**22**		**300**	**500**	**--**
Cumulative Credits for PG in Major Subject (Two Year PG Degree) = 54 Electives = 16 RM = 4 OJT / FP = 4 RP = 10								**88**				
Cumulative Credits required for PG in Major Subject (One Year PG Degree) = 44 **Cumulative Credits required for PG in Major Subject (Two Year PG Degree) = 88**												

M. SC. SEMESTER-III BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I BIOCHEMISTRY AND METABOLISM
(M-BO631T)

Hours: 4Hours/Week **Marks: 60(SEE)+40(CIE)=100** **Credit: 4**

Course objective: To provide a comprehensive understanding of the biochemical composition of plant cells and the metabolic processes that sustain plant growth, development, and adaptation.

Course outcome:

- Understand the chemical basis of life by studying the structure, properties, and functions of biomolecules
- Develop knowledge of enzyme chemistry and enzyme kinetics and their role in plant metabolism.
- Gain an understanding of cellular bioenergetics, energy transfer mechanisms, and the role of ATP in biological systems.
- Study and explore various metabolism in plants and develop practical skills in biochemical analysis.
- Understand metabolic regulation and integration, and how plants coordinate metabolic pathways in response to developmental and environmental signals.

Unit I: Biomolecules, Enzymology and Bioenergetics (15 Hours)

Chemical Basis of Life: Water as a biological solvent: properties and significance. Chemical bonds in biological systems: covalent, ionic, hydrogen, hydrophobic interactions, and van der Waals forces. pH, buffers, and their biological significance.

Cellular Bioenergetics: Concept of free energy and energy transformations.

Laws of thermodynamics in biological systems. ATP: structure, properties, and biological significance. Oxidation–reduction reactions and biological electron carriers: NAD^+/NADH, $FAD/FADH_2$ $NADP^+$/NADPH

Unit II: Enzymology and Carbohydrate Metabolism (15 Hours)

Enzymology: Definition, nomenclature, and classification of enzymes. Structure and properties of enzymes. Active site and enzyme specificity. Mechanism of enzyme action,

Enzyme Kinetics: Michaelis–Menten equation, Km and Vmax concepts. Factors affecting enzyme activity:

Enzyme Regulation: Competitive, non-competitive, and uncompetitive inhibition. Allosteric regulation. Feedback inhibition. Role of enzymes in plant metabolism.

Carbohydrate Metabolism : Classification: monosaccharides, disaccharides, oligosaccharides, and polysaccharides. Structure and properties of carbohydrates. Biological functions of carbohydrates. Storage and structural polysaccharides in plants: starch, cellulose, hemicellulose, and pectin. Glycoproteins and glycolipids.

Unit III: Protein and Lipid Metabolism (15 Hours)

Proteins and Amino acids: classification, structure, and properties. Peptide bond and protein structure: Primary structure, Secondary structure, Tertiary structure, Quaternary structure, Classification of proteins., Biological functions of proteins, Protein denaturation and renaturation. Amino acid biosynthesis and transamination reactions. Biosynthesis of essential amino acids.

Lipids: Classification: simple, compound, and derived lipids. Structure and properties of fatty acids. Triglycerides, phospholipids, glycolipids, and sterols. Membrane lipids and membrane organization. Biological functions of lipids. Synthesis and breakdown of triglycerides, β-oxidation, α oxidation glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination.

Unit IV: Nucleic Acids and Vitamins (15 Hours)

Nucleic Acids: Structure and properties of nucleotides. DNA and RNA: structure, types, and functions. Biological significance of nucleic acids.

Vitamins: Classification: fat-soluble and water-soluble vitamins. Role of vitamins as coenzymes and metabolic regulators.

Nitrogen Metabolism: Nitrogen cycle and nitrogen nutrition in plants. biological nitrogen fixation: Symbiotic nitrogen fixation non-symbiotic nitrogen fixation. Structure and function of nitrogenase. Nitrate reduction and ammonium assimilation. GS-GOGAT pathway. Regulation of nitrogen metabolism

Reference:

1. Biochemistry and Molecular Biology of Plants Buchanan, B.B., Gruissem, W. & Jones, R.L. Wiley-Blackwell.
2. Biochemistry and Molecular Biology of Plants Buchanan, B.B., Gruissem, W. & Jones, R.L. Wiley-Blackwell.
3. Lehninger Principles of Biochemistry, Nelson, D.L. & Cox, M.M. W.H. Freeman and Company, 8th Edition
4. Biochemistry; Voet, D. & Voet, J.G. John Wiley & Sons 5th Edition
5. Plant Physiology and Development, Taiz, L., Zeiger, E., Møller, I.M. & Murphy, A. Oxford University Press 7th Edition.
6. Molecular Biology of the Cell, Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P.; Garland Science 7th Edition.
7. Biochemical Methods, Sadasivam, S. & Manickam, A. New Age International Publishers, 3rd Edition
8. Biochemistry, Satyanarayana, U. & Chakrapani, U. Elsevier India 6th Edition

Suggested activity:

Seminar, Quiz, debate, Assignments, collection and preparation of different plants, Study Projects, Models etc. are Part of Curriculum. Botanical Excursion (one short excursion is compulsory)

M. SC. SEMESTER-III BOTANY

DSC Laboratory Exercise based on DSC Paper-1

List of Practicals

1. Preparation and buffer capacity determination of phosphate buffer.
2. Determination of pH of biological samples.
3. Determination of Km and Vmax
4. Determination of effect of pH on enzyme activity
5. Effect of Enzyme Concentration and temperature on Reaction Rate
6. Estimation of Starch in Plant Tissues
7. Estimation of soluble sugars during germination.
8. Estimation of Cellulose Content in Plant Material
9. Estimation of Pectin from Fruit Samples
10. Determination of oxygen consumption (Respiratory Activity) in Germinating Seeds
11. Study of Dehydrogenase Activity in Germinating Seeds.
12. Estimation of Glycolate Content in Leaves.
13. Estimation of Chlorophyll Content
14. Qualitative biochemical test of different samples
15. Estimation of Soluble Proteins by Lowry Method
16. Effect of Temperature on Protein Denaturation
17. Estimation of Free Amino Acids by Ninhydrin Method
18. Estimation of Total Free Amino Acids in Plant Tissues
19. Determination of Acid Value of Plant Oils
20. Estimation of Total Lipids by Gravimetric Method
21. Histochemical Localization of Lipids in Seeds
22. Determination of Vitamin C Content in Fruits and Vegetables
23. Estimation of Nitrate Content in Plants
24. Effect of Nitrogen Fertilizers on Chlorophyll Content
25. Estimation of Ascorbic Acid (Vitamin C)

Note : At least 15 experiments to be performed

M. SC. SEMESTER-III BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-II CELL AND MOLECULAR BIOLOGY- II
(M-BO632T)

Hours: 4Hours/Week **Marks: 60(SEE)+40(CIE)=100** **Credit: 4**

Course objectives: -

1. Knowledge on structure and functions of ribosomes, mechanism of transcription and translation in pro- and eukaryotes.
2. Understanding the gene structure and regulation of gene expression
3. Knowledge on genome organization and recombination mechanisms
4. Understanding the mechanism of cell cycle, apoptosis, techniques in cell biology

Course outcome: -

After successful completion of the course the students will be able to

1. Learn structure and functions of ribosomes, mechanism of transcription and
2. translation.
3. Learn gene structure and regulation of gene expression

Learn mechanism of cell cycle, apoptosis, application of cell biology techniques.

Unit-I Ribosomes, Transcription and Translation (15 Hrs)

1. Ribosomes Structure and function
2. Transcription in prokaryotic and eukaryotic cells, plant promoters, transcription factors, types of RNA and their function, RNA splicing, mRNA transport
3. Translation in prokaryotic and eukaryotic cells, structural levels of proteins, post-translational modification; structure and role of rRNA and tRNA.

Unit-II Protein sorting and Regulation of gene expression (15 Hrs)

1. Protein sorting, Protein glycosylation; vesicles involved in protein transport; protein targeting to plastids, mitochondria, peroxisomes, nucleus, vacuoles; modification during transport.
2. Gene structure, Chemical nature of gene; Fine structure of gene: Classical and modern concept of gene, Cis-trans test; fine structure analysis in eukaryotes; introns and their significance, RNA splicing
3. Regulation of gene expression, Prokaryotes- Positive and negative control, inducible and repressible operons, lac operon, trp operon, attenutation, riboswitch; Eukaryotes- Regulation at DNA, transcription, translation and post translational level.

Unit-III Genome organization and Genetic recombination (15 Hrs)

1. Genome organization in prokaryotes and eukaryotic organelles: Phage genome, genetic recombination in phage and mapping phage genes; mapping of bacterial genes through transformation, conjugation and transduction; genome of mitochondria and chloroplast.
2. Genetic recombination and genetic mapping: Recombination; independent assortment

and crossing over; molecular mechanism of recombination; role of RecA and RecBCD enzymes; homologous, non- homologous and site-specific recombination; chromosome mapping- linkage group, genetic markers, types of maps, construction of molecular maps, correlation of genetic and physical maps; Somatic cell genetics -an alternative approach to gene mapping.

Unit-IV Cell Cycle Regulation, Apoptosis and Signal Transduction (15 Hrs)

1. Cell cycle, Control mechanisms of bacterial and eukaryotic cell cycle, check point control, presence of regulators of cell cycle, G1 – S progression, G2 – M progression, role of cyclins and cyclin dependent kinases; retinoblastoma and E2F proteins; cytokinesis and cell plate formation; Apoptosis and its pathway.
2. Signal transduction, Overview, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascades, diversity in protein kinases and phosphatases, specific signaling mechanisms e.g. two-component sensor-regulator system in bacteria and plants, sucrose sensing mechanism.

Suggested readings

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K.and Watson, J.D. 1999. Molecular Biology of Cell, Garland Publishing, Inc., New York.

2. Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA.

3. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8th Ed. B. I. Waverly Pvt. Ltd., New Delhi.

4. Jones R, Ougham H, Thomas H, Waaland S 2013 The Molecular life of plants. WileyBlackwell, USA

5. Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.

6. Khush, G.s. 1973 Cytogenetics of Aneuploids, Academic Press, New York, London

7. Kleinsmith, L.J. and Kish, V.M. 1995 Principles of Cell and Molecular Biology (2 nd Edi.) Harper Collins Coll. Publisher, New York, USA.

8. Lewin, B. 2000 Gene VII Oxford Univ. press, New York.

9. Lodish, H., Berk, A. Zipursky, S. L. Matsudaira, P., Baltimore, D. and Darnell, J. 2000

10. Molecular Cell Biology Edi.W.H. Freeman and Co., New York, USA.

11. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3rd Edi.)Jones and Bartiet Pub. Inc., London.

12. Russel, P. J. 1998 Genetics (5th Edi.) The Banjamin/ Cummings Publishing Com. Inc., USA 79

13. Sunstad, D. P. and Simmons, M. J. 2000 Principles of Genetics (2nd Edi.) John Wiley & Sons Inc., USA.

14. Tamarin, R. H. 2001 Principles of Genetics 7th Edi.The McGraw-Hill Companies.

15. Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.

16. References: Online journals available on UGC V-SAT programme

M. SC. SEMESTER-III BOTANY

DSC Laboratory Exercise based on DSC Paper-2

List of Practicals

1. Isolation of nuclei and identification of histones by SDS-PAGE.
2. To perform the restriction digestion of the DNA and analyse the digest over agarose gel.
3. To study the growth characteristics of E. coli using plating methods.
4. To study the growth characteristics of E. coli using turbidometric methods.
5. To isolate the plasmid from E. coli and quantify it with suitable method.
6. To study conjugation in bacterial cells.
7. To prepare competent cells from the given bacterial culture.
8. To transform the competent bacterial cells with the given vector and perform blue-white selection.
9. Demonstration of prokaryotic/ eukaryotic transcription (Live model/ audio-visuals)
10. Demonstration of translation (Live model/ audio visuals)
11. To detect the presence of specific antigen by ELISA
12. Isolation of RNA and quantification by spectrophotometric method.
13. To map the genes on the basis of given cross-over data.
14. Separation of amino acids by paper chromatography method.
15. Separation of amino acids by TLC method.
16. Separation of carbohydrates by paper chromatography method.
17. Separation of carbohydrates by TLC method.

M. SC. SEMESTER-III BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-I REPRODUCTIVE BIOLOGY OF ANGIOSPERM
(M- BO633TRB)

Hours: 4Hours/Week **Marks: 60 (SEE) + 40 (CIE) = 100** **Credits: 4**

Course Objective: -The primary objective of the course is to equip students with a comprehensive understanding of the structural, functional, and molecular mechanisms underlying sexual reproduction in flowering plants.

Course outcome: -

By the end of this course, the students will be able to:

The ultimate outcome of angiosperm reproductive biology is the continuation of the plant's life cycle.

The Core Reproductive Events, Evolutionary and Ecological Significance

Unit-I Anther Development and Male Gametophyte Formation (15Hrs)

1. Anther: Structure, anther wall; endothecium, middle layer, tapetum-Structure, types , role of tapetum, microsporogenesis-sporogenous cells cytoplasmic reorganization during sporogenesis (Ultrastructural changes),
2. Pollen tetrad development.
3. Male gametophyte development: formation of vegetative and generative cells.
4. Pollen: Pollen storage, viability, causes for loss of viability.

Unit-II Megasporogenesis, and Female Gametophyte Development (15Hrs)

1. Pistil: Ovule and its structural details.
2. Megasporogenesis: Meiosis, functional megaspores, organization of female gametophyte structure of the embryo sac, egg, synergid-ultrastructure, central cell, antipodal cell, haustoria, types of embryo sac, nutrition of embryo sac.

Unit-III Pollination Biology and Pollen–Pistil Interaction (15Hrs)

1. Pollen-pistil interaction: The Stigma-Types and structure, stigmatic exudates, style-transmitting tissue, canal cell, post pollination events (stigma receptivity, pollen adhesion, pollen hydration, pollen germination and pollen tube growth)
2. Pollination: pollination mechanism, biotic and abiotic pollination, floral attractants and rewards.
3. Incompatibility: General concept, self-incompatibility (Intraspecific type) heteromorphic, homomorphic types, mechanism of self compatibility, importance of self compatibility, methods of overcoming self-incompatibility.

Unit-IV Fertilization and Endosperm Development (15Hrs)

1. Fertilization: Growth of the pollen tube through the style, passage of sperm into the embryo sac, fusion of nuclei, double fertilization, triple fusion.
2. In-vitro approaches to the study of fertilization-Intra-ovarian pollination, in-vitro fertilization and placental pollination.
3. Endosperm: types of endosperms, ruminate endosperm. Endosperm haustoria, food reserve in endosperm, role of endosperm in embryo development.

List of Books / References / Online Resources

1. Bhandari N. N. 1984, The microsporangium in embryology of angiosperms (ed B.M. Johri) Springer-Verlag, Berlin, pp. 53-121.
2. Bhandari N.N., M. Bhargava and P. Chitralekha 1986, Cellularization of free nuclear endosperm of Pappaver somniferum L. Phytomorphology, 36, 357-366.
3. Bouman F. 1984 The ovule in embryology of angiosperms (ed B.M.Johri), Springer-Verlag, Berlin, pp. 123-157.
4. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.
5. Raghavan, V. 1999. Developmental Biology of Flowering Plants.Springer -Verlag, New York.
6. Shivana, K.R. and Rangaswamy, N.S. 1992. Pollen Biology: A Laboratory Manual. Springer-Verlag, Berlin.
7. Shivana, K.R. and Johri, B.M. 1985. The Angiosperm Pollen: Structure and Function.Wiley Eastern Ltd., New York.
8. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.
9. Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
10. Raghavan, V. 1999. Developmental Biology of Flowering Plants.Springer -Verlag, New York.
11. Shivanna, K.R. and Sawhney, V.K. (eds) 1997. Pollen Biotechnology for Crop Production and Improvement, Cambridge University Press, Cambridge.

Suggested activity:

Seminar, Quiz, debate, Assignments, visit to a nearby fossiliferous site, Field work, Study Projects, Models etc. are Part of Curriculum. Botanical Excursion (one short excursion is compulsory)

M. SC. SEMESTER-III BOTANY

DSE Laboratory Exercise based on DSE Paper-I

List of Practicals

1) Study from the permanent preparations.
    a) Development and structures of anther pollen.
    b) Structure of ovule, types, megasporogenesis, embryo sac types.
    c) Development of endosperm, types.
    d) Structure and development of embryo-types
    e) Pericarp and seed coat structure from sections and macerations.
2) Preparation of dissected whole mounts of endothecium, tapetum, endosperm and embryo, squash preparations of tapetum, microspore mother cells, dyads, tetrads pollinia and massulae.
3) Study of different pollen using acetolysed and non acetolysed pollen, preparation of permanent slides for morphological study. (polarity, symmetry, shape, size, aperture, sporoderm stratification, slides to prepare).
4) Interpretation of electron micrographs (SEM, TEM) of pollen.
5) Short term exercises on pollen viability and their percentage of germination.
6) Viability of seed through germination, biochemical and excised embryo method.

M. SC. SEMESTER-III BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-II INHERITANCE BIOLOGY
(M- BO633TIB)

Hours: 4 Hours/Week Marks: 60 (SEE) + 40 (CIE) = 100 Credit: 4

Course Objectives:

1. Identify the basic principles and current trends in classical genetics and plant breeding.
2. Recognize the historical process of the evolution of molecular genetics from classical genetics.
3. Develop theoretical background on molecular genetics to provide a strong support for the student for future research and employability.
4. To impart theoretical knowledge and practical skills about plant breeding objectives, and genetic consequences, breeding methods for crop improvement.
5. To identify gene locus and construct gene map.

Course Outcomes: By the end of this course, the students will be able to

1. Students will know the Fundamentals of Mendelian and post-Mendelian Genetics.
2. Students will understand concept of plant breeding.
3. Students will develop their analytical, quantitative and problem-solving skills from classical to molecular genetics.
4. Students will be able to understand the knowledge base of plant genetic resources and its conservation.
5. Students will be able to understand the techniques of hybrid varieties development and biometrical techniques in plant breeding.

Unit-I: Microbial & Mendelian Genetics (15 Hrs)

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. Mendelian principles: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests.

Unit-II: Extensions of Mendelian Principles (15 Hrs)

Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Quantitative genetics: Polygenic inheritance.

Unit-III: Gene Mapping & Mutation (15 Hrs)

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function.

Unit-IV: Chromosomal Alterations & Recombination (15 Hrs)

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Recombination: Homologous and non-homologous. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

List of Books / Online Resources

1. Atherly, A.G., Girton, J.R. and Mc Donald, J.F. 1999. The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers, New York.
2. Benjamin A. Pierce. 2003. Genetics: A Conceptual Approach. W.H. Freeman and Company, New York, NY.
3. Gardner E.J., Simmons, M.J., and Snustad, D.P. 1991. Principles of Genetics (8th edition). John Wiley & Sons Inc., New York.
4. Griffith A.F. J., Miller, J.H., Suzuki, D.T., Lewontin, R.C., Geibart, W.M. 1993. An Introduction to Genetic analysis (7th edition). W.H. Freeman & Company, New York.
5. Hartl D. L., Jones E.W. 2001. Genetics: An analysis of Genes and Genomes (5th edition). Jones & Bartlett Publishers, Boston.
6. Klug, W. and Cummings, M. R. 2003. Concepts of Genetics (7th edition). Pearson Education, Singapore.
7. Russell, P.J. 2005. Genetics: A Molecular Approach (2nd edition). Pearson/Benjamin Cummings, San Francisco.
8. Stansfield. 1991. Genetics (3rd edition), Schaum's outline series, McGraw Hill, New York.
9. Weaver, R.F. and Hedrick P.W. 1997. Genetics (3rd edition), Wm. C. Brown Publishers.
10. Toronto. Fukui, K. and Nakayama, S. 1996. Plant Chromosomes: Laboratory Methods. CRC Press, Boca Raton, Florida.
11. Sharma, A.K. and Sharma, A. 1999. Plant Chromosomes: Analysis, Manipulation and Engineering. Harwood Academic Publishers, Australia.
12. Shukla and P.S. Chandel. 2004. Cytogenetics, Evolution and Plant Breeding (3rd Edition).
13. Chandrasekaran, S.N. & Parthasarathy, S.V. 1975. Cytogenetics and plant breeding (Revised Edition) Eds. Krishnaswamy. P. Varadachary & Co., Madras.
14. Elliott, J. 1958. Plant Breeding and Cytogenetics. McGrawHill Publications, London.
15. Goodenough, U. 1984. Genetics. Holt – Saunders International, London.
16. Jain, K. & Kharkwal, M.C. 2004. Plant Breeding – Mendelian to Molecular Approaches. Narosa Publishing House, New Delhi.
17. Jorde, B.L., Carey, J.C., Bamshed, M.J. & White, R.L. 2003. Medical Genetics (3rd edition), Elsevier Scientific Publ. Amsterdam.
18. Sen, S., Kar, D.K. 2005. Cytology and Genetics – Narosa Publishing House, New Delhi.

19. Burnham, C.R. 1962. Discussions in Cytogenetics. Burgess Publishing Co., Minnesota.
20. Bush, H. and Rothblum, L. 1982. Volume X. The Cell Nucleus & DNA Part A. Academic Press.
21. Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4th Edition). Jones and Bartlett Publishers, Massachusetts, USA.
22. Khush, G.S. 1973. Cytogenetics of Aneuploïds. Academic Press, New York, London.
23. Lewis R. 1997. Human Genetics: Concepts and Applications (2nd Edition). WCB McGraw Hill, USA.
24. Russel, P.J. 1998. Genetics (5th Edition). The Benjamin/Cummings Publishing Company Inc., USA.
25. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd Edition). John Wiley and Sons Inc., U.S.A.
26. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers, Boston, Massachusetts.
27. Hall, J.L. and Moore, A.L. 1983. Isolation of Membranes and Organelles from Plant Cells. Academic Press, London, U.K.
28. Harris, N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.
29. Fukui, K. and Nakayama, S. 1996. Plant Chromosomes: Laboratory Methods. CRC Press, Boca Raton, Florida.
30. R. Dnyansagar (1986). Cytology and Genetics. Tata McGraw-Hill, ISBN 0074515721.

Suggested Activity

Seminar, Quiz, debate, Assignments, collection and study of Fungi and Plant diseases available in local area, Field work, Study Projects, Models etc. are Part of Curriculum. Botanical Excursion (one short excursion is compulsory).

M. SC. SEMESTER-III BOTANY

DSE Laboratory Exercise based on DSE Paper-II

List of Practical's:

1. Preparations of Stains, Dyes, Preservatives, Fixatives and pre-treatment agents for the Plant material
2. Preparation of mitosis and meiotic slides from suitable plant materials.
3. To determine mitotic index and mitotic index frequency.
4. Karyo-morphological studies from slides/photograph.
5. Induction of mitotic abnormalities through mutagens.
6. To determine pollen viability and germination using TTC
7. Problem on Mendelian inheritance and interaction of genes, linkage and crossing over.
8. To study polygenic inheritance.
9. Study of quality traits in some local crops cotton, soybeans, Wheat, Brassica etc.
10. Study the Meiotic configurations in maize, Allium, Rheo, Tradescantia, Aloe etc.
11. Study of Mendelian Inheritance and Gene Interaction (Non-Mendelian Inheritance)
12. Linkage, Recombination and Gene Mapping problems.
13. Study of Human Karyotypes (Normal and Abnormal).
14. Study of Pedigree Charts.
15. Application of Probability to Problems in Genetics.

M. SC. SEMESTER-III BOTANY

Practical Examination based on DSC and DSE Lab. M-BO634P

Time: 6-8 Hours **Full marks: 180**

Q. 1 One Major Experiment from DSC Paper 1.	20
Q.2 One Minor Experiment from DSC Paper 1.	10
Q.3 One Major Experiment from DSC Paper II.	20
Q. 4 One Minor Experiment from DSC Paper II.	10
Q. 5 One Major Experiment from DSE Paper.	20
Q.6. One Minor Experiment from DSE Paper.	10
Q. 7 Spotting	5x6=30
1. DSC I 2. DSC I 3. DSC II 4. DSC II 5. DSE 6. DSE	
Q. 8 Viva-voce	30
Q. 9 Practical Record, Excursion Report	30

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
30	30	30	30	**120**

M. SC. SEMESTER-III BOTANY
RESEARCH PROJECT / DISSERTATION (Core)
(M-BO635PRP)

Hours: 8 Hours/Week **Marks (CIE): 200** **Credits: 4**

The Research Project is designed to provide M.Sc. Botany students with practical exposure to scientific research through laboratory and/or field investigations. Under the guidance of a faculty supervisor, students will identify a research problem, conduct a literature review, formulate objectives, design and execute experiments or field studies, collect and analyze data, and interpret the results using appropriate scientific methods. The project may be undertaken in any area of Botany, including Plant Taxonomy, Ecology, Plant Physiology, Genetics, Biotechnology, Molecular Biology, Microbiology, Plant Breeding, Environmental Science, or related disciplines. Students are required to prepare and submit a dissertation in the prescribed format, present their research findings through a seminar, and defend their work in a viva-voce examination. **Evaluation shall be based on Continuous Assessment (50 marks), Dissertation/Project Report (100 marks), Seminar Presentation (25 marks), and Viva-Voce Examination (25 marks), totaling 200 marks.** The course aims to develop research aptitude, analytical skills, scientific writing, and effective communication while fostering ethical research practices.

CIE Evaluation

Continuous Assessment	Dissertation	Seminar Presentation	Viva-Voce	Total
50	100	25	25	**200**

M. SC. SEMESTER-IV BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I PLANT ECOLOGY
(M-BO641T)

Hours: 4Hours/Week **Marks: 60(SEE)+40(CIE)=100** **Credit: 4**

Course objectives: -

1. Understanding the concept of community, ecological succession trends and climax.
2. Understanding the structures and functions of ecosystem
3. Understanding and applying various methods of plant conservation; importance and maintenance of National parks, sanctuaries, Biospheres, botanical gardens etc.

Course outcome: -

After successful completion of the course the students will be able to

1. Learn structure and function of ecosystems and their succession and climax Formation.
2. Learn and apply the knowledge of conservation methods.

Learn and apply techniques of Botanical gardens etc.

Unit-I Plant Community Ecology and Vegetation Dynamics (15 Hrs)

1. Concepts of community and continuum, analysis of communities (analytical ad synthetic characters): interspecific associations, concept of ecological niche.
2. Vegetation development: Temporal changes (cyclic and non-cyclic); mechanism of ecological succession (relay floristics and initial floristic composition; facilitation, tolerance and inhibition models).
3. Community function- Dynamics and succession, laboratory model, trends in succession, climax concept, General introduction to autecology.

Unit-II Ecosystem organization (15 Hrs)

1. Structure and functions; primary production (methods of measurement, global pattern, controlling factors); energy dynamics (trophic organization, energy flow pathways, ecological efficiencies)
2. Litter fall and decomposition (mechanism, substrate quality and climatic factors); global biogeochemical cycles of C, N, P and S. Nutrient budget in forest and aquatic ecosystem.

Unit-III Ecosystem stability and management (15 Hrs)

1. Concept (resistance and resilence); Ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion; environmental impact assessment; ecosystem restoration.
2. Ecological management: Concepts; sustainable development; sustainability indicators.

Unit-IV Biodiversity and Environmental Issues (15 Hrs)

1. Biological diversity: Concept and levels; role of biodiversity in ecosystem functions and stability; speciation and extinction; IUCN categories of threat; distribution and global patterns; terrestrial biodiversity hot spots; inventory.

2. Environmental issues: Deforestation and habitat fragmentation; ice melting and global sea level rise, weather extremes, loss of marine diversity; restoration of degraded land; effects of pollution on biological systems.

Suggested readings

1. Ambasht R.S. 1968. Freshwater ecosystem-Manual of Ecology 123-137 (See Misra KC et al 1968) 43
2. Ambasht R.S. 1966 Conservation Ecology, Abs Proc School on Plant Ecol (Full paper in press Oxford and IBH Calcutta).
3. Ambasht R.S. 1995 A text book of plant ecology Student and co. Varanasi-5
4. Anderson JM Ecology for environmental sciences: biosphere ecosystems and man
5. Billings WB 1964 Plants and the ecosystem Macmillan & co, London.
6. Clements FE 1916 Plant succession, An analysis of the development of vegetation. Carnegie Institute of Washington.
7. Cragg JB 1968 The theory and practice of conservation, IUCN Publ, New Series No. 12, 25-35.
8. Dash MC 1993 Fundamentals of Ecology WB Saunders and co. Philadelphia USA.
9. Deangelis DL Energy flow, nutrient cycling and ecosystem resilience. Ecology 56, 23843.
10. Dwivedi Rama Shankar 1968. The decomposer system manual of ecology See Misra KC et al 1970)
11. Frankel OH, Soule ME, 1981, Conservation and Evolution, Cambridge Univ Press.
12. Grace J 1983, Plant atmosphere relationships. Champman & Hall.
13. Greig Smith P 1983, Quantitative plant ecology, Univ California Press, California.
14. Hutchings MJ (ed) 1988, Plant population biology, Blackwell.
15. Hutchinson GE 1978, An introduction to population ecology. Yale Univ. Press.
16. Kochhar PL 1986 Plant Ecology Ratan prakashan, Mandi, Agra.
17. Krebs GJ 1972 Ecology Harper and Row Publ, New York.
18. Kumar HD 1994 Modern concepts of ecology. Vikas publishing house pvt ltd, New Delhi.
19. May RM (ed) 1981 Theoretical Ecology, Blackwell.
20. Odum EP 1963 Ecology Holt Reinhart and Winston Inc.
21. Odum EP 1983 Basic Ecology, Saunders Publ Philadelphia.
22. Reynolds CS 1984 The ecology of phytoplankton, Cambridge Univ Press
23. Silverton JW 1982 Introduction to plant population ecology, Longman.
24. Southwick CH 1983 (ed) Global Ecology Sinauer.
25. Whittaker RH 1975 Communities and Ecosystems (2nded) MacMillan, New York.

M. SC. SEMESTER-IV BOTANY

DSC Laboratory Exercise based on DSC Paper-I

(M-BO644P)

List of Practicals

1. To estimate DO content in the eutrophic and oligotrophic water samples by azide modification of Winklers method.
2. Determination of the total hardness of the water sample.
3. To study the toxic effect of sewage water on seed germination.
4. To determine gross and net phytoplankton productivity by light and dark bottle method.
5. To estimate chlorophyll content in SO2 fumigated and unfumigated leaves.
6. Demonstration of different horizons of local soil profile.
7. Analysis of soils of two different areas i.e. Cropland and forest/ grassland for certain nutrients, CO3, NO3, Base deficiency.
8. To study hydrophytic adaptation in plants.

9. To study xerophytic adaptation in plants.
10. To determine soil water rising capacity of the given soil samples.
11. To determine soil percolation capacity of the given soil samples.
12. Study of Satellite Imagery or Arial Photographs.

M. SC. SEMESTER-IV BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-II PLANT BIOTECHNOLOGY AND PLANT BREEDING (M-BO642T)

Hours: 4Hours/Week **Marks: 60(SEE)+40(CIE)=100** **Credit: 4**

Course objectives: -

1. Understanding the principles and techniques of gene cloning, types of vectors
2. Knowledge on recombinant DNA technology & its tools, microbial genetic
3. manipulations.
4. Understanding the basic concepts of tissue culture and knowledge on transgenics.
5. Practical knowledge and analysis skills in usage of various bioinformatic tools.

Course outcome: -

After successful completion of the course the students will be able to

1. Learn gene cloning, recombinant DNA technology etc.
2. Learn tissue culture methods.

Learn and apply bioinformatic tools for analysis of bioinformation data.

Unit-I Recombinant DNA Technology and Plant Genetic Engineering (15 Hrs)

1. Recombinant DNA technology: Gene cloning- Principles and technique; vectors- types (cloning & expression; plasmid & viral) and their properties; construction of DNA libraries (gDNA and cDNA); splicing of insert into the vector; screening of DNA libraries and introduction of the recombinant DNA into the host cells.
2. Genetic engineering of plants: Aims, strategies for development of transgenics (with suitable examples); Agrobacterium-the natural genetic engineer; T-DNA and transposon mediated gene tagging.

Unit-II Applied Molecular Biotechnology (15 Hrs)

1. Bacterial transformation, selection of recombinants and transformants, genetic improvement of industrial microbes and nitrogen fixers, fermentation technology.
2. Genomics and proteomics, Functional genomics; Protein profiling and its significance.
3. DNA synthesis; DNA sequencing; basic polymerase chain reaction and applications of PCR; DNA fingerprinting

Unit-III Plant Tissue Culture and Modern Plant Biotechnology (15 Hrs)

1. Plant tissue culture: Basic concepts; Principles and scope; tissue culture media; callus induction and cell suspension; aspects of morphogenesis; haploid and triploid production; production of somatic embryos; applications of plant tissue culture; protoplast isolation and culture; production of cybrids.
2. Transgenic production: Methods to introduce gene in plants; selection of transformed plants/explants; salient achievements in crop biotechnology.

Unit-IV Bioinformatics, Biological Databases and Plant Breeding (15 Hrs)

1. Introduction, History, Definition and applications of bioinformatics; Database:

Sequences (nucleotide and amino acid); nomenclature- IUPAC symbols, nomenclature of DNA & protein sequences, directionality of sequences, types of sequences used in bioinformatics;

2. Definitions, types and classification of databases- Primary Databases, Secondary databases, Literature database and Taxonomy database.
3. Plant breeding: Methods of breeding sexually (self and cross pollinated) and vegetatively propagated crops; heterosis and inbreeding depression and their genetic basis; use of male sterility in hybrid production.

Suggested readings

1. Baxevanis, A. D., Davison, D. B.; Page, R. D. M.; Petsko, G. A.; Stein, L. D. and Stormo, G. D. 2008 Current Protocols in Bioinformatics, John-Wiley and Sons Publications, New York.

2. Baxevanis, A. D. and Ouellate, B. F. F. 2009 Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.

3. Brown, T. A. 1999. Genomes, John Wiley &Sons(Asia) Pvt. Ltd., Singapore.

4. Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use, CAB International, Oxon UK.

5. Chrispeeels, M. J. and Sadava, D. E. 1994, Plants, Genes and Agriculture.Jones & Barlett Publishers, Boston, USA.

6. Dubey, R. C. 2014 Advanced Biotechnology. S. Chand & Co. Pvt. Ltd., New Delhi.

7. Glazer, A. N. and Nikaido, H. 1995.Microbial Biotechnology. W. H. Freeman & Company, New York, USA.

8. Gustafson, R. J. 2000. Genomes.Kluwer Academic Plenum Publishers, New York, USA.

9. Henry, R. J. 1997. Practical Applications of Plant Molecular Biology.Chapman & Hall, London, UK.

10. Jain, S. M., Sopory, S. K. and Veilleux, R.E. 1996. In vitro Haploid Production in Higher

11. Plants, Vols. 1-5, Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.

12. Jolles, O. and Jornvall, H. (eds) 2000. Proteomics in Functional Genomics.Birkhauser Verlag, Basel, Switzerland.

13. Kartha, K. K. 1985. Cryopreservation of Plant Cells and Organs.CRC Press, Boca Raton, Florida USA.

14. Kingsman, S. M. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, Blackwell Scientific Publications, Oxford, 1998 82

15. Mount W. 2004 Bioinformatics and sequence genome analysis 2nd Edi. CBS Pub. New Delhi

16. Old, R. W. and Primrose, S. B. 1989.Principles of Genome Analysis. Blackwell Scientific Publications. Oxford, UK.

17. Primrose, S. B.1995. Principles of Genome Analysis. Blackwell Scientific Ltd., Oxford, UK.

18. Raghavan, V. 1997.Molecular Biology of Flowering Plants. Cambridge University Press, New York, USA.

M. SC. SEMESTER-IV BOTANY

DSC Laboratory Exercise based on DSC Paper-II

(M-BO644P)

List of Practicals

1. Aseptic culture techniques for establishment and maintenance of cultures.
2. To prepare the media for plant tissue culture.
3. To surface sterilize the given seeds/explant for tissue cultural manipulation.
4. Synthesis of artificial seeds.
5. To isolate protoplast and determine its viability.
6. To fuse the protoplast for production somatic hybrid.
7. To workout the DNA sequence from the given autoradiogram and identify the gene using online tools.
8. To search literature database of different organisms.
9. To search the genes in the Genebank.
10. To search the given amino acid in NCBI.
11. To use the various tools to retrieve information available from NCBI.
12. To locate gene(s) on chromosomes for a given disease/disorder.
13. To emasculate and bag the given flower for crossing.
14. To hybridise the given flower using pollens from the appropriate donor plant.

M. SC. SEMESTER-IV BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-I PALEOBOTANY
(M-BO643TPB)

Hours: 4Hours/Week Marks: 60 (SEE) + 40 (CIE) = 100 Credits: 4

Course Objective: -

- Students will be introduced to the fundamentals of Petrology, Geological Time Scale, early land Plants, Primitive Gymnosperm, Deccan traps and Inter-traps.

Course outcome: -

By the end of this course, the students will be able to:

- Classify various types of rocks and interpret the Geological Time Scale
- Apply techniques of fossil preparation and age determination.
- Reconstruct early land plants and evaluate their evolutionary significance.
- Compare diversification patterns in primitive gymnosperms.
- Assess paleoclimate and paleogeography using Deccan Intertrappean flora.

Unit-I Fundamentals of Paleobotany (15Hrs)

1. Introduction to the Science of Petrology: The classification of rocks i.e. Endogenetic and Exogenetic (Igneous, Metamorphic and Sedimentary) and their brief account.
2. Geological column and time scale.
3. Fossilization: Modes of Preservation (Types)
4. Preparation and age determination techniques.
5. Principles of fossil systematics, reconstruction, and nomenclature.
6. Role of paleobotany in stratigraphy and petroleum geology. Principles of stratigraphic correlation
7. Application of Paleobotany in coal and oil exploration.

Unit-II Evolutionary trends in early land plants (15Hrs)

1. Life in Precambrian
2. Greening of Earth –Speculation.
3. Devonian flora: Rhyniopsida- *Rhynia,* Horneophytopsida- *Horneophyton.*
4. Significance of Devonian flora in plant evolution, role in atmospheric oxygen increase
5. Origin of vascular tissue and Transition from gametophyte to sporophyte dominance.
6. Arborescent Lycopods of Carboniferous: *Lepidodendron, Lepidophlois, Lepidocarpon, Lepidostrobus,Stigmaria*.
7. Shpenopsids of Carboniferous: Its origin and evolutionary consideration. Sphenophyllales: *Sphenophyllum* and Calamitales: *Calamites*

Unit-III Diversification of Primitive Gymnosperms (15Hrs)

1. Pteridosperms of Carboniferous:- Lyginopteridales: Lyginopteridaceae,
2. Progymnosperms: Archaeopteris a crucial evolutionary link

3. Diversification in primitive Gymnosperm;- Cycadeoidales- Cycadeoidaceae, Williamsoniaceae
4. Caytoniales:- Caytoniaceae Cordaitales, Glossopteridales ,Pentoxylales.
5. Evolutionary significance of Glossopteridales in Gondwana.
6. Economic importance of Pentoxylales and their fossil record.

Unit-IV Deccan Intertrappean flora and Paleogeography (15Hrs)

1. Deccan Intertrappean flora of India: Formation of Deccan traps and Intertraps, age and its floristic composition in relation to Pteridophytes (*Azolla, Salvinia, Surangea*),
2. Gymnosperms (*Mohgaostrobus, Harrisostrobus*)
3. Angiosperms (*Palmoxylon, Palmocarpon, Triccoccites, Enigmocarpon, Chitaleypushpam, Sahnianthus, Sahnipushpam*).
4. Mass extinction and angiosperm radiation.
5. Palynology of Deccan Intertraps.
6. Paleoclimate and Paleogeography of Deccan Intertraps. Applied relevance in paleoclimate reconstruction.
7. Correlation of Deccan flora with global Cretaceous–Paleogene boundary events.

***Note:-** Different plant groups are to be studied with key genera for their morphology and anatomy of vegetative and reproductive parts

List of Books / References / Online Resources

1. Agashe S.N.(1995)-Palaeobotany , Oxford &IBH publishing company-New Delhi.
2. Andrews H.N.(1961)-Studies in Palaeobotany, Willey and Sons –New York.
3. Arnold,C.A.(1947)-An Introduction to Palaeobotany, MC-Graw Hills.,New York
4. Beck,C.B.and Wight, D.C.(1988)-Progymnosperm, In origin and evolution of Gymnosperms,Columbia Uni. Press-New York.
5. Beck, C.B.(1976)-Current status of the Progymnospermosida, Review of Palaeobotany and Palynology
6. Darrah, W.C. (1960)-Principles of Paleobotany.
7. Chandra,S.and Surange, K.R.(1979)-Revision of the Indian species of Glossopteris, Monograph,Birbal Sahni Institute of Palaeobotany.
8. Meyen, S.V.(1987) – Fundamentals of Palaeobotany Chapman and Hill,London,New York.
9. Parihar ,N.S.(1995) –Essentials of Palaeobotany, Central Book –Allahabad.
10. Sahni, B.(1964)- Revisions of Indian fossils plants, -III(Monocotyledons) –BSIP-Lucknow.
11. Stewart, W.N.& Rothwell, G.V. (1993)-Palaeobotany and Evolution of Plants, Cambridge Univ., Press-Cambridge.

Suggested activity:

Seminar, Quiz, debate, Assignments, visit to a nearby fossiliferous site, Field work, Study Projects, Models etc. are Part of Curriculum. Botanical Excursion (one short excursion is compulsory)

M. SC. SEMESTER-IV BOTANY

DSE Laboratory Exercise based on DSE Paper-I

List of Practicals

1. Identification and classification of rock samples (endogenetic vs exogenetic).
2. Physiographic division of India.
3. Construction of GTS
4. Study of *Rhynia*
5. Comparative study of **Carboniferous arborescent lycopods** (*Lepidodendron*, *Lepidocarpon*).
6. Study of *Calamites* and *Sphenophyllum*.
7. Study of fossil slides/photographs of **pteridosperms** (*Lyginopteridaceae*).
8. Study of *Cycadeoidia*.
9. **Study of *Glossopteris* leaves and fructifications**
10. **Study of Pentoxylales fossils**– morphology and evolutionary significance.
11. Study of hand specimens/slides of **Deccan Intertrappean pteridophytes** (*Azolla*, *Salvinia*).
12. Morphological study of **gymnosperm fossils** (*Mohgaostrobus*, *Harrisostrobus*).
13. Analysis of **angiosperm woods and flowers** (*Palmoxylon*, *Sahnianthus*, *Chitaleypushpam*).
14. Field visit: **Nagpur Intertrappean fossil localities**

M. SC. SEMESTER-IV BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-II PLANT BIODIVERSITY AND CONSERVATION
(M-BO643TPC)

Hours: 4Hours/Week **Marks: 60(SEE)+40(CIE)=100** **Credit: 4**

Course Objective: -

1. Understanding Biodiversity of India and World.
2. Understanding need of plant conservation.
3. Understanding importance of National parks, Biospheres, botanical gardens etc.
4. Understand the vegetation types around them.

Course outcome: -

By the end of this course, the students will be able to:

1. Learn and apply the knowledge of Biodiversity and conservation methods.
2. Learn and apply the knowledge of conservation methods.
3. Learn and apply techniques of Botanical gardens etc.
4. Learn and understanding value of rare and threatened plant.

Unit-I Plant Evolution, Phytogeography, and Vegetation of India (15Hrs)

1. Theory of land bridge, theory of continental drift, polar oscillations and glaciations.
2. Centre of origin of plant – Vavilov's concept, types. Phytogeographical regions – concept, phytogeographical regions of India.
3. Vegetation types of India– Composition and distribution of evergreen, semi evergreen, deciduous, scrub, mangroves, shoal forests and grasslands. An account of the vegetation of the Western Ghats. Application of Paleobotany in coal and oil exploration.

Unit-II Biodiversity: Concepts, Values, and Conservation (15Hrs)

1. Biodiversity: Definition, types of biodiversity - habitat diversity, species diversity and genetic diversity.
2. Global and Indian species diversity. SDG's in biodiversity conservation. Values of Biodiversity – Economic and aesthetic value, Medicinal and timber yielding plants. NTFP. Threats to biodiversity.

Unit-III Biodiversity Hotspots and Conservation Strategies (15Hrs)

1. Biodiversity Hotspots and Hottest hotspot, Biodiversity hot spots of India, Concept of endemism and endemic species.
2. Conservation methods – In-situ and ex-situ methods,
3. Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, Social approaches to conservation, Pteridosperms of Biodiversity awareness programmes, Sustainable development.

Unit-IV Protected Areas and Ex Situ Conservation of Biodiversity (15Hrs)

1. IUCN- General Account, categories, Commissions, role in conservation; Red Data Book
2. Protected areas- Sanctuaries, National parks, Biosphere reserves.

3. Wetlands and Mangroves Coral Reefs- Types, importance, artificial reefs, conservation measures Botanical gardens, Seed Banks; In-vitro repositories; Cryobanks.

***Note:-** Different plant conservation methods are to be studied with examples of world.

List of Books / References / Online Resources

1. Sharma, P.D. 2018. Fundamentals of Ecology.Rastogi Publications.
2. Odum E.P. (1975): Ecology By Holt, Rinert& Winston.
3. Oosting, H.G. (1978): Plants and Ecosystem Wadworth Belmont.
4. Kochhar, P.L. (1975): Plant Ecology. (9th Edn.,) New Delhi, Bombay, Calcutta- 226pp.,
5. Kumar, H.D. (1992): Modern Concepts of Ecology (7th Edn.,) Vikas Publishing Co., New Delhi.
6. Kumar H.D. (2000): Biodiversity & Sustainable Conservation. Oxford & IBH Publishing Co Ltd. New Delhi.
7. Newman, E.I. (2000): Applied Ecology, y, Blackwell Scientific Publisher, U.K.
8. 8.Chapman, J.L&M.J. Reiss (1992): Ecology (Principles & Applications). Cambridge University Press, U.K.
9. Malcolm L. Hunter Jr., James P. Gibbs, Viorel D. Popescu, 2020. Fundamentals of Conservation Biology, 4th Edition.Wiley-Blackwel.
10. Saha T. K., 2017. Ecology and Environmental Biology.Books and Allied Publishers

Suggested activity:

Seminar, Quiz, debate, Assignments, visit to a nearby fossiliferous site, Field work, Study Projects, Models etc. are Part of Curriculum. Botanical Excursion (One short excursion is compulsory).

M. SC. SEMESTER-IV BOTANY

DSE Laboratory Exercise based on DSE

List of Practicals

1. A trip to the grass land/ forest/ water body to get acquainted with their plant species.
2. Demonstration of different types of vegetation sampling methods – transects and quadrats.
3. To determine minimum size and number of quadrats required to study grassland.
4. To determine minimum size and number of quadrats required to study Forest area.
5. Qualitative parameters of distribution of plant species, Frequency, Density, Basal cover, dominance, Abundance and IVI.
6. To determine the homogeneity of vegetation by Raunkier's frequency diagram.
7. To determine diversity indices (Shannon-Weiner, species richness, B-diversity) from given data.
8. Population structure study of dominant tree species of the locality.
9. To study the various methods of conservation- In-situ and Ex-situ.

Based on Biostatistics

1. Calculate mean, variance, standard deviation and coefficient of variation for comparing two means related to given ecological data.

2. Calculate mean, variance, and to use t-test for comparing two means related to given ecological data.

3. To find out association between important grassland species from the given data using chi• square test.

4. To find out relationship between two ecological variables using correlation analysis.

5. To perform the one-way ANOVA from the given data.

M. SC. SEMESTER-IV BOTANY

Practical Examination based on DSC and DSE Lab. M-BO644P

Time: 6-8 Hours **Full marks: 120**

Q. 1 Experiment A from DSC 1 paper	10
Q.2 Experiment B from DSC 1 paper.	10
Q.3 Experiment C from DSC II paper.	10
Q. 4 Experiment D from DSC II paper.	10
Q. 5 Experiment E from DSE Paper.	10
Q.6. Experiment F from DSE Paper.	10
Q. 7 Spotting	6x3=18
1. DSC I 2. DSC I 3. DSC II 4. DSC II 5. DSE 6. DSE	
Q. 8 Viva-voce	20
Q. 9 Practical Record, Excursion Report	22

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
20	20	20	20	**80**

M. SC. SEMESTER-IV BOTANY
RESEARCH PROJECT / DISSERTATION (Core)
(M-BO645POJT)

Hours: 12Hours/Week **Marks: (CIE)=300** **Credit: 6**

The Research Project provides M.Sc. Botany students with practical training in scientific research through laboratory and field investigations. Students will identify a research problem, review relevant literature, design and conduct experiments, collect and analyze data, and interpret results using appropriate scientific methods. The project may be undertaken in any branch of Botany, such as Taxonomy, Ecology, Biotechnology, Genetics, Molecular Biology, Plant Physiology, or Environmental Science. Each student shall prepare and submit a dissertation, deliver a seminar presentation, and appear for a viva-voce. **Evaluation will be based on Continuous Assessment (100 marks), Dissertation (100 marks), Seminar Presentation (50 marks), and Viva-Voce (50 marks), totaling 300 marks.**

CIE Evaluation

Continuous Assessment	Dissertation	Seminar Presentation	Viva-Voce	Total
100	100	50	50	**300**