Institute of Science, Nagpur

(An Autonomous Institute of Govt. of Maharashtra)

DEPARTMENT OF BOTANY

CREDIT STRUCTURE, EVALUTION SCHEME,

AND SYLLABUS OF FOUR-YEAR BACHELOR OF SCIENCE (HONORS/RESEARCH) DEGREE WITH A SEMESTER PATTERN IN BOTANY

B. Sc. BOTANY

(FACULTY OF SCIENCE &TECHNOLOGY)

BASED ON DIRECTION 1 OF 2024 ISSUED BY THE INSTITUTE OF SCIENCE, NAGPUR AS PER NEP 2020

To be implemented from 2026-2027

B.Sc. Botany (NEP 2020)

Programme Outcomes (POs)

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

- **PO1. Foundational Knowledge Graduates** will demonstrate comprehensive understanding of plant sciences, including microbes, algae, fungi, bryophytes, pteridophytes, gymnosperms, and angiosperms.
- **PO2. Laboratory & Field Skills** Ability to perform staining, microscopy, disease diagnosis, taxonomy, ecological surveys, and field projects with accuracy and safety.
- **PO3. Research & Innovation** Competence in designing experiments, analyzing data, and applying modern tools (biotechnology, genetic engineering, tissue culture, instrumentation).
- **PO4. Ethics & IKS** Appreciation of Indian Knowledge Systems (IKS), environmental ethics, biodiversity conservation, and sustainable practices.
- **PO5. Communication & Outreach Skills** in scientific writing, presentations, group discussions, and community service for science outreach.
- **PO6. Employability & Lifelong Learning** Preparedness for careers in teaching, research, forestry, agriculture, biotechnology, and industry, with adaptability to lifelong learning.

B.Sc. Botany (NEP 2020)

Programme Specific Outcomes (PSOs)

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

PSO1. Plant Diversity & Systematics Ability to classify, identify, and understand evolutionary relationships among plants, fossils, and cryptogams.

PSO2. Cell, Genetics & Development Understanding of cell biology, genetics, embryology, and developmental processes in plants.

PSO3. Physiology & Biochemistry Knowledge of photosynthesis, respiration, water relations, plant hormones, and molecular biology.

PSO4. Applied Botany Practical expertise in mushroom cultivation, herbal medicine, tissue culture, forestry, economic botany, and phytochemistry.

PSO5. Ecology & Conservation Skills in ecological surveys, soil science, biodiversity assessment, and conservation strategies.

PSO6. Research & Professional Practice Competence in research methodology, dissertation writing, internships/apprenticeships, and use of modern instrumentation.

Teaching and Examination Schemes:

Teaching and Examination Schemes Four Year B.Sc. (of eight semesters) program is as follows.

Table 1: B.Sc. Semester I

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	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** Subject (One will be Major and other Minor in Semster III)	Subject 1:- **MICROBES, FUNGI AND PLANT PATHOLOGY**	B-BO111T	4.5	2	--	--	2	2	30	20	25
		Subject 1 Lab	B-BO112P		--	--	2	1	4	30	20	25
		Subject 2:-			2	--	--	2	2	30	20	25
		Subject 2 Lab			--	--	2	1	4	30	20	25
2	**GE**	Refer to GE Basket			2	--	--	2	2	30	20	25
		Refer to GE Basket			2	--	--	2	2	30	20	25
3	**VSEC**	Refer VSC Basket **MUSHROOM CULTIVATION**	B-BO113P		--	--	4	2	4 - 6	60	40	50
4	**AEC**	English Compulsory			2	--	--	2	2	30	20	25
5	**VEC**	Environmental Studies			2	--	--	2	2	30	20	25
6	**IKS**	**TRADITIONAL KNOWLEDGE OF PLANTS- I**	B-BO114T		2	--	--	2	2	30	20	25
7	**CC**	NSS /NCC / Sports / Cultural			--	--	4	2	--	--	100	50
TOTAL					**14**	**--**	**16**	**22**	**--**	**390**	**360**	**--**

Table 2: B.Sc. Semester II

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	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** Subject (One will be Major and other Minor in Semster III)	Subject 1:- **ALGAE, LICHENS AND BRYOPHYTES**	B- BO121T	4.5	2	--	--	2	2	30	20	25
		Subject 1 Lab	B-BO122P		--	--	2	1	4	30	20	25
		Subject 2			2	--	--	2	2	30	20	25
		Subject 2 Lab			--	--	2	1	4	30	20	25
2	**GE**	Refer to GE Basket			2	--	--	2	2	30	20	25
		Refer to GE Basket			2	--	--	2	2	30	20	25
3	**VSEC**	Refer VSC Basket **IDENTIFICATION OF ANGIOSPERMS**	B- BO123P		--	--	4	2	4 - 6	60	40	50
4	**AEC**	English Compulsory			2	--	--	2	2	30	20	25
5	**VEC**	Constitution of India			2	--	--	2	2	30	20	25
6	**IKS**	**TRADITIONAL KNOWLEDGE OF PLANTS-II**	B-BO124T		2	--	--	2	2	30	20	25
7	**CC**	NSS /NCC / Sports / Cultural			--	--	4	2	--	--	100	50
TOTAL					**14**	**--**	**16**	**22**	**--**	**390**	**360**	**--**

Table 3: B.Sc. Semester III

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	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:- **PTERIDOPHYTES AND GYMNOSPERMS**	B-BO231T	5.0	2	--	--	2	2	30	20	25
		Paper 2:- **PALAEOBOTANY**	B-BO232T		2	--	--	2	2	30	20	25
		DSC Lab	B-BO233P		--	--	4	2	4 - 6	60	40	50
2	**Minor**	Paper 1:- **DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS**	B-BO234T		2	--	--	2	2	30	20	25
		Paper 2:- **DIVERSITY OF PLANT FOSSILS**	B-BO235T		2	--	--	2	2	30	20	25
		Minor Lab	B-BO236P		--	--	4	2	4 - 6	60	40	50
3	**GE**	Refer to GE Basket			2	--	--	2	2	30	20	25
4	**VSEC**	Refer SEC Basket **HERBAL MEDICINE**	B-BO237P		--	--	4	2	4 - 6	60	40	50
5	**AEC**	Second Language			2	--	--	2	2	30	20	25
6	**FP**	**FIELD PROJECT**	B-BO238P		--	--	4	2	4 - 6	--	100	50
7	**CC**	NSS / NCC / Sports / Cultural			--	--	4	2	--	--	100	50
Total					**12**	**--**	**20**	**22**	**--**	**360**	**440**	**--**

Table 4: B.Sc. Semester IV

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	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 ANATOMY**	B-BO241T	5.0	2	--	--	2	2	30	20	25
		Paper 2:- **PLANT TAXONOMY**	B-BO242T		2	--	--	2	2	30	20	25
		DSC Lab	B-BO243P		--	--	4	2	4 - 6	60	40	50
2	**Minor**	Paper 1:- **ANATOMY OF PLANTS**	B-BO244T		2	--	--	2	2	30	20	25
		Paper 2:- **TAXONOMY OF PLANTS**	B-BO245T		2	--	--	2	2	30	20	25
		Minor Lab	B-BO246P		--	--	4	2	4 - 6	60	40	50
3	**GE**	Refer to GE Basket			2	--	--	2	2	30	20	25
4	**VSEC**	Refer SEC Basket **LABORATORY TECHNIQUES IN BOTANY**	B-BO247P		--	--	4	2	4 - 6	60	40	50
5	**AEC**	Second Language			2	--	--	2	2	30	20	25
6	**CEP**	Community Service	B-BO248P		--	--	4	2	4 - 6	0	100	50
7	**CC**	NSS / NCC / Sports / Cultural			--	--	4	2	--	0	100	50
Total					**12**	**--**	**20**	**22**	**--**	**360**	**440**	**--**

Table 5: B.Sc. Semester V

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	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:- **CELL BIOLOGY**	B-BO351T	5.5	3	--	--	3	3	45	30	38
		Paper 2:- **PLANT PHYSIOLOGY**	B-BO352T		3	--	--	3	3	45	30	38
		DSC LAB (BASED ON PAPER 1 + PAPER2)	B-BO353P		--	--	6	3	6	90	60	75
		Paper 3:- **PLANT DEVELOPMENT AND EMBRYOLOGY**	B-BO354T		2	--	--	2	2	30	20	25
		DSC LAB (BASED ON PAPER 3)	B-BO355P		--	--	2	1	4	30	20	25
2	**DSE**	Elective 1:- **MYCOLOGY AND INDUSTRIAL MICROBIOLOGY** Elective 2:- **FORESTRY**	B- BO356MY B- BO356FO		2	--	--	2	2	30	20	25
		DSE LAB	B-BO357P		--	--	4	2	4 - 6	60	40	50
3	**Minor**	Paper 1:- **PLANT EMBRYOLOGY**	B-BO358T		2	--	--	2	2	30	20	25
		MINOR LAB	B-BO359P		--	--	2	1	4	30	20	25
4	**VSEC**	Refer SEC Basket **PLANT TISSUE CULTURE**	B- BO3510P		--	--	4	2	4 - 6	60	40	50
5	**CEP**	**COMMUNITY SERVICE**	B- BO3511P		--	--	2	1	--	--	50	25
TOTAL					**12**	**--**	**20**	**22**		**450**	**350**	**--**

Table 6: B.Sc. Semester VI

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:- **GENETICS**	B- BO361T	5.5	3	--	--	3	3	45	30	38
		PAPER 2:- **FUNDAMENTAL PROCESSES IN BIOLOGY**	B- BO362T		3	--	--	3	3	45	30	38
		DSC LAB (BASED ON PAPER 1 + PAPER2)	B- BO363P		--	--	6	3	6	90	60	75
		PAPER 3:- **PLANT BIOTECHNOLOGY & GENETIC ENGINEERING**	B- BO364T		2	--	--	2	2	30	20	25
		DSC LAB	B- BO365P		--	--	2	1	4	30	20	25
2	**DSE**	ELECTIVE 3:- **PLANT ECOLOGY & SOIL SCIENCE** ELECTIVE 4:- **ECONOMIC BOTANY & PHYTOGEOGRAPHY**	B- BO366PE B-BO366EB		2	--	--	2	2	30	20	25
		DSE LAB	B- BO367P		--	--	4	2	4 - 6	60	40	50
3	**VSEC**	REFER SEC BASKET **INSTRUMENTATION IN BOTANY**	B- BO368P		--	--	4	2	4 - 6	60	40	50
4	**OJT**	**INTERNSHIP / APPRENTICESHIP** (RELATED TO DSC)	B- BO369P		--	--	8	4	--	--	200	100
TOTAL					**10**	**--**	**24**	**22**		**390**	**460**	**--**

Table 7: B.Sc. Semester-VII (Honors)

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:- **CRYPTOGAMIC BOTANY**	B-BOH471T	6.0	4	--	--	4	3	80	20	50
		Paper 2:- **GYMNOSPERMS & PLANT SYSTEMATICS**	B-BOH472T		4	--	--	4	3	80	20	50
2	**DSE**	Electives:- **5) PHYCOLOGY AND HYDROBIOLOGY 6) MYCOLOGY AND APPLIED PLANT PATHOLOGY**	B- BOH473PH B- BOH473MP		4	--	--	4	3	80	20	50
3	**DSC /DSE**	**DSC Lab** (Based on Paper 1 + Paper 2+ Elective)	B-BOH474P		--	--	12	6	8 - 12	240	60	150
4	**RM**	**RESEARCH METHODOLOGY**	B- BOH475RM		4	--	--	4	3	80	20	50
TOTAL					**16**	**--**	**12**	**22**		**560**	**140**	**--**

Table 8: B.Sc. Semester-VIII (Honors)

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**	B-BOH481T	6.0	4	--	--	4	3	80	20	50
		Paper 2:- **PLANT PHYSIOLOGY**	B-BOH482T		4	--	--	4	3	80	20	50
2	**DSE**	Electives:- 7) **PHYTOCHEMISTRY** 8) **PALYNOLOGY**	B- BOH483PC B-BOH483PN		4	--	--	4	3	80	20	50
3	**DSC /DSE**	**DSC LAB** (Based on Paper 1 + Paper 2+ Elective)	B-BOH484P		--	--	12	6	8-12	240	60	150
4	**OJT**	**INTERNSHIP / APPRENTICESHIP** (Related to DSC)	B-BOH485P		--	--	8	4	--	--	200	100
TOTAL					**12**	**--**	**20**	**22**		**480**	**320**	**--**

Table 9: B.Sc. Semester-VII (Honors with Research)

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:- **CRYPTOGAMIC BOTANY**	B-BOR471T	6.0	4	--	--	4	3	80	20	50
		Paper 2:- **GYMNOSPERMS & PLANT SYSTEMATICS**	B-BOR472T		4	--	--	4	3	80	20	50
2	**DSE**	Electives:- **5) PHYCOLOGY AND HYDROBIOLOGY 6) MYCOLOGY AND APPLIED PLANT PATHOLOGY**	B- BOR473PN B- BOR473PB		4	--	--	4	3	80	20	50
3	**DSC /DSE**	**DSC LAB** (Based on Paper 1 + Paper 2)	B-BOR474P		--	--	4	2	4 - 6	80	20	50
4	**RM**	**RESEARCH METHODOLOGY**	B- BOR475RM		4	--	--	4	3	80	20	50
5	**RP**	**RESEARCH PROJECT** (Core)	B-BOR476P		--	--	8	4	--	--	200	100
TOTAL					**16**	**--**	**12**	**22**		**400**	**300**	**--**

Table 10: B.Sc. Semester-VIII (Honors with Research)

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:- **CELL AND MOLECULAR BIOLOGY- I**	B-BOR481T	6.0	4	--	--	4	3	80	20	50
		Paper 2:- **PLANT PHYSIOLOGY**	B-BOR482T		4	--	--	4	3	80	20	50
2	**DSE**	Electives:- 7) **PHYTOCHEMISTRY** 8) **PALYNOLOGY**	B- BOR483PC B-BOR483PN		4	--	--	4	3	80	20	50
3	**DSC /DSE**	**DSC LAB** (Based on Paper 1 + Paper 2+ Elective)	B-BOR484P		--	--	4	2	4 - 6	80	20	50
4	**RP**	**RESEARCH PROJECT / DISSERTATION 1** (Core)	B-BOR485P		--	--	8	4	--	--	200	100
		RESEARCH PROJECT / DISSERTATION 2 (Core)	B-BOR486P		--	--	8	4	--	--	200	100
TOTAL					**12**	**--**	**20**	**22**		**320**	**480**	**--**

Total Credits:

1. Three-Year UG Degree Program: 132
2. Four-Year UG Degree Program: 176

Table 11: Table showing course category wise credit distribution semester wise

Exit Point / Course Category	Certificate in Science	Diploma in Science	Three Year Bachelor of Science	Bachelor of Science (Honors) Degree	Bachelor of Science (Honors with Research) Degree
Major Credits	6	12	32	36	28
Minor Credits	6	12	3	--	--
GE	8	4	--	--	--
VSEC	8	4	4	--	--
AEC	4	4	--	--	--
VEC	4	--	--	--	--
IKS	4	--	--	--	--
CC	4	4	--	--	--
FP	--	2	--	--	--
CEP	--	2	1	--	--
OJT	--	--	4	4	--
RP	--	--	--	--	12
RM	--	--	--	4	4
Total Credits	44	44	44	44	44

Table 12: Table showing total marks in theory and Practical semester wise

Semester	Theory	Practical	Total Marks
I	350	400	750
II	350	400	750
III	300	500	800
IV	300	500	800
V	300	500	800
VI	250	600	850
VII (Honors)	560	140	700
VIII (Honors)	480	320	800
VII (Honors with Research)	400	300	700
VIII (Honors with Research)	320	480	800
For Honors	2550	3700	6250
For Research	2550	3700	6250

1. 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, internships, Apprenticeships, 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.

2. Assessment

The 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 Discussions, Seminars, PowerPoint 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 min. period of three years by the respective department for verification by the competent authority. Separate circular will be issued for detailed direction regarding **CIE**

(B) Semester End Evaluation (SEE)

(a) Pattern of Theory Question Paper of 30 marks

1. There will be four units in each paper.

2. Maximum marks for each theory paper will be 30.

3. Question paper will consist of five questions, each of 06 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 (B.Sc.) I, II, III, IV, V, VI, VII and VIII 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.

Institute of Science, Nagpur

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DEPARTMENT OF BOTANY

CREDIT STRUCTURE, EVALUTION SCHEME,

AND SYLLABUS OF FOUR-YEAR BACHELOR OF SCIENCE (HONORS/RESEARCH) DEGREE WITH A SEMESTER PATTERN IN BOTANY

B. Sc. I YEAR BOTANY

(FACULTY OF SCIENCE &TECHNOLOGY)

BASED ON DIRECTION 1 OF 2024 ISSUED BY THE INSTITUTE OF SCIENCE, NAGPUR AS PER NEP 2020

To be implemented from 2026-2027

Teaching and Examination Schemes:

Teaching and Examination Schemes Four Year B.Sc. (of eight semesters) program is as follows.

Table 1: B.Sc. Semester I

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					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	**DSC** Subject (One will be Major and other Minor in Semster III)	Subject 1:- **MICROBES, FUNGI AND PLANT PATHOLOGY**	B-BO111T	4.5	2	--	--	2	2	30	20	25
		Subject 1 Lab	B-BO112P		--	--	2	1	4	30	20	25
		Subject 2:-			2	--	--	2	2	30	20	25
		Subject 2 Lab			--	--	2	1	4	30	20	25
2	**GE**	Refer to GE Basket			2	--	--	2	2	30	20	25
		Refer to GE Basket			2	--	--	2	2	30	20	25
3	**VSEC**	Refer VSC Basket **MUSHROOM CULTIVATION**	B-BO113P		--	--	4	2	4 - 6	60	40	50
4	**AEC**	English Compulsory			2	--	--	2	2	30	20	25
5	**VEC**	Environmental Studies			2	--	--	2	2	30	20	25
6	**IKS**	**TRADITIONAL KNOWLEDGE OF PLANTS- I**	B-BO114T		2	--	--	2	2	30	20	25
7	**CC**	NSS /NCC / Sports / Cultural			--	--	4	2	--	--	100	50
TOTAL					**14**	**--**	**16**	**22**	**--**	**390**	**360**	**--**

B. SC. SEMESTER-I BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I MICROBES, FUNGI AND PLANT PATHOLOGY
(B-BO111T)

Hours: 2Hours/Week **Marks: 30 (SEE) + 20 (CIE) = 50** **Credits: 2**

Course objectives: - To acquaint students about the morphology, characters, and importance of different microorganisms.

Course outcome: -

By the end of this course, the students will be able to:
1. Identify different types of microorganisms: virus, bacteria, Cyanobacteria, Mycoplasmas and fungi.
2. Describe different types of microorganisms.
3. Describe pathogen, symptoms and control measures of plant diseases.

Unit-I Viruses and Mycoplasma (7.5Hrs)

1. Viruses: General characteristic and nature of viruses, Classification of viruses based on host and nucleic acid.
2. Ultrastructure of TMV, Structure and multiplication of T4 – bacteriophage, economic importance of Viruses, Viroids and Prions.
3. Mycoplasma: morphology, properties, and reproduction.

Unit-II Bacteria (7.5Hrs)

1. Bacteria: cell structure, pilia, flagella, Reproduction: Asexual and Genetic recombination. Economic importance of Bacteria.
2. Cyanobacteria: Cell ultrastructure, Structure of heterocyst, Structure, and reproduction in *Nostoc*. Economic importance of Cyanobacteria.

Unit-III Fungi (7.5Hrs)

1. Fungi: Classification (Ainsworth, 1973)
2. Economic importance of Fungi.
3. Life history of – *Albugo* (Oomycetes), *Mucor* (Zygomycetes), and *Aspergillus* (Ascomycetes)

Unit-IV Fungi and Plant Pathology (7.5Hrs)

1. Fungi: life history of – *Puccinia* (Basidiomycetes) and *Cercospora* (Deuteromyctes)

2. Plant Pathology: Introduction, Host, Pathogen, symptoms and control measures of Powdery mildew of teak, Downy mildew of grapes,
Late blight of potato, Red rot of Sugarcane and Wilt of banana.

List of Reference Books

1. Singh V., Pande, P. C., and Jain D.K. (2005): A Text book of

Botany, Rastogi Publications, Meerut.

2. Alexopoulos, C. J. (1962): C.J.: Introductory Mycology, Wiley International Edition.

3. Gangulee. H. C. and Kar, A. K. (1989): College Botany, Vol. l New

Central Book Agency, (P) Ltd. London.

4. Dubey R. C., Maheshwari D.K. (1999): Text Book of Microbiology (S.

Chand and Co.)

5. Prescott et. al., (1999): Microbiology 3RDedn. (WmC. Brown Pub)

6. Vasishta, B. R. (1990): Fungi (S. Chand and Co. New Delhi)

7. Dutta A. C. (1963), Botany for degree students, (Revised edition) Oxford

University Press, New Delhi 110002, India.

Suggested Classroom activities:
Seminar, Quiz, debate, Models etc.

Botanical Excursion (one short excursion is compulsory)

Theory CIE Evaluation

Attendance	**Assignment**	**Class test**	**Classroom activities**	**Total**
05	05	05	05	**20**

B. SC. SEMESTER-I BOTANY
DSC LABORATORY EXERCISE-I BASED ON DSC PAPER-I (B-BO112P)

Hours: 2 Hours/Week **Marks: 30 (SEE) +20 (CIE)=50** **Credit: 1**

List of Practicals

1. Study of ultrastructure of TMV
2. Study of ultrastructure of T4 Bacteriophages.
3. Study of Mycoplasma structure
4. Study of various types of Bacteria.
5. Gram staining technique
6. Study of *Nostoc*
7. Study of Fungal genera:
    - *Albugo,*
    - *Mucor,*
    - *Aspergillus,*
    - *Puccinia*
    - *Cercospora*
8. Study of fungal diseases:
    - Powdery mildew of teak
    - Downy mildew of grapes
    - Late blight of potato
    - Red rot of Sugarcane
    - Wilt of banana

B. Sc. - SEMESTER –I BOTANY
PRACTICAL EXAM BASED ON DSC LAB-I (B-BO112P)

Time: 4hrs. **Max. Marks: 30**

1. Perform Gram staining on the given Bacterial strain/stain the given Cyanobacterial material (A) identify giving reasons. 5 Marks
2. Identify the given Fungal material (B) prepare temporary mount and write identifying characters. 5 Marks
3. Identify the given Plant disease (C) and write down causal organism, symptoms, and control measure. 5 Marks
4. Spotting: 6 Marks

D. Virus

E. Mycoplasma/ Bacteria

F. Fungi/ plant disease

5. Viva-voce 5 Marks
6. Record and excursion report (submission is compulsory) 4 Marks

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
05	05	05	05	**20**

B. SC. SEMESTER-I BOTANY
VOCATIONAL SKILL COURSE (VSC)
VSC LAB MUSHROOM CULTIVATION
(B-BO113P)

Hours: 4Hours/Week Marks: 60 (SEE) + 40 (CIE) = 100 Credits: 2

Course objectives: - To provide hands-on training on the principles and techniques of mushroom cultivation for vocational competency.

Course outcome: -

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

1. Describe morphology of mushrooms.
2. Perform aseptic techniques, biochemical tests, prepare spawn, cultivate common edible mushrooms, and understand the economics of a mushroom unit.

List of Practicals

1. To study and document the detailed morphological features of commonly cultivated mushrooms and learn to use a simple dichotomous key for basic identification.
2. Perform qualitative biochemical tests for the presence of carbohydrates, proteins, and lipids, and to estimate the moisture content in mushroom samples.
3. Study of tools, equipment, and required laboratory setup for mushroom cultivation (laminar flow, autoclave, humidity chamber).
4. Preparation and sterilization of culture media (PDA, MEA) and preparation of culture tubes.
5. Preparation of compost/substrate for mushroom cultivation (e.g., sterilization/pasteurization of straw).
6. Preparation and inoculation of grain spawn for mushroom cultivation.
7. Cultivation of Oyster Mushroom and Paddy Straw Mushroom in the laboratory.
8. Identification and management of common contaminants and competitors (weed molds, pests) and calculation of Biological Efficiency (B.E.).
9. Study of post-harvest handling and basic preservation techniques (drying/blanching).
10. Preparation of value-added mushroom dishes/products.
11. Visit to a commercial mushroom growing facility and preparation of a basic project report/balance sheet outlining cost and revenue.

Suggested activity:

Collection of mushrooms from local area, Field work, Models etc.

B. Sc. - SEMESTER –I BOTANY
PRACTICAL EXAM BASED ON VSC LAB (B-BO113P)

Time: 6hrs. **Max. Marks: 60**

1. Describe morphology of given mushroom **(A)**. **10 Marks**
2. Perform casing on mycelial mat/ Inoculate the given fungal culture **(B)** on slant under aseptic condition. **8 Marks**
3. Demonstrate inoculation of spawn **(C)** for cultivation of Oyster /paddy straw mushroom under aseptic condition. **8 Marks**
4. Perform qualitative biochemical tests given mushroom material **(D)**. **8 Marks**
5. **Spotting:** **6 Marks**

   E. Tools used for mushroom cultivation
   F. Mushroom dishes/ Identification of common contaminants.
6. Viva-voce **10 Marks**
7. Practical Record and report of visit to mushroom growing facility. (Submission is compulsory) **10 Marks**

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
10	10	10	10	**40**

B. SC. SEMESTER-I BOTANY
INDIAN KNOWLEDGE SYSTEM (IKS)
IKS PAPER TRADITIONAL KNOWLEDGE OF PLANTS-I
(B-BO114T)

Hours: 2Hours/Week Marks: 30(SEE)+20(CIE)=50 Credit: 2

Course objectives: -

1. To introduce traditional Indian knowledge related to plant sciences
2. To understand the scientific basis of indigenous botanical practices
3. To explore ethnobotany, Ayurveda, and sustainable plant use
4. To integrate ancient wisdom with modern botanical science for sustainable resource management
5. To promote biodiversity awareness and conservation ethics
6. To encourage innovation based on traditional knowledge

Course outcome: -

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

1. Explain the concept and significance of Indian knowledge systems in botany
2. Identify and describe traditional uses of plants
3. Analyze the role of ethnobotany in biodiversity conservation
4. Evaluate the scientific relevance of Ayurvedic plant knowledge
5. Apply indigenous knowledge for sustainable plant resource management

Unit I: Introduction to Indian Knowledge System (IKS) (7.5 hrs)

- Concept, definition, and scope of IKS ,
- Ancient texts and botanical references (Vedas, Upanishads, Puranas)
- Contributions of ancient scholars (e.g., Charaka, Sushruta)
- Principles of Ayurveda related to plants
- Classification of medicinal plants (Rasayana, herbs, etc.)

Unit II: Ethnobotany and Traditional Knowledge (7.5 hrs)

- Concept and scope of ethnobotany
- Indigenous knowledge of plants among tribal communities
- Sacred groves and conservation practices
- Plants used in rituals, culture, and traditions
- Important medicinal plants and their uses (e.g., Tulsi, Neem, Ashwagandha, Turmeric)
- Herbal formulations and traditional healthcare systems
- Plants in Indian economy (timber, spices, fibers, dyes)
- Traditional industries based on plant resources
- Role of plants in art, literature, and religion

Unit III: Agriculture, Conservation and Biodiversity (7.5 hrs)

- Traditional agricultural practices in India
- Organic farming and Jhum cultivation

- Crop diversity and seed preservation
- Role of communities in conservation
- Sacred plants and biodiversity protection
- Role of plants in sustainable agriculture
- Integration of IKS with modern conservation biology

Unit IV: Intellectual Property Rights and Biopiracy (7.5 hrs)

- Traditional knowledge and IPR
- Issues of biopiracy (e.g., Neem, Turmeric cases)
- Protection of indigenous knowledge
- National and international policies
- Ethnopharmacology and bioprospecting

Suggested Readings

- Jain, S.K. – *Ethnobotany in India*
- Trivedi, P.C. – *Medicinal Plants: Utilization and Conservation*
- Government of India – IKS and Ayurveda publications
- Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
- Knowledge Traditions and Practices of India Kapil Kapoor 1, Michel Danino2

Teaching and Examination Schemes:

Teaching and Examination Schemes Four Year B.Sc. (of eight semesters) program is as follows.

Table 2: B.Sc. Semester II

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	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** Subject (One will be Major and other Minor in Semster III)	Subject 1:- **ALGAE, LICHENS AND BRYOPHYTES**	B- BO121T	4.5	2	--	--	2	2	30	20	25
		Subject 1 Lab	B-BO122P		--	--	2	1	4	30	20	25
		Subject 2			2	--	--	2	2	30	20	25
		Subject 2 Lab			--	--	2	1	4	30	20	25
2	**GE**	Refer to GE Basket			2	--	--	2	2	30	20	25
		Refer to GE Basket			2	--	--	2	2	30	20	25
3	**VSEC**	Refer VSC Basket **IDENTIFICATION OF ANGIOSPERMS**	B- BO123P		--	--	4	2	4 - 6	60	40	50
4	**AEC**	English Compulsory			2	--	--	2	2	30	20	25
5	**VEC**	Constitution of India			2	--	--	2	2	30	20	25
6	**IKS**	**TRADITIONAL KNOWLEDGE OF PLANTS-II**	B-BO124T		2	--	--	2	2	30	20	25
7	**CC**	NSS /NCC / Sports / Cultural			--	--	4	2	--	--	100	50
TOTAL					**14**	**--**	**16**	**22**	**--**	**390**	**360**	**--**

B. SC. SEMESTER-II BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I ALGAE LICHENS AND BRYOPHYTES
(B-BO121T)

Hours: 2Hours/Week **Marks: 30 (SEE) + 20 (CIE) = 50** **Credits: 2**

Course objectives: -

1. To inform students about the morphology, characters and importance of different algae and bryophytes.

Course outcomes:-

1. The course, will enable students to know about different types of algae, lichen and bryophytes.

Unit-I (7.5Hrs)

1. Algae –General characters, Classification (Fritsch 1945), Evolution of thallus in algae
2. Economic and Ecological importance of Algae
3. Life history of
    1. *Oedogonium* (Chlorophyceae)
    2. *Chara* (Chlorophyceae)

Unit-II (7.5Hrs)

Algae – life history of

3. *Vaucheria* (Xanthphyceae)
4. *Ectocarpus* (Phaeophyceae)
5. *Batrachospermum* (Rhodophyceae)

Unit-III (7.5Hrs)

1. Lichens: Types, Reproduction and Economic importance.
2. Bryophyta: Classification (Proskauer 1957).
3. General characters of various classes of Brypophyta (Hepaticopsida, Anthocerotopsida and Bryopsida),
4. Economic and Ecological importance, Alternation of Generation.

Unit-IV (7.5Hrs)

Life history of –

1. *Riccia* (Haepaticopsida)
2. *Anthoceros* (Anthoceratopsida)
3. *Funaria* (Bryopsida)

Evolution of sporophyte in Bryophytes

(Note: Development stages not expected)

List of Books

1. Bold H.C. and M. J. Wynne (1978): Introduction of Algae: structure and reproduction (Prentices Hall of India, Pvt. Ltd.)
2. Morris (1986): Introduction to the Algae. Cambridge University press, UK
3. Chopra, G. I. and D. I. Yadav (1980): A text Book of Bryophyta (Arihant Press)
4. Kumar H. D. (1988): Introductory Phycology, Affiliate East- West Press. Pvt. Ltd. (New Delhi)
5. Casselman. (1993). Craft of the Dyer-colour from plants and Lichens. Dover publications, Inc., N. Y.
6. Singh K. P. and Sinha G. P. (2010) Indian Lichens an annotated checklist, M/s Bishen Singh Mahendra pal Singh
7. Smith G. M. (1971) Cryptogamic Botany, Vol. II Bryophyta and Pteridohyta (THM)
8. Sporne, K.R.11: The Morphology of Bryophyta (Hutchinson University, London)
9. Vasistha B. R. (1992): Bryophyta (S. Chand and co. New Delhi)
10. Ram Udar (1970): An introduction to Bryophyta (ShashidharMalviyaPrakashan, Lucknow)
11. Parihar, N. S. (1997): The Biology and morphology of Bryophytes (Central Book Depot. Allahabad)

B. SC. SEMESTER-II BOTANY
DISCIPLINE SPECIFIC CORE COURSE LABORATORY EXERCISE-I
(B-BO122P)

Based on DSC Paper I	**Hours: 2 Hours/Week**	**Marks: 30(SEE)+20(CIE)=50**	**Credit: 1**

1. Study of Algal genera:
    - *Oedogonium,*
    - *Chara,*
    - *Vaucheria,*
    - *Ectocarpus*
    - *Batrachospermum*
2. Study of Lichens: Thallus structure, Types
3. Study of Bryophytes:
    - *Riccia*
    - *Anthoceros*
    - *Funaria*

Suggested activity:

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

B. SC. - SEMESTER –II BOTANY PRACTICAL EXAM BASED ON DSC LAB-I B-BO122P (SEE)

Time: 4hrs. Max. Marks: 30

1. Identify the given **Lichen** material **(A)** **2 Marks**
2. Identify the given **Algal** material **(B)** prepare a temporary mount and write **4 Marks** Identifying characters.
3. Identify the given **Algal** material **(C)** prepare a temporary mount and write identifying characters. **4 Marks**
4. Identify the given **Bryophytic** material **(D)** prepare temporary mount and write identifying characters. **4 Marks**

5. Spotting: 6 Marks

E. Lichen

F. Algae.

G. Bryophyte

6. Viva-voce **5 Marks**
7. Record and excursion report (submission is compulsory) **5 Marks**

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
05	05	05	05	**20**

B. SC. SEMESTER-II BOTANY

VSC COURSE LABORATORY EXERCISE

VSC LAB IDENTIFICATION OF ANGIOSPERM PLANT

(B-BO123P)

Hours: 4Hours/Week Marks: 60(SEE)+40(CIE)=100 Credit: 2

Course objectives: -

1. To study the morphology of plant
2. To learn process of identifying the plant
3. To make use of flora for identifying plant

Course outcome: -

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

1. Describe morphology of flowering plants.
2. Learn the technique of Herbarium.
3. Learn to use flora for Identification of flowering plants.
4. Learn the technique of Identification of flowering plants.
5. Understand identification of plant families

Laboratory Exercise

1. To study morphology of different types of Roots and its Modifications with Examples
2. To study morphology of different types of Stem and its Modifications with Examples.
3. To study morphology of different types of Leaf and its Modifications with Examples
4. To study phyllotaxy and venation pattern of different leaves with locally available suitable examples.
5. Study of different types of Inflorescence- 1) Racemose, 2) Cymose, 3) Special types
6. To study structure of typical flower.
7. To study accessory whorls of flower-Calyx and Corolla with modifications
8. To study essential whorls of flower Androecium and Gynoecium with Modifications.
9. To study types of fruits-Simple, aggregate and composite with suitable examples.
10. Describe commonly available flowering plant in technical language *(Hibiscus rosa-sinensis, and Cassia siamea).*
11. Herbarium technique

Suggested activity:

Seminar, Quiz, debate, Assignments, collection of Angiosperm plant and study of higher plants, preparation of herbarium and visit to local area, Field work, Study Projects, Models etc. are Part of Curriculum and considered along with attendance for Continuous Internal Evaluation (CIE)

B. SC. - SEMESTER –II BOTANY PRACTICAL EXAM
VSC COURSE LABORATORY EXERCISE (B-BO123P) (SEE)

Time: 6hrs. **Max. Marks: 60**

1. Describe the Morphology and modification of Root material (A). 8 Marks
2. Describe the morphology and modifications of leaf/stem material (B). 8 Marks
3. Identify the inflorescence/fruit from given material (C) and describe its morphology. 8 Marks
4. Describe (Calyx, Corolla, Androecium & Gynoecium) of given Flower [D] 10 Marks
5. Spotting: 8 Marks
   E. Vegetative Morphology
   F. Floral morphology
   G. Accessory/Essential whorl
   H. Inflorescence
   I. Fruit
6. Herbarium Submission 8 Marks
7. Viva-voce 5 Marks
8. Practical Record and tour report (submission is compulsory) 5 Marks

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
10	10	10	10	**40**

B. SC. SEMESTER-II BOTANY
INDIAN KNOWLEDGE SYSTEM (IKS)
IKS PAPER TRADITIONAL KNOWLEDGE OF PLANTS-II
(B-BO114T)

Hours: 2Hours/Week Marks: 30(SEE)+20(CIE)=50 Credit: 2

Course objectives: -

1. To introduce traditional Indian knowledge related to plant sciences
2. To understand the scientific basis of indigenous botanical practices
3. To explore ethnobotany, Ayurveda, and sustainable plant use
4. To integrate ancient wisdom with modern botanical science for sustainable resource management
5. To promote biodiversity awareness and conservation ethics
6. To encourage innovation based on traditional knowledge

Course outcome: -

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

1. Explain the concept and significance of Indian knowledge systems in botany
2. Identify and describe traditional uses of plants
3. Analyze the role of ethnobotany in biodiversity conservation
4. Evaluate the scientific relevance of Ayurvedic plant knowledge
5. Apply indigenous knowledge for sustainable plant resource management

Unit I: Introduction to Indian Knowledge System (IKS) (7.5 hrs)

- Concept, definition, and scope of IKS ,
- Ancient texts and botanical references (Vedas, Upanishads, Puranas)
- Contributions of ancient scholars (e.g., Charaka, Sushruta)
- Principles of Ayurveda related to plants
- Classification of medicinal plants (Rasayana, herbs, etc.)

Unit II: Ethnobotany and Traditional Knowledge (7.5 hrs)

- Concept and scope of ethnobotany
- Indigenous knowledge of plants among tribal communities
- Sacred groves and conservation practices
- Plants used in rituals, culture, and traditions
- Important medicinal plants and their uses (e.g., Tulsi, Neem, Ashwagandha, Turmeric)
- Herbal formulations and traditional healthcare systems
- Plants in Indian economy (timber, spices, fibers, dyes)
- Traditional industries based on plant resources
- Role of plants in art, literature, and religion

Unit III: Agriculture, Conservation and Biodiversity (7.5 hrs)

- Traditional agricultural practices in India
- Organic farming and Jhum cultivation
- Crop diversity and seed preservation
- Role of communities in conservation
- Sacred plants and biodiversity protection

- Role of plants in sustainable agriculture
- Integration of IKS with modern conservation biology

Unit IV: Intellectual Property Rights and Biopiracy (7.5 hrs)

- Traditional knowledge and IPR
- Issues of biopiracy (e.g., Neem, Turmeric cases)
- Protection of indigenous knowledge
- National and international policies
- Ethnopharmacology and bioprospecting

Suggested Readings

- Jain, S.K. – *Ethnobotany in India*
- Trivedi, P.C. – *Medicinal Plants: Utilization and Conservation*
- Government of India – IKS and Ayurveda publications
- Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
- Knowledge Traditions and Practices of India Kapil Kapoor 1, Michel Danino2

Institute of Science, Nagpur

(An Autonomous Institute of Govt. of Maharashtra)

DEPARTMENT OF BOTANY

CREDIT STRUCTURE, EVALUTION SCHEME,

AND SYLLABUS OF FOUR-YEAR BACHELOR OF SCIENCE (HONORS/RESEARCH) DEGREE WITH A SEMESTER PATTERN IN BOTANY

B. Sc. II YEAR BOTANY

(FACULTY OF SCIENCE &TECHNOLOGY)

BASED ON DIRECTION 1 OF 2024 ISSUED BY THE INSTITUTE OF SCIENCE, NAGPUR AS PER NEP 2020

To be implemented from 2026-2027

Teaching and Examination Schemes:

Teaching and Examination Schemes Four Year B.Sc. (of eight semesters) program is as follows.

Table 1: B.Sc. Semester III

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	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:- **PTERIDOPHYTES AND GYMNOSPERMS**	B-BO231T	5.0	2	--	--	2	2	30	20	25
		Paper 2:- **PALAEOBOTANY**	B-BO232T		2	--	--	2	2	30	20	25
		DSC Lab	B-BO233P		--	--	4	2	4 - 6	60	40	50
2	**Minor**	Paper 1:- **DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS**	B-BO234T		2	--	--	2	2	30	20	25
		Paper 2:- **DIVERSITY OF PLANT FOSSILS**	B-BO235T		2	--	--	2	2	30	20	25
		Minor Lab	B-BO236P		--	--	4	2	4 - 6	60	40	50
3	**GE**	Refer to GE Basket			2	--	--	2	2	30	20	25
4	**VSEC**	Refer SEC Basket **HERBAL MEDICINE**	B-BO237P		--	--	4	2	4 - 6	60	40	50
5	**AEC**	Second Language			2	--	--	2	2	30	20	25
6	**FP**	**FIELD PROJECT**	B-BO238P		--	--	4	2	4 - 6	--	100	50
7	**CC**	NSS / NCC / Sports / Cultural			--	--	4	2	--	--	100	50
Total					**12**	**--**	**20**	**22**	**--**	**360**	**440**	**--**

B. SC. SEMESTER-III BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I PTERIDOPHYTES AND GYMNOSPERM
(B-BO231T)

Hours: 2Hours/Week **Marks: 30(SEE)+20(CIE)=50** **Credit: 2**

Course objectives: -

1. To raise curiosity in students for study of Pteridophytes and Gymnosperm
2. To understand ecological importance of Pteridophytes and Gymnosperms.

Course outcome :-

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

1. Describe morphology of Pteridophytes.
2. Describe the reproduction of Pteridophytes.
3. Describe morphology of Gymnosperms.
4. Identify Pteridophyte and Gymnosperm in Nature

Unit 1:

1. Pteridophytes: General characteristics and classification (Smith 1952), alternation of generations.
2. Eusporangiate and leptosporangiate ferns.
3. Structure of sporophytes and life-cycles. Distribution, morphology, anatomy, reproduction, and lifecycles of *Psilotum*, *Selaginella*

Unit 2:

1. Structure of sporophytes and lifecycle. Distribution, morphology, anatomy, reproduction and lifecycle of Equisetum, *Marsilea*
2. Apospory, Apogamy, Heterospory and seed habit.
3. Stelar evolution in Pteridophytes.
4. Ecological and economic importance of pteridophytes.

Unit 3:

1. Gymnosperms- General characteristics. Distribution and classification of Gymnosperms (Stewart 1982), alternation of generations.
2. Study of the habit, habitat, distribution, anatomy, reproduction, and life-cycles of
    - *Cycas*
    - *Pinus*

Unit 4:

1. Study of the habitat, distribution, habit, anatomy, reproduction, and life-cycles in
    - *Ginkgo*
    - *Gnetum.*
2. Economic importance of Gymnosperms - food, timber, industrial uses, and medicines.

Suggested Reading

1. Sharma, O P; 2012; Pteridophyta, McGrow Hill Education New Delhi.
2. Vashishta, P C, Sinha, A K; Kumar, A; 2010; Pteridophyta, S. Chand& company New Delhi.
3. V. Singh, P.C. Pande and D.K. Jain 2008. A Text Book of Botany, Rastogi Publications Meerut
4. H.C. Ganguly and A.K. Kar 1999, College Botany. Vol. 2, NCBA
5. Rashid, A, 1999, Pteridophyta, Vikas publishing house
6. S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., E-28, Sector- 8, Noida-201301(U. P.) India.
7. A. C. Dutta, (1963), Botany for degree students (Revised edition) Oxford University Press, New Delhi 110002, India.
8. H.C. Ganguly and A.K. Kar 1999, College Botany. Vol. 2, NCBA
9. Rashid, A, 1999, Pteridophyta, Vikas publishing house
10. S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., E-28, Sector- 8, Noida-201301(U. P.) India.
11. A. C. Dutta, (1963), Botany for degree students (Revised edition) Oxford University Press, New Delhi 110002, India.
12. P. C. Vashishta, (1990), Botany for degree students, gymnosperms, Vol. V, S. Chand and Company Ltd., Ram Nagar, New Delhi- 110 055.
13. S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., Noida-201301 (U. P.) India.
14. V. Singh, P. C. Pandey D. K. Jain, 2016 Text Book of Botany, Rastogi Publications, Gangotri Shivaji Road, Meerut, 250002.
15. Biswas C, Johri B.M (1997). Pentoxylales. In: The Gymnosperms. Springer, Berilin, Heidelberg. • Osborn J M, Taylor T N, Crane P R (1991).
16. Singh V P. (2006). Gymnosperm (naked seeds plant): structure and development. Sarup& sons.
17. S.P Bhatnagar and Alok Moita, 1996, Gymnosperms. New age international publications, New Delhi.
18. Vashishta PC, 1996, Gymnosperms. S. Chand & Company Ltd. New Delhi.
19. Kumar A. 2006, Botany for Degree Students Gymnosperm. S. Chand Company Ltd.New Delhi.
20. https://en.wikipedia.org/wiki/Ginkgo_biloba
21. https://www.britannica.com/plant/Gnetum

B. SC. SEMESTER-III BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-II PALEOBOTANY
(B-BO232T)

Hours: 2Hours/Week Marks: 30 (SEE) + 20 (CIE) = 50 Credits: 2

Course objectives:

1. To raise curiosity in students for study of plant fossils.
2. To understand the plants available in past

Course outcome: -

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

1. Learn the process of fossilisation.
2. Describe morphology and anatomy of plant fossils
3. Learn importance of fossils in human welfare.

Unit-I Paleobotany (7.5Hrs)

1. Geological Time scale: Outline of Eras, periods and epochs; Major events in the Geological time scale.
2. Palaeobotany- definition, fossils, Preservation of plant fossils, Types of fossils- impressions, compressions, petrification, mould, cast and coal balls.

Unit-II Applied paleobotany (7.5Hrs)

1. Radiocarbon dating.
2. Importance of fossils.
3. Exploration of fossil fuels.
4. Pseudofossil, Living fossil
5. Birbal Sahni Institute of Paleosciences.

Unit-III Pteridophyte fossils (7.5Hrs)

1. *Rhynia*: External morphology anatomy and reproduction.
2. *Lepidodendron*: Habit, Habitat and structure
3. *Lepidocarpon*: morphology and anatomy
4. *Calamites*: External morphology, anatomy and reproduction.

Unit-IV Gymnosperm fossils (7.5Hrs)

1. *Lyginopteris*: External morphology, anatomy and reproduction.
2. *Glossopteris*: External morphology, anatomy and reproduction.
3. *Cycadeoidea*: External morphology, anatomy and reproduction.

List of Reference Books

1. H.C. Ganguly and A.K. Kar 1999, College Botany. Vol. 2, NCBA
2. Rashid, A, 1999, Pteridophyta, Vikas publishing house
3. S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., E-28, Sector- 8, Noida-201301 (U. P.) India.
4. A. C. Dutta, (1963), Botany for degree students (Revised edition) Oxford University Press, New Delhi 110002, India.
5. P. C. Vashishta, (1990), Botany for degree students, gymnosperms, Vol. V, S.

Chand and Company Ltd., Ram Nagar, New Delhi- 110 055.
6. S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., Noida-201301 (U. P.) India.
7. V. Singh, P. C. Pandey D. K. Jain, 2016 Text Book of Botany, Rastogi Publications, GangotriShivaji Road, Meerut, 250002.
8. Taylor, T.N., Taylor, E.L., & Krings, M. (2009). Paleobotany: The Biology and Evolution of Fossil Plants. Academic Press
9. Cleal, C.J. & Thomas, B.A. (2009). Introduction to Plant Fossils. Cambridge University Press
10. Willis, K.J. & McElwain, J.C. (2014). The Evolution of Plants. Oxford University Press

B. SC. SEMESTER-III BOTANY
DSC LAB EXERCISE-I BASED ON DSC PAPER- I & II
(B-BO233P)

Hours: 4 Hours/Week Marks: 60 (SEE) +40 (CIE)=100 Credit: 2

List of Practicals

1. To study types of fossils: impressions, compressions, petrification, mold, cast and coal balls
2. Study of fossil plants: To study morphology, Anatomy and reproductive characters of following genera:
    - *Rhynia*
    - *Lepidodendron,*
    - *Lepidocarpon,*
    - *Lyginopteris,*
    - *Calamites,*
    - *Glossopteris*
    - *Cycadeoidea.*
3. Study of Pteridophytes: To study morphology, Anatomy and reproductive characters of following genera:
    - *Psilotum*
    - *Selaginella*
    - *Marsilea*
    - *Equisetum*
4. Study of Gymnosperms: To study morphology, Anatomy and reproductive characters of following genera:
    - *Cycas,*
    - *Pinus,*
    - *Ginkgo*
    - *Gnetum*

B. SC. - SEMESTER –III BOTANY
PRACTICAL EXAM BASED ON DSC LAB-I (B-BO233P)

Time: 6hrs. **Max. Marks: 60**

1. Identify and classify the given Pteridophyte material [**A**],&prepare a temporary mount. **10 Marks**
2. Identify and classify the given Gymnosperm material [**B**],&prepare a temporary mount. **10 Marks**
3. Identify and classify the given Pteridophyte fossil [**C**], & comment on it. **8 Marks**
4. Identify and classify the given Gymnosperm fossil [**D**], & comment on it. **8 Marks**
5. **Spotting:** **12 Marks**
   E. Pteridophyte
   F. Gymnosperm
   G. Types of fossils
6. Viva voce **06 Marks**
7. Record and excursion report (submission is compulsory) **06 Marks**

Continuous Internal Evaluation (CIE) Allocation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
10	10	10	10	**40**

B. SC. SEMESTER-III BOTANY
MINOR (MIN)
MIN PAPER-I DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERM
(B-BO234T)

Hours: 2Hours/Week **Marks: 30(SEE)+20(CIE)=50** **Credit: 2**

Course objectives: -

1. To raise curiosity in students for study of Pteridophytes and Gymnosperm
3. To understand ecological importance of Pteridophytes and Gymnosperms.

Course outcome :-

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

5. Describe morphology of Pteridophytes.
6. Describe the reproduction of Pteridophytes.
7. Describe morphology of Gymnosperms.
8. Identify Pteridophyte and Gymnosperm in Nature

Unit 1:

4. Pteridophytes: General characteristics and classification (Smith 1952), alternation of generations.
5. Eusporangiate and leptosporangiate ferns.
6. Structure of sporophytes and life-cycles. Distribution, morphology, anatomy, reproduction, and lifecycles of *Psilotum*, *Selaginella*

Unit 2:

5. Structure of sporophytes and lifecycle. Distribution, morphology, anatomy, reproduction and lifecycle of Equisetum, *Marsilea*
6. Apospory, Apogamy, Heterospory and seed habit.
7. Stelar evolution in Pteridophytes.
8. Ecological and economic importance of pteridophytes.

Unit 3:

3. Gymnosperms- General characteristics. Distribution and classification of Gymnosperms (Stewart 1982), alternation of generations.
4. Study of the habit, habitat, distribution, anatomy, reproduction, and life-cycles of
    - *Cycas*
    - *Pinus*

Unit 4:

3. Study of the habitat, distribution, habit, anatomy, reproduction, and life-cycles in
    - *Ginkgo*
    - *Gnetum.*
4. Economic importance of Gymnosperms - food, timber, industrial uses, and medicines.

Suggested Reading

1. Sharma, O P; 2012; Pteridophyta, McGrow Hill Education New Delhi.
2. Vashishta, P C, Sinha, A K; Kumar, A; 2010; Pteridophyta, S. Chand& company New Delhi.
3. V. Singh, P.C. Pande and D.K. Jain 2008. A Text Book of Botany, Rastogi Publications Meerut
4. H.C. Ganguly and A.K. Kar 1999, College Botany. Vol. 2, NCBA
5. Rashid, A, 1999, Pteridophyta, Vikas publishing house
6. S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., E-28, Sector- 8, Noida-201301(U. P.) India.
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8. H.C. Ganguly and A.K. Kar 1999, College Botany. Vol. 2, NCBA
9. Rashid, A, 1999, Pteridophyta, Vikas publishing house
10. S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., E-28, Sector- 8, Noida-201301(U. P.) India.
11. AC. Dutta, (1963), Botany for degree students (Revised edition) Oxford University Press, New Delhi 110002, India.
12. P. C. Vashishta, (1990), Botany for degree students, gymnosperms, Vol. V, S. Chand and Company Ltd., Ram Nagar, New Delhi- 110 055.
13. S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., Noida-201301 (U. P.) India.
14. V. Singh, P. C. Pandey D. K. Jain, 2016 Text Book of Botany, Rastogi Publications, Gangotri Shivaji Road, Meerut, 250002.
15. Biswas C, Johri B.M (1997). Pentoxylales. In: The Gymnosperms. Springer, Berilin, Heidelberg. • Osborn J M, Taylor T N, Crane P R (1991).
16. Singh V P. (2006). Gymnosperm (naked seeds plant): structure and development. Sarup& sons.
17. S.P Bhatnagar and Alok Moita, 1996, Gymnosperms. New age international publications, New Delhi.
18. Vashishta PC, 1996, Gymnosperms. S. Chand & Company Ltd. New Delhi.
19. Kumar A. 2006, Botany for Degree Students Gymnosperm. S. Chand Company Ltd.New Delhi.
20. https://en.wikipedia.org/wiki/Ginkgo_biloba
21. https://www.britannica.com/plant/Gnetum

B. SC. SEMESTER-III BOTANY
MINOR (MIN)
MIN PAPER-II DIVERSITY OF FOSSILS
(B-BO235T)

Hours: 2Hours/Week Marks: 30 (SEE) + 20 (CIE) = 50 Credits: 2

Course objectives:

1. To raise curiosity in students for study of plant fossils.
2. To understand the plants available in past

Course outcome: -

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

1. Learn the process of fossilisation.
2. Describe morphology and anatomy of plant fossils
3. Learn importance of fossils in human welfare.

Unit-I Paleobotany (7.5Hrs)

1. Geological Time scale: Outline of Eras, periods and epochs; Major events in the Geological time scale.
2. Palaeobotany- definition, fossils, Preservation of plant fossils, Types of fossils- impressions, compressions, petrification, mould, cast and coal balls.

Unit-II Applied paleobotany (7.5Hrs)

1. Radiocarbon dating.
2. Importance of fossils.
3. Exploration of fossil fuels.
4. Pseudofossil, Living fossil
5. Birbal Sahni Institute of Paleosciences.

Unit-III Pteridophyte fossils (7.5Hrs)

1. *Rhynia*: External morphology anatomy and reproduction.
2. *Lepidodendron*: Habit, Habitat and structure
3. *Lepidocarpon*: morphology and anatomy
4. *Calamites*: External morphology, anatomy and reproduction.

Unit-IV Gymnosperm fossils (7.5Hrs)

1. *Lyginopteris*: External morphology, anatomy and reproduction.
2. *Glossopteris*: External morphology, anatomy and reproduction.
3. *Cycadeoidea*: External morphology, anatomy and reproduction.

List of Reference Books

1. H.C. Ganguly and A.K. Kar 1999, College Botany. Vol. 2, NCBA
2. Rashid, A, 1999, Pteridophyta, Vikas publishing house
3. S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., E-28, Sector- 8, Noida-201301 (U. P.) India
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University Press, New Delhi 110002, India.
5. P. C. Vashishta, (1990), Botany for degree students, gymnosperms, Vol. V, S. Chand and Company Ltd., Ram Nagar, New Delhi- 110 055.
6. S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., Noida-201301 (U. P.) India.
7. A.V. Singh, P. C. Pandey D. K. Jain, 2016 Text Book of Botany, Rastogi Publications, Gangotri Shivaji Road, Meerut, 250002.
8. Taylor, T.N., Taylor, E.L., & Krings, M. (2009). Paleobotany: The Biology and Evolution of Fossil Plants. Academic Press
9. Cleal, C.J. & Thomas, B.A. (2009). Introduction to Plant Fossils. Cambridge University Press
10. Willis, K.J. & McElwain, J.C. (2014). The Evolution of Plants. Oxford University Press

B. SC. SEMESTER-III Botany
MINOR LAB EXERCISE-I BASED ON MIN PAPER- I & II (B-BO236P)

Hours: 4 Hours/Week Marks: 60 (SEE) +40 (CIE)=100 Credit: 2

List of Practicals

1. To study types of fossils: impressions, compressions, petrification, mold, cast and coal balls
2. Study of fossil plants: To study morphology, Anatomy and reproductive characters of following genera:
    - *Rhynia*
    - *Lepidodendron,*
    - *Lepidocarpon,*
    - *Lyginopteris,*
    - *Calamites,*
    - *Glossopteris*
    - *Cycadeoidea.*
3. Study of Pteridophytes: To study morphology, Anatomy and reproductive characters of following genera:
    - *Psilotum*
    - *Selaginella*
    - *Marsilea*
    - *Equisetum*
4. Study of Gymnosperms: To study morphology, Anatomy and reproductive characters of following genera:
    - *Cycas,*
    - *Pinus,*
    - *Ginkgo*
    - *Gnetum*

B. Sc. - SEMESTER –III BOTANY
PRACTICAL EXAM BASED ON MIN LAB-I (B-BO236P)

Time: 6hrs. **Max. Marks: 60**

1. Identify and classify the given Pteridophyte material [**A**],&prepare a temporary mount. **10 Marks**
2. Identify and classify the given Gymnosperm material [**B**],&prepare a temporary mount. **10 Marks**
3. Identify and classify the given Pteridophyte fossil [**C**], & comment on it. **8 Marks**
4. Identify and classify the given Gymnosperm fossil [**D**], & comment on it. **8 Marks**
5. **Spotting:** **12 Marks**
   H.Pteridophyte
   I. Gymnosperm
   J. Types of fossils
6. Viva voce **06 Marks**
7. Record and excursion report (submission is compulsory) **06 Marks**

CIE Evaluation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
10	10	10	10	**40**

B. SC. SEMESTER-III BOTANY
SKILL ENHANCEMENT COURSE (SEC)
SEC LAB HERBAL TECHNOLOGY
(B-BO237P)

Hours: 4 Hours/Week Marks: 60(SEE)+40(CIE)=100 Credits: 2

Course objectives: - 1**.** To provide students with fundamental and applied knowledge of medicinal plants and herbal drugs.

2. It develops scientific understanding of herbal medicines and equips students with practical skills for herbal product development, conservation, and entrepreneurship in the herbal industry.

Course outcome: -

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

1. To develop skills in identification and authentication of important medicinal plants and describe their botanical characteristics and therapeutic uses.
2. Prepare simple herbal products and understand principles of formulation, standardization, and safety of herbal medicines.
3. Appreciate the importance of biodiversity conservation and sustainable utilization of medicinal plant resources.

List of Practical

1. Identification of medicinal plants based on morphology and diagnostic characters. (At least 25 plants)
2. Study of medicinal plants as raw herbal preparations used for different ailments like wound healing and bleeding, inflammation, irritation and pain etc. (also Cosmetics and skin care)
3. Study of nutraceuticals and their benefits commonly used in Indian diets.
4. Study of different types of herbal medicines commonly used with commercial examples.
5. Study of different steps in collection and processing of plant material in herbal preparation.
6. Preparation and evaluation (pH determination, Viscosity, Moisture content and extractive value etc.) of herbal products:
    A. Herbal tea (Infusion and decoction),
    B. Herbal powder (Churna),
    C. Herbal ointment/ cream (Lep),
    D. Herbal oils and lotion (Taila),
    E. Herbal shampoo,
    F. Herbal syrup.
7. Analysis commercial Asava/ arista and cough syrup and estimation of alcohol content in them.

8. Evaluation of excipients of natural origin
    A. Gum
    B. Starch
    C. Honey
9. Preliminary phytochemical screening of medicinal plant samples.
10. Visit to a Medicinal plant field/ nursery/ Pharma industry/ Ayurvedic institution to identify medicinal plants and understand herbal technology.

Suggested activity:

Seminar, Quiz, debate, Assignments, collection of medicinal plants and herbarium preparation from local area, Field work, Study Projects, Models etc. are Part of Curriculum.

B.SC. - SEMESTER –III BOTANY PRACTICAL
SEC COURSE LABORATORY EXERCISE
SEC LAB HERBAL TECHNOLOGY (B-BO237P) (SEE)

Time: 6hrs. **Max. Marks: 60**

1. Describe morphology and medicinal uses of given medicinal plant/ plant part **(A)**. (Any five) **10 Marks**
2. Preparation and evaluation of given herbal product. **(B) 8 Marks**
3. Analysis commercial Asava/ arista and cough syrup and estimation of alcohol content in them. **(C) 8 Marks**
4. Evaluation of excipients of natural origin **(D)**. **8 Marks**
5. **Spotting:** **6 Marks**

   E. Medicinal plants/ part as raw herbal preparations

   F. Commercial herbal medicine.

   G. Nutraceutical
6. Viva-voce and submission of herbarium (Digital) **10 Marks**
7. Practical Record and report of field/industry visit/ assignments. (Submission is compulsory) **10 Marks**

CIE Evaluation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
10	10	10	10	**40**

Table 2: B.Sc. Semester IV

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	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 ANATOMY**	B-BO241T	5.0	2	--	--	2	2	30	20	25
		Paper 2:- **PLANT TAXONOMY**	B-BO242T		2	--	--	2	2	30	20	25
		DSC Lab	B-BO243P		--	--	4	2	4 - 6	60	40	50
2	**Minor**	Paper 1:- **ANATOMY OF PLANTS**	B-BO244T		2	--	--	2	2	30	20	25
		Paper 2:- **TAXONOMY OF PLANTS**	B-BO245T		2	--	--	2	2	30	20	25
		Minor Lab	B-BO246P		--	--	4	2	4 - 6	60	40	50
3	**GE**	Refer to GE Basket			2	--	--	2	2	30	20	25
4	**VSEC**	Refer SEC Basket **LABORATORY TECHNIQUES IN BOTANY**	B-BO247P		--	--	4	2	4 - 6	60	40	50
5	**AEC**	Second Language			2	--	--	2	2	30	20	25
6	**CEP**	Community Service	B-BO248P		--	--	4	2	4 - 6	0	100	50
7	**CC**	NSS / NCC / Sports / Cultural			--	--	4	2	--	0	100	50
Total					**12**	**--**	**20**	**22**	**--**	**360**	**440**	**--**

B. SC. SEMESTER-IV BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I PLANT ANATOMY
(B-BO241T)

Hours: 2 Hours/Week **Marks: 30 (SEE) + 20 (CIE) = 50** **Credit: 2**

Course Objectives:

1. To understand the internal tissue organization, cell structural variations, and specialized cell types in plants.
2. To develop an analytical understanding of primary and secondary growth patterns along with anomalies across plant groups.

Course Outcomes:

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

1.Identify and differentiate various simple, complex, and secretory tissues.
2. Gain knowledge of internal layouts of roots, stems, and leaves across monocots and dicots.
3. develop critical skills to identify anomalous tissue variations and normal secondary development structural elements.

Unit-I: Plant Tissues & Meristems (7.5 Hrs)

1. Anatomy: Introduction, definition, scope and applications in plant science. Types of Tissues: Simple and complex tissues outline.
2.Meristematic tissues: Definition, characteristics, classification based on origin, position, and plane of division. Apical cell organization theories: Histogen theory, Tunica-Corpus theory.
3. Permanent tissues: Structure, location, and functions of simple permanent tissues (Parenchyma, Collenchyma, Chlorenchyma, and Sclerenchyma).

Unit-II: Complex & Secretory Tissue Systems (7.5 Hrs)

1. Complex permanent tissues: Components, structure, and functions of Xylem (tracheids, vessels, xylem fibres, xylem parenchyma) and Phloem (sieve tubes, companion cells, phloem parenchyma, phloem fibres).
2.Vascular bundle arrangements: Types of vascular bundles (Conjoint, collateral, bicollateral, concentric, open, closed).
3. Secretory tissues: Structure and significance of laticiferous tissue (latex cells and vessels) and glandular tissue (internal and external glands).

Unit-III: Primary Internal Organization (7.5 Hrs)

1. Epidermal tissue systems: Structure of typical epidermis, cuticle, trichomes, and internal details.
2.Stomata structure: Morphology and variations of typical stomata in dicotyledons and monocotyledons.
3. Internal organization of primary plant body: Detailed internal structure of dicotyledon and monocotyledon root.
4.Internal structure of dicotyledon and monocotyledon stem. Internal structure of dicotyledon (dorsiventral) and monocotyledon (isobilateral) leaf.

Unit-IV: Secondary Growth & Structural Anomalies (7.5 Hrs)

1.Normal secondary growth: Principle and process in dicotyledonous stem. Cambium: Structure, formation of cambial ring, and seasonal activity.
2.Secondary xylem and phloem development, annual growth rings, heartwood, and sapwood concepts.
3.Periderm organization: Development of phellogen, phellem (cork), and phelloderm; lenticels structure.
4.Anomalous secondary growth: Introduction, primary concepts, and structural adaptations with representative examples (e.g., Dracena stem and Bignonia stem).

Suggested Readings

1. Chandurkar, P.J. (1989). Plant Anatomy. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Dutta, A.C. (2003). Botany for Degree students. Oxford University Press, New Delhi.
3. Eames, A. J. and Mc Daniels (1994). An Introduction to Plant Anatomy. Tata McGraw Hill Publishing Comp., New Delhi.
4. Esau, K. (1993). Plant Anatomy. Wiley Eastern Ltd. New Delhi.
5. Esau, K. (2006). Anatomy of seed plants. John Wiley and Sons, New York.
6. Fahn, A. (1974). Plant Anatomy. Pergamum Press Oxford.
7. Gangulee, Das and Dutta (2002). College Botany. Vol. I. New Central Book Agency, Kolkata.
8. Pandey, B.P. (2007). Plant Anatomy. S. Chand and Co. Ltd. New Delhi.
9. Pandey, B.P. (2009). A Text Book of Botany- Angiosperms. S. Chand and Co. Ltd. New Delhi.

B. SC. SEMESTER-IV BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-II PLANT TAXONOMY
(B-BO242T)

Hours: 2Hours/Week Marks: 30(SEE)+20(CIE)=50 Credit: 2

Course objectives: -

1. To understand the major features and evolutionary origins of vascular plant.
2. To know Identification of plants using dichotomous key.
3. To understand the systematic position of Dicot and Monocot families.

Course outcome: -

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

1. Understand the origin of Angiosperm
2. Identify the Angiospermic plants with the help of key and flora
3. Know the features of Dicot and Monocot families.
4. Learn skills required for effective identification of order, family, genus and species

Unit-I (7.5Hrs)

1. Origin of Angiosperms (Benettitalean theory). Phylogeny of Angiosperm: Homology, monophyly, polyphyly, Clads.
2. Fossil Angiosperms: Flower (Sahanianthus), Fruit (Enigmocarpon) Introduction to Angiosperms Taxonomy: Definition, scope, objectives and importance of taxonomy.
3. Floras, Herbarium, keys (Indented and Bracketed), Botanical Nomenclature:
   Principles (rank and ending of taxa, principle of priority)
4. Rules and Recommendations; 'Type' specimen and its types (Holotype, Paratype, Isotype, Lectotype, Neotype).
5. Concept of Typification. Ranks and endings of taxa names, Coining of Genus
   and Species names Single, double and multiple authority citations

Unit-II (7.5Hrs)

1. Systems of classification, Comparative account of various systems of classification
   a) Artificial system- Carl Linnaeus
   b) Natural system- Bentham and Hooker
   c) Phylogenetic system- Engler and Prantl
   d) APG system- A brief review
2. Modern trends in Taxonomy: Cytotaxonomy (Karyotype), Phytochemistry (Proteins, flavonoids, Betalains), Taximetrics to taxonomy

Unit-III (7.5Hrs)

1. Study of Plant Families (Dicot): Study of following families with reference to systematic position (As per Bentham and Hooker's system of classification), salient features, floral formula, floral diagram and any two examples with their economic importance-
   a. Malvaceae,
   b. Brassicaceae
   c. Fabaceae (Papilionoideae, Caesalpinioideae, Mimosoideae)

Unit-IV (7.5Hrs)

1. Study of Families (Dicot):
   d. Solanaceae,
   e. Asteraceae,
   f. Apocynaceae,
   g. Euphorbiaceae
2. Study of Families (Monocot): Poaceae, Liliaceae

List of Books / References / Online Resources

1. Balfour Austin (2016). Plant Taxonomy. Syrawood Publishing House
2. Chopra G.L. (1984). Angiosperms: Systematics and Life-Cycle., Pradeep Publications
3. Cooke, Theodore (1903-8). The Flora of the Presidency of the Bombay Vol. I, II, III (Repr. ed), Botanical Survey of India.
4. Cronquist, A. (1968). The Evolution and Classification of Flowering Plants. Thomas Nel and Sons Ltd. London.
5. Datta S.C. (1988). Systematic Botany. New Age Publ.
6. Davis P.H and V.H Heywood (1963). Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
7. Heywood V.H. (1967). Plant Taxonomy, Hodder & Stoughton Educational, London.
8. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. (2008). Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers.Sunderland, Massachusetts, USA.
9. Lawrence G.H.M. (1955). An Introduction to Plant Taxonomy. McMillan, New York.
10. Lawrence, G.H.M. (1951). Taxonomy of Vascular Plants. McMillan, New York.
11. Mondol A.K. (2016) Advanced Plant Taxonomy, New Central Book Agency (NCBA)
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13. Pande B.P. (2001) Taxonomy of Angiosperms. S. Chand.
14. Radford A.E. 1986. Fundamentals of Plant Systematics, Harper and Row N Y.
15. Santapau H. (1953). The Flora of Khandala on the Western Ghats of India. BSI
16. Sharma O.P. (2011), Plant Taxonomy, Tata Mc grow Hill
17. Shivrajan V.V. & N.K.P. Robson (1991). Introduction to Principles of Plant Taxonomy. Cambridge Univ. Press
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Vikas Publ.
19. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam.

20. Singh N.P. (2001) Flora of Maharashtra Volume-II BSI, Kolkatta
21. Singh N.P. (2003) Flora of Maharashtra Volume-III BSI, Kolkatta
22. Singh N.P., S. Karthikeyan (1996) Flora of Maharashtra Volume-I, BSI, Kolkatta
23. Singh V. and D.K. Jain, (1981). Taxonomy of Angiosperms. Rastogi Publication, Meerut.
24. Singh, Gurcharan. (2012). Plant Systematics: Theory and Practice. Completely revised and enlarged 3rd edition. Oxford & IBH, New Delhi.
25. Stuessy, Tod F. (2009). Plant Taxonomy: The Systematic Evaluation of Comparative
Data, second edition. Columbia University Press.
26. Swingle D.B. (1946). A Text book of Systematic Botany. McGraw Hill Book Co. New York.
27. Takhtajan A. (1969). Flowering Plants: Origin and Disposal.

B. SC. SEMESTER-IV BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC LAB EXERCISE BASED ON DSC PAPER-I AND II (B-BO243P)

Hours: 4 Hours/Week Marks: 60 (SEE) +40 (CIE)=100 Credit: 2

DSC LAB: PLANT ANATOMY

List of Practicals:

1. Study of meristems (apical, intercalary, and lateral) using permanent slides, models, or diagrams.

2. Microscopic examination of simple permanent tissues (Parenchyma, Chlorenchyma, Collenchyma, and Sclerenchyma).

3. Study of complex permanent tissue components (Xylem elements and Phloem elements) from permanent slides/macerated samples.

4. Study of various types of vascular bundles (Conjoint, collateral, bicollateral, open, closed, and concentric) using permanent slides.

5. Study of epidermal peeling variations: Trichomes and stomatal types in dicotyledons and monocotyledons.

6. Preparation of temporary stained transverse sections (T.S.) of a typical Dicot root (e.g., Sunflower / Cicer).

7. Preparation of temporary stained transverse sections (T.S.) of a typical Monocot root (e.g., Maize / Asparagus).

8. Preparation of temporary stained transverse sections (T.S.) of a typical Dicot stem (e.g., Sunflower / Cucurbita).

9. Preparation of temporary stained transverse sections (T.S.) of a typical Monocot stem (e.g., Maize / Cyperus).

10. Preparation of temporary stained transverse sections (T.S.) of a Dorsoventral (Dicot) leaf and Isobilateral (Monocot) leaf.

11. Study of normal secondary growth structures in a typical Dicot stem via permanent slides (e.g., Helianthus/Helianthus secondary).

12. Study of anomalous secondary growth tissue layouts in the stem of Darcena using temporary/permanent preparations.

13. Study of anomalous secondary growth configurations in the stem of Bignonia using temporary/permanent preparations.

14. Histochemical micro-chemical tests for localization of lignin, cellulose, and suberin in plant cell walls.

Suggested activity:

Seminar, Quiz, assignments, collection of local plant twigs to study wood variations, preparation of an individual portfolio containing at least 5 hand-drawn structural anatomical diagrams, and active engagement in continuous evaluation parameters.

DSC LAB: PLANT TAXONOMY

List of Practicals:

1. Study of fossil Angiosperms specimens: Sahanianthus, Enigmocarpon
2. Study of representative genera from each family with floral diagram and floral formula and identifying characters . Malvaceae,
3. Brassicaceae
4. Fabaceae (Papilionoideae, Caesalpinioideae, Mimosoideae)
5. Solanaceae,
6. Asteraceae,
7. Apocynaceae,
8. Euphorbiaceae
9. Study of Families (Monocot): Poaceae,
10. Liliaceae
11. To study the preparation of Family Keys.
12. Identification of plant species using flora.

Suggested activity:
Seminar, Quiz, debate, Assignments, Botanical Excursions (Two short or One long out of the state is compulsory).

B.SC - SEMESTER –IV BOTANY PRACTICAL EXAM
BASED ON DSC PAPER I AND PAPER II (B-BO243P)

Time: 6hrs. **Max. Marks: 60**

1. Prepare temporary mount of the given material [A](Root)/Stem & identify giving diagnostic character 8 Marks
2. Prepare a temporary stained T.S. of the given specimen showing anomalous secondary growth 8 Marks
3. Make an epidermal peel preparation to demonstrate stomatal layout/trichome variation. 8 Marks
4. Describe the given Angiospermic material [C] (dicot) in technical language. Classify
   & Identify the Family giving reasons 8 Marks
5. Identify plant species [F] using flora / Prepare a family key 8 Marks
6. Spotting: 10 Marks

G. Morphology of Plant
E. Root Anatomy
F. Stem Anatomy
G. Morphology of plant
H. Fossil Angiosperm

7. Viva-voce 5 Marks
8. Record and excursion report (submission is compulsory) 5 Marks

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
10	10	10	10	**40**

B. SC. SEMESTER-IV BOTANY
MINOR (MIN)
MIN PAPER-I ANATOMY OF PLANTS
(B-BO244T)

Hours: 2Hours/Week **Marks: 30(SEE)+20(CIE)=50** **Credit: 2**

Course Objectives:

1. To understand the internal tissue organization, cell structural variations, and specialized cell types in plants.
2. To develop an analytical understanding of primary and secondary growth patterns along with anomalies across plant groups.

Course Outcomes:

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

1.Identify and differentiate various simple, complex, and secretory tissues.
2. Gain knowledge of internal layouts of roots, stems, and leaves across monocots and dicots.
3. develop critical skills to identify anomalous tissue variations and normal secondary development structural elements.

Unit-I: Plant Tissues & Meristems (7.5 Hrs)

1. Anatomy: Introduction, definition, scope and applications in plant science. Types of Tissues: Simple and complex tissues outline.
2.Meristematic tissues: Definition, characteristics, classification based on origin, position, and plane of division. Apical cell organization theories: Histogen theory, Tunica-Corpus theory.
3. Permanent tissues: Structure, location, and functions of simple permanent tissues (Parenchyma, Collenchyma, Chlorenchyma, and Sclerenchyma).

Unit-II: Complex & Secretory Tissue Systems (7.5 Hrs)

1. Complex permanent tissues: Components, structure, and functions of Xylem (tracheids, vessels, xylem fibres, xylem parenchyma) and Phloem (sieve tubes, companion cells, phloem parenchyma, phloem fibres).
2.Vascular bundle arrangements: Types of vascular bundles (Conjoint, collateral, bicollateral, concentric, open, closed).
3. Secretory tissues: Structure and significance of laticiferous tissue (latex cells and vessels) and glandular tissue (internal and external glands).

Unit-III: Primary Internal Organization (7.5 Hrs)

1. Epidermal tissue systems: Structure of typical epidermis, cuticle, trichomes, and internal details.
2.Stomata structure: Morphology and variations of typical stomata in dicotyledons and monocotyledons.
3. Internal organization of primary plant body: Detailed internal structure of dicotyledon and monocotyledon root.
4.Internal structure of dicotyledon and monocotyledon stem. Internal structure of dicotyledon (dorsiventral) and monocotyledon (isobilateral) leaf.

Unit-IV: Secondary Growth & Structural Anomalies (7.5 Hrs)

1.Normal secondary growth: Principle and process in dicotyledonous stem. Cambium: Structure, formation of cambial ring, and seasonal activity.

2.Secondary xylem and phloem development, annual growth rings, heartwood, and sapwood concepts.

3.Periderm organization: Development of phellogen, phellem (cork), and phelloderm; lenticels structure.

4.Anomalous secondary growth: Introduction, primary concepts, and structural adaptations with representative examples (e.g., Dracena stem and Bignonia stem).

Suggested Readings

1. Chandurkar, P.J. (1989). Plant Anatomy. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Dutta, A.C. (2003). Botany for Degree students. Oxford University Press, New Delhi.
3. Eames, A. J. and Mc Daniels (1994). An Introduction to Plant Anatomy. Tata McGraw Hill Publishing Comp., New Delhi.
4. Esau, K. (1993). Plant Anatomy. Wiley Eastern Ltd. New Delhi.
5. Esau, K. (2006). Anatomy of seed plants. John Wiley and Sons, New York.
6. Fahn, A. (1974). Plant Anatomy. Pergamum Press Oxford.
7. Gangulee, Das and Dutta (2002). College Botany. Vol. I. New Central Book Agency, Kolkata.
8. Pandey, B.P. (2007). Plant Anatomy. S. Chand and Co. Ltd. New Delhi.
9. Pandey, B.P. (2009). A Text Book of Botany- Angiosperms. S. Chand and Co. Ltd. New Delhi.

B. SC. SEMESTER-IV BOTANY
MINOR (MIN)
MINOR PAPER-II TAXONOMY OF PLANTS
(B-BO245T)

Hours: 2Hours/Week Marks: 30(SEE)+20(CIE)=50 Credit: 2

Course objectives: -

4. To understand the major features and evolutionary origins of vascular plant.
5. To know Identification of plants using dichotomous key.
6. To understand the systematic position of Dicot and Monocot families.

Course outcome: -

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

5. Understand the origin of Angiosperm
6. Identify the Angiospermic plants with the help of key and flora
7. Know the features of Dicot and Monocot families.
8. Learn skills required for effective identification of order, family, genus and species

Unit-I (7.5Hrs)

6. Origin of Angiosperms (Benettitalean theory). Phylogeny of Angiosperm: Homology, monophyly, polyphyly, Clads.
7. Fossil Angiosperms: Flower (Sahanianthus), Fruit (Enigmocarpon) Introduction to Angiosperms Taxonomy: Definition, scope, objectives and importance of taxonomy.
8. Floras, Herbarium, keys (Indented and Bracketed), Botanical Nomenclature:
   Principles (rank and ending of taxa, principle of priority)
9. Rules and Recommendations; 'Type' specimen and its types (Holotype, Paratype, Isotype, Lectotype, Neotype).
10. Concept of Typification. Ranks and endings of taxa names, Coining of Genus
    and Species names Single, double and multiple authority citations

Unit-II (7.5Hrs)

3. Systems of classification, Comparative account of various systems of classification
   a) Artificial system- Carl Linnaeus
   b) Natural system- Bentham and Hooker
   c) Phylogenetic system- Engler and Prantl
   d) APG system- A brief review
4. Modern trends in Taxonomy: Cytotaxonomy (Karyotype), Phytochemistry (Proteins, flavonoids, Betalains), Taximetrics to taxonomy

Unit-III (7.5Hrs)

2. Study of Plant Families (Dicot): Study of following families with reference to systematic position (As per Bentham and Hooker's system of classification), salient features, floral formula, floral diagram and any two examples with their economic importance-
   h. Malvaceae,
   i. Brassicaceae
   j. Fabaceae (Papilionoideae, Caesalpinioideae, Mimosoideae)

Unit-IV (7.5Hrs)

3. Study of Families (Dicot):
   k. Solanaceae,
   l. Asteraceae,
   m. Apocynaceae,
   n. Euphorbiaceae
4. Study of Families (Monocot): Poaceae, Liliaceae

List of Books / References / Online Resources

1. Balfour Austin (2016). Plant Taxonomy. Syrawood Publishing House
2. Chopra G.L. (1984). Angiosperms: Systematics and Life-Cycle., Pradeep Publications
3. Cooke, Theodore (1903-8). The Flora of the Presidency of the Bombay Vol. I, II, III (Repr. ed), Botanical Survey of India.
4. Cronquist, A. (1968). The Evolution and Classification of Flowering Plants. Thomas Nel and Sons Ltd. London.
5. Datta S.C. (1988). Systematic Botany. New Age Publ.
6. Davis P.H and V.H Heywood (1963). Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
7. Heywood V.H. (1967). Plant Taxonomy, Hodder & Stoughton Educational, London.
8. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. (2008). Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers.Sunderland, Massachusetts, USA.
9. Lawrence G.H.M. (1955). An Introduction to Plant Taxonomy. McMillan, New York.
10. Lawrence, G.H.M. (1951). Taxonomy of Vascular Plants. McMillan, New York.
11. Mondol A.K. (2016) Advanced Plant Taxonomy, New Central Book Agency (NCBA)
12. Naik V.N. (1988) Taxonomy of Angiosperms. Oxford and IBH
13. Pande B.P. (2001) Taxonomy of Angiosperms. S. Chand.
14. Radford A.E. 1986. Fundamentals of Plant Systematics, Harper and Row N Y.
15. Santapau H. (1953). The Flora of Khandala on the Western Ghats of India. BSI
16. Sharma O.P. (2011), Plant Taxonomy, Tata Mc grow Hill
17. Shivrajan V.V. & N.K.P. Robson (1991). Introduction to Principles of Plant Taxonomy. Cambridge Univ. Press
18. Shukla Priti and Shital Mishra (1982). An introduction to Taxonomy of angiosperms.
Vikas Publ.
19. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam.

20. Singh N.P. (2001) Flora of Maharashtra Volume-II BSI, Kolkatta
21. Singh N.P. (2003) Flora of Maharashtra Volume-III BSI, Kolkatta
22. Singh N.P., S. Karthikeyan (1996) Flora of Maharashtra Volume-I, BSI, Kolkatta
23. Singh V. and D.K. Jain, (1981). Taxonomy of Angiosperms. Rastogi Publication, Meerut.
24. Singh, Gurcharan. (2012). Plant Systematics: Theory and Practice. Completely revised and enlarged 3rd edition. Oxford & IBH, New Delhi.
25. Stuessy, Tod F. (2009). Plant Taxonomy: The Systematic Evaluation of Comparative
Data, second edition. Columbia University Press.
26. Swingle D.B. (1946). A Text book of Systematic Botany. McGraw Hill Book Co. New York.
27. Takhtajan A. (1969). Flowering Plants: Origin and Disposal.

B. SC. SEMESTER-IV BOTANY
MINOR LAB EXERCISE BASED ON MIN PAPER-I & II
(B-BO246P)

Hours: 4 Hours/Week Marks: 60 (SEE) +40 (CIE)=100 Credit: 2

MINOR LAB: PLANT ANATOMY

Hours: 2 Hours/Week

List of Practicals:

1. Study of meristems (apical, intercalary, and lateral) using permanent slides, models, or diagrams.

2. Microscopic examination of simple permanent tissues (Parenchyma, Chlorenchyma, Collenchyma, and Sclerenchyma).

3. Study of complex permanent tissue components (Xylem elements and Phloem elements) from permanent slides/macerated samples.

4. Study of various types of vascular bundles (Conjoint, collateral, bicollateral, open, closed, and concentric) using permanent slides.

5. Study of epidermal peeling variations: Trichomes and stomatal types in dicotyledons and monocotyledons.

6. Preparation of temporary stained transverse sections (T.S.) of a typical Dicot root (e.g., Sunflower / Cicer).

7. Preparation of temporary stained transverse sections (T.S.) of a typical Monocot root (e.g., Maize / Asparagus).

8. Preparation of temporary stained transverse sections (T.S.) of a typical Dicot stem (e.g., Sunflower / Cucurbita).

9. Preparation of temporary stained transverse sections (T.S.) of a typical Monocot stem (e.g., Maize / Cyperus).

10. Preparation of temporary stained transverse sections (T.S.) of a Dorsoventral (Dicot) leaf and Isobilateral (Monocot) leaf.

11. Study of normal secondary growth structures in a typical Dicot stem via permanent slides (e.g., Helianthus/Helianthus secondary).

12. Study of anomalous secondary growth tissue layouts in the stem of Darcena using temporary/permanent preparations.

13. Study of anomalous secondary growth configurations in the stem of Bignonia using temporary/permanent preparations.

14. Histochemical micro-chemical tests for localization of lignin, cellulose, and suberin in plant cell walls.

Suggested activity:

Seminar, Quiz, assignments, collection of local plant twigs to study wood variations, preparation of an individual portfolio containing at least 5 hand-drawn structural anatomical diagrams, and active engagement in continuous evaluation parameters.

MINOR LAB: TAXONOMY OF PLANTS

Hours: 2 Hours/Week

1. Study of fossil Angiosperms specimens: Sahanianthus, Enigmocarpon
2. Study of representative genera from each family with floral diagram and floral formula and identifying characters . Malvaceae,
3. Brassicaceae
4. Fabaceae (Papilionoideae, Caesalpinioideae, Mimosoideae)
5. Solanaceae,
6. Asteraceae,
7. Apocynaceae,
8. Euphorbiaceae
9. Study of Families (Monocot): Poaceae,
10. Liliaceae
11. To study the preparation of Family Keys.
12. Identification of plant species using flora.

Suggested activity:
Seminar, Quiz, debate, Assignments, Botanical Excursions (Two short or One long out of the state is compulsory).

B.SC - SEMESTER –IV BOTANY PRACTICAL EXAM BASED ON MIN PAPER I AND PAPER II (B-BO246P)

Time: 6hrs. **Max. Marks: 60**

1. Prepare temporary mount of the given material [A](Root)/Stem & identify giving diagnostic character 8 Marks
2. Prepare a temporary stained T.S. of the given specimen showing anomalous secondary growth 8 Marks
3. Make an epidermal peel preparation to demonstrate stomatal layout/trichome variation. 8 Marks
4. Describe the given Angiospermic material [C] (dicot) in technical language. Classify
    a. & Identify the Family giving reasons 8 Marks
5. Identify plant species [F] using flora / Prepare a family key 8 Marks
6. Spotting: 10 Marks
   G. Morphology of Plant
   E. Root Anatomy
   F. Stem Anatomy
   G. Morphology of plant
   H. Fossil Angiosperm
7. Viva-voce 5 Marks
8. Record and excursion report (submission is compulsory) 5 Marks

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
10	10	10	10	**40**

B. SC. SEMESTER-IV BOTANY
SKILL ENHANCEMENT COURSE (SEC)
SEC LAB LABORATORY TECHNIQUES IN BOTANY

Hours: 4 Hours/Week Marks: 60(SEE)+40(CIE)=100 Credits: 2

Course Objectives:

1. To train students in basic plant microtechniques, staining procedures, and tissue preservation methods.
2. To provide practical hands-on experience in physiological extraction, herbarium management, and solution preparation.

Course Outcomes:

1. To master the art of making temporary and permanent plant slide preparations.

2. To efficiently process, poison, mount, and preserve plant specimens for long-term herbarium storage.

3. To gain practical knowledge of chemical solution preparations, paper chromatography, and maceration techniques.

Laboratory Exercise

1. Preparation of standard solutions (Percent, Molar, and Normal solutions) and laboratory buffers.
2. Demonstration of plant microtechnique: Fixation, dehydration, clearing, and embedding of plant tissues.
3. Preparation of permanent slides using double staining technique (e.g., Safranin and Fast Green).
4. Collection, processing, and wet preservation of plant specimens in specimen jars.
5. Herbarium technique: Collection, pressing, drying, poisoning, and mounting of angiospermic specimens.
6. Separation of chloroplast pigments using Paper Chromatography / Thin Layer Chromatography (TLC).
7. Fungal staining technique using Cotton Blue and Lactophenol from infected local plant material.
8. Histochemical localization of starch, proteins, and lipids in plant tissue sections.
9. Isolation, peeling, and mounting of plant trichomes, stomata, and epidermal peels.
10. Maceration technique for studying and measuring xylem elements (vessels and tracheids).
11. Measurement of microscopic plant structures (cell size, spore size) using Micrometry (Ocular and Stage micrometers).
12. Determination of osmotic potential of plant cell sap by plasmolysis method using Rhoeo discolor epidermal peel.
13. Estimation of pollen viability and in vitro pollen tube germination using different concentrations of sucrose medium.
14. Preparation of basic plant tissue culture media (e.g., Murashige and Skoog - MS Medium) and stock solutions.

Suggested activity:
Botanical excursion/field collection tour, submission of a well-maintained herbarium (minimum 10 sheets), preparation and submission of 5 permanent slides, project report on local plant preservation techniques, and active participation in continuous evaluation metrics.

B.Sc. - SEMESTER – IV
BOTANY PRACTICAL EXAM
SEC LAB LABORATORY TECHNIQUES IN BOTANY

Time: 4hrs. **Max. Marks: 60**

1. Perform double staining / maceration technique and prepare a slide of the given plant material. 12 Marks
2. Separate plant pigments using chromatography OR determine osmotic potential using plasmolysis. 12 Marks
3. Demonstrate micrometry calibration OR artificial seed preparation as per instructions. 12 Marks
4. Spotting (Based on laboratory techniques, stains, fixatives, or macro-elements): 10 Marks
   a) ....
   b) ....
5. Viva-voce 08 Marks
6. Practical Record, permanent slides, and herbarium submission. 06 Marks

CIE Evaluation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
10	10	10	10	**40**

Institute of Science, Nagpur

(An Autonomous Institute of Govt. of Maharashtra)

DEPARTMENT OF BOTANY

CREDIT STRUCTURE, EVALUTION SCHEME,

AND SYLLABUS OF FOUR-YEAR BACHELOR OF SCIENCE (HONORS/RESEARCH) DEGREE WITH A SEMESTER PATTERN IN BOTANY

B. Sc. III YEAR BOTANY

(FACULTY OF SCIENCE &TECHNOLOGY)

BASED ON DIRECTION 1 OF 2024 ISSUED BY THE INSTITUTE OF SCIENCE, NAGPUR AS PER NEP 2020

To be implemented from 2026-2027

Table 1: B.Sc. Semester V

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	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:- **CELL BIOLOGY**	B-BO351T	5.5	3	--	--	3	3	45	30	38
		Paper 2:- **PLANT PHYSIOLOGY**	B-BO352T		3	--	--	3	3	45	30	38
		DSC LAB (BASED ON PAPER 1 + PAPER2)	B-BO353P		--	--	6	3	6	90	60	75
		Paper 3:- **PLANT DEVELOPMENT AND EMBRYOLOGY**	B-BO354T		2	--	--	2	2	30	20	25
		DSC LAB (BASED ON PAPER 3)	B-BO355P		--	--	2	1	4	30	20	25
2	**DSE**	Elective 1:- **MYCOLOGY AND INDUSTRIAL MICROBIOLOGY** Elective 2:- **FORESTRY**	B- BO356MY B- BO356FO		2	--	--	2	2	30	20	25
		DSE LAB	B-BO357P		--	--	4	2	4 - 6	60	40	50
3	**Minor**	Paper 1:- **PLANT EMBRYOLOGY**	B-BO358T		2	--	--	2	2	30	20	25
		MINOR LAB	B-BO359P		--	--	2	1	4	30	20	25
4	**VSEC**	Refer SEC Basket **PLANT TISSUE CULTURE**	B- BO3510P		--	--	4	2	4 - 6	60	40	50
5	**CEP**	**COMMUNITY SERVICE**	B- BO3511P		--	--	2	1	--	--	50	25
TOTAL					**12**	**--**	**20**	**22**		**450**	**350**	**--**

B. SC. SEMESTER-V BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER - I CELL BIOLOGY
(B-BO351T)

Hours: 3 Hours/Week **Marks: 45 (ESE) + 30 (CIE) = 75** **Credit: 3**

Course Objectives:

1. Understanding the structural dynamics, biogenesis, and functional specialized properties of the cell wall, plasma membrane architectures, and intercellular plasmodesmata links.
2. Exploring the ultrastructure, internal layouts, and specialized functional roles of core cellular organelles alongside cytoskeleton motility assemblies.
3. Analyzing the structural organization of genes and chromosomes, chromatin packaging domains, and cell cycle regulatory control systems.
4. Investigating bacterial growth kinetics, microbial physiology, and the active physiological mechanisms protecting plants against environmental stress factors.

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

1. Know and differentiate the specialized cell wall boundaries and overall cellular organization across prokaryotic and eukaryotic models.
2. Learn the molecular layout of the cell cytoskeleton network, tracing its active roles in motility, cell division, and intracellular sorting tracks.
3. Evaluate the phases and control systems regulating the cell cycle alongside apoptosis, necrosis, and autophagy pathways.
4. Understand microbial growth kinetics, structural patterns of unique and repetitive DNA, and plant defense mechanisms against biotic and abiotic extremes.

Course Content

Unit-I: Cell Wall, Plasma Membrane & Transport Dynamics (11.25 Hrs)

1. Cell wall: Structural hierarchy, macromolecular components and chemical cyto-chemistry. 2. Plasma membrane: Molecular architecture and structural evolution (Fluid Mosaic Model). Functional dynamics of membrane proteins, lipid bilayers, diffusion vectors, and osmosis properties. Active and passive transport: Ion channels, transport carriers, selective pumps (ATPases), mechanisms of sorting, and electrical properties of membranes. 3. Plasmodesmata: Ultrastructure, macromolecular transport channels.

Unit-II: Structural Organization of Organelles & Cytoskeleton (11.25 Hrs)

1. Cellular organelles: Ultrastructure, sub-compartmentalization, and functional specializations of the Golgi complex, lysosomes, peroxisomes, endoplasmic reticulum, mitochondria, peroxisomes, plastids, chloroplasts, and plant vacuole systems. 2. Cell shape and motility: The molecular cytoskeleton layout. Structural organization and functional

mechanics of microfilaments, intermediate filaments, and microtubules. Motor proteins and macromolecular movements; functional implications in mitotic spindle assembly, flagellar movements, and cytoplasmic streaming.

Unit-III: Gene Organization, Chromosome Structure & Cell Cycle (11.25 Hrs)

1. Nucleus and its organization: Nuclear envelope, nuclear pore complexes, nucleolus dynamics, and nuclear matrix architecture. 2. Organization of genes and chromosomes: Structural features of unique and repetitive DNA sequences. Chromatin architecture: Heterochromatin vs. euchromatin transitions, nucleosome assembly, and chromosomal higher-order packaging structures. 3. Cell division and cell cycle: Mitosis and meiosis mechanics.

Unit-IV: Microbial Physiology & Plant Stress Biology (11.25 Hrs)

1. Microbial Physiology: Bacterial growth kinetics, continuous and batch cultivation models. 2. Stress biology: Definition and classification of environmental stresses. Biotic stress: Plant defense mechanisms (passive structural barriers and active metabolic systems), Hypersensitive Response (HR), and Systemic Acquired Resistance (SAR); modulation of plant metabolism, production of Reactive Oxygen Species (ROS), PR proteins, and R-genes. Abiotic stress: Physiological impacts of water, temperature, salt, and light stress; developmental and physiological protection mechanisms.

Suggested Readings

1. De Robertis, E.D.P. and De Robertis, E.M.F. (2010). Cell and Molecular Biology. 8th Edition, Lippincott Williams & Wilkins.

2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Martin, K.C. (2021). Molecular Cell Biology. 9th Edition, W.H. Freeman and Company, New York.

3. Karp, G., Iwasa, J. and Marshall, W. (2020). Karp's Cell and Molecular Biology. 9th Edition, John Wiley & Sons, New York.

4. Kleinsmith, L.J. and Kish, V.M. (1995). Principles of Cell and Molecular Biology. 2nd Edition, HarperCollins College Publishers.

5. Cooper, G.M. (2022). The Cell: A Molecular Approach. 9th Edition, Oxford University Press.

6. Krishnamurthy, K.V. (2000). Methods in Cell Wall Cyto-chemistry. CRC Press, Boca Raton, Florida.

B. SC. SEMESTER-V BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER- II PLANT PHYSIOLOGY
(B-BO352T)

Hours: 3 Hours/Week **Marks: 45 (ESE) + 30 (CIE) = 75** **Credit: 3**

Course Objectives:

1. Understand the mechanisms of water and mineral uptake and transport in plants, including hydraulic conductance and aquaporins.
2. Explore the evolutionary dynamics and diversity of photosynthesis across different organisms.
3. Analyze the processes involved in the light reaction and the Calvin cycle, including electron pathways and key enzymes.
4. Investigate the role of light in the activation of dark phase enzymes and the regulation of C4 and CAM photosynthesis.

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

* Explain the physiological regulation of mineral homeostasis and adaptive strategies under different environmental conditions.
* Describe the evolution and diversity of photosynthesis, including carbon-concentating mechanisms and photo-protectant systems.
* Analyze the light reaction and Calvin cycle, detailing the involvement of reaction centers and electron pathways.
* Evaluate the regulation of dark phase enzymes and the mechanisms of C4 and CAM photosynthesis.

Course Content

Unit-I: Plant-Water Relations & Long-Distance Transport (11.25 Hrs)

1. Plant-water relations: Properties of water, diffusion, diffusion pressure deficit and its significance; Osmosis: Concept, types, osmotic potential and its significance; Imbibition: concept and significance. 2. Ascent of sap: Definition, Root pressure theory, cohesion-adhesion theory. 3. Transpiration: Definition, types, mechanism of stomatal movements (K+-malate hypothesis). 4. Phloem transport: Munch hypothesis.

Unit-II: Photosynthetic Mechanisms & Photo-Regulation (11.25 Hrs)

1. Evolution and diversity of photosynthesis from bacteria to higher plants, Carbon-concentrating mechanisms in bacteria, algae and plants. 2. Photosynthesis: Definition, significance, photosynthetic pigments and their role, photosystems. 3. Mechanism of Photosynthesis: Light Reaction: cyclic and non-cyclic photophosphorylation, Light independent reactions: C3, C4 and CAM pathways and their significance.

Unit-III: Cellular Respiration & Metabolic Pathways (11.25 Hrs)

1. Overview, historical account, evolution of anaerobic and aerobic respiration. 2. Aerobic respiration: Glycolysis and its regulation, TCA cycle, Pentose phosphate pathway. 3. Plant mitochondrial electron transport and ATP synthesis, alternative oxidase system. 4. Anaerobic respiration: Alcoholic and Lactic acid fermentation. 5. Gluconeogenesis, glyoxylate pathway and Hexose monophosphate Shunt.

Unit-IV: Nitrogen Assimilation, Plant Movements & Developmental Physiology (11.25 Hrs)

6. Nitrogen metabolism: Definition, Mechanism of biological nitrogen fixation (Symbiotic and non-symbiotic). 7. Plant movements: Definition, outline, Tropic (geotropic, phototropic, thigmotropic) and Nastic- seismonastic. 8. Photoperiodism: Definition, classification (short day, long day & day neutral plants) Photoperiodic induction, Florigen hormone. 9. Circadian rhythms and biological clock.

Suggested Readings

1. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

2. Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.

3. Davies P J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.

4. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley and Sons, U.S.A. 4th Edition.

5. Nelson, D.L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5th ed.). W.H. Freeman & Co., New York.

6. Taiz, L., Zeiger, E., (2014). Plant Physiology. Sinauer Associates Inc., U.S.A. 6th Edition.

B. SC. SEMESTER-V BOTANY
DSC LAB EXERCISE-I BASED ON DSC PAPER- I & II
(B-BO353P)

Hours: 6 Hours/Week **Marks: 90 (SEE) +60 (CIE)=150** **Credit: 3**

DSC Lab: Cell Biology

List of Practicals

1. Study of prokaryotic and eukaryotic cell structure variations using representative model specimens under light microscopy.
2. Isolation and cytochemical staining of plant cell walls to identify structural components (cellulose vs. lignin localization).
3. Determination of plasma membrane permeability changes across gradients of organic solvents (e.g., ethanol/acetone treatments on beetroots).
4. Observation of plasmolysis and deplasmolysis dynamics in onion epidermal peels to compute cell osmotic thresholds.
5. Isolation and microscopic verification of plastids (chloroplasts, chromoplasts, and amyloplasts) from vegetative tissues.
6. Staining and structural evaluation of the nuclear envelope, nucleolus, and chromatin using acetocarmine or orcein stains.
7. Examination of various phases of Mitosis using temporary squash preparations of Allium cepa root tips.
8. Examination of various stages of Meiosis using temporary squash mounts of anther flower buds.
9. Microscopic study of cyclosis / cytoplasmic streaming in Hydrilla or Tradescantia stipular hairs.
10. Simple Experiment: Plotting a bacterial growth curve using turbidimetric data models or population count values.
11. Simple Experiment: Visual demonstration of tissue necrosis or oxidative stress indices via starch/ROS staining under abiotic stress traits.
12. Simple Experiment: Vital staining of plant cells with Neutral Red or Janus Green B to identify functional vacuoles and active mitochondria structures.

Suggested activity:

Seminar presentations on modern microscopy advances, continuous cell division log updates, assembly of a cell biology portfolio comprising at least 5 certified hand-drawn ultrastructural schematics of core cell organelles, and regular active compliance with evaluation targets.

DSC Lab: Plant Physiology

List of Practicals

1. To study the permeability of plasma membrane using different concentrations of organic solvents.
2. To study the effect of temperature on permeability of membranes.
3. To determine the osmotic potential of vacuolar sap by plasmolytic method.
4. To determine the water potential of any tuber.
5. To compare the rate of transpiration from two surfaces of leaf- a) bell jar method b) Cobalt chloride method.
6. To determine the path of water (Ascent of sap).
7. To measure rate of photosynthesis by Wilmott's bubbler under variable conditions of light, temperature and CO2.
8. Simple Experiment: To demonstrate the phenomenon of imbibition using different seed types (e.g., starch vs. protein rich seeds).
9. Simple Experiment: To separate photosynthetic plant pigments using standard paper chromatography.
10. Simple Experiment: To demonstrate anaerobic respiration / fermentation using a simple fermentation flask setup.
11. Simple Experiment: To demonstrate phototropism / geotropism using a simple clinostat or dark box setup.
12. Simple Experiment: To localize or demonstrate catalase/peroxidase enzyme activity in living plant tissue extracts.

Suggested activity:
Seminar presentation, quiz panels, continuous field or lab observations, maintenance of a digital physiological portfolio containing hand-drawn mechanical physiological path diagrams, and active engagement in continuous evaluation parameters.

B. SC. SEMESTER-V BOTANY
PRACTICAL EXAMINATION
DSC LAB -I BASED ON DSC PAPER- I & II

Time: 6 hrs. **Max. Marks: 90**

1. Major Practical Experiment (Cell Biology Domain)

Perform a temporary cytological squash/peel preparation of the provided plant material to demonstrate active mitotic/meiotic stages or cell plasmolysis dynamics. Isolate, mount, and chart the observable phases or cell structural changes.

12 Marks

2. Major Practical Experiment (Plant Physiology Domain)

Set up the assigned major plant physiology experiment (e.g., Osmotic/Water potential determination or Photosynthetic bubble measurement under variable parameters) using the provided material and log raw experimental values.

12 Marks

3. Minor Practical Experiment (Cell Biology Domain)

Execute a localized cytochemical staining task, organic solvent membrane permeability test, or organelle differentiation setup via vital staining dyes on the provided plant tissue samples.

08 Marks

4. Minor Practical Experiment (Plant Physiology Domain)

Perform or demonstrate a minor physiological setup (e.g., Comparative transpiration rate index testing, tissue barrier path verification, or photosynthetic pigment separation using paper chromatography capillary systems).

08 Marks

5. Analytical Problem Solving & Mathematical Worksheets (Combined)

Solve the two provided data and computational exercises distributed across the specific core disciplines:

a) Exercise A (Cell Biology): Calculate a bacterial growth kinetic index curve or plot a comparative physiological stress necrosis distribution chart from the given dataset values. (3 Marks)

b) Exercise B (Plant Physiology): Solve standard plant physiological calculations related to osmotic/water potential curves, stomatal transpiration indices, or respiratory quotient parameters. (3 Marks)

10Marks

6. Laboratory Microscopic & Macromolecular Spotting (Combined)

Identify, illustrate, and explain the biological mechanism or structural importance of the four provided laboratory spotters:

a) Spotter A (Cell Biology): Plasma membrane layout chart, selective transport channel scheme, or an intercellular plasmodesmata ultrastructure model.

b) Spotter B (Cell Biology): Organelle ultrastructure electron micrograph model (Mitochondria, Chloroplast, or Golgi Complex assembly).

c) Spotter C (Plant Physiology): Plant-water relations diagram setup, phloem Munch mass-flow transport model, or a photosynthetic photosystem Z-scheme layout.

d) Spotter D (Plant Physiology): Mitochondrial electron transport carrier scheme, biological nitrogen fixation nodules, or a photoperiodic induction/plant movement experimental setup.

10 Marks

7. Viva-voce *15 Marks*

8. Certified Laboratory Record & Portfolio Submission *15 Marks*

CIE Evaluation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
15	15	15	15	**60**

B. SC. SEMESTER-V BOTANY
DSC PAPER-III PLANT DEVELOPMENT AND EMBRYOLOGY
(B-BO354T)

Hours: 2Hours/Week Marks: 30 (SEE) + 20 (CIE) = 50 Credits: 2

Course objectives:

1. To acquainted students about the morphology, characters, and importance of Plant development.
2. Understanding the basic growth kinetics and growth patterns in plants
3. Understanding the plant growth regulators with respect to plant growth and embryology

Course outcome: -

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

1. Know the basic growth kinetics and role of phytohormones in plant development
2. Know the molecular mechanism of growth and differentiation of root, leaf flowers and seeds.
3. Know the development of male and female gametophyte.Pollen pistil interaction.
4. Know the development of endosperm and it's importance.

Unit-I (7.5Hrs)

1. Plant development: Seedling growth: Tropisms; Photomorphogenesis of seedling.
2. Shoot Development: Organization of shoot apical meristem (SAM); tissue differentiation in the shoot.
3. Phytohormones: Classification, chemical nature and their role in plant development.

Unit-II (7.5Hrs)

1. Leaf growth and differentiation: Determination; phyllotaxy; differentiation of epidermis (with special reference to stomata & trichomes) and mesophyll.
2. Root Development: Organization of root apical meristem (RAM);
3. Flower Development: photoperiodism
4. Pollination mechanisms and vectors.

Unit-III (7.5Hrs)

1. Anther and Male Gametophyte Development
2. Introduction, scope and significance of Plant Embryology
3. Structure and development of anther

4. Microsporogenesis
5. Pollen grain structure and development
6. Male gametophyte development (Micro gametogenesis)

Unit-IV (7.5Hrs)

1. Ovule and Female Gametophyte Development: Female Gametophyte: Ovule types; megasporogenesis; organization and types of embryo sac; structure of embryo sac cells.
2. Pollen-pistil interaction; pollen-stigma interactions, double fertilization.
3. Endosperm development: Nuclear, Cellular and Helobial types
4. Seed development and maturation

List of Reference Books

1) Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.
2) Fageri, K. and Van der Pol, L. 1979. The Principles of Pollination Ecology. Pergamon Press, Oxford. 3) Fahn, A. 1982. Plant Anatomy, (3rd edition). Pergamon Press, Oxford.
4) Fosket, D.E. 1994. Plant Growth and Development.A molecular Approach. Academic Press, San Diego.
5) Howell, S.H. 1998, Molecular Genetics of Plant Development. Cambridge University Press, Cambridge.
6) Leins, P., Tucker, S.C. and Endress, P.K. 1988. Aspects of Floral Development. J. Cramer, Germany.
7) Lyndon, R.F., 1990. Plant Development.The Cellular Basis. Unnin Hyman, London.
8) Murphy, T.M. and Thompson, W.F. 1988. Molecular PlantDevelopment. Prentice Hall, New Jersey. 9) Proctor, M. and Yeo, P. 1973. The Pollination of Flowers.William Collins Sons, London.
10) Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
11) Raghavan, V. 1999. Developmental Biology of Flowering Plants.Springer - Verlag, New York. 33 12) Raven, P.H., Evert, R.F. and Eichhorn, S.E. 1992. Biology of Plants (5th Edition).worth, New York. 13) Steeves, T.A. and Sussex, I.M. 1989. Patterns in Plant Development (2nd edition). Cambridge University Press, Cambridge.
14) Sedgely, M. and Griffin, A.R. 1989. Sexual Reproduction of Tree Crops, Academic Press, London.
15) Waisel, Y., Eshel, A. and Kafkaki, U. (eds) 1996. Plant Roots: The Hidden Hall (2nd edition.) Marcel Dekker, New York.
16) Shivanna, K.R. and Sawhney, V.K. (eds) 1997. Pollen Biotechnology for Crop Production and Improvement, Cambridge University Press, Cambridge.
17) Shivana, K.R. and Rangaswamy, N.S. 1992. Pollen Biology: A Laboratory Manual. Springer-Verlag, Berlin.

18) Shivana, K.R. and Johri, B.M. 1985. The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd., New York.
19) The Plant Cell. Special issue on Reproductive Biology of Plants, Vol. 5(10) 1993.The American Society of Plant Physiologists, Rockville, Maryland, USA.
20) On line Journals available on UGC -VSAT

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)

B. Sc. Semester-V

DSC Laboratory Exercise based on DSC Paper III

Hours: 2 Hours/Week Marks:30 (SEE) +20 (CIE)=50 Credit: 1

List of Practical's

1. Tissue systems, meristem, vascular and cork cambium.
2. Internal structure of root, stem and leaf (dicot and monocot), advanced secondary growth in dicot stem and root.
3. Study of living shoot apices by dissections using aquatic plants such as Ceratophyllum and Hydrilla. 4. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant such as Coleus, Kalanchoe, Tobacco.
4. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
5. Study of alternate and distichous, alternate and superposed, opposite and superposed; opposite and decussate leaf arrangement.
6. Microscopic examination of vertical sections of leaves such as Cleome, Nerium, Maize and Wheat to understand the internal structure of leaf tissues and trichomes, glands etc. Also study the C3 and C4 leaf anatomy of plant.
7. Study of epidermal peels of leaves such as Coccinia, Gaillardia, Tradescantia, Thunbergia, etc. to study the development and finalstructure of stomata and prepare stomatal index. Demonstration ofthe effect of ABA on stomatal closure.
8. Study of whole roots in monocots and dicots. Examination of L.S. of root from permanent preparation to understand the organization of root apical meristem and its derivatives. (use(use maize, aerial roots of banyan, Pistia, Jussieua etc.).
9. Study of leguminous roots with different types of nodules.
10. Study of microsporogenesis and gametogenesis in sections of anthers.

11. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (Maize, Grasses, Crotolaria, Tradescantia, Brassica, Petunia, Solanum melongena, etc.)
12. Tests for pollen viability using stains and in vitro germination.
13. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
14. Estimating percentage and average pollen tube length in vitro.
15. Study of floral structure related to reproduction.
16. Study of anther development through permanent slides.
17. Observation of pollen grains and pollen germination.
18. Study of ovule types and embryo sac structure.
19. Demonstration of pollination and fertilization stages.
20. Study of dicot and monocot embryo development using prepared slides.
21. Observation of endosperm types through specimens/slides.
22. Study of polyembryony and apomixis.
23. Demonstration of embryo culture techniques (through charts/videos).

B. SC. SEMESTER-V BOTANY
PRACTICAL EXAMINATION
DSC LAB-III

Time: 2-4 Hrs. **Max. Marks: 30**

Q. 1) To perform the given exercise based on plant development. A 05 Marks
Q.2) In vitro pollen germination percentage and pollen tube growth. Record the data under
given conditions. B 05 Marks
Q.3) Identification and comment on the given spots : 10 Marks
C - Plant development
D ,- Plant development
E,- Plant development
F- Embryology
Q.4) Viva-voce 05 Marks
Q.5) Practical Record 05 Marks

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
5	5	5	5	**20**

B. SC. SEMESTER-V BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-I MYCOLOGY AND INDUSTRIAL MICROBIOLOGY
(B-BO356TMIM)

Hours: 2Hours/Week **Marks: 30 (SEE) + 20 (CIE) = 50** **Credits: 2**

Course objectives: -

1. To demonstrate a systematic, extensive and coherent knowledge an understanding of basic and applied mycology.
2. To links to other disciplinary areas of the study; including critical understanding of the established theories, principles and concepts of a number of advanced and emerging issues in the field of mycology.

Course outcome: -

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

1. Understand advanced knowledge of structure and diversity of different fungal groups.
2. Analyzed different fungal forms and classify into different groups on the basis of microscopic and macroscopic observations.
3. Apply the knowledge of mycology for research and development.

Unit I – Basics and Diversity of Fungi (7.5 Hrs)

- Vegetative phase: Thallus and kind of mycelia, Types of septa, structures associated with mycelia and aggregations of mycelia.
- Reproduction: vegetative, asexual and sexual, types of fructifications.
- Nutrition in fungi- Saprotrophs, Biotrophs,Necrotrophs, Symbiotrophs
- Habitat diversity: aquatic fungi, soil fungi, root-inhibiting fungi, coprophilous fungi, lignocolous fungi, cellulolytic fungi,keratinophilic fungi, entomogenous fungi, predacious fungi, phylloplane fungi, psychrophilic fungi, thermophilic fungi and ambrosia fungi.

Unit II – Bioprospecting of fungi in Agriculture and Industry (7.5 Hrs)

- Types of Mycorrhizae and role of AM fungi in agriculture.
- Mycoinsecticides and mycopesticides
- Trichoderma and other fungal antagonistic as a biocontrol agents.
- Role of fungi in the production of alcohol, organic acids and enzymes
- Fermentation methods and biomass production by fungi
- Principle and production of antibiotics

Unit III – Methods for studying microorganisms (7.5 Hrs)

- Culture media: preparation and types of defined, differential, selective and enrichment culture, Isolation techniques: Pour plate, spread plate, streak plate. Preservation and maintenance of culture.
- Methods of sterilization: physical and chemical, media types, Isolation and maintenance of pure cultures of microorganisms, and preservation techniques.

Unit IV – Introduction to Fermentation (7.5 Hrs)

- Introduction to Fermentation processes, Microbial culture selection for fermentation processes. Media formulation and optimization; inoculum development; strain improvement.
- Microbial growth, Microbial growth kinetics in Batch, fed batch and continuous cultures.
- Design of fermenters Design and operation of Fermenters, Basic concepts for selection of a reactor, Packed bed reactor, Fluidized bed reactor, Trickle bed reactor, Bubble column reactor, Scale up of Bioreactor.

List of Reference Books

1. Ulloa, M., & Aguirre-Acosta, E. (2019). Illustrated generic names of fungi. APS Press.
2. Ulloa, M., & Hanlin, R. T. (2000). Illustrated dictionary of mycology. Amer Phytopathological Society. ISBN-10: 0890542570; ISBN-13: 978-0890542576.
3. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (2007). Introductory mycology (4th ed.). Wiley. ISBN-10: 8126511087; ISBN-13: 978-8126511082.
4. Aneja, K. R. (2015). An introduction to mycology (2nd ed.). New Age
5. International Private Limited. ISBN-10: 8122437966; ISBN-13: 978-8122437966.
6. Arora, D., & Shepherd, G. (2008). Economic botany (Vol. 62, #3). The New York Botanical Garden Press.
7. Ainsworth, G. C., & Sussman, A. S. (Eds.). (n.d.). The fungi: An advance treatise (Vols. I-IV). Academic Press.
8. Aneja, K. R. (1993). Experimental in microbiology, plant pathology & tissue culture. Viswa Prakashan.
9. Bessey, E. A. (1950). Morphology and taxonomy of fungi. The Blakiston Co.

10. Bilgrami, K. S., & Dube, H. C. (1985). A textbook of modern plant pathology. Vikas Publication House.
11. Butler, E. J., & Jones, S. J. (1949). Plant pathology. Macmillan & Co.
12. Dube, R. C., & Maheshwari, D. K. (2000). Practical microbiology. S. Chand & Co. Ltd.
13. Gupta, V. K., & Behl, M. K. (1994). Indian plant viruses and mycoplasma. Kalyani Publishers.
14. Jha, D. K. (1993). A textbook of seed pathology. Vikas Publication House.
15. Manibhushan Rao, K., & Mahadevan, A. (n.d.). Recent development in biocontrol of plant pathogens. Today and Tomorrow Publishers.
16. Mehrotra, R. S., & Aneja, K. R. (1998). An introduction to mycology. New Age Intermediate Press.
17. Mukadam, D. S., & Gangawane, L. V. (1978). Experimental plant pathology (edited). Marathwada University.
18. Pande, P. B. (1997). Plant pathology. S. Chand & Co.
19. Rangaswamy, G., & Mahadevan, A. (1999). Diseases of crop plants in India. Prentice Hall of India.
20. Singh, R. S. (1994). Plant pathology. Oxford and IBH Publication Co.
21. Thind, T. S. (1998). Diseases of field crops and their management. National Agricultural Technology Information Centre.
22. Manoharachary, C., Tilak, K. V. B. R., Mallaiah, K. V., & Kunwar, I. K. (2016). Mycology and microbiology. Scientific Publishers.
23. Aneja, K. R., & Mehrotra, R. S. (2015). An introduction to mycology. New Age International Private Limited.
24. Dubey, H. C. (2017). Introduction to fungi, bacteria and viruses. Agribios.
25. Gupta, R. C., & Sharma, O. M. P. (2010). Textbook of fungi. Oxford Publication.
26. Sharma, O. P. (1989). Textbook of fungi. Tata McGraw-Hill Publishing Company.

Suggested activity:

Seminar, Quiz, debate, Assignments, study and collection of fungi from local habitats, Field work, Study Projects, Models etc. are Part of Curriculum. Botanical Excursion (one short excursion is compulsory)

B. SC. SEMESTER-V BOTANY
DSE LABORATORY EXERCISE-1 BASED ON DSE PAPER-I (B-BO357P)

Hours: 4 Hours/Week **Marks:60 (SEE) +40 (CIE)=100** **Credit: 2**

List of Practicals

Mycology

1. Demonstration on Cultivation of Fungi
2. Washing and sterilization of glassware.
3. PDA preparation, pouring, preparation of slants and sterilization, inoculation, staining techniques, Microscopic examination of fungi
4. Isolation of aquatic fungi
5. Isolation Rhizosphere fungi by serial dilution technique
6. Isolation of soil fungi by Warcup method
7. Isolation of Phyllosphere fungi.
8. Isolation of Coprophilous fungi.
9. Isolation of keratinophilic fungi.
10. Study of aeromycoflora from different localities
11. Isolation of mycorrhizal spores from soil.
12. Staining of fungi using lactophenol and cotton blue (*Rhizopus*, *Mucor*, *Aspergillus*, *Penicillium*).

Industrial Microbiology

13. Microbiology good laboratory practices and biosafety.
14. Neutralization and cleaning of glassware.
15. Measurement of microorganisms (Micrometry).
16. To study the principle of and application of important instruments – Autoclave, Incubator, BOD Incubator, Hot Air Oven, pH Meter, spectrophotometer, Colony Counter, Centrifuge Machine and Laminar Air Flow.
17. Preparation of different culture media- nutrient agar/nutrient broth for bacterial culture, PDA for fungal culture.
18. Isolation of pure culture of bacteria by streak-plate method.
19. Staining of bacteria- Simple staining- methylene blue, Gram's staining, Acid fast staining, ZiehlNeelsen staining, Giemsa staining, Structural staining- capsule, endospore.
20. Sterilization of culture media using autoclave and assessment for sterility.
21. Sterilization of glassware using hot air oven.
22. Demonstration of fermentation by Ethanol Production from Sugar Solution.
23. Amylase enzyme assay.

B. SC. SEMESTER-V BOTANY
PRACTICAL EXAM BASED ON DSE LAB. I (B-BO357P)

Time: 6hrs. **Max. Marks: 60**

1. Isolation Rhizosphere fungi by serial dilution technique. 10 Marks

2. Isolation of mycorrhizal spores from soil. 10 Marks

3. Isolation of pure culture of bacteria by streak-plate method. 10 Marks

4. Demonstration of Fermentation/ Enzyme assay 10 Marks

5. Spotting 09 Marks

   D. Instruments for sterilization

   E. Identify and comments on bacterial staining

   F. Identify and comment on fungal culture.

6. Viva-voce 06 Marks

7. Practical record and Field visit report 05 Marks

CIE Evaluation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
10	10	10	10	**40**

B. SC. SEMESTER-V BOTANY
DSE PAPER-II FORESTRY
(B-BO356TF)

Hours: 2Hours/Week Marks: 30 (SEE) + 20 (CIE) = 50 Credits: 2

Course objectives: -

1. To demonstrate a systematic, extensive and coherent knowledge an understanding of basic and applied mycology.
2. To links to other disciplinary areas of the study; including critical understanding of the established theories, principles and concepts of a number of advanced and emerging issues in the field of mycology.

Course outcome: -

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

1. Understand advanced knowledge of structure and diversity of different fungal groups.
2. Analyzed different fungal forms and classify into different groups on the basis of microscopic and macroscopic observations.
3. Apply the knowledge of mycology for research and development.

Unit I – Forest ecosystem (7.5 Hrs)

1. Forest ecosystem concept,
2. Types of forests in India,
3. Importance of forest.
4. Introduction to Current Status of Forest Resources, Resource Exploitation

Unit II – Forest Conservation (7.5 Hrs)

1. Deforestation and its consequences,
2. Developmental Activities (Mining, Dam, Infrastructure Development etc.) and their Impact on Forest,
3. Importance of trees,
4. Forest and Tribal Life,
5. Forest Policy and Forest Protection Laws,
6. Forest Conservation Management Strategy.

Unit III – Forest management (7.5 Hrs)

1. Forest regeneration types and methods,
2. Principles of forest management; classical forest management and joint forest management.
3. Social Forestry,
4. Agroforestry: definition, need, benefits and importance.

5. Agroforestry management in India.

Unit IV – Forestry (7.5 Hrs)

1. Forest mensuration: diameter, height and volume,
2. Silviculture,
3. Global warming, and forests,
4. Miyawaki Forest,
5. National Forest Policy – 1894, 1952 and 1988.

List of Books / References / Online Resources

- C. Nagamani S.R. Reddy; 2017; Introduction to Forestry, KALYANI PUBLISHERS.
- K Manikandan, 2018, Indian Forestry A Breakthrough Approach to Forest Service - 8th Edition, Scientific publishers (India)
- NIRAKAR BHOL, V.K. MISHRA, S.K. CHAUHAN, 2020, Text Book Of Introduction To Forestry, KALYANI PUBLISHERS
- Important websites and links
- https://www.fs.usda.gov/forestmanagement/vegetation-management/silviculture/index.shtml#:~:text=Silviculture%20is%20the%20art%20and,recreation%20on%20a%20sustainable%20basis.
- https://daily.jstor.org/the-miyawaki-method-a-better-way-to-build-forests/

B. SC. SEMESTER-V BOTANY
DSE LABORATORY EXERCISE BASED ON DSE PAPER-II (B-BO357P)

Hours: 4 Hours/Week Marks:60 (SEE) +40 (CIE)=100 Credit: 2

List of Practicals

1. Identification of trees suitable for timber, fuelwood and fodder.
2. Identification of trees suitable for road side plantation and for waste lands.
3. Measurement of Diameter of trees in field.
4. Measurement of height of trees in field.
5. Volume measurement of trees.
6. Pot making technique for planting saplings.
7. Study of forest products.
8. To mark forest types in map of India.
9. Planting forest tree seedlings.

B. Sc. - SEMESTER –V BOTANY
PRACTICAL EXAM BASED DSE LAB-II
(B-BO357P)

Time: ~~4-6~~hrs. **Max. Marks: 60**

1. Measurement of Diameter/Height/Volume of trees [A] in field. **12 Marks**
2. Preparation of pot for planting sapling [B]. **12 Marks**
3. Demonstrate planting forest tree seedlings. **9 Marks**
4. Mark forest type on map of India. **9 Marks**
5. **Spotting:** **6 Marks**

   C. Tree identification

   D. Forest products

6. Viva-voce **6 Marks**
7. Record and excursion report (submission is compulsory) **6 Marks**

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
10	10	10	10	**40**

B. SC. SEMESTER-V BOTANY
MINOR (MIN)
MINOR PAPER- I PLANT EMBRYOLOGY
(B-BO358T)

Hours: 2Hours/Week Marks: 30 (SEE) + 20 (CIE) = 50 Credits: 2

Course objectives: -

Understanding of structure of male and female reproductive parts and thei development in Angiosperms.

- Understanding & Application of knowledge of male sterility .
- Understanding of pollen mechanism, pollen-pistil interaction and incompatability.

Course outcome: -

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

- Learning the structure, and developmental variation in the sexual organs in Angiosperms.

Know the development of male and female gametophyte.Pollen pistil interaction.
Know the development of endosperm and it's importance.

Unit-I Structure of anther (7.5Hrs)

1. Introduction, scope and significance of Plant Embryology
2. Anther: Structure, anther wall; endothecium, middle layer, tapetum-Structure, types structure,function relationship, role of tapetum.
3. Microsporogenesis-sporogenous cells cytoplasmic reorganization during sporogenesis (Ultrastructural changes).
4. Pollen tetrad development.

Unit-II Male gametophyte development: (7.5Hrs)

1. Microsporogenesis- Male gametophyte development (Microgametogenesis)
2. Formation of vegetative and generative cells, differential behaviour of sperms, pollen storage, viability, causes for loss of viability.
3. Pollen abortion and male sterility, gametocides.

Unit-III Ovule and Female Gametophyte Development (7.5Hrs)

Pistil: Carpel determination, ovule and its structural details.Types of ovule.
Megasporogenesis: Meiosis, functional megaspores.
organization of female gametophyte structure of the embryo sac, egg, synergid-ultrastructure, role central cell, antipodal cell, haustoria, cytoskeleton of the embryo sac, types of embryo sac, nutrition of embryo sac.

Unit-IV Pollen-pistil interaction and incompatibility (7.5Hrs)

1. Pollen-pistil interaction: The stigma-Types and structure, stigmatic exudates, style-transmitting tissue, canal cell, post pollination events.
2. Pollen hydration, pollen germination.
(Chemotropism) pollen allelopathy.
3. Incompatibility: General concept, self incompatibility (Intraspecific type). Importance of self compatibility, methods of overcoming self incompatibility. Parasexual hybridization.
4. Endosperm development: Nuclear, Cellular and Helobial types.
5. Seed development and maturation.

List of Reference Books

1) Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.
2) Leins, P., Tucker, S.C. and Endress, P.K. 1988. Aspects of Floral Development. J. Cramer, Germany.
3) Proctor, M. and Yeo, P. 1973. The Pollination of Flowers.William Collins Sons, London.
4) Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
5) Raghavan, V. 1999. Developmental Biology of Flowering Plants.Springer -Verlag, New York. 33.
6) Shivanna, K.R. and Sawhney, V.K. (eds) 1997. Pollen Biotechnology for Crop Production and Improvement, Cambridge University Press, Cambridge.
7) Shivana, K.R. and Rangaswamy, N.S. 1992. Pollen Biology: A Laboratory Manual. Springer-Verlag, Berlin.
8) Shivana, K.R. and Johri, B.M. 1985. The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd., New York.
9) The Plant Cell. Special issue on Reproductive Biology of Plants, Vol. 5(10) 1993.The American Society of Plant Physiologists, Rockville, Maryland, USA.
10) On line Journals available on UGC -VSAT

B. SC. SEMESTER-V BOTANY
MINOR LABORATORY PLANT EMBRYOLOGY
(B-BO359P)

Hours: 2 Hours/Week **Marks:30 (SEE) +20 (CIE)=50** **Credit: 1**

List of Practicals

1. Study of floral structure related to reproduction.
2. Study of anther development through permanent slides.
3. Observation of pollen grains and pollen germination.
4. Study of ovule types and embryo sac structure.
5. Study of pollination and fertilization stages.
6. Study of dicot and monocot embryo development using prepared slides/charts..
7. Observation of endosperm types through specimens/slides.
8. Study of polyembryony and apomixis.
9. Demonstration of embryo culture techniques (through charts/videos).
10. 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 of embryo sacs.
e) Pericarp and seed coat structure from sections and macerations.

11. Preparation of dissected wholemounts of endothecium, tapetum, endosperm and embryo, squash preparations of tapetum, microspore mother cells, dyads, tetrads pollinia and massulae. Study of mitosis and meiosis and identification of various stages.
12. Short term exercises on pollen production, viability and their percentage of germination. Rate of growth of germ tube to be studied in a given period.

B. SC. SEMESTER-V BOTANY
MINOR LABORATORY PRACTICAL EXAMINATION
(B-BO359P)

Time: 2-4 Hrs. **Marks: 30**

1) Dissect and mount the endothecium/endosperm from the given materials. A 05 Marks

2.) In vitro pollen germination percentage and pollen tube growth. Record the data under given conditions. B 05 Marks

3) Localize the Biochemical compounds in a given plant material. C 05 Marks

4) Identification and comment on the given spots. 05 Marks

D,…..

E ……

7. Practical record 05 Marks

8. Viva-voce 05 Marks

CIE Evaluation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
05	05	05	05	**20**

B. SC. SEMESTER-V BOTANY
SKILL ENHANCEMENT COURSE (SEC)
SEC LAB PLANT TISSUE CULTURE
(B-BO3510P)

Hours: 4 Hours/Week **Marks: 60 (SEE) + 40 (CIE) = 100** **Credits: 2**

Course objectives: - To make students aware of tools and technique of plant tissue culture.

Course outcome: -

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

1. Understand the need of Plant tissue culture.
2. Understand Preparation of Culture Medium.
3. Get the hands-on skills of sterilization.
4. Discuss the inoculation and incubation technique.

List of Practicals

1. Introduction to equipment used in Plant Tissue Culture laboratory (Autoclave, Hot Air Oven, Laminar Air Flow, Culture racks, Incubation facility).
2. Study of Plant Tissue Culture laboratory organization and layout.
3. Sterilization of glassware.
4. Preparation of concentrated stock solutions.
5. Demonstration of preparation of Plant Tissue Culture (MS) medium.
6. Demonstration of surface sterilization of explants.
7. Inoculation and Incubation of explants for callus development.
8. Regeneration of plants from callus (shoot induction).
9. Root induction of in-vitro shoots.
10. Hardening and acclimatization of regenerated plantlets.
11. Photographic study of advanced tissue culture techniques:
    - Anther culture
    - Embryo culture
    - Endosperm culture
    - Micropropagation
    - Somatic embryogenesis
    - Artificial seeds
12. Preparation of artificial seeds.

Suggested activity:

Seminar, Quiz, debate, Assignments, Field work, Study Projects, Models etc. are Part of Curriculum for all units.

B. SC. SEMESTER-V BOTANY

PRACTICAL EXAM BASED ON SEC LAB- I (B-BO3510P)

Time: 6 hrs. **Max. Marks: 60**

1. Surface Sterilization the given plant material. 10 Marks
2. Inoculation of given explants on culture medium. 10 Marks
3. Media pouring and test tube preparation. 10 Marks
4. Write about a given advanced plant tissue culture technique. 5 marks
5. Prepare artificial seeds from given material. 7 Marks
6. Spotting 8 Marks
7. Viva-voce 5 Marks
8. Practical Record and tour report 5 Marks

CIE Evaluation

Attendance	Practical skills	Record	Participation in Lab activities	Total
10	10	10	10	**40**

B. SC. SEMESTER-V BOTANY
COMMUNITY ENGAGEMENT PROGRAM (CEP)
(B-BO3511P)

Hours: 2 Hours/Week **Marks: (CIE) 50** **Credit: 1**

Couse Objective: To enable students to:

1. Provide opportunities to understand the different socio-economic contexts.
2. Understand the village/society work ethics, culture, tradition, and conventional methods, giving students exposure to development-related issues in rural and urban areas.
3. Offer hands-on experience in teamwork with sincerity and earnestness about the rural community practices, thereby enhancing professional skills such as communication, work ethics, conflict resolution, etc., with a lasting impact on lifelong learning and professional development.
4. Gain knowledge about botanical resources used by rural community, their conservation, and the structure and components of village ecosystems.

Course Outcomes: After completing the community service, the student will be able to:

1. Practice teamwork skills with sincerity and earnestness in botanical research.
2. Adapt the village/society's botanical work ethics, traditions, and conventional methods in their professional practice.
3. Disseminate knowledge plant resources, their sustainable use, and conservation strategies.
4. Document the biodiversity tied to ecology/mycology resources of the village ecosystem, identifying and designating its respective components.

Guidelines:

1. CEP is explicitly linked with DSC/DSE papers. A student is required to undergo and successfully complete this 30 hour of Community Services course as mentioned in the teaching and examination scheme under the guidance of a supervisor/mentor assigned by Head of the Department. This course must be corresponding to the 'MAJOR' i.e Botany.
2. The Field based community engagement and Services is an individual or a group activity with a maximum of three students in a group.
3. The activity shall include biodiversity documentation tied ecology/mycology. Participation in the activities related to National Service Scheme (NSS), National Cadet Corps (NCC) literacy initiatives, biodiversity preservation, and mentoring school students with minimum of 30 Hrs. of work either in Institute Campus or above-mentioned activities.
4. The student or the group of students done the work will have to make a final presentation and appear for one Viva-Voce based on the work describing their participation and contribution in the activity at the end of semester as per the schedule given by the Institute.

5. The completed Community Service report should be submitted to the CEP-Coordinator on or before the last day of the semester. The report should include photographs, species lists, GIS maps, or interviews.
6. The Field based community service draft report as well as the final presentation will be evaluated by an external examiner (as per norms). If an external examiner is not available, the Head of department may appoint an external examiner from the Department with the prior permission of the Director.
7. **Following activities shall be covered under Community Engagement Program:**
    a. Creating environmental awareness among villagers/society in residential areas about flora.
    b. Urban ecological issues (e.g., waste management, urban greening) to balance rural focus.
    c. Contribute for prevention of nearby biodiversity loss.
    d. Communicate residential/commercial areas on importance of biodiversity.
    e. Study the ecosystem in the surrounding areas.

CIE Evaluation

Attendance	**Report Quality**	**Presentation**	**Viva-voce**	**Total**
10	10	20	10	**50**

Table 2: B.Sc. Semester VI

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:- **GENETICS**	B- BO361T	5.5	3	--	--	3	3	45	30	38
		PAPER 2:- **FUNDAMENTAL PROCESSES IN BIOLOGY**	B- BO362T		3	--	--	3	3	45	30	38
		DSC LAB (BASED ON PAPER 1 + PAPER2)	B- BO363P		--	--	6	3	6	90	60	75
		PAPER 3:- **PLANT BIOTECHNOLOGY & GENETIC ENGINEERING**	B- BO364T		2	--	--	2	2	30	20	25
		DSC LAB	B- BO365P		--	--	2	1	4	30	20	25
2	**DSE**	ELECTIVE 3:- **PLANT ECOLOGY & SOIL SCIENCE** ELECTIVE 4:- **ECONOMIC BOTANY & PHYTOGEOGRAPHY**	B- BO366PE B-BO366EB		2	--	--	2	2	30	20	25
		DSE LAB	B- BO367P		--	--	4	2	4 - 6	60	40	50
3	**VSEC**	REFER SEC BASKET **INSTRUMENTATION IN BOTANY**	B- BO368P		--	--	4	2	4 - 6	60	40	50
4	**OJT**	**INTERNSHIP / APPRENTICESHIP** (RELATED TO DSC)	B- BO369P		--	--	8	4	--	--	200	100
TOTAL					**10**	**--**	**24**	**22**		**390**	**460**	**--**

B. SC. SEMESTER-VI BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I GENETICS
(B-BO361T)

Hours: 3 Hours/Week **Marks: 45 (ESE) + 30 (CIE) = 75** **Credit: 3**

Course Objectives:

1) To understand the core principles of Mendelian inheritance, gene interactions, and the mechanics of linkage and crossing over.

2) To develop comprehensive technical knowledge regarding chromosomal variations, population genetics, and statistical tools applied to biological systems.

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

- Students will be able to solve intricate genetic problems involving Mendelian ratios, allelic interactions, and linkage maps.
- Students will gain thorough knowledge of structural and numerical chromosomal variations along with cytoplasmic inheritance patterns across various plant groups.
- Students will develop critical skills to implement biometrical calculations, statistical test applications, and analyze basic quantitative genomic concepts.

Course Content

Unit-I: Mendelian Genetics & Gene Interactions (7.5 Hrs)

Introduction to Genetics: Pre-Mendelian concepts. Biography of Gregor Mendel and his classic experiments on Pisum sativum. Law of Segregation (Monohybrid cross layout, back cross, and test cross models). Law of Independent Assortment (Dihybrid cross arrangements). Gene interactions outline: Modifications of classical ratios. Structural and functional traits of Incomplete dominance, Co-dominance, and Lethal genes. Epistasis: Detailed mechanisms, structural pathways, and examples of Supplementary, Complementary, Duplicate, and Inhibitory gene layouts.

Unit-II: Linkage & Crossing Over. (7.5 Hrs)

Linkage: Definition, characteristics, classification of complete and incomplete linkage. Crossing over: Cytological basis, precise mechanism, evolutionary significance. Linkage mapping: Primary concept, mathematical evaluation, and construction of mapping coordinates via two-point and three-point test crosses.

Unit-III: Chromosomal Variations & Extranuclear Inheritance. (7.5 Hrs)

Chromosomal aberrations and variations: Numerical variations including Euploidy (Autopolyploidy, Allopolyploidy and structural adaptations) and Aneuploidy

(Monosomy, Nullisomy, Trisomy, Tetrasomy). Structural variations: Detailed layouts of Deletion, Duplication, Inversion, and Translocation configurations.

Extranuclear inheritance: Definition, foundational concepts, and properties of cytoplasmic or maternal inheritance in plants. Representative layouts including Plastid inheritance (Variegation in Mirabilis jalapa) and Mitochondrial variations (Cytoplasmic Male Sterility in crops).

Unit-IV: Population Genetics & Quantitative inheritance. (7.5 Hrs)

Population Genetics: Mathematical frameworks of the Hardy-Weinberg Law, structural assumptions, and forces affecting gene/genotype frequencies (Mutation, Migration, Natural Selection, and Genetic Drift). Biometrical Genetics introduction: Quantitative metrics including Mean, Variance, Standard Deviation, and basic application parameters of the Chi-square test for goodness of fit. Quantitative inheritance: Multigenic frameworks explained with classic model examples (Kernel color index in wheat and Corolla length variations in Nicotiana tobacco).

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. John Wiley & Sons, New York.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, San Francisco.
3. Gupta, P.K. (2018). Genetics. Rastogi Publications, Meerut, India.
4. Singh, B.D. (2015). Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
5. Snustad, D.P., Simmons, M.J. (2011). Principles of Genetics. John Wiley & Sons, New York.
6. Stansfield, W.D. (2002). Schaum's Outline of Genetics. Tata McGraw-Hill, New Delhi.
7. Verma, P.S., Agarwal, V.K. (2009). Genetics. S. Chand & Company Ltd., New Delhi.
8. Strickberger, M.W. (2008). Genetics. Pearson Education, New Delhi.

B. SC. SEMESTER-VI BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER- II FUNDAMENTAL PROCESSES IN BIOLOGY
(B-BO362T)

Hours: 3 Hours/Week Marks: 45 (ESE) + 30 (CIE) = 75 Credit: 3

Course Objectives:

1. To explore the molecular mechanisms of genetic information flow, high-fidelity maintenance, and enzymatic orchestration across the central dogma cascades.
2. To develop comprehensive technical knowledge regarding post-transcriptional modifications, translational control architectures, and eukaryotic epigenetic control loops.

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

3. Students will be able to map and analyze core replication forks, promoter consensus sequence frameworks, and translation initiation reading windows.
4. Students will gain thorough knowledge of structural spliceosome mechanics, alternative splicing configurations, and viral vs. cellular operon regulatory loops.
5. Students will develop critical skills to implement non-chemical simulations of natural selection, calculate kinetic enzyme denaturation pathways, and evaluate gene silencing protocols.

Course Content

Unit-I: DNA Replication (7.5 Hours)

Mechanics of Replication & Replicons

The basic unit of replication (replicon) across cellular domains. Structural layout of replication origins (ori C in prokaryotes, ARS elements in yeast). Enzymes and cofactor machinery: DNA Polymerases (I, II, III in prokaryotes; alpha, delta, epsilon in eukaryotes), Helicase, Primase, Topoisomerases, Single-Stranded Binding Proteins (SSBs), and DNA Ligase. Continuous vs. discontinuous elongation synthesis: Leading strand and lagging strand progression via Okazaki fragments.

Unit-II: DNA Damage & Cellular Repair Systems

Spontaneous modifications (depurination, deamination), oxidative stresses, chemical mutagens (alkylating agents, base analogs), and physical radiation damage (UV-induced thymine dimers, ionizing breakages). Molecular cascades of DNA repair: Direct reversal via Photoreactivation. Base Excision Repair (BER) pathways and

Nucleotide Excision Repair (NER) architectures. Mismatch Repair (MMR) systems and structural discrimination

Unit-III: RNA Synthesis, Processing and Regulation (7.5 Hours)

Transcription Frameworks & Machinery

Molecular architecture of transcription units. Structural progression of initiation, elongation, and termination cycles. Prokaryotic transcription: Core RNA polymerase vs. Holoenzyme, sigma factor properties, and promoter recognition elements (-10 and -35 boxes). RNA Polymerases I, II, and III. Action dynamics of classical transcriptional inhibitors (Rifampicin, Actinomycin D, Alpha-amanitin).

Post-Transcriptional Modulatory Processing

Primary transcript maturation steps: 5' end capping configurations (7-methylguanosine cap linkage) and 3' end polyadenylation processing (cleavage and polyadenylation specificity factors cascade)

Unit-IV: Protein Synthesis (7.5 Hours)

Translational Cascade Mechanics

Ribosome architectural anatomy: Composition of prokaryotic (70S) and eukaryotic (80S) complexes, functional domains (A, P, and E sites). The Genetic Code: Deciphering properties (triplet nature, degeneracy, non-overlapping syntax, universality), codon-anticodon interactions, and the Wobble Hypothesis. Translation phases: Aminoacyl-tRNA synthese charging accuracy. Initiation mechanics (Shine-Dalgarno sequence recognition in bacteria). Elongation factors, peptide bond formation catalyzed by peptidyl transferase ribozyme activity, and translocation cycles. Termination factors recognizing stop codons.

B. SC. SEMESTER-VI BOTANY
DSC LAB EXERCISE-I BASED ON DSC PAPER- I & II
(B-BO363P)

Hours: 6 Hours/Week **Marks: 90 (SEE) +60 (CIE) = 150** **Credit: 3**

DSC Lab: Genetics

List of Practicals:

1. Solving genetic problems related to Monohybrid, Dihybrid, and Trihybrid ratios using mathematical algorithms.

2. Analysis and troubleshooting of genetic problems involving gene interactions (Incomplete dominance, Co-dominance, Lethal factors, and Epistatic deviations).

3. Construction of linear chromosomal linkage maps based on experimental two-point and three-point test cross raw data metrics.

4. Calculation of gene frequencies and genotype frequencies in population samples utilizing the Hardy-Weinberg equilibrium framework.

5. Biometrical analysis evaluation: Calculation of Mean, Mode, Median, Variance, and Standard Deviation from given biological datasets.

6. Statistical data validation: Application of the Chi-square test for verifying the goodness of fit across standard Mendelian genetic ratios.

7. Preparation of temporary stained squash mounts of Onion (Allium cepa) root tips to examine and identify distinct stages of Mitosis.

8. Preparation of temporary stained acetocarmine/orcein squash mounts of Onion (Allium cepa) or Rheo flower buds to identify stages of Meiosis.

9. Microscopic examination or analysis of polytene and lampbrush gigantic chromosomes utilizing permanent slides, models, or micrographs.

10. Cytological study of structural chromosomal aberrations (Deletion, Duplication, Inversion, Translocation layouts) via permanent slides or diagram models.

11. Analytical construction and evaluation of human/plant Karyotypes and Idiograms from supplied chromosomal photographs.

12. Analysis of classical human pedigree charts to deduce patterns of inheritance (e.g., ABO Blood groups, Color blindness, Haemophilia, PTC tasting).

Suggested activity:

Seminar presentation, competitive mock quiz panels, targeted field assignments, layout collection of local mutant plant phenotypes, preparation of an individualized comprehensive portfolio containing at least 5 solved complex multigenic genetic problems alongside 5 master hand-drawn structural cytogenetic/chromosomal diagrams, and active engagement in continuous evaluation parameters.

DSC Lab: Fundamental Processes in Biology

List of Practical's

1. Crude Isolation of Plant DNA using Household Reagents
2. Semi-Quantitative Assessment of Isolated Nucleic Acids via Precipitation Density
3. Paper Chromatography Model for Separation of Nucleic Acid Base Mimics or Pigments
4. UV-Induced Lesion Mapping and Photoreactivation Using Plant Seedling Epidermis
5. Graphical Modelling and Construction of the Prokaryotic Replication Fork
6. Analysis of Eukaryotic and Prokaryotic Promoter Maps Using Consensus Sequence Data
7. Kinetic Profiling of Translation Products via Salivary Amylase Denaturation Dynamics
8. Deciphering the Genetic Code: Solving Translation, Degeneracy, and Wobble Coordinate Problems
9. Structural Mapping of the Lac Operon and Gene Regulation Problem Sets
10. Quantitative Assessment of Stomatal Density Transitions Across Environmental Gradients
11. Mapping Ribosome Architecture and tRNA Functional Sites via Paper Models
12. Visualizing Spliceosome Architectures and Alternative Splicing Intron-Exon Variations
13. Non-Chemical Population Simulation of Natural Selection and Genetic Drift Patterns

B. SC. SEMESTER-VI BOTANY
DSC LAB PRACTICAL EXAMINATION
Combined Practical Course: Genetics & Fundamental Processes

Time: 6hrs. **Max. Marks: 90**

1. Major Practical Experiment (Genetics Domain)

Perform a temporary cytological squash preparation of the given plant specimen to show mitotic or meiotic chromosomal stages. Identify, draw, and label at least two clean stages of cell division.

12Marks

2. Major Practical Experiment (Molecular Biology Domain)

Perform a crude biochemical extraction or execute a semi-quantitative density profiling of plant DNA/RNA from the provided vegetative source tissue sample.

12 Marks

3. Minor Technical & Statistical Exercise (Genetics Domain)

Apply biostatistical metrics or execute a Chi-square test on the provided raw experimental genetic data set for empirical ratio validation.

08 Marks

4. Minor Applied Technical Exercise (Molecular Biology Domain)

Set up or interpret a paper chromatography capillary separation configuration, or verify and map out an experimental enzymatic denaturation kinetics curve.

08 Marks

5. Analytical Workspace & Complex Problem Solving (Combined)

Solve the two provided analytical data problem sheets distributed across the core syllabus disciplines:

a) Problem A (Genetics): Complete an intricate genetic cross layout tracking a Monohybrid, Dihybrid, or modified Allelic/Epistatic gene interaction calculation. (3 Marks)

b) Problem B (Fundamental Processes): Solve standard computational molecular problem sets mapping translation reading frames, transcription consensus regions, point mutation impacts, or operon expression logic charts. (3 Marks)

10 Marks

6. Microscopic & Macro-Anatomical Spotting (Combined)

Identify, illustrate, and explain the structural importance of the four provided laboratory spotters:

a) Spotter A (Genetics - Cytogenetics): Structural chromosomal aberration slide, specialized giant chromosome, or karyotype map model.

b) Spotter B (Genetics - Applied): Classical pedigree layout chart pattern or a documented mutant plant variant phenotype.

c) Spotter C (Fundamental Processes - Synthesis): Structural replication fork model or transcriptional promoter consensus matrix segment blueprint.

d) Spotter D (Fundamental Processes - Regulation): Ribosomal cavity translation tracking scheme or an operon regulatory feedback loop chart/gene silencing cascade diagram.

10 Marks

7. Viva-voce Interaction Panel. *15 Marks*

8. Certified Laboratory Record. *15 Marks*

CIE Evaluation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
15	15	15	15	**60**

B. SC. SEMESTER-VI BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-III PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING
(B-BO364T)

Hours: 2 Hours/Week **Marks: 30 (SEE) + 20 (CIE) = 50**
Credits: 2

Course objectives: - 1. To introduce the students with the various concept of biotechnology.
2. To introduce the aims and objectives of genetic engineering
3. To make them aware of various application of plant biotechnology
4. To explain the process of plant tissue culture

Course outcome: -

After studying this course, the students will be,
1. Able to understand the concept of Biotechnology
2. Aware of purpose of genetic engineering
3. Can use methods of plant tissue culture.
4. Aware of various applications of plant biotechnology.

Unit-I Recombinant DNA technology (7.5Hrs)

1. Recombinant DNA technology: Restriction Endonucleases (History, Types I-IV, biological role and application); Cloning Vectors: Prokaryotic (pBR322, Ti plasmid, BAC); Lambda phage, Eukaryotic Vectors (YAC).
2. Genetic engineering of plants: Aims, strategies for development of transgenics (with suitable examples); Agrobacterium-the natural genetic engineer

Unit-II Gene cloning (7.5Hrs)

1.Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR

Unit-III Plant Tissue Culture (7.5Hrs)

1. Plant tissue culture: Basic concepts; Principles and scope; tissue culture media; callus induction and cell suspension; aspects of morphogenesis;
2. Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion.

Unit-IV Gene Transfer (7.5Hrs)

1. Methods of gene transfer: Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment.

2. Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).
3. Applications of Biotechnology: Pest resistant (Bt-cotton); Transgenic crops with improved quality traits (Golden rice)

List of Reference Books

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
6. Dubey, R. C. 2014 Advanced Biotechnology. S. Chand & Co. Pvt. Ltd., New Delhi.

Suggested activity:

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

B. SC. SEMESTER-VI BOTANY
DSC LAB EXERCISE-I BASED ON
DSC PAPER-III PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING
(B-BO365P)

Hours: 2Hours/Week **Marks: 30 (SEE) + 20(CIE) = 50** **Credits: 1**

List of Practicals

1. Introduction of Equipments required for Plant Tissue culture: Autoclave, Hot Air Oven, Laminar Flow, Culture racks, Incubation facility.
2. Sterilization of glasswares
3. Preparation of MS medium.
4. Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, Datura, Brassica etc.
5. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
6. Isolation of protoplasts.
7. Construction of restriction map of circular and linear DNA from the data provided.
8. Study of methods of gene transfer through photographs: Agrobacterium- mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
9. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
10. Isolation of plasmid DNA.
11. Restriction digestion and gel electrophoresis of plasmid DNA.

B.Sc. - SEMESTER – VI
BOTANY PRACTICAL EXAMINATION
DSC PAPER-III LAB PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING
(B-BO365P)

Time: 4 hrs. **Max. Marks: 30**

1. To perform one major experiment (A) and report the findings. 08
2. To perform one minor experiment (B) and report the findings. 04
3. To study the steps in genetic engineering using given example. 03
4. Write about the gene transfer method from the provided photograph. 03
5. Spotting 04
6. Practical record 05
7. Viva-voce 03

CIE Evaluation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
5	5	5	5	**20**

B. SC. SEMESTER-VI BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-I PLANT ECOLOGY AND SOIL SCIENCE
(B-BO366TES)

Hours: 2Hours/Week **Marks: 30 (SEE) + 20 (CIE) = 50** **Credits: 2**

Course objectives: - To introduce students to the principles of plant ecology and soil science.

Course outcome: -

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

- Learn ecological principles, levels of organization, and ecosystem functioning.
- Get trained in soil science fundamentals (origin, composition, profile, fertility).
- Build understanding of ecological factors, adaptations, succession, and population dynamics.
- Understand ecosystem structure, biogeochemical cycles, soil-plant interactions.

Unit I – Ecology & Ecological Factors (7.5 hrs)

- Ecology: Concepts, levels of organization, branches, homeostasis.
- Water: Hydrological cycle, water table, soil moisture.
- Light, temperature, wind, fire: Variations and plant adaptations.
- Physiographic factors

Unit II – Soil Science (7.5 hrs)

- Soil science: Origin, formation, composition (physical, chemical, biological).
- Soil profile, edaphic factors, role of climate in soil development.
- Soil fertility, bulk density, porosity, infiltration, nutrient cycling.

Unit III –Adaptations & Biotic Interactions (7.5 hrs)

- Morphological/anatomical adaptations of hydrophytes, xerophytes.
- Population ecology: Characteristics, dynamics, ecological amplitude, niche.
- Biotic interactions: Symbiosis, commensalism, parasitism, predation.
- Succession: Processes, types, climax concepts.

Unit IV – Ecosystem (7.5 hrs)

- Ecosystem structure, trophic organization, food chains/webs, pyramids.
- Energy flow models, productivity, ecological efficiencies.
- Biogeochemical cycles: Carbon, nitrogen, phosphorus.

List of Reference Books

1. Odum, E.P. (2005). Fundamentals of Ecology. Cengage Learning India Pvt. Ltd., New Delhi.
2. Shukla & Chandel (2016). A Textbook of Plant Ecology. S. Chand Publication, New Delhi.
3. Ambasht, R.S. (1995). A Textbook of Plant Ecology. Student & Co., Varanasi.
4. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
5. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut.
6. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press.
7. Kormondy, E.J. (1996). Concepts of Ecology. PHI Learning Pvt. Ltd., Delhi.
8. Dash, M.C. (1993). Fundamentals of Ecology. WB Saunders & Co., Philadelphia.
9. Clements, F.E. (1916). Plant Succession: An Analysis of the Development of Vegetation. Carnegie Institute of Washington.
10. Kumar, H.D. (1994). Modern Concepts of Ecology. Vikas Publishing House, New Delhi.

Suggested activity:
Seminar, Quiz, debate, Assignments, study of local ecosystem, Field work, Study Projects, Models etc. are Part of Curriculum. Botanical Excursion (one short excursion is compulsory)

B. SC. SEMESTER-VI BOTANY
DSE LABORATORY EXERCISE-I BASED ON DSE PAPER-I (B-BO367P)

Hours: 4 Hours/Week **Marks: 60 (SEE) +40 (CIE) =100** **Credit: 2**

List of Practicals

1. Study of Instruments for microclimatic variables (soil thermometer, rain gauge, lux meter).
2. To determine pH of Soil & water samples.
3. Analysis of Soil for detection of: carbonates, chlorides, nitrates, sulphates, organic matter.
4. To determine Bulk density, porosity, infiltration rate different soil samples.
5. Preparation of soil profile chart.
6. To determine Dissolved oxygen in polluted and unpolluted water.

7. To study Morphological and anatomical adaptations of Hydrophytes & xerophytes.
8. To study Biotic interactions: *Cuscuta*, and epiphytes.
9. To determine minimal size of quadrat for vegetation analysis.
10. To study vegetation of an area by quadrat method, to determine frequency, density, abundance.
11. A Field visit to: Aquatic/ forest ecosystem/ disturbed habitats.

B. SC. SEMESTER-VI BOTANY
PRACTICAL EXAM BASED ON DSE LAB I
(B-BO367P)

Time: 6hrs. **Max. Marks: 60**

1. To study vegetation of an area by quadrat method 12 Marks

2. To determine pH of given Soil or water samples (A) 06 Marks

3 To study Morphological and anatomical adaptations of given Hydrophytes & xerophytes specimen (B) 10 Marks

4. To determine Dissolved oxygen in given water sample (C) 10 Marks

5. Spotting 12 Marks

D. Instruments for microclimatic variables

E. Identify and comments on biotic interaction

F. Analysis of Soil for detection of: carbonates, nitrates, organic matter.

6. Viva-voce 05 Marks

7. Practical record and Field visit report 05 Marks

CIE Evaluation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
10	10	10	10	**40**

B. SC. SEMESTER-VI BOTANY
SKILL ENHANCEMENT COURSE (SEC)
SEC LAB INSTRUMENTATION FOR BOTANY LABORATORY (B-BO368P)

Hours: 4 Hours/Week **Marks: 60 (SEE) +40 (CIE)=100** **Credit: 2**

Course Objectives:

1) To provide judicious mix of skills relating to a profession and appropriate content of Laboratory Instrumentation

2) Familiarize students with the sterilization Techniques.

Course Outcomes:

- To learn the basic principles of instrumentation
- To demonstrate the methods in microbiology sterilization
- To gain the Knowledge about laboratory organization for molecular biology

Laboratory Exercise

1. Neutralization and cleaning of glassware.
2. To study the principle of and application of Autoclave,
3. To study the principle of and application of BOD Incubator
4. To study the principle of and application of Hot Air Oven
5. To study the principle of and application of pH Meter, spectrophotometer, Colony Counter,
6. To study the principle of and application of spectrophotometer
7. To study the principle of and application of Centrifuge Machine
8. To study the principle of and application of Laminar Air Flow.
9. Sterilization of culture media using autoclave and assessment for sterility.
10. Sterilization of glassware using hot air oven.

Suggested activity:

Seminar, Quiz, debate, Assignments, collection of Angiospermic plant and study of higher plants preparation of herbarium and visit to local area, Field work, Study Projects, Models etc. are Part of Curriculum and considered along with attendance for Continuous Internal Evaluation (CIE)

B. SC. SEMESTER-VI BOTANY
PRACTICAL EXAM
SEC LAB BASED ON INSTRUMENTATION FOR BOTANY LABORATORY

Time: 6 hrs. **Max. Marks: 60**

1. Sterilization of Culture media in an Autoclave. 10 Marks
2. To perform Bacterial culture streaking in laminar air flow. 10 Marks
3. To take absorbance of given sample using spectrophotometer. 10 Marks
4. Spotting: 10Marks
   a) ....
   b) ....
5. Viva-voce 10Marks
6. Practical Record and tour report (submission is compulsory) 10 Marks

CIE Evaluation

Attendance	**Practical skills**	**Record**	**Participation in Lab activities**	**Total**
10	10	10	10	**40**

B. SC. SEMESTER-VI BOTANY
ON JOB TRAINING (OJT)
(B-BO369P)

Hours: 8 Hours/Week **Marks: = 200** **Credit: 4**

Couse Objective: To enable students to:

1. **Gain workplace exposure** by engaging in real-time professional environments related to Botany and allied sciences.
2. **Develop applied skills** in laboratory techniques, fieldwork, biodiversity documentation, and industrial practices.
3. **Enhance professional competencies** such as communication, teamwork, ethics, and problem-solving in organizational settings.
4. **Bridge theory with practice** by applying classroom knowledge to practical, industry, and community-based projects.
5. **Prepare for career readiness** through exposure to research institutions, industries, NGOs, and government programs.

Course Outcomes: After completing the OJT, the student will be able to:

1. **Apply theoretical knowledge** in real-world laboratory, industrial, or field settings.
2. **Demonstrate professional behavior** including punctuality, ethics, and responsibility in workplace contexts.
3. **Document and analyze** workplace processes, biodiversity resources, or industrial practices with scientific rigor.
4. **Collaborate effectively** with peers, supervisors, and professionals in multidisciplinary teams.
5. **Present findings** through structured reports, presentations, and viva-voce, showcasing applied learning outcomes.

Guidelines:

1. A student is required to undergo and successfully complete **120 hours of On-the-Job Training** under the guidance of a supervisor/mentor assigned by the Head of Department.
2. The OJT must correspond to the **'MAJOR' subject i.e., Botany**, and may include laboratory internships, biodiversity surveys, industrial training, or NGO/community projects.
3. The activity can be **individual or group-based** (maximum of three students per group).
4. Students must maintain a **daily logbook/portfolio** documenting tasks, observations, and reflections.
5. At the end of the semester, students must submit a **final OJT report** (including photographs, species lists, industrial processes) to the OJT Coordinator.
6. Students will make a **final presentation** and appear for a **viva-voce** describing their participation and contribution.

7. Evaluation will be conducted by an **external examiner** (as per norms). If unavailable, the Head of Department may appoint an internal examiner with prior permission of the Director.
8. Suggested OJT activities include:
    - **Laboratory internships** in plant physiology, microbiology, or biotechnology labs.
    - **Industrial training** in agro-based industries, nurseries, or herbal product units.
    - **Field biodiversity surveys** in forests, wetlands, or urban ecosystems.
    - **Community projects** with NGOs on conservation, awareness, or ecological restoration.
    - **Government program participation** such as afforestation drives, biodiversity boards, or environmental monitoring schemes.

Institute of Science, Nagpur

(An Autonomous Institute of Govt. of Maharashtra)

DEPARTMENT OF BOTANY

CREDIT STRUCTURE, EVALUTION SCHEME,

AND SYLLABUS OF FOUR-YEAR BACHELOR OF SCIENCE (HONORS/RESEARCH) DEGREE WITH A SEMESTER PATTERN IN BOTANY

B. Sc. IV YEAR BOTANY

(FACULTY OF SCIENCE &TECHNOLOGY)

BASED ON DIRECTION 1 OF 2023 ISSUED BY THE INSTITUTE OF SCIENCE, NAGPUR AS PER NEP 2020

To be implemented from 2026-2027

Table 1: B.Sc. Semester VII (Honors)

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:- **CRYPTOGAMIC BOTANY**	B-BOH471T	6.0	4	--	--	4	3	80	20	50
		Paper 2:- **GYMNOSPERMS & PLANT SYSTEMATICS**	B-BOH472T		4	--	--	4	3	80	20	50
2	**DSE**	Electives:- **5) PHYCOLOGY AND HYDROBIOLOGY 6) MYCOLOGY AND APPLIED PLANT PATHOLOGY**	B- BOH473PH B- BOH473MP		4	--	--	4	3	80	20	50
3	**DSC /DSE**	**DSC Lab** (Based on Paper 1 + Paper 2+ Elective)	B-BOH474P		--	--	12	6	8 - 12	240	60	150
4	**RM**	**RESEARCH METHODOLOGY**	B- BOH475RM		4	--	--	4	3	80	20	50
TOTAL					**16**	**--**	**12**	**22**		**560**	**140**	**--**

Table 2: B.Sc. Semester-VIII (Honors)

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**	B-BOH481T	6.0	4	--	--	4	3	80	20	50
		Paper 2:- **PLANT PHYSIOLOGY**	B-BOH482T		4	--	--	4	3	80	20	50
2	**DSE**	Electives:- 7) **PHYTOCHEMISTRY** 8) **PALYNOLOGY**	B- BOH483PC B-BOH483PN		4	--	--	4	3	80	20	50
3	**DSC /DSE**	**DSC LAB** (Based on Paper 1 + Paper 2+ Elective)	B-BOH484P		--	--	12	6	8-12	240	60	150
4	**OJT**	**INTERNSHIP / APPRENTICESHIP** (Related to DSC)	B-BOH485P		--	--	8	4	--	--	200	100
TOTAL					**12**	**--**	**20**	**22**		**480**	**320**	**--**

Table 3: B.Sc. Semester-VII (Honors with Research)

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:- **CRYPTOGAMIC BOTANY**	B-BOR471T	6.0	4	--	--	4	3	80	20	50
		Paper 2:- **GYMNOSPERMS & PLANT SYSTEMATICS**	B-BOR472T		4	--	--	4	3	80	20	50
2	**DSE**	Electives:- **5) PHYCOLOGY AND HYDROBIOLOGY 6) MYCOLOGY AND APPLIED PLANT PATHOLOGY**	B- BOR473PN B- BOR473PB		4	--	--	4	3	80	20	50
3	**DSC /DSE**	**DSC Lab** (Based on Paper 1 + Paper 2+ Elective)	B-BOR474P		--	--	4	2	4 - 6	80	20	50
4	**RM**	**RESEARCH METHODOLOGY**	B- BOR475RM		4	--	--	4	3	80	20	50
5	**RP**	**RESEARCH PROJECT** (Core)	B-BOR476P		--	--	8	4	--	--	200	100
TOTAL					**16**	**--**	**12**	**22**		**400**	**300**	**--**

Table 4: B.Sc. Semester-VIII (Honors with Research)

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**	B-BOR481T	6.0	4	--	--	4	3	80	20	50
		Paper 2:- **PLANT PHYSIOLOGY**	B-BOR482T		4	--	--	4	3	80	20	50
2	**DSE**	Electives:- 7) **PHYTOCHEMISTRY** 8) **PALYNOLOGY**	B- BOR483PC B-BOR483PN		4	--	--	4	3	80	20	50
3	**DSC /DSE**	**DSC LAB** (Based on Paper 1 + Paper 2+ Elective)	B-BOR484P		--	--	4	2	4 - 6	80	20	50
4	**RP**	**RESEARCH PROJECT / DISSERTATION 1** (Core)	B-BOR485P		--	--	8	4	--	--	200	100
		RESEARCH PROJECT / DISSERTATION 2 (Core)	B-BOR486P		--	--	8	4	--	--	200	100
TOTAL					**12**	**--**	**20**	**22**		**320**	**480**	**--**

Total Credits:

1. Four-Year UG Degree Program: 176

B. SC. SEMESTER-VII BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I CRYPTOGAMIC BOTANY
(B-BOH471T)

Hours: 4Hours/Week **Marks: 80(SEE)+20(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
-

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
-

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.

B. SC. SEMESTER-VII BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-II PLANT SYSTEMATICS
(B-BOH472T)

Hours: 4Hours/Week Marks: 80(SEE)+20(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

B. SC. SEMESTER-VII BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-I PHYCOLOGY AND HYDROBIOLOGY
(B- BOH473TPH)

Hours: 4Hours/Week **Marks: 80(SEE)+20(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

B. SC. SEMESTER-VII BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-III ADVANCED MYCOLOGY AND PLANT PATHOLOGY
(B- BOH473TMP)

Hours: 4Hours/Week **Marks: 80 (SEE) + 20 (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.

B. SC. SEMESTER-VII BOTANY

PRACTICAL EXAMINATION

DSC AND DSE LAB

B-BOH474P

Question paper

Time : 6-8 Hours **Max marks : 240**

1. One experiment from DSC Paper-1……. 25 Marks
2. One experiment from DSC Paper-1 ……12 Marks
3. One experiment from DSC Paper-2 ……25 Marks
4. One experiment from DSC Paper-2 ……12 Marks
5. One experiment from DSE ……...25 Marks
6. One experiment from DSE ……...16 Marks
7. Spotting: (5 marks for each spot) ……40 Marks

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

8. Viva-voce ……40 Marks
9. Record and excursion report (submission is compulsory) ……...40 Marks

CIE Evaluation

Attendance	Assignment	Class test	Classroom activities	Total
15	15	15	15	**60**

B. SC. SEMESTER-VII BOTANY
RESEARCH METHODOLOGY
B-BOH475TRM

RM-Theory Hours: 4 Hours/Week Marks: 80 (SEE) + 20 (CIE) =100 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.

Table 2: B.Sc. Semester-VIII (Honors)

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**	B-BOH481T	6.0	4	--	--	4	3	80	20	50
		Paper 2:- **PLANT PHYSIOLOGY**	B-BOH482T		4	--	--	4	3	80	20	50
2	**DSE**	Electives:- 7) **PHYTOCHEMISTRY** 8) **PALYNOLOGY**	B- BOH483PC B-BOH483PN		4	--	--	4	3	80	20	50
3	**DSC /DSE**	**DSC LAB** (Based on Paper 1 + Paper 2+ Elective)	B-BOH484P		--	--	12	6	8-12	240	60	150
4	**OJT**	**INTERNSHIP / APPRENTICESHIP** (Related to DSC)	B-BOH485P		--	--	8	4	--	--	200	100
TOTAL					**12**	**--**	**20**	**22**		**480**	**320**	**--**

B. SC. SEMESTER-VIII BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-I CELL AND MOLECULAR BIOLOGY
(B-BOH481T)

Hours: 4Hours/Week Marks: 80 (SEE) + 20 (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

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15. Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.
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17. Krishnamurthy, K.V. 2000 Methods in Cell wall Cyto-chemistry. CRC Press, Boca Raton, Florida
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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.

B. SC. SEMESTER-VIII BOTANY
DISCIPLINE SPECIFIC CORE COURSE (DSC)
DSC PAPER-II PLANT PHYSIOLOGY
B-BOH482T

Hours: 4 Hours/Week. Marks: 80(SEE) + 20(CIE) = 100. Credit: 4

Course Objectives:

1. Understanding basic concepts of photosynthesis & respiration.
2. 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.
2. 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).
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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.

B. SC. SEMESTER-VII 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.
2. Explore the evolutionary dynamics and diversity of photosynthesis across different organisms.
3. Analyze the processes involved in the light reaction and the Calvin cycle, including electron pathways and key enzymes.
4. Investigate the role of light in the activation of dark phase enzymes and the regulation of C4 and CAM photosynthesis.
5. 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.

B. SC. SEMESTER-VIII BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-I PHYTOCHEMISTRY
(B- BOH483TPC)

DSE-Theory Elective Hours: 4Hours/Week Marks: 80+20=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

B. SC. SEMESTER-VIII BOTANY
DSE LABORATORY EXERCISE I
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)

B. SC. SEMESTER-VIII BOTANY
DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
DSE PAPER-II PALYNOLOGY
B-BOR483TPN

Hours: 4Hours/Week **Marks: 80 (SEE) + 20 (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.
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8. spores. Journs.Indian. Bot. Soc. XLIV (4):
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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)

B. SC. SEMESTER-VIII BOTANY
DSE LABORATORY EXERCISE II
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.

B. SC. SEMESTER-VIII BOTANY

PRACTICAL EXAMINATION

DSC AND DSE LAB

Time : 6-8 Hours **Max marks : 240**

1. One experiment from DSC Paper-1…… 25 Marks
2. One experiment from DSC Paper-1 ……12 Marks
3. One experiment from DSC Paper-2 ……25 Marks
4. One experiment from DSC Paper-2 ……12 Marks
5. One experiment from DSE ……...25 Marks
6. One experiment from DSE ……...16 Marks
7. Spotting: (5 marks for each spot) ……40 Marks

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

8. Viva-voce ……40 Marks
9. Record and excursion report (submission is compulsory) ……...40 Marks

CIE Evaluation

Attendance	**Assignment**	**Class test**	**Classroom activities**	**Total**
15	15	15	15	**60**