

INDIRA GANDHI UNIVERSITY

Meerpur, Rewari (HR)



Scheme of Examination and Syllabus for Under-Graduate Programme (Subject: **Botany**)

**Under Multiple Entry-Exit, Internship and CBCS-LOCF in
accordance to NEP-2020 w.e.f. 2024-25 (in phased manner)**

Indira Gandhi University, Meerpur, Rewari
Scheme of Examination for Under-Graduate Programme
Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f.
2024-25 (in phased manner)
Department of Botany

Semester-I

Remarks on Scheme	Course Type & Total Credits	Course Code	Course Nomenclature		Credits	Hours/ week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)	
A, B & C	CC-1 MCC-1 (4 Credits)	24L4.5- BOT-101	Microbial World and Thallophytes	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
C	MCC-2 (4 Credits)	24L4.5- BOT-102	Applied Phycology and Phytopathology	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
A & B	CC-M1* (2 Credits)	24L4.5- BOT-103	Diversity of Non- Flowering and Flowering Plants	T	1	1	10	20	30	50	3
				P	1	2	05	15	20		4
C	CC-M1	From Available CC-M1 of 4 credits as per NEP									
A, B, C & D	MDC-1	From Available Pool of MDC-1 of 3 credits as per NEP									
A, B & C	AEC-1	From Available Pool of AEC-1 of 2 credits as per NEP									
	SEC-1	From Available Pool of SEC-1 of 3 credits as per NEP									
	VAC-1	From Available Pool of VAC-1 of 2 credits as per NEP									

T and P represents **Theory** and **Practical**

CC: Core Course

MDC: Multidisciplinary Course

SEC: Skill Enchantment Course

CC-M: Minor

AEC: Ability Enchantment Course

VAC: Value Added Course



*For students who opt Botany as a minor subject

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Semester-II

Remarks on Scheme	Course Type & Total Credits	Course Code	Course Nomenclature		Credits	Hours/ week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)		
A, B & C	CC-2 MCC-3 (4 Credits)	24L4.5- BOT-201	Pteridophytes, Gymnosperms and Fossils	T	3	3	20	50	70	100	3	
				P	1	2	10	20	30		4	
C	DSEC-1 (4 Credits)	24L4.5- BOT-202	Paleobotany and Phytogeography	T	3	3	20	50	70	100	3	
				P	1	2	10	20	30		4	
A & B	CC-M2* (2 Credits)	24L4.5- BOT-203	Plants as Resource	T	1	1	10	20	30	50	3	
				P	1	2	05	15	20		4	
C	CC-M2	From Available CC-M2 of 4 credits as per NEP										
A, B, C & D	MDC-2	From Available Pool of MDC-2 of 3 credits as per NEP										
A, B & C	AEC-2	From Available Pool of AEC-2 of 2 credits as per NEP										
	SEC-2	From Available Pool of SEC-2 of 3 credits as per NEP										
	VAC-2	From Available Pool of VAC-2 of 2 credits as per NEP										
A, B & C	Internship	24L4.5- BOT-204	Internship of 4 Credits of 4-6 weeks after II Semester (mandatory in case of exit)						50	50	100	

T and P represents **Theory** and **Practical**

CC: Core Course

MDC: Multidisciplinary Course

SEC: Skill Enchantment Course

DSEC: Discipline Skill Enhancement Course

CC-M: Minor

AEC: Ability Enchantment Course

VAC: Value Added Course

 *For students who opt Botany as a minor subject.

❖ **Note: UG Certificate in Basic Life-Science with 52 Credits** (in case of **Scheme-A & B**);
UG Certificate in Basic Botany with 48 Credits (in case of **Scheme-C**)
will be provided if student want to exit after II Semester.

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Semester-III

Remarks on Scheme	Course Type & Total Credits	Course Code	Course Nomenclature	Credits	Hours/ week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)		
A, B & C	CC-3 MCC-4 (4 Credits)	24L5.0- BOT-301	Cell Biology, Genetics and Plant Biotechnology	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	MCC-5 (4 Credits)	24L5.0- BOT-302	Plant Molecular Biology	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B	MCC-2 (4 Credits)	24L4.5- BOT-102	Applied Phycology and Phytopathology	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
A & C	CC-M3	From Available CC-M3 of 4 credits as per NEP									
B	CC-M3(V)	From Available Pool of minor (Vocational) courses VOC-1 of 4 credits as per NEP									
A, B, C & D	MDC-3	From Available Pool of MDC-3 of 3 credits as per NEP									
A, B & C	AEC-3	From Available Pool of AEC-3 of 2 credits as per NEP									
	SEC-3	From Available Pool of SEC-3 of 3 credits as per NEP									
C	VAC-3	From Available Pool of VAC-3 of 2 credits as per NEP									

T and P represents **Theory** and **Practical**

CC: Core Course

MDC: Multidisciplinary Course

SEC: Skill Enchantment Course

CC-M(V): Minor (Vocational)

AEC: Ability Enchantment Course

VAC: Value Added Course

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Semester-IV

Remarks on Scheme	Course Type & Total Credits	Course Code	Course Nomenclature		Credits	Hours/ week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)	
A, B & C	CC-4 MCC-6 (4 Credits)	24L5.0-BOT-401	Taxonomy and Reproduction of Flowering Plants	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	MCC-7 (4 Credits)	24L5.0-BOT-402	Palynology and Seed Science	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	MCC-8 (4 Credits)	24L5.0-BOT-403	Biotechnology and Genetic Engineering	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	DSE-1 (4 Credits)	24L5.0-BOT-404	Applied Plant Propagation and Tissue Culture	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
	Any one	24L5.0-BOT-405	Plant Breeding and Crop Improvement	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
A, B & C	CC-M4(V)	From Available Pool of minor (Vocational) courses VOC-2 of 4 credits as per NEP									
	AEC-4	From Available Pool of AEC-4 of 2 credits as per NEP									
A & B	VAC-3	From Available Pool of VAC-3 of 2 credits as per NEP									
C	VAC-4	From Available Pool of VAC-4 of 2 credits as per NEP									
A, B & C	Internship	24L5.0-BOT-406	Internship of 4 Credits of 4-6 weeks after IV Semester (mandatory in case of exit, if not done after II Semester)					50	50	100	

T and P represents **Theory** and **Practical**

CC: Core Course
MDC: Multidisciplinary Course
SEC: Skill Enchantment Course

CC-M(V): Minor (Vocational)
AEC: Ability Enchantment Course
VAC: Value Added Course

❖ **Note:** **UG Diploma in Basic Life-Science with 96 Credits** (in case of **Scheme-A**);
UG Diploma in Developmental Botany with 100 Credits (in case of **Scheme-B**);
UG Diploma in Developmental Botany with 94 Credits (in case of **Scheme-C**)
will be provided if want to exit after IV Semester (If not done in II Semester).

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Semester-V

Remarks on Scheme	Course Type & Total Credits	Course Code	Course Nomenclature		Credits	Hours/ week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)	
A, B & C	CC-5 MCC-9 (4 Credits)	24L5.5-BOT-501	Plant Anatomy Physiology and Biochemistry	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	MCC-10 (4 Credits)	24L5.5-BOT-502	Biomolecules and Metabolism	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	DSE-2 (4 Credits)	24L5.5-BOT-503	Plant Bioengineering and Synthetic Biology	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
	Any one	24L5.5-BOT-504	Plant-Based Food Processing and Post- Harvest Technology	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	DSE-3 (4 Credits)	24L5.5-BOT-505	Plant-Based Products and Bioprospecting	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
	Any one	24L5.5-BOT-506	Phytochemistry and Natural Products	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
A, B & C	Internship	24L5.5-BOT-507	Internship of 4 credits of 4-6 weeks after V Semester (if not done after II or IV semester)					50	50	100	
A & C	CC-M5(V)	From Available Pool of minor (Vocational) courses VOC-1 of 4 credits as per NEP									

T and P represents **Theory** and **Practical**

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MDC: Multidisciplinary Course

SEC: Skill Enchantment Course

DSE: Discipline Specific Elective Course

CC-M(V): Minor (Vocational)

AEC: Ability Enchantment Course

VAC: Value Added Course

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Semester-VI

Remarks on Scheme	Course Type & Total Credits	Course Code	Course Nomenclature		Credits	Hours/ week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)	
A, B & C	CC-6 MCC-11 (4 Credits)	24L5.5-BOT-601	Ecology and Economic Botany	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	MCC-12 (4 Credits)	24L5.5-BOT-602	Dendrology, Pomology and Arboriculture	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	DSE-4 (4 Credits)	24L5.5-BOT-603	Marine Flora and Coastal Ecology	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
	Any one	24L5.5-BOT-604	Aquatic Botany and Wetland Management	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	DSE-5 (4 Credits)	24L5.5-BOT-605	Field Botany and Plant Resource Entrepreneurship	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
	Any one	24L5.5-BOT-606	Laboratory Techniques and Biostatistics	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
A	CC-M6	From Available CC-M6 of 4 credits as per NEP									
A	CC-M7(V)	From Available Pool of minor (Vocational) courses VOC-3 of 4 credits as per NEP									
B	CC-M5(V)										
C	CC-M6(V)										
C	SEC-4	From Available SEC-4 of 2 credits as per NEP									

T and P represents **Theory** and **Practical**

CC: Core Course

MDC: Multidisciplinary Course

SEC: Skill Enchantment Course

DSE: Discipline Specific Elective Course

CC-M(V): Minor (Vocational)

AEC: Ability Enchantment Course

VAC: Value Added Course

❖ **Note: Bachelor Degree in Life-Science with 132 Credits** (in case of **Scheme-A**);
Bachelor Degree in Life-Science with Major Subject as Botany with 136 Credits (in case of **Scheme-B**);
Bachelor Degree with major in Botany with 136 Credits (in case of **Scheme-C**)
 will be awarded.

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Semester-VII

For Hons. / Hons. With Research in Botany									
Remarks on Scheme	Course Type & Total Credits	Course Code	Course Nomenclature	Credits	Hours/ week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)
B & C	CC-H1 (4 Credits)	24L6.0-BOT-701	Cyanobacteria, Phycology and Bryology	4	4	30	70	100	3
	CC-H2 (4 Credits)	24L6.0-BOT-702	Pteridophytes, Palaeobotany and Gymnosperms	4	4	30	70	100	3
	CC-H3 (4 Credits)	24L6.0-BOT-703	Microbiology and Mycology	4	4	30	70	100	3
	DSE-6-H1 (4 Credits)	24L6.0-BOT-704	Cell and Inheritance Biology	4	4	30	70	100	3
	Any one	24L6.0-BOT-705	AI, Machine Learning and Computational Biology	4	4	30	70	100	3
	PS-H1 (4 Credits)	24L6.0-BOT-706	Practical Based on 24L6.0-BOT-701 to 24L6.0-BOT-703 and any one out of 24L6.0-BOT-704/ 24L6.0-BOT-705	4	8	30	70	100	3
	CC-HM1	From Available Core Courses in Minor Subjects of 4 credits as per NEP							

CC-(A/B/C): Core Course
DSE: Discipline Specific Elective Course

CC-HM: Minor
PC: Practicum Course

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Semester-VIII

For Hons.									
Remarks on Scheme	Course Type & Total Credits	Course Code	Course Nomenclature	Credits	Hours/ week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)
B & C	CC-H4 (4 Credits)	24L6.0-BOT-801	Angiosperm Systematics and Economic Botany	4	4	30	70	100	3
	CC-H5 (4 Credits)	24L6.0-BOT-802	Plant Anatomy and Embryology	4	4	30	70	100	3
	CC-H6 (4 Credits)	24L6.0-BOT-803	Plant Ecology and Environmental Biology	4	4	30	70	100	3
	DSE-7-H2 (4 Credits)	24L6.0-BOT-804	Molecular and Evolutionary Biology	4	4	30	70	100	3
	Any one	24L6.0-BOT-805	Plant Immunity and Defense Systems	4	4	30	70	100	3
	PS-H2 (4 Credits)	24L6.0-BOT-806	Practical Based on 24L6.0-BOT-801 to 24L6.0-BOT-803 and any one out of 24L6.0-BOT-804/ 24L6.0-BOT-805	4	8	30	70	100	3
	CC-HM2	From Available Core Courses in Minor Subject of 4 credits as per NEP							
For Hons. With Research in Botany									
Remarks on Scheme	Course Type & Total Credits	Course Code	Course Nomenclature	Credits	Hours/ week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)
B & C	CC-H4 (4 Credits)	24L6.0-BOT-801	Angiosperm Systematics and Economic Botany	4	4	30	70	100	3
	CC-H5 (4 Credits)	24L6.0-BOT-802	Plant Anatomy and Embryology	4	4	30	70	100	3
	Research (12 Credits)	24L6.0-BOT-803	Dissertation (Check university website for details)						
	CC-HM2	From Available Core Courses in Minor Subject of 4 credits as per NEP							

CC-(A/B/C): Core Course
DSE: Discipline Specific Elective Course

CC-HM: Minor
PC: Practicum Course

❖ **Note: Bachelor Hons. / Bachelor Hons. (With Research) Degree in Botany with 184 Credits (in case of Scheme-B & C) will be awarded.**

Scheme of MDC, VAC, SEC and VOC

Semester	Course Type & Total Credits	Remarks on Scheme	Course Code	Course Nomenclature	Credits	Hours/week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)			
Multidisciplinary Course (MDC)													
I	MDC-1 (3 Credits)	A, B, C & D	24L4.5-MDC-BOT-101	Fundamentals of Botany	T	2	2	15	35	50	75	3	
					P	1	2	05	20	25		3	
II	MDC-2 (3 Credits)		24L4.5-MDC-BOT-201	Plants for Human Welfare	T	2	2	15	35	50	75	3	
					P	1	2	05	20	25		3	
III	MDC-3 (3 Credits)		24L5.0-MDC-BOT-301	Ornamental Plants	T	2	2	15	35	50	75	3	
					P	1	2	05	20	25		3	
Value Added Course (VAC)													
III	VAC-3 (2 Credits)	C	24L5.0-VAC-BOT-301	Ethnobotany	2	2	15	35	50	3			
IV	VAC-3 (2 Credits)	A & B	24L5.0-VAC-BOT-401	Basics of Medicinal Plants	2	2	15	35	50	3			
	VAC-4 (2 Credits)	C											
Skill Enhancement Course (SEC)													
II	SEC-2 (3 Credits)	A, B & C	24L4.5-SEC-BOT-201	Biofertilizers	T	2	2	15	35	50	75	3	
					P	1	2	05	20	25		3	
	SEC-2 (3 Credits)		24L4.5-SEC-BOT-202	Vertical Farming	T	2	2	15	35	50	75	3	
					P	1	2	05	20	25		3	
III	SEC-3 (3 Credits)		24L4.5-SEC-BOT-301	Plant Hybridization	T	2	2	15	35	50	75	3	
					P	1	2	05	20	25		3	
VI	SEC-4 (2 Credits)		C	24L5.5-SEC-BOT-601	Olericulture	T	1	1	10	20	30	50	3
						P	1	2	05	15	20		3
Vocational Course (VOC)													
III	VOC-1 (4 Credits)	B	24L5.0-VOC-BOT-301	Organic Farming	T	3	3	20	50	70	100	3	
					P	1	2	10	20	30		4	
IV	VOC-1 (4 Credits)	A & C	24L5.0-VOC-BOT-401	Floriculture	T	3	3	20	50	70	100	3	
	VOC-2 (4 Credits)	B			P	1	2	10	20	30		4	
	VOC-1 (4 Credits)	A & C	24L5.0-VOC-BOT-402	Nursery and Gardening	T	3	3	20	50	70	100	3	
	VOC-2 (4 Credits)	B			P	1	2	10	20	30		4	
V	VOC-2 (4 Credits)	A & C	24L5.5-VOC-BOT-501	Organic Farming	T	3	3	20	50	70	100	3	
					P	1	2	10	20	30		4	
VI	VOC-3 (4 Credits)	A, B & C	24L5.5-VOC-BOT-601	Mushroom Culture and Technology	T	3	3	20	50	70	100	3	
					P	1	2	10	20	30		4	

PREAMBLE

The role of education is paramount in nation building. One of the major objectives of UGC is maintenance of standards of higher education. Over the past decades the higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. Such changes have gained momentum with the introduction of Choice Based Credit System (CBCS) which further expects Learning Outcome-Based curriculum to maximize the benefits of the newly designed curriculum. The Learning Outcome- Based Curriculum in Microbiology will help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process. The commission strives to promote the link of students with the society/industry such that majority of the students engage in socially productive activities during their period of study in the institutions and at least half of the graduate students will secure access to employment/ self-employment or engage themselves in pursuit of higher education. The model curriculum envisages to cater to the developmental trends in higher education, incorporating multi- disciplinary skills, professional and soft skills such as teamwork, communication skills, leadership skills, time management skills and inculcate human values, professional ethics and the spirit of innovation/ entrepreneurship and critical thinking among students and promote avenues for display of these talents, linking general studies with professional courses. Besides imparting disciplinary knowledge to the learners, curriculum should aim to equip the students with competencies like problem solving, analytical reasoning and moral and ethical awareness. Introduction of internship and appropriate fieldwork/ case studies are embedded in the curriculum for providing wider exposure to the students and enhancing their employability.

Learning outcomes specify what exactly the graduates are expected to know after completing a Programme of study. The expected learning outcomes are used as reference points to help formulate graduate attributes, qualification descriptors, Programme learning outcomes and course learning outcomes. Keeping the above objectives of higher education in mind the Learning Outcome-Based Curriculum Framework (LOCF) for the discipline of Microbiology has been prepared and presented here.

Aims of Bachelor's degree programme

The broad aims of the bachelor's degree in Botany programme are:

1. To provide an environment that ensures the cognitive development of students in a holistic manner. A dialogue about plants and their significance is fostered in this framework, rather than didactic monologues on mere theoretical aspects.
2. To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A botany graduates as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
3. To mould a responsible citizen who is aware of the most basic domain-independent knowledge, including critical thinking and communication.
4. To enable the graduate to prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.

Course Introduction

The new curriculum of B.Sc. in Botany offers essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using a unique combination of core, elective and vocational papers with significant inter-disciplinary components. Students would be exposed to cutting-edge technologies that are currently being used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

B.Sc. Botany Programme covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects would also be organized for real-life experience and learning. Candidates who have curiosity in plants kingdom, ecosystem, love exploring exotic places and wish to work as researchers or professions like Botanist/ Environmentalist, Conservationist, Ecologist, etc. can choose B.Sc. Degree course.

Program Learning Outcomes

The students graduating with the Three-years B.Sc. and Four-years B.Sc. (Honors) Degree in Botany should be able to acquire.

Core competency: Students will acquire core competency in the subject Botany and allied subject areas.

1. The student will be able to identify major groups of plants and compare the characteristics of lower (e.g. algae and fungi) and higher (angiosperms and gymnosperms) plants.
2. Students will be able to use the evidence-based comparative botany approach to explain the evolution of organisms and understand the genetic diversity on the earth. The students will be able to explain various plant processes and functions, metabolism, concepts of gene, genome and how organism's function is influenced at the cell, tissue and organ level.
3. Students will be able to understand the adaptation, development and behavior of different forms of life.
4. The understanding of networked life on earth and tracing the energy pyramids through nutrient flow is expected from the students.
5. Students will be able to demonstrate the experimental techniques and methods of their area of specialization in Botany.

Analytical ability: The students will be able to demonstrate the knowledge in understanding research and addressing practical problems.

Application of various scientific methods to address different questions by formulating the hypothesis, data collection and critically analyze the data to decipher the degree to which their scientific work supports their hypothesis.

Critical Thinking and problem-solving ability: An increased understanding of fundamental concepts and their applications of scientific principles is expected at the end of this course. Students will become critical thinkers and acquire problem-solving capabilities.

Digitally equipped: Students will acquire digital skills and integrate the fundamental concepts with modern tools.

Ethical and Psychological strengthening: Students will also strengthen their ethical and moral values and shall be able to deal with psychological weaknesses.

Team Player: Students will learn team workmanship in order to serve efficiently institutions, industry and society.

Independent Learner: Apart from the subject-specific skills, generic skills, especially in botany, the program outcome would lead to gain knowledge and skills for further higher studies, competitive examinations and employment. Learning outcomes-based curriculum would ensure equal academic standards across the country and a broader picture of their competencies.

The Bachelor's program in Botany and honors may be mono-disciplinary or multidisciplinary with following broad objectives.

1. Critically evaluation of ideas and arguments by collecting relevant information about the plants, to recognize the position of the plant in the broad classification and phylogenetic level.
2. Identify problems and independently propose solutions using creative approaches, acquired through interdisciplinary experiences, and a depth and breadth of knowledge/ expertise in the field of species identification.
3. Accurately interpretation of collected information and use taxonomical information to evaluate and formulate a position of the organism and in taxonomy.
4. Students will be able to apply the scientific method to questions in botany by formulating testable hypotheses, collecting data that address these hypotheses and analyzing those data to assess the degree to which their scientific work supports their hypotheses.
5. Students will be able to present scientific hypotheses and data both orally and in writing in the formats that are used by practicing scientists.
6. Students will be able to access the primary literature, identify relevant works for a particular topic, and evaluate the scientific content of these works.
7. Students will be able to apply fundamental mathematical tools (statistics, calculus) and physical principles (physics, chemistry) to the analysis of relevant biological situations.
8. Students will be able to identify the major groups of organisms with an emphasis on plants and be able to classify them within a phylogenetic framework. Students will be able to compare and contrast the characteristics of plants, algae and fungi that differentiate them from each other and other forms of life.
9. Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They will be able to use specific examples to explicate how descent with modification has shaped plant morphology, physiology and life history.
10. Students will be able to explain the ecological interconnectedness of life on earth by tracing energy and nutrient flow through the environment. They will be able to relate the physical features of the environment to the structure of populations, communities and ecosystems.
11. Students will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization within biology.

B.Sc. Botany Programme outcomes as per NEP 2020

Name of the Degree Program: B.Sc./ B.Sc. Honours/ B.Sc. Honors with Research

Discipline Core: Botany

Total Credits for the Program: 132 (Scheme A); 136 (Scheme B); 136 (Scheme C)

Starting year of implementation: 2024-25

Program Outcomes:

By the end of the program the students will be able to:

(Refer to literature on outcome-based education (OBE) for details on Program Outcomes)

PO1: Skill development for the proper description using botanical terms, identification, naming and classification of life forms especially plants and microbes.

PO2: Acquisition of knowledge on structure, life cycle and life processes that exist among plant and microbial diversity through certain model organism studies.

PO3: Understanding of various interactions that exist among plants and microbes; to develop the curiosity on the dynamicity of nature.

PO4: Understanding of the major elements of variation that exist in the living world through comparative morphological and anatomical study.

PO5: Ability to explain the diversity and evolution based on the empirical evidences in morphology, anatomy, embryology, physiology, biochemistry, molecular biology and life history.

PO6: Skill development for the collection, preservation and recording of information after observation and analysis- from simple illustration to molecular database development.

PO7: Making aware of the scientific and technological advancements- Information and Communication, Biotechnology and Molecular Biology for further learning and research in all branches of Botany.

PO8: Internalization of the concept of conservation and evolution through the channel of spirit of inquiry.

PO9: To enable the graduates to prepare for national as well as international level competitive examinations like UGC-CSIR, UPSC, KPSC, etc.

PO10: To enable the students for practicing the best teaching pedagogy as a biology teacher including the latest digital modules.

PO11: The graduates should be knowledgeable and competent enough to appropriately deliver on aspects of global importance like climate change, SDGs, green technologies, etc. at the right opportunity.

PO12: The graduate should be able to demonstrate sufficient proficiency in the hands-on experimental techniques for their area of specialization within biology during research and in the professional career.

Syllabus

Subject: Botany Semester I (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-1 MCC-1 (4 Credits) Scheme A, B & C	24L4.5-BOT-101	Microbial World and Thallophytes	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: The main objective of this course is for students to acquire in-depth knowledge cell structure and organization, cultivation methods and growth patterns, and reproduction of microbes, algae and fungi.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to									
1. understand the general characteristics of Viruses and Bacteria. 2. develop a conceptual understanding of Algae and Bryophytes. 3. gain knowledge on the concepts of Fungi. 4. understand the biology of Lichens.									
5. gain the knowledge of practical aspects of microorganisms, algae, fungi, lichens and bryophytes.									
Part B - Contents of the Course									
Instruction for Paper Setter									
1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Microbial Diversity: Introduction, discovery and scope of microbiology. Virus: General account, structure and reproduction of TMV and Bacteriophage. Bacteria: Structure, types (gram +/-), reproduction and economic importance.								11
II	Cyanobacteria: General account with special reference to <i>Nostoc</i> and <i>Oscillatoria</i> . Role in Nitrogen metabolism. Algae: General characters, classification (up to class level), economic importance. Life-History of <i>Oedogonium</i> , <i>Volvox</i> , <i>Vaucheria</i> , <i>Ectocarpus</i> and <i>Polysiphonia</i> .								12

III	Bryophytes: General characters, classification (up to class level), economic and ecological importance. Morphology, anatomy and reproduction (excluding development) of <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i> .	11
IV	Fungi: General characters, classification (up to class level), economic importance. Life-History of <i>Mucor</i> , <i>Penicillium</i> , <i>Colletotrichum</i> , <i>Puccinia</i> and <i>Agaricus</i> . Lichens: Introduction, structure, types and ecological and economic importance.	11
V	Suggested Practical works	
	Models of viruses: TMV, Line drawing/ Photograph of Lytic and Lysogenic Cycles. Types of Bacteria from temporary/permanent slides/photographs; Binary Fission; Conjugation; Structure of root nodule. Study of vegetative and reproductive structures of <i>Nostoc</i>, <i>Oscillatoria</i>, <i>Volvox</i>, <i>Vaucheria</i>, <i>Ectocarpus</i> and <i>Polysiphonia</i> through temporary preparations and permanent slides. <i>Marchantia</i>- Morphology of thallus, W.M. rhizoids and scales, W.M. gemmae, V.S. thallus with gemma cup, V.S. antheridiophore, archegoniophore, L.S. sporophyte (temporary/ permanent slides). <i>Anthoceros</i>- Morphology of thallus, W.M. rhizoids, V.S. thallus, V.S. Antheridia and Archegonia, L.S. sporophyte (temporary/ permanent slides). <i>Funaria</i>- Morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores, slides showing antheridial and archegonial heads, L.S. capsule (temporary/ permanent slides). Study of vegetative & reproductive structures of <i>Mucor</i>, <i>Penicillium</i>, <i>Colletotrichum</i>, <i>Puccinia</i> and <i>Agaricus</i>: Asexual and sexual stages through temporary preparations and permanent slides. Study of slides/photographs of lichens (crustose, foliose and fruticose). Note: Any other relevant practical can be offered. Excursion Report: Report on excursion tours with photographs, collection and preservation specimens related to Algae, Bryophytes, Fungi and Lichen.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20

✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA	
Part C - Recommended Books/ e-resources	
• Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. (2019) Prescott's Microbiology. 11th Edn., McGraw Hill International. • Pelczar, M.J. (2001) Microbiology, 5th Edn., Tata McGraw-Hill Co, New Delhi. • Lee, R.E. (2018) Phycology. 5th Edn. Cambridge University Press. • Singh, V., Pande, P.C. and Jain D.K. (2017) Biodiversity (Microbiology, Fungi, Algae, Archegoniate: Bryophyta, Pteridophyta and Gymnosperms). Rastogi Publications. Meerut. • Aluwalia, A.S. (2020) Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi. • Dube, H.C. (2012) An Introduction to Fungi, Vikas Publishing House Pvt. Ltd., 4th Edn. Delhi. • Mehrotra, R.S. and Aggarwal, A. (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd, New Delhi. • Sethi, I.K. and Walia, S.K. (2011) Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi. • Mehrotra, R.S. and Aneja K.R. (2005) An Introduction to Mycology. New Age International Pvt. Ltd., New Delhi. • Sumbali, G. (2010) The Fungi, 2nd Edn., Narosa Publishing House, New Delhi. • Kumar, A., Vashishta, B.R. and Sinha, A.K. (2012) Bryophyta, S. Chand Publishing, New Delhi. • https://www.mooc-list.com/tags/microbiologyhttps:// • microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf	

Subject: Botany									
Semester I (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
MCC-2 (4 Credits) Scheme B & C	24L4.5-BOT-102	Applied Phycology and Pathology	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: The course has been conceived to equip the students with mechanism of infection of fungi, various defense mechanism employed by the plants to protect themselves against plant pathogens. This course also includes algal usage in several industries and medicines.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to									
1. know the use of algae for environment, human welfare and industries.									
2. learn algal culture techniques and their commercial production.									
3. gain skills necessary to isolate and handle fungi from nature.									
4. learn about the biology of major and emerging pathogens and pests of crop plants.									
5. gain the knowledge of practical aspects of plant fungal pathogens.									
Part B - Contents of the Course									
Instruction for Paper Setter									
1. Nine questions will be set in all. All questions will carry equal marks.									
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Scope of Phycology: Algae in biotechnology, nanotechnology, bioenergy (Biofuels- bioethanol, biodiesel). Algae in Daily Needs and Culture: Algae as food, feed and fodder with suitable examples. General account on Provasoli ES medium.								11
II	Algae in industry: General account of Phycocolloids (Agar-agar, Alginic acid and Carrageenan). Pharmaceutical and Nutraceutical uses of algae. Role of Algae in Environment: Algae as pollution indicators, algae in wastewater treatment and wasteland reclamation. Algal blooms; algal toxins and red tides.								11
III	Phytoplasma: General characteristics, role in plant diseases. Pathology: History, introduction, agents and classification of plant disease and predaceous fungi.								12

	Causal organisms, symptoms and management of some common plant disease: Yellow-vein-mosaic of bhindi, Red-rot of sugarcane, Black-rust of wheat, White-rust of crucifer, Smut of bajra, Downy-mildew of cucurbits, Late-blight of potato.	
IV	Genetic Exchange in Fungi: Heterokaryosis, heterothallism, parasexuality and sex hormones Applied Mycology: Mycoremediation, mycorrhizae and mycotoxins. Application of fungi in food industry- fermentation, organic acids, enzymes and medicines.	11
V	Suggested Practical works	
	Isolation and identification of algal species (any three) in water samples from polluted and non-polluted sources through temporary mounts. Nutritional analysis (protein and carbohydrates) of <i>Spirulina/ Chlorella</i>. Phycocolloid (Agar-agar/ Alginates/ Carrageenan) extraction (demonstration/ digital resources). Commercial applications of algae through photographs/ products (edible, cosmetics, biofuels, pharmaceutical, nutraceutical, phyco-remediation). Demonstration of isolation pathogen from an infected plant sample and preparation of Fungal Medium (Potato Dextrose Agar). Study the symptoms through specimens/ fresh samples, temporary mounts of plant disease on leaf (V.S.)/ stem/ fruit of Yellow-vein-mosaic of bhindi, Red-rot of sugarcane, Black-rust of wheat, Downy-mildew of grapes/ cucurbits, Late-blight of potato. Herbarium specimens of some common bacterial, fungal diseases on leaf/ stem whichever available. Note: Any other relevant practical can be offered. Excursion Report: Project work on any applied aspect of algae/ Visit to any Institute or Industry.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Lee, R.E. (2008) Phycology, 4th Edn., Cambridge University Press, Cambridge.		

- Kumar, H.D. (1999) Introductory Phycology, 2nd Edn., Affiliated East-West Press, New Delhi.
- Andersen, R.A. (2005) Algal Culturing Techniques. Elsevier Academic Press.
- Agrios, G.N. (2005) Plant Pathology, 5th Edn., Elsevier Academic Press, Amsterdam.
- Sharma, P.D. (2014) Plant Pathology. Rastogi Publications, Meerut, U.P.
- Mehrotra, R.S. and Aneja K.R. (2005) An Introduction to Mycology. New Age International Pvt. Ltd., New Delhi.
- Singh, R.S. (2018) Plant Diseases, 10th Edn., Medtech, New Delhi.
- Ownley, B. and Trigiano, R.N. (2017). Plant Pathology: Concepts and Laboratory Exercises, 3rd Edn., CRC Press.

Subject: Botany Semester I (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-M1 (2 Credits)	24L4.5- BOT-103	Diversity of Non-Flowering and Flowering Plants	T	1	1	10	20	30	3
Scheme A & B			P	1	2	05	15	20	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: Student will gain the knowledge about the practical aspects related to identification, structure, economic values of microorganisms, algae, fungi, bryophytes, pteridophytes gymnosperms, and angiosperms.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to									
1. know general characteristics of microorganisms, algae, fungi, and lichens will be understandable to students.									
2. acquire a conceptual grasp of bryophytes and pteridophytes.									
3. attain knowledge about the fundamental features of gymnosperms.									
4. acquire a foundational understanding of angiosperm morphology.									
5. gain the knowledge about the practical aspects related to identification, structure, economic values of microorganisms, algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.									
Part B - Contents of the Course									
Instruction for Paper Setter									
1. Nine questions will be set in all. All questions will carry equal marks.									
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Diversity of Microbes and Mycology: General characteristics, morphology and economic importance of viruses, bacteria, fungi and lichens.								4
II	Algae, Bryophytes and Pteridophytes: General characteristics, morphology, economic and ecological importance.								4
III	Gymnosperms: General characteristics, morphology, economic and ecological importance.								3
IV	Angiosperms: General characteristics, morphology and economic importance.								4
V	Suggested Practical works								30

	Identification of some common algae and fungi. Morphological study of some common Bryophytes. Morphological study of some common Pteridophytes. Morphological study of some common Gymnosperms. Morphological study of some common Angiosperms. Note: Any other relevant practical can be offered.	
Suggested Evaluation Methods		
Internal Assessment (15)		End Term Examination (35)
➤ Theory ✓ Class Participation: 4 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: NA ✓ Mid-Term Exam: 6 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 5 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 20 ➤ Practicum ✓ Practical Examination: 15
Part C - Recommended Books/ e-resources		
• Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. (2019) Prescott's Microbiology. 11th Edn., McGraw Hill International. • Mehrotra, R.S. and Aneja K.R. (2005) An Introduction to Mycology. New Age International Pvt. Ltd., New Delhi. • Pelczar, M.J. (2001) Microbiology, 5th Edn., Tata McGraw-Hill Co, New Delhi. • Lee, R.E. (2018) Phycology. 5th Edn. Cambridge University Press. • Singh, V., Pande, P.C. and Jain D.K. (2017) Biodiversity (Microbiology, Fungi, Algae, Archegoniate: Bryophyta, Pteridophyta and Gymnosperms). Rastogi Publications. Meerut. • Aluwalia, A.S. (2020) Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi. • Dube, H.C. (2012) An Introduction to Fungi, Vikas Publishing House Pvt. Ltd., 4th Edn. Delhi. • Mehrotra, R.S. and Aggarwal, A. (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd, New Delhi. • Sethi, I.K. and Walia, S.K. (2011) Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi. • Lakhanpal, R.N., Maheshwari, H.K. and Awasthi N. (1976) A Catalogue of Indian Fossil Plants, Covering All Available Records from 1821 to 1970. Birbal Sahni Institute of Palaeobotany (Originally from the University of California). • Kumar, A., Vashishta, B.R. and Sinha, A.K. (2012) Bryophyta, S. Chand Publishing, New Delhi. • https://www.mooc-list.com/tags/microbiologyhttps://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf		

Subject: Botany									
Semester II (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-2 MCC-3 (4 Credits) Scheme A, B & C	24L4.5- BOT-201	Pteridophytes, Gymnosperms and Fossils	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: The main objective of this course is for students to acquire in-depth knowledge structure, morphology, and reproduction of Pteridophytes and Gymnosperms.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to									
1. recognize of common ferns samples in nearby environment.									
2. develop a conceptual understanding of fossils and geological life scale.									
3. gain knowledge on the concepts of Gymnosperms.									
4. learn about the origin and evolution of sporophyte, heterospory, origin of seed habit, evolutionary trends in stele and spore producing organs.									
5. gain the knowledge of practical aspects of Pteridophytes and Gymnosperms.									
Part B - Contents of the Course									
Instruction for Paper Setter									
1. Nine questions will be set in all. All questions will carry equal marks.									
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Pteridophytes: General characters, classification (up to class level), structure and reproduction (excluding development) of <i>Selaginella</i> , <i>Equisetum</i> and <i>Pteris</i> .								12
II	Evolutionary trends: Apogamy, apospory and Heterospory; origin of seed habit; stelar evolution; telome concept; affinities and evolutionary significance of Pteridophytes. Economic and ecological importance of Pteridophytes.								11
III	Fossils: Fossilization, importance and types of fossils. General account of fossil pteridophytes (<i>Rhynia</i> , <i>Lepidodendron</i>). Evolutionary significance of fossil gymnosperm <i>Williamsonia</i> and <i>Lyginopteris</i> .								11
IV	Gymnosperms: General characteristics, distribution and economic importance, classification up to classes. Morphology, anatomy and reproduction (excluding								11

	development) of <i>Cycas</i> , <i>Pinus</i> and <i>Ephedra</i> . Affinities and evolutionary significance of Gymnosperms.	
V	Suggested Practical works	
	<i>Selaginella</i>- Morphology, W.M. leaf with ligule, T.S. stem, W.M. strobilus, W.M. microsporophyll and megasporophyll, L.S. strobilus (temporary/ permanent slide). <i>Equisetum</i>- Morphology, T.S. internode, L.S. strobilus, T.S. strobilus, W.M. sporangiophore, W.M. spores (wet and dry) (temporary slides); T.S. rhizome (permanent slide). <i>Pteris</i>- Morphology, T.S. rachis, V.S. sporophyll, W.M. sporangium, W.M. spores, T.S. rhizome, W.M. prothallus with sex organs and young sporophyte (temporary/permanent slide). Photographs/ preserved specimens of Fossils. Comparative study of stele system through T.S. of above specimens and/ or through permanent slides. <i>Cycas</i>- Morphology (coralloid roots, bulbil, leaf, megasporophyll), T.S. coralloid root, T.S. rachis, V.S. leaflet, V.S. microsporophyll, W.M. microspores, L.S. ovule, T.S. root (temporary/ permanent slide). <i>Pinus</i>- Morphology (long and dwarf shoots, W.M. dwarf shoot, male cones and female cones), W.M. dwarfshoot, T.S. needle, T.S. stem, L.S./ T.S. male cone, W.M. microsporophyll, W.M. microspores (temporary slides), L.S. female cone (temporary/ permanent slide). <i>Ephedra</i>- Morphology, T.S. internode, L.S./ T.S. male and female strobili, W.M. spores (wet and dry), T.S. rhizome (temporary/permanent slide). Note: Any other relevant practical can be offered. Excursion Report: Report on excursion tours with photographs, collection and preservation specimens related to Pteridophytes and Gymnosperms.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010) Pteridophyta, S. Chand Publication. Delhi. • Parihar, N.S., (1977) The Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad,		

India.

- Singh, V., Pande, P.C. and Jain D.K. (2017) Biodiversity (Microbiology, Fungi, Algae, Archegoniate: Bryophyta, Pteridophyta and Gymnosperms). Rastogi Publications. Meerut.
- Bhatnagar, S.P. and Moitra, A. (1996) Gymnosperms. New Age International (P) Ltd. Publishers, New Delhi, India.
- Lakhanpal, R.N., Maheshwari, H.K. and Awasthi N. (1976) A Catalogue of Indian Fossil Plants, Covering All Available Records from 1821 to 1970. Birbal Sahni Institute of Palaeobotany (Originally from the University of California).
- <https://palaeobotany.org/>
- <https://pteridoportal.org/portal/index.php>
- <https://www.conifers.org/zz/gymnosperms.php>

Subject: Botany
Semester II (Session 2024-25)

Part A - Introduction

Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSEC-1 (4 Credits)	24L4.5- BOT-202	Paleobotany and Phytogeography	T	3	3	20	50	70	3
Scheme C			P	1	2	10	20	30	4

Level of the course (As per Annexure-I) – 100-199

Pre-Requisite for the course (if any):

Learning Objectives: The course will help the students to gain knowledge of early life and Earth system science; scope and subdivisions of geology; solar system; origin and age of the Earth; shape, size, mass, density, magnetism and orbital parameters of the Earth; internal structure of the Earth.

Course Learning Outcomes (CLO): After completing this course, the learner will be able to

1. identify common rock-forming minerals in hand specimens and in thin sections using diagnostic physical, optical, and chemical properties.
2. learn about atmosphere, hydrosphere, biosphere and lithosphere.
3. gain skills necessary to understand different fossil types.
4. locate different phytogeographical regions of the world and India and can analyze their floristic wealth.
5. gain the knowledge of ecological, ethnic and importance of different groups of fossil plants and biogeographical region of India.

Part B - Contents of the Course

Instruction for Paper Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.

Unit	Topics	Contact Hours
I	Palaeontology: Colonization and rise of early land plants. Introduction and types of Megafossils and microfossils. Major extinction events and their impact on plant evolution. Brief account on Birbal Sahni.	11
II	Index fossils: Introduction, significance and types of fossilization. Reconstruction and nomenclature and Taphonomy. General account and geological time scale. Importance of fossils in studying the Gondwana period.	11
III	Phytogeography: Introduction, scope and importance, continental drift; theory of tolerance. Concept, types and examples of endemic plants in India and worldwide. Study of the fossilized plants including <i>Glossopteris</i> , <i>Gangamopteris</i> and their significance in understanding paleoclimate and continental drift.	12

IV	Flora and Vegetation of Haryana; Biogeographic zones and vegetation pattern of India; adaptation of plants in arid regions and desert ecosystem. Succession, zonation and seasonal changes in vegetation.	11
V	Suggested Practical works	30
	Field survey and learning what and how are to be collected, observed, and record some fossils, if available. Study of available fossil groups of plants. Study the process of fossilization visual presentation. Study of major geomorphic features and their relationships with outcrops through physiographic models. Detailed study of topographic sheets and preparation of physiographic description of an area Study of soil profile of any specific area Study of distribution of major lithostratigraphic units on the map of India Study of distribution of major dams on map of India/ Haryana and their impact on river systems. Note: Any other relevant practical can be offered.	
Excursion Report: Project work on any nearby area to study soil/ rock types.		
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Lakhanpal, R.N., Maheshwari, H.K. and Awasthi N. (1976) A Catalogue of Indian Fossil Plants, Covering All Available Records from 1821 to 1970. Birbal Sahni Institute of Palaeobotany (Originally from the University of California). • Pelletier, J.D. (2008) Quantitative Modeling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago. • Charles, C.P., Diane, H.C. and Lisa H. (2016) Physical Geology, 15th Edn., McGraw-Hill Education. • Stewart,W.N. and Rothwell, G.W. (2005). Paleobotany and the Evolution of Plants. Cambridge University Press, New York. • https://palaeobotany.org/		

Subject: Botany									
Semester II (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-M2 (2 Credits) Scheme A & B	24L4.5- BOT-203	Plants as Resource	T	1	1	10	20	30	3
			P	1	2	05	15	20	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: Student will gain the knowledge about the practical aspects related to identification, structure, economic values of microorganisms, algae, fungi, bryophytes, pteridophytes gymnosperms, and angiosperms.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to									
1. gain a foundational understanding of the origins of significant cultivated plants.									
2. develop a conceptual understanding of important plants that yield vegetables, fiber, and oil.									
3. acquire knowledge about the cultivation techniques of essential plants.									
4. gain a conceptual understanding of the processing methods applied to economically significant plants.									
5. gain the knowledge of economic values of cereals, legumes, spices, oil & fibre yielding plants.									
Part B - Contents of the Course									
Instruction for Paper Setter									
1. Nine questions will be set in all. All questions will carry equal marks.									
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Morphology and Economic Importance of: Food plants - Cereals (Rice, Wheat and Maize); Pulses - Gram, Arhar and Pea.								4
II	Botanical Description and Processing of: Vegetables- Potato, Tomato and Onion; Fiber- Cotton; Oils- Mustard and Coconut.								4
III	Morphology and Economic Importance of the Following: Spices- Turmeric, Coriander, Ginger and Cloves								3
IV	Medicinal Plants: Cinchona, Opium, Cannabis, Withania, Neem. Beverages: Tea, Coffee								4
V	Suggested Practical works								30

	Study of economically important plants: Wheat, Rice, Maize, Gram, Pea, Arhar, Black pepper, Ginger, Clove, Tea, Coffee, Cotton, Coconut, Mustard and different types of wood. Collection and preparation of reports on various crops and economically important plants being cultivated/wildly available in your area. Note: Any other relevant practical can be offered.	
Suggested Evaluation Methods		
Internal Assessment (15)		End Term Examination (35)
➤ Theory ✓ Class Participation: 4 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: NA ✓ Mid-Term Exam: 6 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 5 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 20 ➤ Practicum ✓ Practical Examination: 15
Part C - Recommended Books/ e-resources		
• Singh, V., Pande, P.C. and Jain, D.K. (2018) Economic Botany, Rastogi Publications, New Delhi. • Kocchar, S.L. (2016) Economic Botany: A Comprehensive Study, 5th Edn., Cambridge India. • Wickens, G.E. (2001) Economic Botany: Principles and Practices, Springer. • Daubenmire, R.F. (2017) Plants & Environment (2nd Edn.,) John Wiley & Sons., New York. • Rajan. S.S. (2007) College Botany Vol-V, Part 1: Taxonomy and Economic Botany Himalaya Publishing House. • Mukharjee, S.K. (2004) College Botany Vol-III. New Central Book Agency, London.		

Subject: Botany Semester III (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-3 MCC-4 (4 Credits) Scheme A, B & C	24L5.0-BOT-301	Cell Biology, Genetics and Plant Biotechnology	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: The main objective of this course is for students to acquire in-depth knowledge of the structural and functional organization of plant cells and the principles of heredity, gene expression and variation through classical and molecular genetics.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand the fundamental characteristics of plant cell and its component. 2. acquire comprehensive knowledge about cell division and the central dogma of molecular biology. 3. learn about the principles of inheritance in biology. 4. develop a thorough understanding of mutations, chromosomal aberrations, and the concept of linkage. 5. understand the basic principles of laws of inheritance, stains & staining techniques, cell division processes, chromosome mapping, and chromosomal aberration.									
Part B - Contents of the Course									
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Structure and Organization of Plant Cell: General structure of plant cell; structure and function of Cell Wall, Chloroplast, Vacuole, Nucleus, Mitochondria, Golgi Apparatus, ER and Ribosomes. Overview of cell cycle in plant cells; mitosis and meiosis								12
II	Classical Genetics: Mendelian laws of inheritance, segregation and independent assortment; monohybrid, dihybrid cross and test cross; allelic (dominance, co-dominance and incomplete dominance) and non-allelic interaction; linkage and crossing over.								11

III	Cytogenetics and Mutation: Structure and function of chromosomes and karyotyping; Mutations – types, causes and consequences; Structural aberrations (deletions, duplications, inversions and translocations) and Numerical aberrations (aneuploidy and polyploidy).	11
IV	Plant Biotechnology: Tools and techniques in plant biotechnology; PCR; overview of cloning vectors, gene libraries and marker genes; concepts and applications of plant tissue culture.	11
V	Suggested Practical works	30
	Study of cell structure using onion epidermal peel. To study different mitotic stages and the karyotype using a given metaphase chromosome picture (<i>Allium cepa</i>). To work out the genetics of a cross from the given F2 harvest. To study meiosis through temporary squash preparation (<i>Tradescantia</i> or <i>Chlorophytum</i>). Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4). Study of linkage and recombination using simulated data. To study chromosome anomaly - Translocation Ring, Laggards and Inversion Bridge, break, etc. through slides. Isolation of DNA from plant material. Preparation, loading and running of DNA samples on agarose gel electrophoresis (hands-on or demonstration). Surface sterilization of plant explants (e.g., leaf or shoot tip). Inoculation of explants onto culture media (callus or shoot induction). Observation of tissue culture stages (callus, shoot, root) from lab or photo samples. Study of different types of cloning vectors using charts or models. Understanding gene cloning steps using flowcharts or animations. Note: Any other relevant practical can be offered.	
	Excursion Report: Visit report to nearby biotech lab or industry (if possible).	
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		

- Chawla, H.S. (2009) Introduction to Plant Biotechnology, 3rd Edn. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Gupta, P.K. (2008) Elements of Biotechnology. Rastogi Publications, Meerut.
- Dubey, R.C. (2014) A Textbook of Biotechnology. S. Chand & Co., New Delhi.
- Purohit, S.S. (2008) Biotechnology: Fundamentals and Applications. Agrobios, Jodhpur.
- Singh, B.D. (2015) Biotechnology: Expanding Horizons. Kalyani Publishers, Ludhiana.
- Brown, T.A. (2016) Gene Cloning and DNA Analysis: An Introduction, 7th Edn. Wiley-Blackwell, Chichester.
- Glick, B.R., Pasternak, J.J. & Patten, C.L. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edn. ASM Press, Washington D.C.
- Primrose, S.B. & Twyman, R.M. (2006) Principles of Gene Manipulation and Genomics, 7th Edn. Blackwell Publishing, Oxford.
- Watson, J.D., Tooze, J. & Kurtz, D.T. (1983) Recombinant DNA: A Short Course. Scientific American Books, New York.

Subject: Botany Semester III (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
MCC-5 (4 Credits)	24L5.0-BOT-302	Plant Molecular Biology	T	3	3	20	50	70	3
Scheme B & C			P	1	2	10	20	30	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: To understand the molecular mechanisms governing gene structure, expression, and regulation in plants, and to explore how these processes influence development, adaptation and biotechnology applications.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understanding of the essential characteristics of DNA. 2. acquire comprehensive knowledge about RNA and its functions. 3. acquire knowledge about proteins, including their structure and functions. 4. develop a comprehensive understanding of the mechanisms and regulation of gene expression. 5. acquire the knowledge of experimentation performed for the identification of DNA/ RNA as genetic material, estimation of DNA/ RNA and bacterial growth medium.									
Part B - Contents of the Course									
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Molecular Basis of Genetic Material: Historical perspective of nucleic acids as carriers of genetic information, DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty); denaturation and renaturation; chloroplast and mitochondrial DNA.								11
II	Genome Organization & Expression: Basic difference between prokaryotic and eukaryotic DNA replication; DNA damage and repair, recombination; extrachromosomal replicons, repetitive DNA, transposable elements.								11
III	RNA and Protein synthesis: RNA – structure and types, RNA polymerases, transcription factors, transcription and processing (capping, splicing, and polyadenylation), RNA transport; RNAi, siRNA, miRNA and their roles in plants.								12

IV	Protein synthesis and Gene Expression: Ribosome, genetic code, aminoacylation of tRNA, aminoacyl tRNA synthetase and translational process, translational inhibitors, primary, secondary, tertiary, quaternary structure and function of proteins. Gene regulation in prokaryotes (operon model).	11
V	Suggested Practical works	30
	Preparation of LB medium and raising <i>E. coli</i> . Isolation of genomic DNA from <i>E. coli</i> / onion roots RNA estimation by orcinol method. DNA estimation by diphenylamine reagent/ UV Spectrophotometry. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments). Study of Barr body from buccal smear preparation. Study of regulatory gene sequences/promoters using software tools. Bioinformatics tools for gene/protein databases (e.g., NCBI, BLAST). Note: Any other relevant practical can be offered.	
	Excursion Report: Visit report to nearby biotech lab or industry (if possible).	
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Ghosh, A. (2012) Molecular Biology and Genetic Engineering. Academic Publishers, Kolkata. • Verma, P.S. & Agarwal, V.K. (2009) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Co., New Delhi). • Sharma, A.K. (2014) Molecular Biology. Pearson Education, New Delhi). • Gupta, P.K. (2016) Molecular Biology. Rastogi Publications, Meerut. • Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H. & Amon, A. (2021) Molecular Cell Biology, 9th Edn. W.H. Freeman, New York. • Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. & Losick, R. (2014) Molecular Biology of the Gene, 7th Edn. Pearson Education, Boston. • Brown, T.A. (2010) Gene Cloning and DNA Analysis: An Introduction, 6th Edn. Wiley-Blackwell, Oxford.		

Subject: Botany									
Semester III (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
MCC-2 (4 Credits) Scheme B & C	24L4.5-BOT-102	Applied Phycology and Pathology	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: The course has been conceived to equip the students with mechanism of infection of fungi, various defense mechanism employed by the plants to protect themselves against plant pathogens. This course also includes algal usage in several industries and medicines.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to									
1. know the use of algae for environment, human welfare and industries.									
2. learn algal culture techniques and their commercial production.									
3. gain skills necessary to isolate and handle fungi from nature.									
4. learn about the biology of major and emerging pathogens and pests of crop plants.									
5. gain the knowledge of practical aspects of plant fungal pathogens.									
Part B - Contents of the Course									
Instruction for Paper Setter									
1. Nine questions will be set in all. All questions will carry equal marks.									
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Scope of Phycology: Algae in biotechnology, nanotechnology, bioenergy (Biofuels- bioethanol, biodiesel). Algae in Daily Needs and Culture: Algae as food, feed and fodder with suitable examples. General account on Provasoli ES medium.								11
II	Algae in industry: General account of Phycocolloids (Agar-agar, Alginic acid and Carrageenan). Pharmaceutical and Nutraceutical uses of algae. Role of Algae in Environment: Algae as pollution indicators, algae in wastewater treatment and wasteland reclamation. Algal blooms; algal toxins and red tides.								11
III	Phytoplasma: General characteristics, role in plant diseases. Pathology: History, introduction, agents and classification of plant disease and predaceous fungi								12

	Causal organisms, symptoms and management of some common plant disease: Yellow-vein-mosaic of bhindi, Red-rot of sugarcane, Black-rust of wheat, White-rust of crucifer, Smut of bajra, Downy-mildew of cucurbits, Late-blight of potato.	
IV	Genetic Exchange in Fungi: Heterokaryosis, heterothallism, parasexuality and sex hormones Applied Mycology: Mycoremediation, mycorrhizae and mycotoxins. Application of fungi in food industry- fermentation, organic acids, enzymes and medicines.	11
V	Suggested Practical works	
	Isolation and identification of algal species (any three) in water samples from polluted and non-polluted sources through temporary mounts. Nutritional analysis (protein and carbohydrates) of <i>Spirulina/ Chlorella</i>. Phycocolloid (Agar-agar/ Alginates/ Carrageenan) extraction (demonstration/ digital resources). Commercial applications of algae through photographs/ products (edible, cosmetics, biofuels, pharmaceutical, nutraceutical, phyco-remediation). Demonstration of isolation pathogen from an infected plant sample and preparation of Fungal Medium (Potato Dextrose Agar). Study the symptoms through specimens/ fresh samples, temporary mounts of plant disease on leaf (V.S.)/ stem/ fruit of Yellow-vein-mosaic of bhindi, Red-rot of sugarcane, Black-rust of wheat, Downy-mildew of grapes/ cucurbits, Late-blight of potato. Herbarium specimens of some common bacterial, fungal diseases on leaf/ stem whichever available. Note: Any other relevant practical can be offered. Excursion Report: Project work on any applied aspect of algae/ Visit to any Institute or Industry.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Lee, R.E. (2008) Phycology, 4th Edn., Cambridge University Press, Cambridge.		

- Kumar, H.D. (1999) Introductory Phycology, 2nd Edn., Affiliated East-West Press, New Delhi.
- Andersen, R.A. (2005) Algal Culturing Techniques. Elsevier Academic Press.
- Agrios, G.N. (2005) Plant Pathology, 5th Edn., Elsevier Academic Press, Amsterdam.
- Sharma, P.D. (2014) Plant Pathology. Rastogi Publications, Meerut, U.P.
- Mehrotra, R.S. and Aneja K.R. (2005) An Introduction to Mycology. New Age International Pvt. Ltd., New Delhi.
- Singh, R.S. (2018) Plant Diseases, 10th Edn., Medtech, New Delhi.
- Ownley, B. and Trigiano, R.N. (2017). Plant Pathology: Concepts and Laboratory Exercises, 3rd Edn., CRC Press.

Subject: Botany

Part A - Introduction

Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-4 MCC-6 (4 Credits)	24L5.0-BOT-401	Taxonomy and Reproduction of Flowering Plants	T	3	3	20	50	70	3
Scheme A, B & C			P	1	2	10	20	30	4

Level of the course (As per Annexure-I) – 100-199

Pre-Requisite for the course (if any):

Learning Objectives: To enable students to understand the principles of plant classification and identify flowering plants, along with gaining knowledge of their reproductive structures, processes and significance in plant diversity and evolution.

Course Learning Outcomes (CLO): After completing this course, the learner will be able to

1. understand and apply principles of botanical nomenclature and classification of angiosperms.
2. acquire a conceptual understanding of angiosperm classification systems and the diversity of families within them.
3. describe the structure and development of reproductive organs like anther, ovule, embryo sac and endosperm.
4. explain pollination mechanisms, fertilization and seed/ fruit development in flowering plants.
5. gain the knowledge about the diagnostic features, morphology, internal structure, economic value of Angiosperms, their reproduction and ecological concepts and biodiversity indices.

Part B - Contents of the Course

Instruction for Paper Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.

Unit	Topics	Contact Hours
I	Principles of Plant Taxonomy: Fundamental components and significance of taxonomy; Botanical nomenclature and major rules of ICBN and ICN; keys to identification of plants; importance of herbaria and botanical gardens; concept of species and hierarchical categories.	12
II	Classification and Systematics of Angiosperms: Systems of classification (Bentham & Hooker, Engler & Prantl); types of inflorescence; diagnostic features and economic importance of the following families – Ranunculaceae, Brassicaceae,	11

	Malvaceae, Euphorbiaceae, Fabaceae, Cucurbitaceae, Solanaceae, Asteraceae, Liliaceae and Poaceae.	
III	Reproductive Development in Flowering Plants: Structure and development of anther and male gametophyte; ovule types, embryo sac development (monosporic, bisporic, tetrasporic); pollination types and adaptations; fertilization; double fertilization.	11
IV	Post-Fertilization Changes: Endosperm – types and importance, embryogenesis in dicots and monocots; apomixis, parthenocarp and polyembryony; structure of dicot and monocot seed, fruit types; dispersal mechanisms in fruits and seeds.	11
V	Suggested Practical works	
	Study of vegetative and floral characters of the one or two member of each family/sub-family mentioned in theory syllabus (Description, V.S. flower, section of ovary, floral diagram, floral formula and systematic position according to Bentham & Hooker's system of classification). Dissection of Flowers – Floral structure analysis of hypogynous, perigynous and epigynous flowers. Observation of permanent slides of anther, pollen grains, ovule, and embryo sac. In vitro germination of pollen grains using sucrose solution (demonstration/practical). Study of various types of seeds and fruits and their dispersal mechanisms. Note: Any other relevant practical can be offered. Excursion Report: Report on excursion tours with photographs, collection, preservation and preparation of herbarium sheets and specimens related to Angiosperms. Mounting of a collected, properly dried and pressed specimen of minimum 20 wild plants with herbarium label.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Vasishtha, P.C. (2007) Taxonomy of Angiosperms. R. Chand & Co., New Delhi. • Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms. 4th revised and enlarge edition. Vikas Publishing House, Delhi. • Cutter, E.G. 1969. Plant Anatomy Part-I, Cells and Tissues, Edward Arnold, London. • Cutter, E.G. 1971. Plant Anatomy: Experiment and Interpretation. Part-II Organs, Edward Arnold		

London.

- Bendre, A.M. & Kumar, A. (2009) A Textbook of Practical Botany (Vol. I). Rastogi Publications, Meerut.
- Rendle, A.B. (2004) The Classification of Flowering Plants (Vol. I & II). Allied Publishers, New Delhi.
- Pandey, B.P. (2011) Embryology of Angiosperms. S. Chand & Co., New Delhi.
- Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. & Donoghue, M.J. (2008) Plant Systematics: A Phylogenetic Approach (3rd Edn.). Sinauer Associates, Sunderland, USA.
- Lawrence, G.H.M. (1951) Taxonomy of Vascular Plants. Macmillan Company, New York.

[illegible]

III	Seed Structure and Development: Endosperm and embryo development; special types of seeds (albuminous, exalbuminous, monocot vs. dicot); seed coat structure and seed appendages; types, causes and methods of breaking seed dormancy; orthodox vs. recalcitrant; seed dispersal mechanisms.	12
IV	Seed Physiology and Technology: Seed viability, vigor and longevity; seed germination – types and factors affecting germination; seed testing, processing, and storage techniques; seed certification, seed banks and role in conservation.	11
V	Suggested Practical works	
	Study of pollen morphology using permanent slides, identification of pollen types (monocolpate, tricolpate, etc.) and acetolysis. Pollen viability tests using fluorochrome staining (e.g., FDA) or acetocarmine. In vitro pollen germination using sucrose-based media. Quantitative analysis of pollen production (pollen output per anther/flower). Pollen calendar preparation using local flora for allergen mapping. Dissection and identification of embryo and endosperm in monocot and dicot seeds. Testing seed viability using the tetrazolium chloride (TZ) test. Seed germination experiments under different environmental conditions (light, temperature, moisture). Breaking seed dormancy using physical and chemical methods (scarification, stratification, GA₃ treatment). Seedling vigor index estimation through measurement of root and shoot length. Seed storage experiments effect of storage conditions on seed viability. Note: Any other relevant practical can be offered. Excursion Report: Visit report to nearby biotech lab or industry (if possible).	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Shivanna, K.R. & Johri, B.M. (1985) The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd., New Delhi. • Nair, P.K.K. (1970) Pollen Morphology of Angiosperms. Vikas Publishing House, New Delhi. • Faegri, K. & Iversen, J. (1989) Textbook of Pollen Analysis, 4th Edn. Wiley, Chichester. • Erdtman, G. (1969) Handbook of Palynology. Hafner Publishing Co., New York.		

- Bewley, J.D. & Black, M. (1994) *Seeds: Physiology of Development and Germination*, 2nd Edn. Plenum Press, New York.
- Basra, A.S. (2006) *Handbook of Seed Science and Technology*. Haworth Press, New York.
- Copeland, L.O. & McDonald, M.B. (2001) *Principles of Seed Science and Technology*, 4th Edn. Springer, Boston.

Subject: Botany									
Semester IV (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
MCC-8 (4 Credits) Scheme B & C	24L5.0-BOT-403	Biotechnology and Genetic Engineering	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: To familiarize students with the core concepts, tools, and applications of biotechnology and genetic engineering, emphasizing DNA manipulation techniques and their role in improving plants, microbes and health outcomes.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to									
1. know the core principles and methodologies of biotechnology.									
2. learn tools of genetic engineering such as rDNA technology, PCR and gene cloning.									
3. explore applications of GMOs in agriculture, medicine and industry.									
4. evaluate biosafety guidelines, ethical concerns and regulatory frameworks.									
5. acquire hands-on skills in genetic engineering techniques such as DNA isolation, gel electrophoresis, PCR and microbial culture handling.									
Part B - Contents of the Course									
Instruction for Paper Setter									
1. Nine questions will be set in all. All questions will carry equal marks.									
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Introduction and Fundamentals: Scope, history and applications; basic tools - restriction enzymes, ligases, vectors (plasmids, Ti plasmid); Types – red, green, white and blue biotechnology; genomic and cDNA library.								11
II	Molecular Techniques: Concept of recombinant DNA technology and gene cloning; Polymerase Chain Reaction (PCR) – types and applications; Blotting techniques – Southern, Northern and Western blot. DNA fingerprinting and molecular markers.								11
III	Genetic Transformation and Applications: Biology of <i>Agrobacterium</i> ; Genetically Modified Organisms (GMOs) – concept and examples; applications in agriculture (Bt crops, Golden Rice) and medicine (insulin, vaccines, gene								12

	therapy); bioethics and public concerns.	
IV	Plant Tissue Culture: MS Media, laboratory setup and sterilization techniques; totipotency and cellular differentiation, callus formation, organogenesis, somatic embryogenesis, micropropagation, protoplast culture and somatic hybridization; application in crop improvement and conservation and metabolite production.	11
V	Suggested Practical works	30
	Isolation of genomic DNA from plant material. Agarose gel electrophoresis of DNA and plasmid DNA isolation. PCR amplification of a DNA fragment (demo or simulation). Restriction digestion and analysis (demo/simulation). Study of genetically modified crops (Bt cotton, Golden rice – samples/images) Preparation and sterilization of growth media. Preparation of MS medium and callus induction. <u>Note: Any other relevant practical can be offered.</u> Excursion Report: Visit report to nearby biotech lab or industry (if possible).	
Suggested Evaluation Methods		
Internal Assessment (30)		
End Term Examination (70)		
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Singh, B.D. (2015) Biotechnology: Expanding Horizons. Kalyani Publishers, Ludhiana. • Brown, T.A. (2016) Gene Cloning and DNA Analysis: An Introduction, 7th Edn. Wiley-Blackwell, Chichester. • Glick, B.R., Pasternak, J.J. & Patten, C.L. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edn. ASM Press, Washington D.C. • Primrose, S.B. & Twyman, R.M. (2006) Principles of Gene Manipulation and Genomics, 7th Edn. Blackwell Publishing, Oxford. • Watson, J.D., Tooze, J. & Kurtz, D.T. (1983) Recombinant DNA: A Short Course. Scientific American Books, New York. • Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H. & Amon, A. (2021) Molecular Cell Biology, 9th Edn. W.H. Freeman, New York.		

Subject: Botany Semester IV (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-1 (4 Credits) Scheme B & C	24L5.0- BOT-404	Applied Plant Propagation and Tissue Culture	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: To provide students with comprehensive knowledge of plant propagation methods including seed, vegetative and tissue culture techniques and to understand the biological, environmental and genetic factors influencing propagation practices.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. acquire knowledge regarding the fundamental aspects of plant propagation. 2. develop a conceptual understanding of propagation and apply the methods in horticulture, forestry and crop improvement. 3. acquire a conceptual understanding of cell and tissue propagation techniques. 4. evaluate the commercial, environmental and ethical aspects of propagation.									
5. demonstrate the basic principles and practical consideration of in vitro plant cell/ tissue culture, plant propagation methods, sterilization methods, tools and techniques.									
Part B - Contents of the Course									
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	General Aspects of Plant Propagation: Evolution of plant propagation techniques; biology of plant propagation – genetic impact on propagability; effect of environment on propagation – greenhouse systems, environmental control.								11
II	Seed Propagation: Seed development, dormancy and viability; principles and practices of seed selection; seed production, processing, storage and handling; techniques of seed propagation and sowing methods.								11
III	Vegetative Propagation: Principles and practices of clonal selection, techniques – cuttings, grafting, budding and layering; propagation by natural and modified forms – rhizomes, tubers, bulbs and runners.								12

IV	Cell and Tissue propagation: Micropropagation from meristematic tissues; tissue culture from non-meristematic tissues; acclimatization and hardening of plantlets; applications in agriculture, horticulture, forestry and conservation.	11
V	Suggested Practical works	30
	Study of tools used in plant propagation. Cutting techniques of selected plants: hardwood cuttings, softwood cuttings, greenwood cuttings, semi-ripe cuttings, root cuttings and leaf cuttings. Layering and air-layering in selected plants. Grafting and division. Micropropagation: Sterilization of explants, dissection of meristematic regions, media preparation and explant proliferation. Preparation of compost/ growing media. Hardening and aftercare of propagated plants. Note: Any other relevant practical can be offered.	
	Excursion Report: Visit to a commercial tissue culture lab or nursery.	
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Razdan, M.K. (2019) Introduction to Plant Tissue Culture, 3rd Edn. Oxford & IBH Publishing, New Delhi. • Beyl, C.A. & Trigiano, R.N. (2014) Plant Propagation Concepts and Laboratory Exercises, 2nd Edn. CRC Press, Boca Raton, FL. • MacDonald, P.T. (2014) The Manual of Plant Grafting: Practical Techniques for Ornamentals, Vegetables, and Fruit, Timber Press, Portland. • Kyte, L., Kleyn, J., Scoggins, H. & Bridgen, M. (2013) Plants from Test Tubes: An Introduction to Micropropagation, 4th Edn. Timber Press, Portland. • Smith, R.H. (2013) Plant Tissue Culture: Techniques and Experiments, 3rd Edn. Elsevier, Amsterdam. • Bhojwani, S.S. & Razdan, M.K. (2009) Plant Tissue Culture: Theory and Practice, Elsevier India Pvt. Ltd., New Delhi.		

Subject: Botany Semester IV (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-1 (4 Credits) Scheme B & C	24L5.0-BOT-405	Plant Breeding and Crop Improvement	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I) – 100-199									
Pre-Requisite for the course (if any):									
Learning Objectives: To enable students to understand and apply classical and modern principles of plant breeding for the genetic improvement of crop plants, focusing on reproductive strategies, genetic resources, cytogenetics and molecular tools aimed at enhancing yield, quality and stress resistance.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand classical and molecular principles of plant breeding and their role in crop improvement. 2. apply reproductive biology knowledge for hybrid seed production and selection strategies. 3. evaluate cytogenetic and biotechnological tools in improving crop traits. 4. interpret and utilize molecular markers and mapping techniques for trait analysis and selection. 5. will develop the practical knowledge about the tools and techniques used in plant breeding and crop improvement.									
Part B - Contents of the Course									
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Fundamentals of Plant Breeding and Reproduction: Objectives and scope of plant breeding and crop improvement; modes of reproduction in crop plants and their significance; historical achievements and limitations of conventional plant breeding; floral biology in self- and cross-pollinated species, male sterility and its applications in hybrid development.								11
II	Genetic Resources and Selection Strategies: Plant genetic resources and their conservation; acclimatization and its importance in breeding; selection methods – mass selection, pure-line and clonal selection; hybridization in self-, cross- and vegetatively propagated crops.								11
III	Cytogenetics and Mutation Breeding in Crop Improvement: Cytogenetic basis								12

	of crop improvement – chromosome number variation, polyploidy, aneuploidy; examples of mutant varieties; interspecific and intergeneric hybridization for crop improvement; role of cytogenetics in crop improvement for quality traits (e.g., protein content, shelf life).	
IV	Molecular Breeding and Genomic Tools: Development of mapping populations – RILs, NILs, DH lines, CSSLs and BILs; principles and methods of QTL mapping and association analysis (GWAS); concepts of inbreeding depression and heterosis genetic basis and breeding applications; crop improvement for nutritional quality (e.g., Golden Rice, biofortification).	11
V	Suggested Practical works	
	Study of floral biology in crop plants and case studies of crop improvement in rice, wheat and maize. Emasculation and hybridization techniques. Study of male sterility types (genetic, cytoplasmic, CMS). Techniques of pollen viability and germination. Demonstration of selection methods in experimental plots. Simulated or case-based QTL mapping using software tools. Selection exercises based on phenotype and genotypic data. <u>Note: Any other relevant practical can be offered.</u> Excursion Report: Visit to a breeding station or gene bank or seed production unit.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Singh, B.D. (2019) Plant Breeding: Principles and Methods. 11th Edn. Kalyani Publishers, Ludhiana. • Chopra, V.L. (2001) Plant Breeding: Theory and Practice. Oxford & IBH, New Delhi. • Allard, R.W. (1999) Principles of Plant Breeding. 2nd Edn. Wiley India, New Delhi. • Acquaah, G. (2012) Principles of Plant Genetics and Breeding. 2nd Edn. Wiley-Blackwell, Oxford. • Sharma, J.R. (1994) Principles and Practice of Plant Breeding. Tata McGraw-Hill, New Delhi. • Roy, D. (2000) Plant Breeding: Classical to Modern, Narosa Publishing House, New Delhi.		

Subject: Botany Semester V (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-5 MCC-9 (4 Credits) Scheme A, B & C	24L5.5-BOT-501	Plant Anatomy, Physiology and Biochemistry	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I)									
Pre-Requisite for the course (if any):									
Learning Objectives: To enable students to understand the structural organization, physiological functions and biochemical processes of plants and to apply this integrated knowledge of plant anatomy, water relations, photosynthesis, growth regulation, metabolism and nitrogen fixation in explaining plant growth, productivity and adaptation.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand the structural organization of plants including tissues, tissue systems, and internal anatomy of dicot and monocot organs, and relate them to their functional significance. 2. apply knowledge of plant-water relations, mineral nutrition, photosynthesis and metabolism to explain plant growth, productivity and adaptation. 3. evaluate physiological and developmental processes including enzyme action, respiration, growth regulation and plant hormone functions in plants. 4. interpret metabolic pathways such as lipid metabolism and nitrogen fixation and their role in plant energy flow and nutrient cycling. 5. develop practical skills in observation, experimentation and analysis of plant anatomy, physiology and biochemical processes using laboratory techniques.									
Part B - Contents of the Course									
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Plant Anatomy and Functional Organization: Meristematic and permanent tissues, internal structure of dicot and monocot root, stem and leaf with functional correlation; xylem structure and water transport; phloem structure and translocation; stomatal apparatus and transpiration regulation; secondary growth								11

	in dicot stem and root.	
II	Plant-Water Relations and Mineral Nutrition: Imbibition, diffusion, osmosis and water potential; absorption and transport of water; transpiration; essential macro- and microelements and their roles; mineral uptake and deficiency symptoms. Photosynthesis: Photosynthetic pigments, light (cyclic and non cyclic photophosphorylation) and dark reactions (Calvin cycle, C₄ and CAM pathway) and photorespiration.	11
III	Growth and Development: Concept and phases of growth and development, seed dormancy, plant movements; photoperiodism and physiology of flowering; plant hormones (discovery, mechanism of action and physiological roles of auxins, gibberellins, cytokinins, abscisic acid and ethylene).	11
IV	Enzymology and Respiration: Discovery and characteristics of enzymes; concept of holoenzyme, apoenzyme, coenzyme and cofactors; mechanism of enzyme action; aerobic and anaerobic respiration, Krebs cycle, electron transport chain, redox potential, chemiosmotic theory and oxidative phosphorylation. Lipid Metabolism and Nitrogen Fixation: Structure and functions of lipids, fatty acid biosynthesis, α and β-oxidation; biology and significance of nitrogen fixation.	12
V	Suggested Practical works	
	Study of meristematic and permanent tissues, tissue systems, and internal structure of dicot and monocot root, stem and leaf; secondary growth in dicot stem and root. Study of xylem and phloem elements and their functional significance. Demonstration of imbibition, diffusion, osmosis and water potential. Measurement of transpiration and determination of stomatal frequency and stomatal index. Identification of mineral deficiency symptoms of essential plant nutrients. Separation of photosynthetic pigments by paper chromatography and study of C₃, C₄ and CAM plants. Study of seed germination and factors affecting germination. Demonstration of plant movements and effects of plant growth regulators. Study of enzyme activity and factors affecting enzyme action. Demonstration of aerobic and anaerobic respiration. Qualitative detection of lipids in plant tissues. Study of biological nitrogen fixation through root nodules of leguminous plants. Preparation of practical record and interpretation of experimental observations. Note: Any other relevant practical can be offered. Excursion Report: Visit to a plant physiology laboratory, botanical garden, greenhouse facility or research institute to study plant structure, growth, development and physiological processes.	30
Suggested Evaluation Methods		

Internal Assessment (30)	End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA	➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources	
• Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A. (2022) Plant Physiology and Development. 7th Edn. Oxford University Press, New York. • Hopkins, W.G. and Hüner, N.P.A. (2014) Introduction to Plant Physiology. 4th Edn. John Wiley & Sons, New York. • Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015) Biochemistry and Molecular Biology of Plants. 2nd Edn. Wiley Blackwell, Oxford. • Pandey, B.P. (2013) Plant Anatomy. Revised Edn. S. Chand & Company Ltd., New Delhi. • Esau, K. (1977) Anatomy of Seed Plants. 2nd Edn. John Wiley & Sons, New York. • Fahn, A. (1990) Plant Anatomy. 4th Edn. Pergamon Press, Oxford. • Salisbury, F.B. and Ross, C.W. (2000) Plant Physiology. 4th Edn. Wadsworth Publishing Company, California. • Jain, V.K. (2017) Fundamentals of Plant Physiology. 19th Edn. S. Chand & Company Ltd., New Delhi. • Verma, S.K. and Verma, M. (2020) A Textbook of Plant Physiology, Biochemistry and Biotechnology. 10th Edn. S. Chand & Company Ltd., New Delhi. • Nelson, D.L. and Cox, M.M. (2021) Lehninger Principles of Biochemistry. 8th Edn. W.H. Freeman & Company, New York.	

Subject: Botany Semester V (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
MCC-10 (4 Credits)	24L5.5- BOT-502	Biomolecules and Metabolism	T	3	3	20	50	70	3
Scheme B & C			P	1	2	10	20	30	4
Level of the course (As per Annexure-I)									
Pre-Requisite for the course (if any):									
Learning Objectives: To enable students to understand the structure, functions and metabolism of major plant biomolecules and enzymes, and to relate biochemical processes to plant growth, development and adaptation.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand the structure, classification and biological significance of carbohydrates, proteins, lipids and nucleic acids in plants. 2. explain the major metabolic pathways involved in carbohydrate and nitrogen metabolism and their role in plant growth and development. 3. interpret the principles of enzymology, enzyme regulation and the significance of enzymes in cellular metabolism and biotechnology. 4. evaluate the biosynthesis and functions of secondary metabolites and the integration of metabolic pathways in plants. 5. develop practical skills in the qualitative and quantitative analysis of biomolecules, enzyme activity and plant metabolites using standard biochemical techniques and scientific data interpretation.									
Part B - Contents of the Course									
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Carbohydrates and Metabolism: Classification, structure and biological significance of monosaccharides, oligosaccharides, polysaccharides and glycoconjugates; glycolysis, gluconeogenesis and sucrose-starch interconversion, pentose phosphate pathway and glyoxylate cycle.								11

II	Proteins and Amino Acids: Classification and properties of amino acids; peptide bond formation; levels of protein organization; denaturation and biological functions of proteins. Nitrogen and Amino Acid Metabolism: Nitrogen assimilation, amino acid biosynthesis and catabolism, transamination and deamination reactions, significance of nitrogen metabolism in plants.	11
III	Enzymes and Enzyme Kinetics: Discovery, classification and nomenclature of enzymes; cofactors, coenzymes and prosthetic groups; mechanism of enzyme action, lock-and-key and induced-fit models, Michaelis-Menten concept. Regulation and Applications of Enzymes: Enzyme inhibition, allosteric regulation, factors affecting enzyme activity; agricultural, industrial and biotechnological applications.	12
IV	Lipids and Nucleic Acids: Classification, structure and functions of lipids; fatty acid biosynthesis and degradation; membrane and storage lipids; structure and functions of nucleotides and nucleic acids. Secondary Metabolism: Significance of alkaloids, phenolics and terpenoids in plant defense, medicine and industry.	11
V	Suggested Practical works	
	Qualitative tests for carbohydrates (reducing sugars, non-reducing sugars and starch). Qualitative tests for proteins and amino acids. Qualitative tests for lipids in plant materials. Estimation of reducing sugars by Benedict's/ DNS method. Estimation of starch content in plant tissues. Extraction and estimation of soluble proteins from plant material. Demonstration of enzyme activity (amylase/ catalase) and factors affecting enzyme activity. Study of the effect of temperature and pH on enzyme activity. Separation of amino acids by paper chromatography. Separation of plant pigments by paper chromatography. Extraction and qualitative detection of alkaloids, phenolics and terpenoids from plant materials. Study of root nodules of leguminous plants and demonstration of biological nitrogen fixation. Note: Any other relevant practical can be offered. Excursion Report: Visit to a biochemistry laboratory, plant research institute, biotechnology facility or herbal processing unit to study biochemical analysis and applications of plant metabolites (if Possible).	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5		➤ Theory ✓ Written Examination: 50 ➤ Practicum

✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA	✓ Practical Examination: 20
Part C - Recommended Books/ e-resources	
• Nelson, D.L. and Cox, M.M. (2021) Lehninger Principles of Biochemistry. 8th Edn. W.H. Freeman & Company, New York. • Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015) Biochemistry and Molecular Biology of Plants. 2nd Edn. Wiley Blackwell, Oxford. • Conn, E.E., Stumpf, P.K., Bruening, G. and Doi, R.H. (2009) Outlines of Biochemistry. 5th Edn. John Wiley & Sons, New York. • Jain, J.L., Jain, S. and Jain, N. (2016) Fundamentals of Biochemistry. 8th Edn. S. Chand & Company Ltd., New Delhi. • Verma, P.S. and Agarwal, V.K. (2019) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. Revised Edn. S. Chand & Company Ltd., New Delhi. • Rastogi, S.C. and Mendiratta, N. (2017) Biochemistry. 4th Edn. McGraw Hill Education, New Delhi.	

Subject: Botany Semester V (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-2 (4 Credits)	24L5.5- BOT-503	Plant Bioengineering and Synthetic Biology	T	3	3	20	50	70	3
Scheme B & C			P	1	2	10	20	30	4
Level of the course (As per Annexure-I)									
Pre-Requisite for the course (if any):									
Learning Objectives: To develop conceptual understanding of plant bioengineering genome editing and synthetic biology with emphasis on their applications biosafety and role in sustainable crop improvement and plant innovation.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. explain principles concepts and tools of plant bioengineering genome editing and synthetic biology. 2. analyze genome editing technologies and synthetic biological systems for plant improvement. 3. evaluate applications of plant bioengineering in crop improvement metabolic engineering and climate resilience. 4. assess biosafety bioethics and regulatory aspects of plant bioengineering and synthetic biology. 5. demonstrate understanding of bioengineering tools genome editing workflows and analysis of plant biotechnology applications through laboratory exercises and case studies.									
Part B - Contents of the Course									
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Plant Bioengineering: Concept, scope and importance; comparison of conventional breeding, genetic engineering, genome editing and synthetic biology; design-build-test-learn cycle in biological systems. Genome Editing in Plants: Principles of genome editing; CRISPR-Cas system, guide RNA, target recognition, gene knockout and gene regulation; advantages and limitations of genome editing technologies.								11
II	Synthetic Biology Principles: Concept and principles of synthetic biology; biological parts including promoters, terminators, reporter genes and regulatory elements; modular genetic design; synthetic promoters and controlled gene								11

	expression. Plant Systems and Metabolic Engineering: Engineering of pathways for pigments, vitamins, fragrances, secondary metabolites and other high-value biomolecules; introduction to plant biosensors and engineered plant traits.	
III	Applications of Plant Bioengineering: Applications of genome editing and synthetic biology in drought, salinity and heat tolerance, nutrient use efficiency and disease resistance, biofortification and photosynthetic improvement, plant-based vaccines and biodegradable biomaterials, biofuel crops and phytosensors.	11
IV	Biosafety and Bioethics: Biosafety concerns of genome-edited and synthetic organisms; ecological risks, gene flow, off-target effects, environmental impact, public perception and ethical considerations. Regulatory Framework and Future Prospects: Risk assessment and responsible innovation; future prospects of plant bioengineering in agriculture, biodiversity conservation and sustainable development.	12
V	Suggested Practical works	
	Familiarization with laboratory tools used in plant genetic engineering and genome editing. Demonstration of CRISPR-Cas components and genome editing workflow using models or software. Retrieval and analysis of plant gene sequences from public databases. Identification of CRISPR target sites using freely available bioinformatics tools. Demonstration of guide RNA design using online resources. Analysis of published case studies on genome-edited crops. Study of synthetic biology components including promoters, reporter genes and genetic circuits. Comparative analysis of conventional breeding, genetic engineering and genome editing. Review of regulatory guidelines for genome-edited plants. Seminar on recent advances in plant bioengineering or synthetic biology. Mini-project based on published literature related to plant bioengineering. Note: Any other relevant practical can be offered. Excursion Report: Visit to a plant biotechnology laboratory, genome editing facility, research institute or startup incubation centre (if possible) and submission of an excursion report.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20

➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA	
Part C - Recommended Books/ e-resources	
• Stewart, C.N. Jr. (2016) Plant Biotechnology and Genetics: Principles Techniques and Applications. 2nd Edn. John Wiley & Sons, Hoboken. • Slater, A., Scott, N.W. and Fowler, M.R. (2008) Plant Biotechnology: The Genetic Manipulation of Plants. 2nd Edn. Oxford University Press, Oxford. • Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015) Biochemistry and Molecular Biology of Plants. 2nd Edn. Wiley Blackwell, Chichester. • Voigt, C.A. (Ed.) (2011) Synthetic Biology: Methods for Engineering Biological Systems. Academic Press, London. • Puchta, H. and Fauser, F. (2014) Synthetic Nucleases for Genome Engineering in Plants: Prospects for a Bright Future. The Plant Journal, 78, 727-741. • Chen, K., Wang, Y., Zhang, R., Zhang, H. and Gao, C. (2019) CRISPR/Cas Genome Editing and Precision Plant Breeding in Agriculture. Annual Review of Plant Biology, 70, 667-697. • Doudna, J.A. and Sternberg, S.H. (2017) A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution. Houghton Mifflin Harcourt, Boston. • National Academies of Sciences, Engineering and Medicine (2017) Preparing for Future Products of Biotechnology. National Academies Press, Washington, DC.	

Subject: Botany									
Semester V (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-2 (4 Credits) Scheme B & C	24L5.5-BOT-504	Plant-Based Food Processing and Post-Harvest Technology	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I)									
Pre-Requisite for the course (if any):									
Learning Objectives: To develop understanding of post-harvest biology and technologies for processing, preservation, quality management and value addition of plant-based foods, promoting sustainable utilization, food security and entrepreneurship.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to									
1. explain post-harvest physiology handling and storage principles of plant produce.									
2. analyze processing preservation and quality management techniques for plant-based foods.									
3. evaluate value-added plant products and post-harvest technologies for reducing losses and improving marketability.									
4. assess food quality safety packaging and entrepreneurship opportunities in plant-based food processing.									
5. demonstrate skills in post-harvest handling processing quality evaluation and preparation of value-added plant products.									
Part B - Contents of the Course									
Instruction for Paper Setter									
1. Nine questions will be set in all. All questions will carry equal marks.									
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Post-Harvest Biology of Plant Produce: Scope and importance of post-harvest technology; harvested plant produce as living tissue; physiological and biochemical changes after harvest. Shelf-Life Physiology: Physiological processes associated with fruit ripening and senescence; factors influencing shelf-life and quality of fruits, vegetables and other plant products.								11
II	Post-Harvest Handling and Storage: Post-harvest handling and storage of plant								11

	produce; Storage methods: ambient, refrigerated, modified atmosphere and controlled atmosphere storage. Post-Harvest Disorders and Quality Maintenance: Post-harvest disorders, losses and quality maintenance during storage and transportation.	
III	Food Processing and Preservation: Principles and methods of food preservation; processing of plant produce and quality preservation. Plant-Based Value Addition: Preparation of value-added products such as beverages, preserves, pickles, dehydrated and functional food products.	11
IV	Food Quality and Safety: Quality evaluation, packaging, labeling and shelf-life of processed plant products; food hygiene, quality standards and safety regulations. Entrepreneurship and Market Readiness: Entrepreneurship and value addition based on locally available fruits, vegetables, cereals, spices and medicinal plants.	12
V	Suggested Practical works	
	Determination of maturity indices in selected fruits and vegetables. Study of climacteric and non-climacteric fruits. Estimation of total soluble solids (TSS) using a hand refractometer. Determination of moisture content in plant produce. Estimation of titratable acidity in fruit juices. Demonstration of grading and packaging of horticultural produce. Preparation of fruit juice, squash or ready-to-serve (RTS) beverage. Preparation of jam, jelly, marmalade or fruit preserve. Preparation of pickle, chutney or sauce from locally available plant materials. Preparation of dehydrated fruits, vegetables or spice products. Sensory evaluation of processed plant products. Packaging and labeling of value-added products. Comparative assessment of shelf-life under different storage conditions. Note: Any other relevant practical can be offered. Excursion Report: Visit to report on medicinal plant garden, herbal garden, botanical garden, natural products laboratory or research institute.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20

Part C - Recommended Books/ e-resources

- Verma, L.R. and Joshi, V.K. (2000) Post-Harvest Technology of Fruits and Vegetables. Indus Publishing Company, New Delhi.
- Thompson, A.K. (2015) Fruit and Vegetables: Harvesting Handling and Storage. 3rd Edn. Wiley-Blackwell, Oxford.
- Wills, R.B.H., McGlasson, W.B., Graham, D. and Joyce, D.C. (2007) Postharvest: An Introduction to the Physiology and Handling of Fruit Vegetables and Ornamentals. 5th Edn. CAB International, Wallingford.
- Salunkhe, D.K., Kadam, S.S. and Chavan, J.K. (1991) Post Harvest Biotechnology of Fruits. CRC Press, Boca Raton.
- Sinha, N.K., Sidhu, J.S., Barta, J., Wu, J.S.B. and Cano, M.P. (2012) Handbook of Fruits and Fruit Processing. 2nd Edn. Wiley-Blackwell, Ames.
- Fellows, P.J. (2017) Food Processing Technology: Principles and Practice. 4th Edn. Woodhead Publishing, Cambridge.
- Ranganna, S. (2010) Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Edn. Tata McGraw-Hill, New Delhi.
- Sharma, R.R. (2018) Postharvest Management of Horticultural Crops. CBS Publishers and Distributors, New Delhi.

Subject: Botany

Part A - Introduction

Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-3 (4 Credits) Scheme B & C	24L5.5-BOT-505	Plant-Based Products and Bioprospecting	T	3	3	20	50	70	3
			P	1	2	10	20	30	4

Level of the course (As per Annexure-I)

Pre-Requisite for the course (if any):

Learning Objectives: To develop understanding of bioprospecting plant-based products sustainable utilization of plant resources and entrepreneurship opportunities based on biodiversity and traditional knowledge.

Course Learning Outcomes (CLO): After completing this course, the learner will be able to

1. explain concepts principles and significance of bioprospecting biodiversity and traditional knowledge in plant resource identification.
2. apply ethnobotanical ecological approaches for exploration and sustainable use of economically important plants.
3. assess value addition quality control and industrial uses of plant based products.
4. evaluate regulatory frameworks IPR, ABS and entrepreneurship in bioprospecting.

5. demonstrate skills in the identification documentation processing value addition and market assessment of economically important plant resources through field surveys laboratory exercises and project-based activities.

Part B - Contents of the Course

Instruction for Paper Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.

Unit	Topics	Contact Hours
I	Introduction to Bioprospecting: Concept, scope and importance of bioprospecting; biodiversity as a source of useful plant products; significance of plant genetic resources and ecosystem services; role of bioprospecting in sustainable utilization of biological resources. Plant Resources and Traditional Knowledge: Ethnobotany and bioprospecting; traditional knowledge and indigenous uses of medicinal, aromatic and economically important plants.	11

II	Approaches in Bioprospecting: Approaches to bioprospecting; traditional knowledge and exploration of economically important plant resources. Sustainable Utilization of Plant Resources: Conservation and sustainable utilization of economically important plants; ethical issues and community participation in biodiversity management.	11
III	Plant-Based Products: Herbal products, nutraceuticals, functional foods, essential oils, plant-based cosmetics, natural dyes, fibres, gums, resins and botanical pesticides; economically important plant products and their applications. Product Development and Value Addition: Processing, value addition and utilization of plant-based products for sustainable livelihoods and entrepreneurship.	11
IV	Industrial Applications and Entrepreneurship: Applications of plant-based products in healthcare, agriculture and industry; entrepreneurship and commercialization. Regulatory Framework and Intellectual Property Rights: Convention on Biological Diversity (CBD), Access and Benefit Sharing (ABS), biopiracy, protection of traditional knowledge, Intellectual Property Rights (IPR) and the role of Traditional Knowledge Digital Library (TKDL).	12
V	Suggested Practical works	
	Field survey of locally available medicinal and economically useful plants. Ethnobotanical documentation through interviews with local users, farmers or traditional healers. Herbarium preparation of important bioprospecting species. Identification and mapping of dryland useful plants in campus/village ecosystem. Preparation of a local plant-use inventory for food, medicine, fibre, fodder or cosmetics. Small-scale preparation of one plant-based product, such as herbal decoction, natural dye, aromatic extract or botanical pesticide. Study of essential oil-bearing plants of dry and semi-arid zones. Market survey of herbal and plant-based products in nearby towns. Case study presentation on a successful plant-based enterprise. Project report on one local plant species with economic or bioprospecting value. Simple quality checks for plant products: colour, odour, texture, moisture, storage behavior. Conservation activity: seed collection, nursery note, or awareness material on sustainable harvesting. Field survey or herbarium-based documentation of phytochemically important plants. Note: Any other relevant practical can be offered. Excursion Report: Visit to a excursion report on medicinal plant garden, herbal garden, botanical garden, natural products laboratory or research institute.	30
Suggested Evaluation Methods		

Internal Assessment (30)	End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA	➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources	
• Jain, S.K. (1995) A Manual of Ethnobotany. 2nd Edn. Scientific Publishers, Jodhpur. • Cotton, C.M. (1996) Ethnobotany: Principles and Applications. John Wiley & Sons, Chichester. • Trivedi, P.C. (2007) Ethnobotany. Pointer Publishers, Jaipur. • Kirtikar, K.R. and Basu, B.D. (2006) Indian Medicinal Plants. 2nd Edn. International Book Distributors, Dehradun. • Chadha, K.L. and Gupta, R. (2003) Advances in Horticulture: Medicinal and Aromatic Plants. Malhotra Publishing House, New Delhi. • Pushpangadan, P. and Nair, K.N. (2001) Value Addition and Marketing of Medicinal Plants. National Medicinal Plants Board, New Delhi. • Duffield, G. (2011) Intellectual Property Rights and the Life Science Industries. Ashgate Publishing, Surrey. • Convention on Biological Diversity (CBD) Secretariat (2020) Convention on Biological Diversity: Text and Annexes. United Nations Environment Programme, Montreal.	

Subject: Botany

Part A - Introduction

Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-3 (4 Credits)	24L5.5-BOT-506	Phytochemistry and Natural Products	T	3	3	20	50	70	3
Scheme B & C			P	1	2	10	20	30	4

Level of the course (As per Annexure-I)

Pre-Requisite for the course (if any):

Learning Objectives: To enable students to understand the diversity, functions and applications of plant-derived phytochemicals, their extraction, analysis and utilization in natural products, healthcare, agriculture, industry and entrepreneurship.

Course Learning Outcomes (CLO): After completing this course, the learner will be able to

1. understand the scope and significance of phytochemistry in plant science.
2. identify major classes of phytochemicals and explain their biological roles.
3. describe basic methods of extraction, screening and chromatographic analysis of plant compounds.
4. evaluate the importance of natural products and value-added plant products in medicine and industry.
5. develop practical skills in phytochemical testing, extraction and simple analysis of plant materials.

Part B - Contents of the Course

Instruction for Paper Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.

Unit	Topics	Contact Hours
I	Introduction to Phytochemistry: Scope, importance and applications of phytochemistry; primary and secondary metabolites, their biological and ecological significance.	11
II	Major Phytochemical Groups: Classification, properties and functions of major groups of phytochemicals with representative examples.	11
III	Extraction, Screening and Analysis: Collection and processing of plant materials; extraction, phytochemical screening, chromatographic techniques and quality evaluation of herbal materials.	11
IV	Natural Products and Applications: Natural products and their applications in healthcare, agriculture and industry; medicinal and aromatic plants, herbal products and entrepreneurship.	12

V	Suggested Practical works	
	Qualitative tests for major phytochemical groups in plant extracts such as alkaloids, flavonoids, tannins, phenols, saponins, glycosides and terpenoids. Collection, drying and preparation of plant material for phytochemical study. Preparation of crude extracts using simple methods such as maceration or Soxhlet extraction. Separation of plant pigments by paper chromatography or TLC. Chromatographic separation of plant extract components using TLC plates and suitable solvents. Study of medicinal and aromatic plants of local importance and their useful parts. Study of essential oil-yielding plants such as mint, lemongrass, eucalyptus and citronella. Standardization-related practicals such as moisture content, extractive value or ash value, wherever facilities are available. Field survey or herbarium-based documentation of phytochemically important plants. Note: Any other relevant practical can be offered. Excursion Report: Visit to a medicinal plant garden, herbal garden, botanical garden, natural products laboratory or research institute.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A. (2022) Plant Physiology and Development. 7th Edn. Oxford University Press, New York. • Hopkins, W.G. and Hüner, N.P.A. (2014) Introduction to Plant Physiology. 4th Edn. John Wiley & Sons, New York. • Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015) Biochemistry and Molecular Biology of Plants. 2nd Edn. Wiley Blackwell, Oxford. • Harborne, J.B. (1998) Phytochemical Methods. 3rd Edn. Chapman & Hall, London. • Trease, G.E. and Evans, W.C. (2009) Pharmacognosy. 16th Edn. Elsevier, London. • Dewick, P.M. (2009) Medicinal Natural Products: A Biosynthetic Approach. 3rd Edn. Wiley, Chichester.		

- Kokate, C.K., Purohit, A.P. and Gokhale, S.B. (2015) Pharmacognosy. 49th Edn. Nirali Prakashan, Pune.
- Bruneton, J. (1999) Pharmacognosy, Phytochemistry, Medicinal Plants. 2nd Edn. Intercept Ltd., Hampshire.
- Chatwal, G.R. and Anand, S.K. (2016) Instrumental Methods of Chemical Analysis. 5th Edn. Himalaya Publishing House, Mumbai.
- Sadasivam, S. and Manickam, A. (2008) Biochemical Methods. 3rd Edn. New Age International, New Delhi.

Subject: Botany

Part A - Introduction

Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-6 MCC-11 (4 Credits) Scheme A, B & C	24L5.5-BOT-601	Ecology and Economic Botany	T	3	3	20	50	70	3
			P	1	2	10	20	30	4

Level of the course (As per Annexure-I)

Pre-Requisite for the course (if any):

Learning Objectives: To enable students to understand the structural organization, physiological functions and biochemical processes of plants and to apply this integrated knowledge of plant anatomy, water relations, photosynthesis, growth regulation, metabolism and nitrogen fixation in explaining plant growth, productivity and adaptation.

Course Learning Outcomes (CLO): After completing this course, the learner will be able to

1. understand basic ecological principles and plant-environment interactions.
 2. explain plant communities, ecosystem functioning and conservation concepts.
 3. identify major categories of economically important plants and their uses.
 4. describe plant products and their role in daily life and rural economy.
-
5. develop field and laboratory skills in ecological observation sampling and identification of economically important plants and plant products.

Part B - Contents of the Course

Instruction for Paper Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.

Unit	Topics	Contact Hours
I	Basics of Ecology: Scope and importance of ecology, levels of ecological organization, abiotic and biotic components, food chain and food web, energy flow and ecological pyramids, concept and characteristics of population and community ecology, trophic level and ecological succession.	11
II	Plant Ecology and Conservation: Plant adaptations to xeric, hydric and saline conditions; life forms and biological spectrum; biodiversity and its significance; biogeochemical cycles (C, N, P); environmental pollution and types including greenhouse effect, greenhouse gases, global warming and ozone depletion;	11

	conservation of plant resources and sustainable use.	
III	Introduction to Economic Botany: Scope and importance of economic botany; origin and domestication of useful plants; major plant products and their uses; cereals (wheat, rice), pulses (chickpea, pigeon pea), oilseeds (mustard, groundnut), sugars (sugarcane), fibres (cotton, jute) and beverages (tea, coffee).	11
IV	Useful Plants and Plant Products: Medicinal plants (ashwagandha, aloe); timber plants (teak, shisham); gums, resins, latex and dyes (gum arabic, pine resin, rubber, indigo); tannins and essential oils (eucalyptus, lemongrass); industrial and commercial plant products (coconut, cinchona).	12
V	Suggested Practical works	
	Study of ecological instruments and methods used in ecological investigations (quadrat, transect, soil thermometer, hygrometer, rain gauge and lux meter). Determination of frequency, density and abundance of plant species using quadrat method in a selected habitat. Study of plant adaptations in hydrophytes, xerophytes and halophytes using suitable examples such as <i>Hydrilla</i>, <i>Eichhornia</i>, <i>Opuntia</i>, <i>Calotropis</i>, <i>Suaeda</i> and <i>Salicornia</i>. Study of ecological succession and plant communities through field observations and preparation of a simple community profile. Identification and study of economically important plants belonging to cereals, pulses, oilseeds, fibres, sugars and beverages [wheat, rice, maize; chickpea, lentil; mustard, sesame; cotton, jute; sugarcane; tea and coffee]. Identification and study of spices, condiments, fodder and medicinal plants [turmeric, black pepper, cardamom; berseem, sorghum; tulsi, ashwagandha and aloe vera]. Identification and study of timber yielding plants and important plant products such as gums, resins, latex, dyes, tannins and essential oils [shisham, teak, sal; gum arabic, pine resin, rubber, indigo, eucalyptus oil and lemongrass oil]. Preparation of herbarium sheets and documentation of economically important plants. Field survey of local vegetation and economically important plant resources and preparation of a short report. Preparation of practical record and interpretation of ecological and economic botanical observations. Note: Any other relevant practical can be offered. Excursion Report: Visit to a botanical garden, forest area, biodiversity park, herbal garden, agricultural farm, nursery, research institute or protected area to study plant diversity, ecological interactions, conservation practices and economically important plant resources.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)

➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA	➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources	
• Odum, E.P. and Barrett, G.W. (2018) Fundamentals of Ecology. 5th Edn. Cengage Learning. • Sharma, P.D. (2022) Ecology and Environment. 14th Edn. Rastogi Publications. • Ambasht, R.S. and Ambasht, N.K. (2019) A Textbook of Plant Ecology. 15th Edn. CBS Publishers. • Simpson, B.B. and Ogorzaly, M.C. (2015) Economic Botany: Plants in Our World. 5th Edn. McGraw-Hill Education. • Kochhar, S.L. (2016) Economic Botany in the Tropics. 4th Edn. Macmillan Education. • Pandey, B.P. (2021) Economic Botany. 8th Edn. S. Chand Publishing. • Verma, V. (2019) Textbook of Economic Botany. Ane Books. • Singh, J.S., Singh, S.P. and Gupta, S.R. (2017) Ecology, Environment and Resource Conservation. Anamaya Publishers. • Jain, S.K. (2016) Manual of Ethnobotany. 2nd Edn. Scientific Publishers. • Raven, P.H., Evert, R.F. and Eichhorn, S.E. (2019) Biology of Plants. 9th Edn. W.H. Freeman.	

Subject: Botany Semester VI (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
MCC-12 (4 Credits)	24L5.5- BOT-602	Dendrology, Pomology and Arboriculture	T	3	3	20	50	70	3
Scheme B & C			P	1	2	10	20	30	4
Level of the course (As per Annexure-I)									
Pre-Requisite for the course (if any):									
Learning Objectives: To enable students to understand the structure, functions and metabolism of major plant biomolecules and enzymes, and to relate biochemical processes to plant growth, development and adaptation.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand principles of dendrology and identify major native exotic and introduced trees and shrubs of South Haryana. 2. explain diversity and ecological importance of arid and semi-arid tree flora. 3. describe basics of pomology and cultivation of hardy fruit crops. 4. apply principles of arboriculture for tree planting maintenance and urban greening.									
5. develop practical skills in identification characterization and field study of trees and fruit crops and demonstrate basic techniques of arboriculture and pomology in laboratory and field conditions.									
Part B - Contents of the Course									
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Dendrology and Tree Identification: Meaning, scope and importance of dendrology; identification, nomenclature and classification of trees and shrubs; field identification of trees; herbaria, arboreta, botanical gardens, and native and exotic woody flora.								11
II	Tree Flora of Arid and Semi-Arid Regions: General account and xerophytic adaptations of the tree flora of arid and semi-arid regions with special reference to important species of South Haryana such as <i>Prosopis cineraria</i> , <i>Azadirachta indica</i> , <i>Acacia nilotica</i> , <i>Albizia lebbeck</i> , <i>Dalbergia sissoo</i> , <i>Tecomella undulata</i> and <i>Butea monosperma</i> .								11

III	Pomology and Hardy Fruit Crops: Meaning, scope and importance of pomology; classification of fruit crops; principles of orchard establishment; fruit production and quality management; important and underutilized fruit crops of arid and semi-arid regions.	12
IV	Arboriculture and Urban Greening: Concept, scope and importance of arboriculture; tree establishment and management; urban arboriculture, landscape development and environmental improvement with special reference to arid and semi-arid regions.	11
V	Suggested Practical works	30
	Study and identification of important trees and shrubs based on morphological characters such as leaf bark flower fruit and habit. Field visit and preparation of herbarium sheets of common woody plants of South Haryana. Identification and description of native exotic cultivated and introduced tree species including <i>Prosopis cineraria</i>, <i>Azadirachta indica</i>, <i>Acacia nilotica</i>, <i>Dalbergia sissoo</i>, <i>Tecomella undulata</i>, <i>Butea monosperma</i>, <i>Albizia lebbbeck</i>, and selected <i>Ficus</i> species. Study of xerophytic adaptations in selected arid zone trees. Study of fruit crops of semi-arid regions including ber aonla bael pomegranate fig jamun phalsa karonda date palm and custard apple. Demonstration of propagation methods in fruit plants such as cutting grafting and budding (where possible). Study of orchard layout principles and basic training and pruning techniques using models or field observations. Identification of avenue ornamental and shade trees used in urban and rural plantations. Study of shelterbelts and windbreak plantations and their role in soil and wind erosion control. Note: Any other relevant practical can be offered. Excursion Report: Visit to a nearby horticultural landscape, plant research institute or orchard to study tree flora and fruit crop diversity of South Haryana region (if Possible).	
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20

✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA	
Part C - Recommended Books/ e-resources	
• Troup, R.S. (1921) The Silviculture of Indian Trees. Vols. I-III. Clarendon Press, Oxford. • Santapau, H. and Henry, A.N. (1973) A Dictionary of the Flowering Plants in India. CSIR, New Delhi. • Chadha, K.L. (2001) Handbook of Horticulture. 2nd Edn. ICAR, New Delhi. • Bose, T.K., Mitra, S.K. and Sadhu, M.K. (2012) Horticulture. 4th Edn. Naya Udyog, Kolkata. • Chattopadhyay, T.K. (2007) A Text Book of Pomology. Kalyani Publishers, Ludhiana. • Hartmann, H.T., Kester, D.E., Davies, F.T. and Geneve, R.L. (2011) Plant Propagation: Principles and Practices. 8th Edn. Pearson, Boston. • Randhawa, G.S. and Mukhopadhyay, A. (1986) Floriculture in India. Allied Publishers, New Delhi. • Arora, J.S. (2014) Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana. • Bhattacharjee, S.K. (2010) Flowering Trees, Shrubs and Climbers in India. 2nd Edn. Oxford and IBH Publishing Co., New Delhi. • Sharma, O.P. (2015) Hill's Economic Botany. 2nd Edn. McGraw Hill Education, New Delhi.	

Subject: Botany									
Semester VI (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-4 (4 Credits) Scheme B & C	24L5.5-BOT-603	Marine Flora and Coastal Ecology	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I)									
Pre-Requisite for the course (if any):									
Learning Objectives: To develop understanding of marine plant diversity coastal ecosystem structure and functioning and the ecological and economic significance of marine flora with emphasis on conservation and sustainable coastal resource management.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. explain diversity distribution adaptations and ecological significance of marine and coastal plants. 2. analyze structure functioning and ecological interactions within marine and coastal ecosystems. 3. evaluate economic importance ecosystem services and resource utilization of marine flora. 4. assess threats conservation strategies and management approaches for sustainable coastal ecosystems.5. Develop practical skills in identification, classification, documentation, interpretation and reporting of marine botanical specimens, coastal habitats, seaweed products and conservation case studies.									
Part B - Contents of the Course									
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Marine Botany and Coastal Ecosystem: Scope and importance of marine botany; basic differences between freshwater, brackish and marine plant habitats; major marine habitats and coastal zones with special reference to estuarine, mangrove, seagrass and coral reef ecosystems; physical and chemical properties of seawater.								11
II	Marine Flora and Coastal Plants: General account, diversity, distribution and ecological significance of marine flora, including phytoplankton, seaweeds and seagrasses with representative examples; general account of mangroves, salt marsh plants and coastal dune vegetation. Marine Plant Resources and Uses: Economic importance of marine flora;								11

	seaweeds as sources of agar, alginates, carrageenan, food, feed, fertilizers, bioactive products and livelihood support; seaweed farming and marine plant-based products.	
III	Adaptations and Ecological Functions: Adaptations of marine and coastal plants to saline and coastal environments; ecological roles of coastal vegetation in shoreline stabilization, nutrient cycling and coastal protection.	11
IV	Threats to Marine Ecosystem: Major threats to coastal ecosystems and marine biodiversity, including pollution, habitat degradation and climate change. Conservation and Coastal Management: Conservation and restoration of mangroves, seagrasses and coastal habitats; marine protected areas of India and Ramsar coastal wetlands, blue carbon and community participation.	12
V	Suggested Practical works	
	Study and identification of major groups of marine algae including green brown and red seaweeds. Identification of common genera of marine algae such as <i>Ulva</i>, <i>Caulerpa</i>, <i>Sargassum</i>, <i>Padina</i>, <i>Gracilaria</i>, <i>Gelidium</i> and <i>Kappaphycus</i>. Morphological adaptations of marine algae seagrasses mangroves and salt marsh plants. Study of seagrass morphology and adaptations using preserved specimens or digital resources. Study of mangrove adaptations including pneumatophores prop roots vivipary and salt regulation mechanisms. Identification of coastal plant communities including mangroves salt marsh vegetation and dune vegetation. Estimation of salinity pH dissolved oxygen and other basic water quality parameters using simulated or field data. Preparation of herbarium sheets or photographic records of marine and coastal plants. Study of economically important marine products including agar alginates carrageenan and seaweed-based fertilizers. Mapping of coastal ecosystems and zonation patterns using satellite imagery or secondary data. Case study on marine protected areas mangrove restoration or seaweed farming in India. Preparation of project report on a selected marine plant resource or coastal conservation programme. Note: Any other relevant practical can be offered. Excursion Report: Visit to a wetland coastal ecosystem marine research centre conservation site biodiversity park or other relevant facility and preparation of an excursion report highlighting biodiversity ecological features management practices and conservation issues (if possible).	30

Suggested Evaluation Methods	
Internal Assessment (30)	End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA	➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources	
• Dawes, C.J. (1998) Marine Botany. 2nd Edn. John Wiley & Sons, New York. • Chapman, V.J. and Chapman, D.J. (1980) Seaweeds and Their Uses. 3rd Edn. Chapman and Hall, London. • Lobban, C.S. and Harrison, P.J. (1997) Seaweed Ecology and Physiology. Cambridge University Press, Cambridge. • Graham, L.E., Graham, J.M. and Wilcox, L.W. (2009) Algae. 2nd Edn. Benjamin Cummings, San Francisco. • Tomlinson, P.B. (1986) The Botany of Mangroves. Cambridge University Press, Cambridge. • Kathiresan, K. and Bingham, B.L. (2001) Biology of Mangroves and Mangrove Ecosystems. Advances in Marine Biology, 40, 81-251. • Alongi, D.M. (2009) The Energetics of Mangrove Forests. Springer, Dordrecht. • Larkum, A.W.D., Orth, R.J. and Duarte, C.M. (2006) Seagrasses: Biology Ecology and Conservation. Springer, Dordrecht. • Nybakken, J.W. and Bertness, M.D. (2005) Marine Biology: An Ecological Approach. 6th Edn. Pearson Education, San Francisco. • Barnes, R.S.K. and Hughes, R.N. (1999) An Introduction to Marine Ecology. 3rd Edn. Blackwell Science, Oxford.	

Subject: Botany									
Semester VI (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-4 (4 Credits) Scheme B & C	24L5.5- BOT-604	Aquatic Botany and Wetland Management	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I)									
Pre-Requisite for the course (if any):									
Learning Objectives: To develop integrated understanding of aquatic plant diversity wetland ecosystem structure and functioning and applied strategies for conservation restoration and sustainable management of freshwater ecosystems especially in semi-arid landscapes.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to									
1. explain diversity classification adaptations and ecological significance of aquatic and wetland plants.									
2. analyze structure functioning productivity and biodiversity of aquatic and wetland ecosystems.									
3. evaluate water quality parameters ecosystem services and factors affecting wetland health and sustainability.									
4. assess wetland degradation processes conservation policies and management strategies for sustainable utilization of wetland resources.									
5. demonstrate skills in identification documentation monitoring and ecological assessment of aquatic plants and wetland habitats.									
Part B - Contents of the Course									
Instruction for Paper Setter									
1. Nine questions will be set in all. All questions will carry equal marks.									
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Aquatic Botany and Wetland Flora: Scope and importance of aquatic botany; significance of wetlands; structure and types of inland aquatic habitats, including ponds, lakes, rivers and wetlands. Classification of Aquatic and Wetland Plants: General account and morphological, anatomical, physiological and reproductive adaptations of submerged, floating, emergent and marginal aquatic plants, with representative examples.								11
II	Water Quality and Wetland Ecology: Physico-chemical characteristics of								11

	freshwater ecosystems; aquatic biota, microbial interactions and their role in ecosystem productivity and nutrient cycling. Wetland Hydrology and Energy Flow: Limnological characteristics and ecosystem functioning of inland aquatic habitats, with emphasis on productivity, nutrient cycling and aquatic vegetation.	
III	Wetland Biodiversity and Ecosystem Services: Wetland biodiversity and ecosystem services including water purification, groundwater recharge, flood moderation, carbon sequestration, biodiversity conservation and livelihood support. Wetland Degradation: Environmental and anthropogenic threats to wetlands; impacts of pollution, eutrophication, habitat modification and climate change on wetland biodiversity.	11
IV	Wetland Management and Conservation: Wetland assessment and monitoring; bioindicator species, aquatic vegetation management, phytoremediation and constructed wetlands. Conservation Policies: Global wetland biodiversity hotspots and brief introduction to Ramsar Convention, Wetlands (Conservation and Management) Rules 2017 and National Plan for Conservation of Aquatic Ecosystems.	12
V	Suggested Practical works	
	Study and identification of common aquatic and wetland plants including submerged floating emergent and marginal species. Morphological and anatomical adaptations of selected hydrophytes. Identification and classification of aquatic macrophytes from local wetlands. Estimation of physico-chemical parameters of water including pH temperature turbidity dissolved oxygen alkalinity hardness nitrates and phosphates. Determination of aquatic plant diversity and abundance in a local pond or wetland. Survey and documentation of invasive aquatic weeds and their ecological impacts. Assessment of wetland biodiversity through observation of aquatic plants plankton birds and associated fauna. Preparation of herbarium specimens or photographic documentation of aquatic and wetland flora. Study of bioindicator species used in water quality monitoring. Field visit to a pond lake reservoir johad or wetland and preparation of a field report. Case study on wetland conservation restoration or phytoremediation project. Preparation of wetland inventory data sheet for a selected aquatic habitat. Note: Any other relevant practical can be offered. Excursion Report: Visit to any wetland area, possibly Ramsar Sites for case studies of successful wetland restoration and sustainable management practices.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)

➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA	➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources	
• Cook, C.D.K. (1996) Aquatic Plant Book. SPB Academic Publishing, Amsterdam. • Gopal, B. (2013) Wetlands: Ecology and Management. National Book Trust, New Delhi. • Mitsch, W.J. and Gosselink, J.G. (2015) Wetlands. 5th Edn. John Wiley & Sons, New Jersey. • Wetzel, R.G. (2001) Limnology: Lake and River Ecosystems. 3rd Edn. Academic Press, San Diego. • Cronk, J.K. and Fennessy, M.S. (2001) Wetland Plants: Biology and Ecology. CRC Press, Boca Raton. • Subramanyam, K. (1962) Aquatic Angiosperms. CSIR, New Delhi. • Kumar, A. and Singh, A.K. (2001) Ecology of Wetlands and Associated Systems. Daya Publishing House, New Delhi. • Trivedi, R.K. and Goel, P.K. (1986) Chemical and Biological Methods for Water Pollution Studies. Environmental Publications, Karad. • Chapman, J.L. and Reiss, M.J. (1999) Ecology: Principles and Applications. 2nd Edn. Cambridge University Press, Cambridge. • Odum, E.P. and Barrett, G.W. (2005) Fundamentals of Ecology. 5th Edn. Thomson Brooks/Cole, Belmont.	

Subject: Botany Semester VI (Session 2024-25)									
Part A - Introduction									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-5 (4 Credits) Scheme B & C	24L5.5-BOT-605	Field Botany and Plant Resource Entrepreneurship	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
Level of the course (As per Annexure-I)									
Pre-Requisite for the course (if any):									
Learning Objectives: To develop skills in field identification documentation assessment and sustainable utilization of plant resources and to promote entrepreneurship innovation and enterprise development based on locally available plant biodiversity.									
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. explain principles and techniques of field botany plant identification and biodiversity documentation. 2. apply field survey methods for assessment and documentation of plant resources across diverse habitats. 3. evaluate plant resources for value addition product development and enterprise potential. 4. assess entrepreneurship opportunities market linkages innovation pathways and regulatory frameworks related to plant-based enterprises.									
5. demonstrate skills in plant identification field documentation resource assessment and preparation of basic enterprise models.									
Part B - Contents of the Course									
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.									
Unit	Topics								Contact Hours
I	Field Botany and Plant Identification: Scope and importance of field botany; field observation, plant documentation, herbarium techniques and identification of plants using vegetative and reproductive characters. Plant Resource Survey and Documentation: Principles and methods of plant resource surveys; habitat-based documentation, ethical collection and conservation practices.								11
II	Plant Resource Assessment: Assessment of plant diversity, abundance, distribution and utilization patterns; preparation of resource inventories and								11

	biodiversity registers; evaluation of conservation and economic importance of plant resources. Economically Important Plant Resources: Survey, identification and evaluation of economically important plant resources including medicinal, aromatic, ornamental, fruit, tree and aquatic plants.	
III	Value Addition of Plant Resources: Collection, cultivation, processing, drying, grading, storage, packaging and value addition of plant resources; quality maintenance and utilization of plant materials for commercial purposes. Plant-Based Products and Enterprise Opportunities: Product development and value addition from medicinal, aromatic and other plant resources; entrepreneurship opportunities and sustainable utilization of local plant resources.	11
IV	Plant-Based Entrepreneurship: Concept and scope of entrepreneurship in plant sciences; identification of enterprise opportunities based on local biodiversity and plant resources. Innovation and Regulatory Framework: Innovation and entrepreneurship in plant-based products and services; startup opportunities, intellectual property rights and ethical frameworks for sustainable utilization of plant resources.	12
V	Suggested Practical works	
	Identification of common plant species using vegetative and reproductive characters. Preparation and maintenance of field notebook and plant checklist. Herbarium specimen collection processing mounting and labeling. Digital herbarium preparation using photographs and GPS coordinates. Field survey of plant resources from different habitats. Documentation of local plant uses and enterprise potential. Preparation of habitat-wise plant resource inventory. Assessment of medicinal aromatic ornamental and economically important plants. Market survey of plant-based products and nursery enterprises. Preparation of value-added product concept note using local plant resources. Development of a simple business model canvas for a plant-based enterprise. Cost estimation branding and packaging exercise for a selected plant product. Note: Any other relevant practical can be offered. Excursion Report: Visit to a herbal garden nursery biodiversity park startup incubation centre medicinal plant farm or related institution (if possible) and submission of an excursion report.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5		➤ Theory ✓ Written Examination: 50

✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA	➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources	
• Jain, S.K. (1995) A Manual of Ethnobotany. 2nd Edn. Scientific Publishers, Jodhpur. • Bridson, D. and Forman, L. (2004) The Herbarium Handbook. 3rd Edn. Royal Botanic Gardens, Kew. • Lawrence, G.H.M. (1951) Taxonomy of Vascular Plants. Macmillan Company, New York. • Simpson, M.G. (2019) Plant Systematics. 3rd Edn. Academic Press, London. • Martin, G.J. (2004) Ethnobotany: A Methods Manual. Earthscan Publications, London. • Wickens, G.E. (1990) Ecoeconomic Botany: Principles and Practices. Chapman and Hall, London. • Hisrich, R.D., Peters, M.P. and Shepherd, D.A. (2020) Entrepreneurship. 11th Edn. McGraw-Hill Education, New York. • Barringer, B.R. and Ireland, R.D. (2019) Entrepreneurship: Successfully Launching New Ventures. 6th Edn. Pearson Education, London. • Government of India (2023) Startup India: Action Plan and Policy Framework. Department for Promotion of Industry and Internal Trade, New Delhi. • National Biodiversity Authority (2021) Biological Diversity Act and Access and Benefit Sharing Guidelines. National Biodiversity Authority, Chennai.	

Subject: Botany

Part A - Introduction

Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-5 (4 Credits) Scheme B & C	24L5.5-BOT-606	Laboratory Techniques and Biostatistics	T	3	3	20	50	70	3
			P	1	2	10	20	30	4

Level of the course (As per Annexure-I)

Pre-Requisite for the course (if any):

Learning Objectives: To develop strong practical competencies in laboratory techniques instrumentation and microscopy along with the ability to independently design and execute experiments under controlled conditions and to apply appropriate statistical tools for rigorous analysis interpretation and presentation of biological data in plant sciences.

Course Learning Outcomes (CLO): After completing this course, the learner will be able to

1. explain principles of laboratory safety good laboratory practices and basic laboratory instrumentation.
2. apply microscopy techniques slide preparation and measurement methods in biological studies.
3. design experiments and organize biological data using scientific methods.
4. analyze biological data using descriptive and inferential statistical tools.

5. demonstrate skills in laboratory techniques microscopy experimental methods and statistical analysis using biological datasets

Part B - Contents of the Course

Instruction for Paper Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.

Unit	Topics	Contact Hours
I	Laboratory Safety and Basic Laboratory Practices: Laboratory safety rules and regulations; handling of glassware, chemicals and biological materials; personal protective equipment; labeling, storage and disposal of laboratory waste; introduction to good laboratory practices in biological sciences.	11
II	Laboratory Instruments and Solutions: Principles, working and applications of laboratory instruments including microscopes and analytical equipment; preparation of stains, reagents, buffers and standard solutions; concepts of concentration, dilution, calibration, maintenance and safe laboratory practices.	11
III	Microscopy and Experimental Design: Preparation of temporary and permanent	11

	slides; sectioning, staining and mounting techniques; microscopy, measurement and documentation of biological structures; principles of experimental design, biological data organization, analysis and scientific reporting.	
IV	Biostatistics and Data Analysis: Scope and applications of biostatistics in biological sciences; data collection, sampling, graphical presentation, descriptive and inferential statistics, probability, correlation, regression, hypothesis testing (t-test, chi-square test and one-way ANOVA) and biological data analysis using spreadsheets or statistical software.	12
V	Suggested Practical works	
	Identification and handling of common laboratory instruments. Preparation of standard solutions using molarity and dilution methods. Demonstration of pH measurement and buffer preparation. Operation of centrifuge and spectrophotometer (basic level). Preparation of temporary and permanent slides of plant material. Section cutting staining and mounting techniques. Measurement of cell size using ocular micrometer. Microscopic observation and diagrammatic representation of tissues. Recording and tabulation of biological experimental data. Construction of graphs (bar histogram frequency polygon pie chart). Calculation of mean median mode variance and standard deviation. Application of t-test and chi-square test using sample datasets. Simple correlation analysis using biological data. Use of Excel or basic statistical software for data analysis. Note: Any other relevant practical can be offered. Excursion Report: Visit to a biological research institute, central instrumentation facility or university laboratory and preparation of a report covering laboratory infrastructure, major scientific instruments, sample processing techniques and basic data analysis workflow.	30
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10 ➤ Practicum ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10 ✓ Mid-Term Exam: NA		➤ Theory ✓ Written Examination: 50 ➤ Practicum ✓ Practical Examination: 20
Part C - Recommended Books/ e-resources		
• Gupta, S.C. and Kapoor, V.K. (2020) Fundamentals of Mathematical Statistics. Sultan Chand and		

Sons, New Delhi.

- Sokal, R.R. and Rohlf, F.J. (2012) Introduction to Biostatistics. 4th Edn. W.H. Freeman, New York.
- Zar, J.H. (2010) Biostatistical Analysis. 5th Edn. Pearson Education, New Jersey.
- Day, R.A. and Underwood, A.L. (2001) Quantitative Analysis in Biological Sciences. Prentice Hall, New Jersey.
- Roy, P. (2014) Biostatistics: A Foundation for Analysis in the Health Sciences. Wiley, New York.
- Sass, J.E. (1958) Botanical Microtechnique. Iowa State University Press, Ames.
- Johansen, D.A. (1940) Plant Microtechnique. McGraw Hill, New York.
- Cram, W.J. (2010) Laboratory Manual in Biochemistry and Molecular Biology. Academic Press, London.

Subject: Botany Semester VII (Session 2026-27)								
Part A - Introduction								
Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-H1 (4 Credits) Scheme B & C	24L6.0-BOT-701	Cyanobacteria, Phycology and Bryology	4	4	30	70	100	3
Level of the course (As per Annexure-I)								
Pre-Requisite for the course (if any):								
Learning Objectives: Develop an understanding of the diversity, classification, structure, life cycles, ecological and economic significance of cyanobacteria, algae and bryophytes and interpret their evolutionary importance in the origin and evolution of land plants.								
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand the diversity, structure and ecological significance of cyanobacteria, photosynthetic prokaryotes and early photosynthetic lineages. 2. analyze the classification, diversity and life cycles of major algal groups. 3. evaluate the ecological, economic and applied significance of algae and the basic biology of bryophytes. 4. interpret the morphology, development and evolutionary significance of major bryophyte groups in land plant evolution								
Part B - Contents of the Course								
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.								
Unit	Topics							Contact Hours
I	Introduction to Cyanobacteria: General characteristics, occurrence, classification and distribution, cell structure and ultrastructure, pigments and reserve food materials, heterocysts, hormogonia, akinetes and gas vacuoles; role in early atmospheric oxygenation, ecological contributions, economic importance and harmful algal blooms. Early Photosynthetic Lineages: Diversity and classification of cryptogams and photosynthetic bacteria; general account of photosynthetic bacteria (purple sulphur bacteria, green sulphur bacteria and non-sulphur bacteria); their significance in evolution and ecosystem functioning.							13

II	Introduction to Phycology: Structural diversity (unicellular to multicellular thalli); classification and its criteria based on pigments, reserve food, cell wall composition and flagella; placement of algae in two-, five-, six- and eight-kingdom classification systems; algae in diversified habitats (terrestrial, aquatic, parasitic and symbiotic conditions). Salient Features and Life Cycle of Major Algal Groups: Prochlorophyta (<i>Prochlorococcus</i>), Chlorophyta (<i>Oedogonium</i>), Charophyta (<i>Chara</i>), Xanthophyta (<i>Vaucheria</i>), Bacillariophyta (<i>Navicula</i>), Phaeophyta (<i>Sargassum</i>) and Rhodophyta (<i>Polysiphonia</i>), comparative morphology, reproduction and life cycle patterns.	17
III	Role of Algae: Economic importance of algae as food, feed, medicines and nutritional supplements with special reference to carrageenan, biofertilizers, algal biotechnology, biofuels and single-cell protein; role in aquatic ecosystems and bioremediation. Introduction to Bryology: Classification and their distribution in India; evolution and affinities with algae and pteridophytes; adaptations to terrestrial life and ecological adaptations, bryophytes as amphibians of plant kingdom; reproduction and life cycle, theories of alternation of generations (antithetic and homologous).	14
IV	Evolutionary and Ecological Significance of Bryophytes: Evolution and organization of sporophyte, spore dispersal mechanisms, ecological significance, economic importance and current perspectives in bryophyte biology. Comparative Morphology and Development: Structure, anatomy and development of Marchantiales (<i>Marchantia</i>), Jungermanniales (<i>Pellia</i>), Anthocerotales (<i>Anthoceros</i>), Sphagnales (<i>Sphagnum</i>), Funariales (<i>Funaria</i>) and Polytrichales (<i>Polytrichum</i>).	16
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		

- Graham, L.E., Graham, J.M., Wilcox, L.W. and Cook, M.E. (2022) *Algae*. 3rd Edn. Pearson.
- Lee, R.E. (2018) *Phycology*. 5th Edn. Cambridge University Press.
- Shaw, A.J., Goffinet, B. and Buck, W.R. (2022) *Bryophyte Biology*. 3rd Edn. Cambridge University Press.
- Vanderpoorten, A. and Goffinet, B. (2009) *Introduction to Bryophytes*. Cambridge University Press.
- Round, F.E. (1981) *The Ecology of Algae*. Cambridge University Press.
- Smith, G.M. (2020) *Cryptogamic Botany: Algae and Fungi*. McGraw-Hill Book Company.
- Kumar, H.D. (2019) *Introductory Phycology*. Reprint Edn. Affiliated East-West Press.
- Singh, V., Pande, P.C. and Jain, D.K. (2020) *A Textbook of Botany: Algae*. Rastogi Publications.
- Gupta, R. (2021) *Bryology*. Kalyani Publishers.
- Vashishta, B.R., Sinha, A.K., Kumar, A. and Singh, V.P. (2022) *Botany for Degree Students: Algae*. S. Chand Publishing.
- Fritsch, F.E. (1945) *The Structure and Reproduction of the Algae*. Vol. I. Cambridge University Press.
- Fritsch, F.E. (1949) *The Structure and Reproduction of the Algae*. Vol. II. Cambridge University Press.
- Smith, G.M. (1955) *Cryptogamic Botany: Algae and Fungi*. Vol. I. McGraw-Hill.
- Parihar, N.S. (1967) *An Introduction to Embryophyta: Bryophyta*. Central Book Depot.
- Kashyap, S.R. (1929-1932) *Liverworts of the Western Himalayas and the Punjab Plain*. Vols. I-II. University of the Punjab.

Subject: Botany Semester VII (Session 2026-27)

Part A - Introduction

Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-H2 (4 Credits) Scheme B & C	24L6.0-BOT-702	Pteridophytes, Palaeobotany and Gymnosperms	4	4	30	70	100	3

Level of the course (As per Annexure-I)	
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Pre-Requisite for the course (if any):

Learning Objectives: To enable students to understand the diversity, evolution, morphology and reproductive biology of pteridophytes, gymnosperms and fossil plants, and to appreciate their phylogenetic significance and role in plant evolution and earth's vegetation history.

Course Learning Outcomes (CLO): After completing this course, the learner will be able to

1. understand the diversity, classification and evolutionary relationships of pteridophytes, gymnosperms and fossil plants.
2. explain the morphology, anatomy and reproductive structures of major groups of pteridophytes and gymnosperms.
3. analyze fossil plant records and interpret major evolutionary trends in plant life forms through geological time.
4. evaluate the phylogenetic significance and economic importance of pteridophytes and gymnosperms in modern plant systems.

Part B - Contents of the Course	
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Instruction for Paper Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.

Unit	Topics	Contact Hours
I	Introduction to Pteridology: General characteristics and classification of pteridophytes, origin and evolution, diversity and distribution, morphology, anatomy, reproduction and life cycle, spore dispersal, economic importance and ecological significance of pteridophytes. Major Groups and Evolutionary Trends: Comparative morphology and reproduction among Psilopsida, Lycopsidea, Sphenopsida and Pteropsida; telome theory, enation theory, stelar evolution, evolution of leaves, heterospory, origin and significance of seed habit.	14

II	Advanced Pteridology: Gametophyte biology, endosporic gametophytes, apogamy and apospory; phylogenetic relationships and adaptive strategies; retention of megaspore, origin and evolution of ovule. Fundamentals of Palaeobotany and Fossil Pteridophytes: Types of rocks, fossils and fossilization processes; notable Indian palaeobotanists; study of fossil pteridophytes with special reference to <i>Rhynia</i> and <i>Lepidodendron</i>; progymnosperms and their evolutionary significance.	16
III	Introduction to Gymnosperms: General characters, classification, origin and evolution of seed plants, diversity and distribution in India, life cycle patterns, ecological significance and economic importance of gymnosperms. Fossil Gymnosperms, Seed Ferns and Gondwana Flora: Study of Pteridospermales (Seed Ferns), Cycadeoidales (<i>Cycadeoidea</i>) and Glossopteridales (<i>Glossopteris</i>); Gondwana flora and its significance in continental drift, palaeogeography, palaeoclimate and evolution of seed plants.	14
IV	Primitive Living Gymnosperms: Morpho-anatomical features and reproduction in <i>Cycas</i> and <i>Ginkgo</i>; comparative study of vegetative organization, reproductive structures and life-cycle patterns. Advanced Living Gymnosperms: Morpho-anatomical features and reproduction in <i>Pinus</i>, <i>Gnetum</i>, <i>Ephedra</i> and <i>Welwitschia</i>; comparative study of vegetative and reproductive structures, gametophytes; evolutionary trends and interrelationships among living gymnosperm groups	16
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		
• Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010) Gymnosperms. S. Chand Publishing. • Rashid, A. (2012) An Introduction to Pteridophyta. Vikas Publishing House. • Bhatnagar, S.P. and Moitra, A. (1996) Gymnosperms. New Age International Publishers. • Taylor, T.N., Taylor, E.L. and Krings, M. (2009) Paleobotany: The Biology and Evolution of Fossil Plants. 2nd Edn. Academic Press. • Stewart, W.N. and Rothwell, G.W. (2010) Paleobotany and the Evolution of Plants. 2nd Edn. Cambridge University Press. • Ranker, T.A. and Haufler, C.H. (Eds.) (2008) Biology and Evolution of Ferns and Lycophytes. Cambridge University Press.		

Subject: Botany Semester VII (Session 2026-27)								
Part A - Introduction								
Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-H3 (4 Credits) Scheme B & C	24L6.0-BOT-703	Microbiology and Mycology	4	4	30	70	100	3
Level of the course (As per Annexure-I)								
Pre-Requisite for the course (if any):								
Learning Objectives: To enable students to understand the diversity, structure, classification and significance of microorganisms and fungi, their ecological roles, economic importance and interactions with plants and the environment.								
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand the diversity, classification and general characteristics of microorganisms and fungi. 2. explain the structural organization, life cycles and reproductive strategies of major microbial and fungal groups. 3. analyze the ecological roles and plant–microbe interactions including beneficial and pathogenic associations. 4. evaluate the economic, industrial and agricultural importance of microorganisms and fungi in biotechnology and plant health management.								
Part B - Contents of the Course								
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.								
Unit	Topics							Contact Hours
I	Introduction to Microbiology and Bacteriology: Scope and history of microbiology, classification and diversity of microorganisms, types and ultrastructure of bacterial cell (cell wall, plasma membrane, capsule, flagella, pili, endospores); general account and economic importance of archaebacteria and eubacteria. Virology and Microbial Diversity: General properties of viruses, bacteriophages, structure and replication of viruses (lytic and lysogenic cycles), characteristics and economic importance of prions, viroids, virusoids, virions, viruses, bacteriophages and phytoplasmas.							14

II	Principles of Mycology: General characters and economic importance of fungi, thallus organization and cell wall composition, reproduction and kinds of spores; classification based on Ainsworth (1973), Hawksworth <i>et al.</i> (1995), Alexopoulos <i>et. al</i> (1996). Morphology, Reproduction and Life-Cycle of Fungal Group: Slime moulds (Dictyosteliomycota, Myxomycota), Mastigomycotina (Chytridiomycota, Oomycota), Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.	16
III	Specialized Mechanisms in Fungi: Heterothallism, heterokaryosis (dikaryotization), parasexuality and sex hormones. Applied Mycology: Role of fungi in agriculture and industry, edible and medicinal mushrooms, production of alcohol, enzymes, antibiotics, vitamins and mycoproteins, role in fermentation processes such as bread and cheese production, fungal deterioration of materials.	14
IV	Plant-Microbe Symbioses: Structure, types, reproduction and significance of mycorrhizal associations, ectomycorrhiza and endomycorrhiza, role in mineral nutrient uptake and plant productivity; biology, ecological significance and agricultural importance of Rhizobium; role in soil fertility. Lichenology: Structure, types, reproduction and classification of lichens, symbiotic nature, ecological significance and economic importance with special reference to lichens as bioindicators.	16
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		
• Brock, T.D., Madigan, M.T., Bender, K.S., Buckley, D.H. and Sattley, W.M. (2021) Brock Biology of Microorganisms. 16th Edn. Pearson. • Piepenbring, M. (2022) Mycology: Diversity, Morphology, Ecology and Evolution of Fungi. Springer. • Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996) Introductory Mycology. 4th Edn. Wiley. • Ananthanarayan, R. and Paniker, C.K.J. Ananthanarayan and Paniker's Textbook of Microbiology. 13th Edn. Orient BlackSwan. • Ainsworth, G.C. and Bisby, G.R. (2008) Dictionary of the Fungi. 10th Edn. CABI Publishing. • Singh, U.S. and Mukhopadhyay, A.N. (Eds.) (2018) Plant Diseases: Identification and Management. CRC Press, Boca Raton. • Butler, E.J. (1918) Fungi and Disease in Plants: An Introduction to the Diseases of Field and Plantation Crops, Especially Those of India and the East. Longmans, Green and Co.		

Subject: Botany Semester VII (Session 2026-27)

Part A - Introduction

Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-6-H1 (4 Credits) Scheme B & C	24L6.0-BOT-704	Cell and Inheritance Biology	4	4	30	70	100	3

Level of the course (As per Annexure-I)	
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Pre-Requisite for the course (if any):

Learning Objectives: To enable students to understand the structure and function of cells, principles of heredity, chromosome organization, cell signalling and genetic mechanisms governing biological processes.

Course Learning Outcomes (CLO): After completing this course, the learner will be able to

1. understand the organization of cells, cell cycle and basic principles of heredity.
2. explain Mendelian and non-Mendelian inheritance patterns and their genetic basis.
3. analyze chromosomal structure, behavior and variations during cell division.
4. apply molecular principles of genetics including gene expression, regulation and mutation.

Part B - Contents of the Course	
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Instruction for Paper Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.

Unit	Topics	Contact Hours
I	Cell Organization: Cell theory, diversity of cell types, prokaryotic and eukaryotic cells, compartmentalization of eukaryotic cells, ultrastructure and functional organization of nucleus, mitochondria, chloroplast, vacuoles, endoplasmic reticulum, golgi complex and ribosomes. Biomembranes and Cell Techniques: Structure and Functions of biomembranes; models of plasma membrane, membrane transport mechanisms, donnan equilibrium; principles and applications of light, fluorescence, phase-contrast and electron microscopy.	14
II	Cell Division and Signal Transduction: Prokaryotic and eukaryotic cell cycle phases; M-phase (mitosis, meiosis and fertilization); regulation and checkpoints; cytokinesis and cell plate formation; cell fractionation, flow cytometry and centrifugation.	16

	Special Chromosomes: Structure, occurrence, origin, morphology, organization and behaviour of polytene chromosomes, lampbrush chromosomes, B chromosomes and sex chromosomes, their cytogenetic significance, functional role and evolutionary implications.	
III	Mendelian and Non-Mendelian (Allelic Interactions) inheritance: Mendelian principles of inheritance, codominance, incomplete dominance, chromosomal basis of inheritance, linkage and crossing over, tetrad analysis, recombination frequency and genetic mapping. Gene Interactions and Patterns of Inheritance: Gene interactions; sex-linked, sex-limited and sex-influenced traits; cytoplasmic inheritance, multiple alleles, pleiotropy, penetrance, expressivity, polygenic inheritance; sex determination and dosage compensation in plants.	14
IV	Mutation and Cytogenetics: Mutation (types, mutagens, mechanism), karyotyping, chromosomal aberrations (structural and numerical alterations) and their evolutionary significance; chromosomal banding techniques. Pedigree and Extra-Chromosomal Inheritance: Pedigree analysis; inheritance of plastid and mitochondrial genes; complementation test; genetic recombination in microbes (conjugation, sexduction, transformation and transduction).	16
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		
• Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. (2015) Molecular Biology of the Cell. 6th Edn. Garland Science. • Cooper, G.M. and Hausman, R.E. (2013) The Cell: A Molecular Approach. 6th Edn. Sinauer Associates. • Brooker, R.J. (2018) Genetics: Analysis and Principles. 6th Edn. McGraw-Hill Education. • Griffiths, A.J.F., Wessler, S.R., Carroll, S.B. and Doebley, J. (2015) Introduction to Genetic Analysis. 11th Edn. W.H. Freeman. • Snustad, D.P. and Simmons, M.J. (2020) Principles of Genetics. 8th Edn. John Wiley & Sons. • Hancock, J.T. (2010) Cell Signalling. 3rd Edn. Oxford University Press. • Sharma, A.K. and Sharma, A. (2014) Chromosome Techniques: Theory and Practice. Elsevier. • Gupta, P.K. (2018) Cell and Molecular Biology. Rastogi Publications. • Verma, P.S. and Agarwal, V.K. (2010) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Publishing.		

Subject: Botany Semester VII (Session 2026-27)								
Part A - Introduction								
Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-6-H1 (4 Credits) Scheme B & C	24L6.0-BOT-705	AI, Machine Learning and Computational Biology	4	4	30	70	100	3
Level of the course (As per Annexure-I)								
Pre-Requisite for the course (if any):								
Learning Objectives: To enable students to understand the fundamentals of artificial intelligence, machine learning and computational biology and their applications in biological data analysis, genomics, proteomics, prediction modelling and life science research.								
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand the basic concepts of artificial intelligence, machine learning and computational biology. 2. explain biological data types and computational approaches used in genomics, proteomics and bioinformatics. 3. analyze algorithms and models used for prediction and pattern recognition in biological systems. 4. apply computational tools for solving biological problems and interpreting large-scale biological datasets.								
Part B - Contents of the Course								
Instruction for Paper Setter								
1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.								
Unit	Topics							Contact Hours
I	Computational Biology and Plant Data: Concept, scope and applications of computational biology in plant sciences; relationship among bioinformatics, computational biology, artificial intelligence and machine learning; types, organization and analysis of plant biological data. Basics of AI and Machine Learning: Concepts of artificial intelligence and machine learning, supervised and unsupervised learning; simple machine learning workflow including data collection, cleaning, training, testing, prediction, visualization and interpretation.							14
II	Biological Databases: Introduction to important biological databases useful in plant sciences including NCBI, UniProt, PDB, Ensembl Plants, TAIR, Gramene,							16

	KEGG and Plant Reactome; retrieval and interpretation of nucleotide, protein, genome and pathway information. Plant Sequence Analysis: Sequence retrieval, FASTA format, BLAST, pairwise alignment, GenBank, multiple sequence alignment and basic phylogenetic interpretation; DNA barcoding and its use in plant identification using selected barcode regions such as <i>rbcL</i> , <i>matK</i> and ITS.	
III	Protein and Functional Information: Introduction to protein sequence and structure data; basic protein structure visualization; interpretation of protein accession, domain information and functional annotation. Plant Omics and Pathway Analysis: Overview of genomics, transcriptomics, proteomics and metabolomics in plant sciences; gene function annotation, biological pathway maps and elementary network visualization.	14
IV	Machine Learning Applications in Plant Sciences: Applications of machine learning in biological sciences with special reference to plant biology, genomics, bioinformatics and natural product research; introduction to regression, decision trees, random forests and clustering. Model Interpretation and Responsible AI: Concept of training and testing datasets, accuracy and confusion matrix; importance of data quality, reproducibility, bias, ethical use of AI tools.	16
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		
• Lesk, A.M. (2019) Introduction to Bioinformatics. 5th Edn. Oxford University Press. • Mount, D.W. (2021) Bioinformatics: Sequence and Genome Analysis. 2nd Edn. Cold Spring Harbor Laboratory Press. • Pevsner, J. (2023) Bioinformatics and Functional Genomics. 4th Edn. Wiley-Blackwell. • Baldi, P. and Brunak, S. (2001) Bioinformatics: The Machine Learning Approach. 2nd Edn. MIT Press. • Alpaydin, E. (2021) Introduction to Machine Learning. 5th Edn. MIT Press. • Mitchell, T.M. (1997) Machine Learning. McGraw-Hill Education. • Russell, S.J. and Norvig, P. (2021) Artificial Intelligence: A Modern Approach. 4th Edn. Pearson. • Zvelebil, M. and Baum, J.O. (2008) Understanding Bioinformatics. Garland Science.		

Subject: Botany Semester VII (Session 2026-27)								
Part A - Introduction								
Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
PS-H1 (4 Credits) Scheme B & C	24L6.0-BOT-706	Practical Based on 24L6.0-BOT-701 to 24L6.0-BOT-703 and any one out of 24L6.0-BOT-704 Or 24L6.0-BOT-705	4	8	30	70	100	3
Level of the course (As per Annexure-I)								
Pre-Requisite for the course (if any):								
Learning Objectives: To develop hands-on competence in the study of plant diversity microscopic structures genetic principles fossil evidence microbial forms and/ or basic computational analysis with an integrated practical approach to modern biological sciences.								
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. identify and document major groups of algae, bryophytes, pteridophytes, fungi and microbes using morphological and microscopic characters. 2. prepare and observe permanent and temporary slides and demonstrate basic techniques in cell biology, genetics and fossil study. 3. apply practical methods for recording analyzing and interpreting biological data from classical and digital sources. 4. use basic AI, machine learning and computational biology tools for simple biological data organization, visualization and interpretation.								
Part B - Contents of the Course								
Suggested Practical Works								Contact Hours
24L6.0-BOT-701: Cyanobacteria, Phycology and Bryology • Study and identification of representative members of cyanobacteria, algae and bryophytes included in the theory syllabus or available in the departmental museum, herbarium, culture collection or local habitats. • Study of important diagnostic characters, classification and economic or ecological significance. • Preparation and observation of temporary slides wherever applicable. • Identification of specimens, preserved materials, charts, models or suitable digital resources.								120

24L6.0-BOT-702: Pteridophytes, Palaeobotany and Gymnosperms

- Study and identification of representative members of pteridophytes and gymnosperms included in the theory syllabus or available in the departmental museum, herbarium or local habitats.
- Study of important vegetative and reproductive structures using fresh materials, preserved specimens, slides, charts or models.
- Study and identification of representative fossil plant specimens, impressions, photographs, casts or digital resources included in the theory syllabus.

24L6.0-BOT-703: Microbiology and Mycology

- Study and identification of representative microorganisms and fungi included in the theory syllabus using cultures, permanent slides, preserved specimens or locally available materials.
- Observation of morphological characteristics, reproductive structures and diagnostic features.
- Preparation of temporary slides and staining techniques wherever applicable.
- Study of economically and ecologically important microorganisms and fungi.

24L6.0-BOT-704: Cell Biology and Inheritance Biology

- Study of mitosis and meiosis using permanent slides, temporary preparations or suitable digital resources.
- Study of cell organelles, chromosomes and cellular structures through prepared slides, models or photomicrographs.
- Preparation of temporary slides using appropriate staining and mounting techniques.
- Calibration and use of ocular micrometer for measurement of cells and tissues.
- Practice of Mendelian genetics through suitable genetic problems, pedigree analysis and interpretation of inheritance patterns.
- Preparation of practical records, labeled diagrams and observation sheets.

OR

24L6.0-BOT-705: AI, Machine Learning and Computational Biology

- Retrieval and organization of nucleotide, protein and biodiversity data from publicly available biological databases including NCBI, UniProt, TAIR and Ensembl Plants.
- Sequence similarity search, sequence alignment and basic phylogenetic interpretation using suitable online bioinformatics tools.
- Preparation, visualization and interpretation of biological datasets using spreadsheets and freely available computational platforms.
- Demonstration of introductory applications of artificial intelligence and machine learning in biological data analysis using suitable datasets and educational software.
- Preparation of reports based on biological databases, computational analysis and digital resources.

Note: The practical exercises are indicative rather than exhaustive. Depending upon the availability of specimens, cultures, laboratory facilities, instruments, software, departmental resources and locally available biological materials, the concerned teacher or department may conduct suitable practical exercises relevant to the theory syllabus while ensuring the attainment of the prescribed

course learning outcomes.		
Excursion/ Educational Visit: An educational visit to a botanical garden, herbarium, museum, microbial culture collection, central instrumentation facility, bioinformatics laboratory, research institute or any other relevant organization may be arranged, wherever feasible and students shall submit an excursion report.		
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		
• Sharma, O.P. (2011) Algae. McGraw Hill Education, New Delhi. • Parihar, N.S. (1991) An Introduction to Embryophyta: Bryophyta. Central Book Depot, Allahabad. • Rashid, A. (1998) An Introduction to Pteridophyta. Vikas Publishing House, New Delhi. • Vashishta, B.R. and Sinha, A.K. (2010) Fungi. S. Chand and Company, New Delhi. • Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996) Introductory Mycology. 4th Edn. John Wiley & Sons, New York. • De Robertis, E.D.P. and De Robertis, E.M.F. (2001) Cell and Molecular Biology. 8th Edn. Lippincott Williams and Wilkins, Philadelphia. • Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2012) Principles of Genetics. 8th Edn. John Wiley & Sons, New York. • Conway Morris, S. (2000) The Crucible of Creation. Oxford University Press, Oxford. • Benton, M.J. and Harper, D.A.T. (2019) Introduction to Paleobiology and the Fossil Record. 2nd Edn. Wiley Blackwell, Hoboken. • Pevsner, J. (2015) Bioinformatics and Functional Genomics. 3rd Edn. Wiley Blackwell, Hoboken. • Lesk, A.M. (2019) Introduction to Bioinformatics. 5th Edn. Oxford University Press, New York. • James, G., Witten, D., Hastie, T. and Tibshirani, R. (2021) An Introduction to Statistical Learning. 2nd Edn. Springer, New York.		

Subject: Botany Semester VIII (Session 2026-27)								
Part A - Introduction								
Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-H4 (4 Credits) Scheme B & C	24L6.0- BOT-801	Angiosperm Systematics and Economic Botany	4	4	30	70	100	3
Level of the course (As per Annexure-I)								
Pre-Requisite for the course (if any):								
Learning Objectives: To enable students to understand the principles of angiosperm classification, systematics and phylogeny along with the economic importance and utilization of flowering plants for food, fibre, medicine and other human needs.								
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand principles of plant taxonomy, nomenclature and classification systems of angiosperms. 2. identify major angiosperm families based on diagnostic morphological characters. 3. analyze phylogenetic relationships and modern classification systems of flowering plants. 4. evaluate the economic importance and uses of plant resources in agriculture, industry and daily life.								
Part B - Contents of the Course								
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.								
Unit	Topics							Contact Hours
I	Taxonomic Resources and Botanical Institutions: history, scope and significance of taxonomy and systematics; importance of floras, manuals, monographs, taxonomic keys, indices, herbaria and botanical gardens; taxonomic hierarchy and ranks; modifications of root, stem and leaf. Botanical Nomenclature and Taxonomic Evidence: Principles of botanical nomenclature and International Code of Nomenclature (ICN) for algae, fungi and plants (ICNafp), BioCode and PhyloCode; typification; taxonomic evidence and dichotomous keys; role of BSI in floristic studies.							14
II	Phylogeny and Evolution of Angiosperms: General characteristics and diversification of angiosperms; evolutionary significance of basal angiosperms (Amborellales, Nymphaeales and Austrobaileyaes); origin and evolution of							16

	flower; overview of major angiosperm clades including magnoliids, monocots, basal eudicots and core eudicots. Systems of Classification and Modern Approaches: Overview of major classification systems with special reference to Bentham & Hooker and APG IV (2016); types of taxonomy (alpha, beta and omega); modern tools such as numerical taxonomy, cladistics, cytotaxonomy, chemotaxonomy and serotaxonomy.	
III	Diagnostic Features, Systematic Position and Economic Importance of Dicot Families: Ranunculaceae, Papaveraceae, Brassicaceae, Malvaceae, Fabaceae, Cucurbitaceae, Apiaceae, Lamiaceae, Solanaceae, Euphorbiaceae and Asteraceae, with special reference to oil-yielding, fibre-yielding, medicinal, aromatic, spices and ornamental plants. Diagnostic Features, Systematic Position and Economic Importance of Monocot Families: Araceae, Liliaceae, Zingiberaceae, Cannaceae, Cyperaceae, Poaceae and Orchidaceae, with special reference to food crops, fodder plants, spices, medicinal and ornamentals.	14
IV	Origin of Agriculture: History and development of agriculture; origin and domestication of economic plants; centres of diversity; plant introduction and secondary centres of origin; innovations for meeting world food demands. Forest Products, Non-Wood Forest Products and Urban Green Resources: Important firewood and timber-yielding plants; non-wood forest products including gums, tannins, dyes, resins, bamboos and rattans; avenue trees for shade and urban landscaping.	16
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		
- Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. (2016) Plant Systematics: A Phylogenetic Approach. 4th Edn. Sinauer Associates. - Simpson, M.G. (2019) Plant Systematics. 3rd Edn. Academic Press. - Rana, T.S. (2014) Plant Taxonomy and Biosystematics: Classical and Modern Methods. New India Publishing Agency. - Simpson, B.B. and Ogorzaly, M.C. (2014) Plants in Our World: Economic Botany. 4th Edn. McGraw-Hill Education. - Kochhar, S.L. (2016) Economic Botany: A Comprehensive Study. 5th Edn. Cambridge University Press. - Sambamurty, A.V.S.S. (2009) Economic Botany in the Tropics. New Age International Publishers.		

Subject: Botany Semester VIII (Session 2026-27)								
Part A - Introduction								
Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-H5 (4 Credits) Scheme B & C	24L6.0-BOT-802	Plant Anatomy and Embryology	4	4	30	70	100	3
Level of the course (As per Annexure-I)								
Pre-Requisite for the course (if any):								
Learning Objectives: To enable students to understand the structural organization of plant body and reproductive development in flowering plants from cellular differentiation to seed formation, integrating anatomy with embryological processes.								
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand plant tissue systems, organ structure and internal anatomy of roots, stems and leaves. 2. explain the development of male and female gametophytes and fertilization in angiosperms. 3. analyze post-fertilization events including embryo, endosperm and seed development. 4. relate anatomical structure with functional adaptations and reproductive success in plants.								
Part B - Contents of the Course								
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.								
Unit	Topics							Contact Hours
I	Plant Tissue Systems: Classification, structure and functions of simple and complex tissues; parenchyma, collenchyma, sclerenchyma, xylem and phloem; tissue systems and their organization in plants. Meristems and Primary Structure: Apical, lateral and intercalary meristems; theories of apical organization; primary tissue organization; structure and functional organization of xylem and phloem.							14
II	Comparative Anatomy: Anatomy of dicot and monocot root, stem and leaf, stomatal types; wood anatomy including growth rings, heartwood, sapwood, porous and non-porous woods. Secondary Growth and Applications of Anatomy: Primary and secondary growth; anomalous structure and abnormal secondary growth in stems; applications of plant anatomy in systematics, archaeology and climate change							16

	studies.	
III	Male Gametophyte Development: Origin and evolution of stamen; structure and development of anther; microsporogenesis and microspore tetrads; tapetum and its functions; pollen development, pollen wall organization and pollenkit. Pollination and Pollen Biology: Pollination mechanisms; pollen-pistil interaction; pollen germination and pollen tube growth; pollen viability and storage; pollen morphology, apertures and exine sculpturing; brief account of palynology and its applications.	14
IV	Female Gametophyte Development: Origin and evolution of carpel; ovule development and types; megasporogenesis; organization of embryo sac; structure and functions of egg apparatus, synergids, antipodals and central cell. Fertilization, Embryogenesis and Reproductive Specializations: Double fertilization; endosperm development and types; embryogeny and seed development; fruit set, fruit development and classification of fruits; polyembryony, apomixis and parthenocarpy.	16
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		
• Evert, R.F. (2005) Esau's Plant Anatomy: Meristems, Cells and Tissues of the Plant Body - Their Structure, Function and Development. John Wiley & Sons. • Crang, R., Lyons-Sobaski, S. and Wise, R. (2018) Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants. Springer Nature. • Esau, K. (1977) Anatomy of Seed Plants. 2nd Edn. John Wiley & Sons. • Bhojwani, S.S. and Bhatnagar, S.P. (2017) The Embryology of Angiosperms. 6th Edn. Vikas Publishing House. • Maheshwari, P. (2012) An Introduction to the Embryology of Angiosperms. McGraw-Hill Education India. • Lersten, N.R. (2013) Flowering Plant Embryology. Wiley India Pvt. Ltd. • Parihar, N.S. and Jain, A.K. (1997) A Textbook of Embryology of Angiosperms. Rastogi Publications.		

Subject: Botany Semester VIII (Session 2026-27)								
Part A - Introduction								
Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
CC-H6 (4 Credits) Scheme B & C	24L6.0-BOT-803	Plant Ecology and Environmental Biology	4	4	30	70	100	3
Level of the course (As per Annexure-I)								
Pre-Requisite for the course (if any):								
Learning Objectives: To enable students to understand ecological principles, plant-environment interactions and ecosystem functioning along with contemporary environmental issues and strategies for conservation and sustainable resource management.								
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand basic ecological concepts, ecosystem structure and environmental components. 2. explain plant interactions with biotic and abiotic environmental factors. 3. analyze ecosystem processes such as energy flow, nutrient cycling and population dynamics. 4. evaluate environmental challenges and conservation strategies for sustainable ecosystem management.								
Part B - Contents of the Course								
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.								
Unit	Topics							Contact Hours
I	The Environment: Physical environment (climate, soil and water), biotic environment, biotic and abiotic interactions, ecophene and ecotype; plant adaptations to major environmental stresses (hydrophytes, xerophytes, halophytes and epiphytes); natural capital and techno-ecosystem. Habitat and Niche Ecology: Concept of habitat and niche, ecological amplitude, niche width and overlap, fundamental and realized niche, character displacement, resource partitioning; Raunkiaer's life forms and biological spectrum; major habitat types of the Indian subcontinent.							14
II	Population Ecology: Population characteristics, population growth curves, population regulation, life history strategies (r- and K-selection), age-structured populations, life tables, survivorship curves and age pyramids. Community Ecology: Nature, structure and attributes of communities,							16

	community analysis (analytical and synthetic characters), species richness and evenness, levels of species diversity and its measurement, edges and ecotones.	
III	Species Interactions and Ecological Succession: Types of interactions (mutualism, competition, herbivory, carnivory, pollination and symbiosis), Lotka-Volterra models of competition and predation, ecological succession, primary and secondary succession, facilitation, tolerance and inhibition models, concept of climax. Ecosystem Functioning and Energy Flow: Trophic structure, ecological pyramids, food chains and food webs, energy flow, ecological efficiencies and ecosystem productivity.	14
IV	Nutrient Cycling and Ecosystem Stability: Decomposition, mechanism of decomposition, substrate quality and climatic factors, global biogeochemical cycles of carbon, nitrogen, phosphorus and sulfur, ecosystem stability and resilience. Environmental Pollution and Climate Change: Air, water and land pollution, acid rain, particulate pollution, global environmental change and its consequences including CO₂ fertilization, global warming, sea-level rise, ozone depletion and UV-B radiation effects.	16
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		
• Molles, M.C. and Sher, A.A. (2019) Ecology: Concepts and Applications. 8th Edn. McGraw-Hill Education. • Cain, M.L., Bowman, W.D. and Hacker, S.D. (2018) Ecology. 4th Edn. Oxford University Press. • Gurevitch, J., Scheiner, S.M. and Fox, G.A. (2020) The Ecology of Plants. 3rd Edn. Oxford University Press. • Sharma, P.D. (2025) Ecology and Environment. 13th Edn. Rastogi Publications. • Singh, J.S., Singh, S.P. and Gupta, S.R. (2017) Ecology, Environmental Science and Conservation. S. Chand Publishing. • Odum, E.P. and Barrett, G.W. (2005) Fundamentals of Ecology. 5th Edn. Thomson Brooks/Cole. • Begon, M., Townsend, C.R. and Harper, J.L. (2006) Ecology: From Individuals to Ecosystems. 4th Edn. Blackwell Publishing. • Ricklefs, R.E. and Relyea, R.A. (2019) Ecology: The Economy of Nature. 8th Edn. W.H. Freeman.		

Subject: Botany Semester VIII (Session 2026-27)								
Part A - Introduction								
Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-7-H2 (4 Credits) Scheme B & C	24L6.0-BOT-804	Molecular and Evolutionary Biology	4	4	30	70	100	3
Level of the course (As per Annexure-I)								
Pre-Requisite for the course (if any):								
Learning Objectives: To enable students to understand molecular mechanisms of heredity, gene expression and evolutionary processes that explain the origin, diversity and adaptation of living organisms.								
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. understand molecular basis of genetic material, gene structure and genome organization. 2. explain mechanisms of gene expression, regulation and molecular inheritance. 3. analyze evolutionary processes including mutation, selection, genetic drift and speciation. 4. evaluate molecular evidence supporting evolution and phylogenetic relationships among organisms.								
Part B - Contents of the Course								
Instruction for Paper Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.								
Unit	Topics							Contact Hours
I	Organization and Structure of Genetic Material: Historical overview and central dogma, DNA as genetic material, DNA structure and forms (A, B, Z), genome organization (DNA renaturation kinetics, repetitive and unique DNA, c-value paradox, interrupted genes and gene families), chromatin organization (euchromatin and heterochromatin), nucleosome concept, chromosome organization (centromere, telomere, kinetochore). DNA Replication and Repair: DNA replication in prokaryotes and eukaryotes, DNA polymerases and other proteins/ enzymes involved in replication, fidelity of replication and replication models, DNA damage and repair mechanisms.							14
II	Transcription and RNA Processing: Transcription in prokaryotes and eukaryotes, RNA types and functions, RNA polymerases and other transcription factors; initiation, elongation and termination; 5' capping, polyadenylation,							16

	splicing, RNA editing, RNA interference and mRNA stability. Translation and Regulation of Gene Expression: Genetic code; ribosome structure; Shine-Dalgarno and Kozak sequences, protein synthesis, Wobble hypothesis, translational regulation, co- and post-translational modifications; epigenetic regulation including chromatin remodelling, DNA methylation and genomic imprinting, DNA-binding motifs.	
III	Genome Function and Molecular Tools: Operon concept, regulation of gene expression in phages, viruses, prokaryotes and eukaryotes; gene silencing; non-coding and regulatory RNAs; mobile DNA; basics of CRISPRs-Cas systems. Molecular Evolution and Organelle Evolution: Neutral theory of molecular evolution; molecular divergence and molecular clocks; genome evolution; gene duplication and divergence; origin of new genes; endosymbiotic theory and the evolution of chloroplasts and mitochondria.	14
IV	Origin of Life and Evolutionary Thought: Origin of life and prebiotic environment; Oparin-Haldane concept; Miller experiment; Lamarckism, Darwinism, Neo-Darwinism and natural selection, modern evolutionary synthesis. Evolutionary Processes and Patterns: Hardy-Weinberg equilibrium; genetic drift, adaptation, mechanisms of speciation; adaptive radiation, convergent evolution, coevolution; monophyletic, paraphyletic and polyphyletic groups), tree of life (three-domain system of Carl Woese); broad evolutionary trends from primitive photosynthetic organisms to angiosperms.	16
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		
• Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Martin, K.C. (2021) Molecular Cell Biology. 9th Edn. W.H. Freeman. • Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2014) Molecular Biology of the Gene. 7th Edn. Pearson. • Lewin, B., Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (2017) Lewin's Genes XII. Jones & Bartlett Learning. • Futuyma, D.J. and Kirkpatrick, M. (2017) Evolution. 4th Edn. Sinauer Associates. • Graur, D. and Li, W.H. (2000) Fundamentals of Molecular Evolution. 2nd Edn. Sinauer Associates. • Verma, P.S. and Agarwal, V.K. (2020) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Publishing. • Mayr, E. (2001). What Evolution Is. Basic Books.		

Subject: Botany Semester VIII (Session 2026-27)
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Part A - Introduction

Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
DSE-7-H2 (4 Credits) Scheme B & C	24L6.0-BOT-805	Plant Immunity and Defense Systems	4	4	30	70	100	3

Level of the course (As per Annexure-I)	
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Pre-Requisite for the course (if any):

Learning Objectives: To enable students to understand the structural, biochemical and molecular mechanisms of plant defense, innate immunity, host-pathogen interactions and induced resistance for sustainable plant health management.

Course Learning Outcomes (CLO): After completing this course, the learner will be able to

1. understand basic concepts of plant–pathogen interactions and plant immune systems.
2. explain structural, biochemical and molecular defense mechanisms in plants.
3. analyze signaling pathways involved in local and systemic plant defense responses.
4. evaluate strategies for enhancing disease resistance and sustainable crop protection.

Part B - Contents of the Course	
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Instruction for Paper Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit.

Unit	Topics	Contact Hours
I	Plant Immune System and Pathogen Recognition: Concepts of plant immunity; biotrophic, necrotrophic and hemibiotrophic pathogens; pathogen-associated molecular patterns, pattern recognition receptors and pattern-triggered immunity. Effector Biology and Effector-Triggered Immunity: Pathogen effectors and effector recognition, resistance (R) and avirulence (Avr) genes, gene-for-gene concept, nucleotide-binding leucine-rich repeat proteins, effector-triggered immunity.	14
II	Signalling Networks in Plant Immunity: Calcium signalling, reactive oxygen species, MAP kinase cascades, nitric oxide signalling, systemic signalling during immune responses. Hormonal Regulation of Defence: Salicylic acid, jasmonic acid and ethylene signalling pathways; hormonal cross-talk, systemic acquired resistance and	16

	induced systemic resistance.	
III	Structural and Biochemical Defense Responses: Cell wall modifications, lignification, callose deposition, phytoalexins, pathogenesis-related proteins, antimicrobial compounds and defense enzymes. RNA-Based and Epigenetic Defense Mechanisms: RNA interference; small RNAs and defense regulation; epigenetic regulation of immunity; defense priming and immune memory.	14
IV	Plant Immunity in Crop Improvement: Resistance breeding, molecular markers for disease resistance, pyramiding of resistance genes, durable resistance, immunity in crop protection. Advanced Approaches in Plant Defense: Genome editing for disease resistance, CRISPR-based approaches, microbiome-assisted immunity, synthetic biology and future directions in plant defence research.	16
Suggested Evaluation Methods		
Internal Assessment (30)		End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10		➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources		
• Agrios, G.N. (2018) Plant Pathology. 6th Edn. Elsevier. • Mehrotra, R.S. and Aggarwal, A. (2017) Plant Pathology. 3rd Edn. McGraw Hill Education. • Jones, J.D.G. and Dangl, J.L. (2006) The Plant Immune System. Nature, 444, 323-329. • Boller, T. and Felix, G. (2009) A Renaissance of Elicitors: Perception of Microbe-Associated Molecular Patterns and Danger Signals by Pattern-Recognition Receptors. Annual Review of Plant Biology, 60, 379-406. • Pieterse, C.M.J., Zamioudis, C., Berendsen, R.L., Weller, D.M., Van Wees, S.C.M. and Bakker, P.A.H.M. (2014) Induced Systemic Resistance by Beneficial Microbes. Annual Review of Phytopathology, 52, 347-375. • Bent, A.F. and Mackey, D. (2007) Elicitors, Effectors and R Genes: The New Paradigm and a Lifetime Supply of Questions. Annual Review of Phytopathology, 45, 399-436.		

Subject: Botany Semester VII (Session 2026-27)								
Part A - Introduction								
Course Type and Remarks	Course Code	Name of the Course	Credit	Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
PS-H2 (4 Credits) Scheme B & C	24L6.0-BOT-806	Practical Based on 24L6.0-BOT-801 to 24L6.0-BOT-803 and any one out of 24L6.0-BOT-804 Or 24L6.0-BOT-805	4	8	30	70	100	3
Level of the course (As per Annexure-I)								
Pre-Requisite for the course (if any):								
Learning Objectives: To develop hands-on competence in the study of plant diversity microscopic structures genetic principles fossil evidence microbial forms and/ or basic computational analysis with an integrated practical approach to modern biological sciences.								
Course Learning Outcomes (CLO): After completing this course, the learner will be able to 1. identify and document major groups of algae, bryophytes, pteridophytes, fungi and microbes using morphological and microscopic characters. 2. prepare and observe permanent and temporary slides and demonstrate basic techniques in cell biology, genetics and fossil study. 3. apply practical methods for recording analyzing and interpreting biological data from classical and digital sources. 4. use basic AI, machine learning and computational biology tools for simple biological data organization, visualization and interpretation.								
Part B - Contents of the Course								
Suggested Practical Works								Contact Hours
24L6.0-BOT-801: Angiosperm, Systematics and Economic Botany • Study, identification, preparation and interpretation of floral formulae, floral diagrams and artificial keys of representative member/s of angiosperms from the families included in the theory syllabus using fresh materials, herbarium sheets, photographs, models or locally available specimens. • Preparation of herbarium sheets, field notes, taxonomic descriptions and plant checklists from locally available angiosperms. • Study of diagnostic vegetative and reproductive characters for plant identification.								120

- Identification of economically important plants, plant products and useful plant parts.
- Field survey and documentation of common cultivated, wild and economically important flowering plants.

24L6.0-BOT-802: Plant Anatomy and Embryology

- Study of internal structure of dicot and monocot root, stem and leaf using permanent slides, temporary preparations or suitable digital resources.
- Study of xylem, phloem, cambium, stomata, trichomes, vascular bundles and other anatomical features.
- Study of normal and anomalous secondary growth in selected plant parts.
- Preparation of temporary slides, sectioning, staining and mounting techniques.
- Study of anther, pollen, ovule, embryo sac, seed and fruit development using slides, models or charts.
- Demonstration of pollen viability, pollen germination or embryological stages wherever material is available.

24L6.0-BOT-803: Plant Ecology and Environmental Biology

- Study of ecological adaptations of xerophytes, hydrophytes and halophytes using fresh materials, preserved specimens or digital resources.
- Quadrat and transect methods for vegetation analysis.
- Estimation of density, frequency, abundance and basal area in a selected plant community.
- Study of soil and water parameters such as pH, moisture, salinity, temperature and dissolved oxygen.
- Documentation of ecological succession, pollution indicators and environmental disturbances through field visits or secondary data.
- Preparation of a brief ecological report based on local habitat observations.

24L6.0-BOT-804: Molecular Biology and Evolutionary Biology

- Isolation and demonstration of DNA or RNA using simple laboratory procedures or models.
- Estimation of nucleic acids and demonstration of electrophoresis through practical demonstration or digital simulation.
- Retrieval of nucleotide and protein sequences from public biological databases.
- Sequence similarity search using BLAST and interpretation of basic results.
- Preparation of simple phylogenetic trees using available software or online tools.
- Study of molecular markers, genome organization and evolutionary relationships using diagrams, charts or digital resources.

OR

24L6.0-BOT-805: Plant Immunity and Defence System

- Study of symptoms of plant diseases, host-pathogen interaction and defence responses using specimens, slides, charts or photographs.
- Identification of structural and biochemical defence mechanisms in plants.
- Study of disease symptoms caused by fungi, bacteria, viruses and nematodes from available materials.
- Demonstration of hypersensitive response, systemic acquired resistance and induced resistance through models, charts or digital resources.

• Preparation of a case study or report on plant disease diagnosis and defence response. • Field visit to a plant protection, pathology or research laboratory if feasible. Note: The practical exercises listed above are indicative rather than exhaustive. Depending upon the availability of specimens, cultures, laboratory facilities, instruments, software, departmental resources and locally available biological materials, the concerned teacher or department may conduct suitable practical exercises relevant to the theory syllabus while ensuring the attainment of the prescribed course learning outcomes. Excursion/ Educational Visit: An educational visit to a botanical garden, herbarium, museum, research institute, central instrumentation facility or any other relevant organization may be arranged wherever feasible, and students shall submit an excursion report.	
Suggested Evaluation Methods	
Internal Assessment (30)	End Term Examination (70)
➤ Theory ✓ Class Participation: 5 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5 ✓ Mid-Term Exam: 10	➤ Theory ✓ Written Examination: 70
Part C - Recommended Books/ e-resources	
• Pandey, B.P. (2010) Botany for Degree Students: Taxonomy of Angiosperms. S. Chand and Company, New Delhi. • Singh, G. (2020) Plant Systematics: Theory and Practice. 4th Edn. CRC Press, Boca Raton. • Jain, S.K. and Rao, R.R. (1977) A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi. • Johansen, D.A. (1940) Plant Microtechnique. McGraw Hill, New York. • Fahn, A. (1990) Plant Anatomy. 4th Edn. Pergamon Press, Oxford. • Bhojwani, S.S. and Bhatnagar, S.P. (2015) The Embryology of Angiosperms. 6th Edn. Vikas Publishing House, New Delhi. • Mishra, R. (2016) Ecology Workbook. Oxford and IBH Publishing Co., New Delhi. • Odum, E.P. and Barrett, G.W. (2005) Fundamentals of Ecology. 5th Edn. Cengage Learning, Belmont. • Brown, T.A. (2020) Gene Cloning and DNA Analysis: An Introduction. 8th Edn. Wiley Blackwell, Hoboken. • Agrios, G.N. (2005) Plant Pathology. 5th Edn. Elsevier Academic Press, Burlington. • Lucas, J.A. (2020) Plant Pathology and Plant Pathogens. 4th Edn. Wiley Blackwell, Hoboken. • Jones, J.D.G. and Dangl, J.L. (2006) The Plant Immune System. Nature, 444, 323-329.	