

# 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)								

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	Angiospermic Taxonomy, Anatomy and Embryology	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	Palynology and Seed Science	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	Biology of Cell, Genetics and Biotechnology	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	Plant Tissue Culture	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	Plant Breeding	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 Biology	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
	Any one	24L5.0- BOT-405	IPR, Biosafety and Bioethics	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)								

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 Physiology and Metabolism	T	3	3	20	50	100	3
				P	1	2	10	20		30
B & C	MCC-10 (4 Credits)	24L5.5- BOT-502	Phytochemistry	T	3	3	20	50	100	3
				P	1	2	10	20		30
B & C	DSE-2 (4 Credits)	24L5.5- BOT-503	Plant Defense Mechanism	T	3	3	20	50	100	3
				P	1	2	10	20		30
	Any one	24L5.5- BOT-504	Restoration Policy and Governance	T	3	3	20	50	100	3
				P	1	2	10	20		30
B & C	DSE-3 (4 Credits)	24L5.5- BOT-505	Natural Plant Products	T	3	3	20	50	100	3
				P	1	2	10	20		30
	Any one	24L5.5- BOT-506	Plants and Medicines	T	3	3	20	50	100	3
				P	1	2	10	20		30
A, B & C	Internship	24L5.5- BOT-507	<b>Internship of 4 credits of 4-6 weeks after V Semester</b> (if not done after II or IV semester)							
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**

**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**

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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	Conservation Biology	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	DSE-4 (4 Credits)  Any one	24L5.5- BOT-603	Forest and Waste Management	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
		24L5.5- BOT-604	Post-harvest Technology of Fruits & Vegetables	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
B & C	DSE-5 (4 Credits)  Any one	24L5.5- BOT-605	Plant Development and Reproductive Biology	T	3	3	20	50	70	100	3
				P	1	2	10	20	30		4
		24L5.5- BOT-606	Evolutionary and Behavioral Biology	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>B &amp; C</b>	<b>CC-H1</b> (4 Credits)	24L6.0-BOT-701	Applied Microbiology and Biostatistics	4	4	30	70	100	3
	<b>CC-H2</b> (4 Credits)	24L6.0-BOT-702	Ethnobiology and Phytoremediation	4	4	30	70	100	3
	<b>CC-H3</b> (4 Credits)	24L6.0-BOT-703	Pharmacognosy	4	4	30	70	100	3
	<b>DSE-6-H1</b> (4 Credits) Any one	24L6.0-BOT-704	Plant Genetic Engineering and Adaptation Biology	4	4	30	70	100	3
		24L6.0-BOT-705	Plant Genomics and Proteomics	4	4	30	70	100	3
		24L6.0-BOT-706	Computational Biology	4	4	30	70	100	3
	<b>PS-H1</b> (4 Credits)	24L6.0-BOT-707	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, 24L6.0-BOT-706	4	8	30	70	100	3
<b>CC-HM1</b>	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**

<b>For Hons.</b>									
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>B &amp; C</b>	<b>CC-H4</b> (4 Credits)	24L6.0-BOT-801	Molecular Biology & Bioinformatics	4	4	30	70	100	3
	<b>CC-H5</b> (4 Credits)	24L6.0-BOT-802	GIS and Remote Sensing	4	4	30	70	100	3
	<b>CC-H6</b> (4 Credits)	24L6.0-BOT-803	Dendrology and Pomology	4	4	30	70	100	3
	<b>DSE-7-H2</b> (4 Credits)	24L6.0-BOT-804	Plant Immunology and Metabolomics	4	4	30	70	100	3
	<b>Any one</b>	24L6.0-BOT-805	Plant Microbiome and Root Biology	4	4	30	70	100	3
	<b>PS-H2</b> (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
<b>CC-HM2</b>	From Available Core Courses in Minor Subject of 4 credits as per NEP								
<b>For Hons. With Research in Botany</b>									
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>B &amp; C</b>	<b>CC-H4</b> (4 Credits)	24L6.0-BOT-801	Molecular Biology & Bioinformatics	4	4	30	70	100	3
	<b>CC-H5</b> (4 Credits)	24L6.0-BOT-802	GIS and Remote Sensing	4	4	30	70	100	3
	<b>Research</b> (12 Credits)	24L6.0-BOT-807	Project/ Dissertation						
	<b>CC-HM2</b>	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.) Degree in Botany with 184 Credits (in case of Scheme-B & C), 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

Remarks on Scheme	Course Type & Total Credits	Semester	Course Code	Course Nomenclature	Credits	Hours/week	Internal Assessment	End Term Marks	Maximum Marks	Exam Duration (hrs)		
<b>Multidisciplinary Course (MDC)</b>												
A, B, C & D	MDC-1 (3 Credits)	I		Fundamentals of Botany	T	2	2	15	35	50	75	3
					P	1	2	05	20	25		3
	MDC-2 (3 Credits)	II		Plants for Human Welfare	T	2	2	15	35	50	75	3
					P	1	2	05	20	25		3
	MDC-3 (3 Credits)	III		Ornamental Plants	T	2	2	15	35	50	75	3
					P	1	2	05	20	25		3
<b>Value Added Course (VAC)</b>												
C	VAC-3 (2 Credits)	III		Basics of Medicinal Plants	2	2	15	35	50	3		
A & B	VAC-3 (2 Credits)	IV		Basics of Medicinal Plants	2	2	15	35	50	3		
C	VAC-4 (2 Credits)	IV		Ethnobotany	2	2	15	35	50	3		
<b>Skill Enhancement Course (SEC)</b>												
A, B & C	SEC-2 (3 Credits)	II		Vertical Farming	T	2	2	15	35	50	75	3
					P	1	2	05	20	25		3
	SEC-2 (3 Credits)			Biofertilizers	T	2	2	15	35	50	75	3
					P	1	2	05	20	25		3
	SEC-3 (3 Credits)	III		Plant Hybridization	T	2	2	15	35	50	75	3
					P	1	2	05	20	25		3
C	SEC-4 (2 Credits)	VI		Olericulture	T	1	1	10	20	30	50	3
					P	1	2	05	15	20		3
<b>Vocational Course (VOC)</b>												
B	VOC-1 (4 Credits)	III		Organic Farming	T	3	3	20	50	70	100	3
					P	1	2	10	20	30		4
A, B & C	VOC-2 (4 Credits)	IV		Floriculture	T	3	3	20	50	70	100	3
					P	1	2	10	20	30		4
A, B & C	VOC-2 (4 Credits)			Nursery and Gardening	T	3	3	20	50	70	100	3
					P	1	2	10	20	30		4
A & C	VOC-1 (4 Credits)	V		Organic Farming	T	3	3	20	50	70	100	3
					P	1	2	10	20	30		4
A, B & C	VOC-3 (4 Credits)	VI		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 Degree B.Sc. Three years and B. Sc. (Honors) 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

<b>Subject: Botany</b>									
<b>Semester I (Session 2024-25)</b>									
<b>Part A - Introduction</b>									
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
<b>Level of the course (As per Annexure-I) – 100-199</b>									
<b>Pre-Requisite for the course (if any):</b>									
<b>Learning Objectives:</b> 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.									
<b>Course Learning Outcomes (CLO):</b> 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.									
<b>Part B - Contents of the Course</b>									
<b>Instruction for Paper Setter</b>									
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	<b>Microbial Diversity:</b> Introduction and discovery, scope of microbiology. Generalized structure of Eukaryotic and prokaryotic cells. General account on Photosynthetic Protists. <b>Virus:</b> General account, structure and reproduction of TMV, CMV and Bacteriophage. <b>Bacteria:</b> Structure, types- gram +/-, nutrition, reproduction and economic importance. Brief introduction to Archaeobacteria.								11



II	<p><b>Cyanobacteria:</b> General account with special reference to <i>Nostoc</i> and <i>Oscillatoria</i>. Role in Nitrogen metabolism.</p> <p><b>Algae:</b> 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>.</p>	12
III	<p><b>Bryophytes:</b> 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>.</p>	11
IV	<p><b>Fungi:</b> General characters, classification (up to class level), economic importance. Life-History of <i>Albugo</i>, <i>Mucor</i>, <i>Penicillium</i>, <i>Agaricus</i>, <i>Puccinia</i>, <i>Colletotrichum</i>.</p> <p><b>Lichens:</b> General account, structure, types and ecological and economic importance.</p>	11
V	<b>Suggested Practical works</b>	
	<p>Models of viruses: TMV, Line drawing/ Photograph of Lytic and Lysogenic Cycles.</p> <p>Types of Bacteria from temporary/permanent slides/photographs; Binary Fission; Conjugation; Structure of root nodule.</p> <p>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.</p> <p><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).</p> <p><i>Anthoceros</i>- Morphology of thallus, W.M. rhizoids, V.S. thallus, V.S. Antheridia and Archegonia, L.S. sporophyte (temporary/permanent slides).</p> <p><i>Funaria</i>- Morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores, slides showing antheridial and archegonial heads, L.S. capsule (temporary /permanent slides).</p> <p>Study of vegetative &amp; reproductive structures of <i>Albugo</i>, <i>Mucor</i>, <i>Puccinia</i>, <i>Penicillium</i> &amp; <i>Colletotrichum</i>: Asexual and sexual stages through temporary preparations and permanent slides.</p> <p>Study of slides/photographs of lichens (crustose, foliose and fruticose).</p> <p>Note: Any other relevant practical can be offered.</p> <p><b>Excursion Report:</b> Report on excursion tours with photographs, collection and preservation specimens related to Algae, Bryophytes, Fungi and Lichen.</p>	30
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment</b>		<b>End Term Examination</b>
➤ Theory		➤ Theory

<ul style="list-style-type: none"> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5</li> <li>✓ Mid-Term Exam: 10</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: NA</li> <li>✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10</li> <li>✓ Mid-Term Exam: NA</li> </ul>	<ul style="list-style-type: none"> <li>✓ Written Examination: 50</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Practical Examination: 20</li> </ul>
<b>Part C - Recommended Books/ e-resources</b>	
<ul style="list-style-type: none"> <li>• Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. (2019) Prescott's Microbiology. 11<sup>th</sup> Edn., McGraw Hill International.</li> <li>• Pelczar, M.J. (2001) Microbiology, 5<sup>th</sup> Edn., Tata McGraw-Hill Co, New Delhi.</li> <li>• Lee, R.E. (2018) Phycology. 5<sup>th</sup> Edn. Cambridge University Press.</li> <li>• Singh, V., Pande, P.C. and Jain D.K. (2017) Biodiversity (Microbiology, Fungi, Algae, Archegoniate: Bryophyta, Pteridophyta and Gymnosperms). Rastogi Publications. Meerut.</li> <li>• Aluwalia, A.S. (2020) Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi.</li> <li>• Dube, H.C. (2012) An Introduction to Fungi, Vikas Publishing House Pvt. Ltd., 4<sup>th</sup> Edn. Delhi.</li> <li>• Mehrotra, R.S. and Aggarwal, A. (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd, New Delhi.</li> <li>• Sethi, I.K. and Walia, S.K. (2011) Text book of Fungi &amp; Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.</li> <li>• Mehrotra, R.S. and Aneja K.R. (2005) An Introduction to Mycology. New Age International Pvt. Ltd., New Delhi.</li> <li>• Sumbali, G. (2010) The Fungi, 2<sup>nd</sup> Edn., Narosa Publishing House, New Delhi.</li> <li>• Kumar, A., Vashishta, B. R. and Sinha, A. K. (2012) Bryophyta, S. Chand Publishing, New Delhi.</li> <li>• <a href="https://www.mooc-list.com/tags/microbiologyhttps://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf">https://www.mooc-list.com/tags/microbiologyhttps://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf</a></li> </ul>	

<b>Subject: Botany</b>									
<b>Semester I (Session 2024-25)</b>									
<b>Part A - Introduction</b>									
<b>Course Type and Remarks</b>	<b>Course Code</b>	<b>Name of the Course</b>	<b>Credit</b>	<b>Contact Hours/ week</b>	<b>Internal Assessment</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (hrs.)</b>	
MCC-2 (4 Credits)  Scheme B & C	24LA.5- BOT-102	Applied Phycology and Pathology	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
<b>Level of the course (As per Annexure-I) – 100-199</b>									
<b>Pre-Requisite for the course (if any):</b>									
<b>Learning Objectives:</b> 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.									
<b>Course Learning Outcomes (CLO):</b> 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.									
<b>Part B - Contents of the Course</b>									
<b>Instruction for Paper Setter</b> 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.									
<b>Unit</b>	<b>Topics</b>								<b>Contact Hours</b>
I	<b>Scope of Phycology:</b> Algae in biotechnology, nanotechnology, bioenergy (Biofuels- bioethanol, biodiesel), agriculture and research. <b>Algae in Daily Needs:</b> Algae as food, feed and fodder with suitable examples. Algae in cosmetics. <b>Algal culture techniques and commercial production:</b> General account on Provasoli ES medium.								11
II	<b>Algae in industry:</b> General account of Phycocolloids (Agar-agar, Alginic acid and Carrageenan) and secondary metabolites. Pharmaceutical and Nutraceutical uses of algae. <b>Role of Algae in Environment:</b> Algae as pollution indicators, algae in wastewater treatment and wasteland reclamation. Algal blooms; algal toxins and red tides.								11

III	<p><b>Phytoplasma:</b> General characteristics, role in plant diseases.</p> <p><b>Pathology:</b> History, introduction, agents and classification of plant disease and predaceous fungi</p> <p><b>Causal organisms, symptoms and management of some common plant disease:</b> 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.</p>	12
IV	<p><b>Genetic Exchange in Fungi:</b> Heterokaryosis, heterothallism, parasexuality and sex hormones</p> <p><b>Applied Mycology:</b> Mycoproteins, mycoremediation, mycorrhizae and mycotoxins. Application of fungi in food industry- fermentation, organic acids, enzymes and medicines.</p>	11
V	<b>Suggested Practical works</b>	
	<p>Isolation and identification of algal species (any three) in water samples from polluted and non-polluted sources through temporary mounts.</p> <p>Nutritional analysis (protein and carbohydrates) of <i>Spirulina/ Chlorella</i>.</p> <p>Phycocolloid (Agar-agar/ Alginates/ Carrageenan) extraction (demonstration/ digital resources).</p> <p>Commercial applications of algae through photographs/ products (edible, cosmetics, biofuels, pharmaceutical, nutraceutical, phyco-remediation).</p> <p>Demonstration of isolation pathogen from an infected plant sample and preparation of Fungal Medium (Potato Dextrose Agar).</p> <p>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.</p> <p>Herbarium specimens of some common bacterial, fungal diseases on leaf/ stem whichever available.</p> <p>Note: Any other relevant practical can be offered.</p> <p><b>Excursion Report:</b> Project work on any applied aspect of algae/ Visit to any Institute or Industry.</p>	30
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment</b>		<b>End Term Examination</b>
<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5</li> <li>✓ Mid-Term Exam: 10</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: NA</li> </ul>		<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Written Examination: 50</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Practical Examination: 20</li> </ul>

✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10	
✓ Mid-Term Exam: NA	
<b>Part C - Recommended Books/ e-resources</b>	
<ul style="list-style-type: none"> <li>• Lee, R.E. (2008) Phycology, 4<sup>th</sup> Edn., Cambridge University Press, Cambridge.</li> <li>• Kumar, H.D. (1999) Introductory Phycology, 2<sup>nd</sup> Edn., Affiliated East-West Press, New Delhi.</li> <li>• Andersen, R.A. (2005) Algal Culturing Techniques. Elsevier Academic Press.</li> <li>• Agrios, G.N. (2005) Plant Pathology, 5<sup>th</sup> Edn., Elsevier Academic Press, Amsterdam.</li> <li>• Sharma, P.D. (2014) Plant Pathology. Rastogi Publications, Meerut, U.P.</li> <li>• Mehrotra, R.S. and Aneja K.R. (2005) An Introduction to Mycology. New Age International Pvt. Ltd., New Delhi.</li> <li>• Singh, R.S. (2018) Plant Diseases, 10<sup>th</sup> Edn., Medtech, New Delhi.</li> <li>• Ownley, B. and Trigiano, R.N. (2017). Plant Pathology: Concepts and Laboratory Exercises, 3<sup>rd</sup> Edn., CRC Press.</li> </ul>	

<b>Subject: Botany</b>									
<b>Semester I (Session 2024-25)</b>									
<b>Part A - Introduction</b>									
<b>Course Type and Remarks</b>	<b>Course Code</b>	<b>Name of the Course</b>	<b>Credit</b>		<b>Contact Hours/ week</b>	<b>Internal Assessment</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (hrs.)</b>
CC-M1 (2 Credits)  Scheme A & B	24L4.5- BOT-103	Diversity of Non-Flowering and Flowering Plants	T	1	1	10	20	30	3
			P	1	2	05	15	20	4
<b>Level of the course (As per Annexure-I) – 100-199</b>									
<b>Pre-Requisite for the course (if any):</b>									
<b>Learning Objectives:</b> Student will gain the knowledge about the practical aspects related to identification, structure, economic values of microorganisms, algae, fungi, bryophytes, pteridophytes gymnosperms, and angiosperms.									
<b>Course Learning Outcomes (CLO):</b> 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.									
<b>Part B - Contents of the Course</b>									
<b>Instruction for Paper Setter</b>									
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.									
<b>Unit</b>	<b>Topics</b>								<b>Contact Hours</b>
I	<b>Diversity of Microbes and Mycology:</b> General characteristics, morphology and economic importance of viruses, bacteria, fungi and lichens.								4
II	<b>Algae, Bryophytes and Pteridophytes:</b> General characteristics, morphology, economic and ecological importance.								4
III	<b>Gymnosperms:</b> General characteristics, morphology, economic and ecological importance.								3
IV	<b>Angiosperms:</b> General characteristics, morphology and economic importance.								4
V	<b>Suggested Practical works</b>								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.	
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment</b>	<b>End Term Examination</b>	
<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: 4</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: NA</li> <li>✓ Mid-Term Exam: 6</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: NA</li> <li>✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 5</li> <li>✓ Mid-Term Exam: NA</li> </ul>	<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Written Examination: 20</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Practical Examination: 15</li> </ul>	
<b>Part C - Recommended Books/ e-resources</b>		
<ul style="list-style-type: none"> <li>• Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. (2019) Prescott's Microbiology. 11<sup>th</sup> Edn., McGraw Hill International.</li> <li>• Mehrotra, R.S. and Aneja K.R. (2005) An Introduction to Mycology. New Age International Pvt. Ltd., New Delhi.</li> <li>• Pelczar, M.J. (2001) Microbiology, 5<sup>th</sup> Edn., Tata McGraw-Hill Co, New Delhi.</li> <li>• Lee, R.E. (2018) Phycology. 5<sup>th</sup> Edn. Cambridge University Press.</li> <li>• Singh, V., Pande, P.C. and Jain D.K. (2017) Biodiversity (Microbiology, Fungi, Algae, Archegoniate: Bryophyta, Pteridophyta and Gymnosperms). Rastogi Publications. Meerut.</li> <li>• Aluwalia, A.S. (2020) Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi.</li> <li>• Dube, H.C. (2012) An Introduction to Fungi, Vikas Publishing House Pvt. Ltd., 4<sup>th</sup> Edn. Delhi.</li> <li>• Mehrotra, R.S. and Aggarwal, A. (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd, New Delhi.</li> <li>• Sethi, I.K. and Walia, S.K. (2011) Text book of Fungi &amp; Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.</li> <li>• 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).</li> <li>• Kumar, A., Vashishta, B.R. and Sinha, A.K. (2012) Bryophyta, S. Chand Publishing, New Delhi.</li> <li>• <a href="https://www.mooc-list.com/tags/microbiologyhttps://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf">https://www.mooc-list.com/tags/microbiologyhttps://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf</a></li> </ul>		

<b>Subject: Botany</b>									
<b>Semester I (Session 2024-25)</b>									
<b>Part A - Introduction</b>									
<b>Course Type and Remarks</b>	<b>Course Code</b>	<b>Name of the Course</b>	<b>Credit</b>		<b>Contact Hours/ week</b>	<b>Internal Assessment</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (hrs.)</b>
MDC-1 (3 Credits)		Fundamentals of Botany	T	2	2	15	35	50	3
Scheme A, B, C & D			P	1	2	05	20	25	3
<b>Level of the course (As per Annexure-I) – 100-199</b>									
<b>Pre-Requisite for the course (if any):</b>									
<b>Learning Objectives:</b> Student will gain the knowledge about the practical aspects related to identification, structure, economic values of microorganisms, algae, fungi, bryophytes, pteridophytes gymnosperms, and angiosperms.									
<b>Course Learning Outcomes (CLO):</b> 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.									
<b>Part B - Contents of the Course</b>									
<b>Instruction for Paper Setter</b>									
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.									
<b>Unit</b>	<b>Topics</b>								<b>Contact Hours</b>
I	<b>Diversity of Microbes and Mycology:</b> General characteristics, morphology and economic importance of viruses, bacteria, fungi and lichens.								8
II	<b>Algae, Bryophytes and Pteridophytes:</b> General characteristics, morphology, economic and ecological importance.								7
III	<b>Gymnosperms:</b> General characteristics, morphology, economic and ecological importance.								7
IV	<b>Angiosperms:</b> General characteristics, morphology and economic importance.								8



V	<b>Suggested Practical works</b>	
	<p>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.</p> <p>Note: Any other relevant practical can be offered.</p> <p><b>Excursion Report:</b> Report on excursion tours with photographs, collection, preservation and preparation of herbarium sheets and specimens related to Archegoniates and Angiosperms. Mounting of a collected, properly dried and pressed specimen of minimum 10 wild plants with herbarium label.</p>	30
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment</b>		<b>End Term Examination</b>
<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: 4</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 4</li> <li>✓ Mid-Term Exam: 7</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: NA</li> <li>✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 5</li> <li>✓ Mid-Term Exam: NA</li> </ul>		<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Written Examination: 35</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Practical Examination: 20</li> </ul>
<b>Part C - Recommended Books/ e-resources</b>		
<ul style="list-style-type: none"> <li>• Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. (2019) Prescott's Microbiology. 11<sup>th</sup> Edn., McGraw Hill International.</li> <li>• Pelczar, M.J. (2001) Microbiology, 5<sup>th</sup> Edn., Tata McGraw-Hill Co, New Delhi.</li> <li>• Lee, R.E. (2018) Phycology. 5<sup>th</sup> Edn. Cambridge University Press.</li> <li>• Singh, V., Pande, P.C. and Jain D.K. (2017) Biodiversity (Microbiology, Fungi, Algae, Archegoniate: Bryophyta, Pteridophyta and Gymnosperms). Rastogi Publications. Meerut.</li> <li>• Aluwalia, A.S. (2020) Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi.</li> <li>• Dube, H.C. (2012) An Introduction to Fungi, Vikas Publishing House Pvt. Ltd., 4<sup>th</sup> Edn. Delhi.</li> <li>• Mehrotra, R.S. and Aggarwal, A. (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd, New Delhi.</li> <li>• Kumar, A., Vashishta, B. R. and Sinha, A. K. (2012) Bryophyta. Chand Publishing, New Delhi.</li> <li>• 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).</li> <li>• <a href="https://www.mooc-list.com/tags/microbiologyhttps://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf">https://www.mooc-list.com/tags/microbiologyhttps://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf</a></li> </ul>		

<b>Subject: Botany</b>									
<b>Semester II (Session 2024-25)</b>									
<b>Part A - Introduction</b>									
<b>Course Type and Remarks</b>	<b>Course Code</b>	<b>Name of the Course</b>	<b>Credit</b>		<b>Contact Hours/week</b>	<b>Internal Assessment</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (hrs.)</b>
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
<b>Level of the course (As per Annexure-I) – 100-199</b>									
<b>Pre-Requisite for the course (if any):</b>									
<b>Learning Objectives:</b> The main objective of this course is for students to acquire in-depth knowledge structure, morphology, and reproduction of Pteridophytes and Gymnosperms.									
<b>Course Learning Outcomes (CLO):</b> 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.									
<b>Part B - Contents of the Course</b>									
<b>Instruction for Paper Setter</b>									
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.									
<b>Unit</b>	<b>Topics</b>								<b>Contact Hours</b>
I	<b>Pteridophytes:</b> General characters, classification (up to class level), structure and reproduction (excluding development) of <i>Psilotum</i> , <i>Selaginella</i> , <i>Equisetum</i> , <i>Marsilea</i> and <i>Pteris</i> .								12
II	<b>Evolutionary trends:</b> Apogamy, apospory and Heterospory; origin of seed habit; stellar evolution; telome concept; affinities and evolutionary significance of Pteridophytes. Economic and ecological importance of Pteridophytes.								11
III	<b>Fossils:</b> Colonization and rise of early land plants. General account and geological time scale, importance of fossil study, types of plant fossils. General account of fossil pteridophytes ( <i>Horneophyton</i> , <i>Lepidodendron</i> ) and gymnosperms								11

	( <i>Williamsonia</i> , <i>Glossopteris</i> ). Evolutionary significance of <i>Cooksonia</i> and <i>Rhynia</i> .	
IV	<b>Gymnosperms:</b> General characteristics, distribution and economic importance, classification up to classes, morphology, anatomy and reproduction (excluding development) of <i>Cycas</i> , <i>Pinus</i> and <i>Ephedra</i> . Affinities and evolutionary significance of Gymnosperms.	11
V	<b>Suggested Practical works</b>	
	<p><i>Psilotum</i>- Morphology, W.M. Synangium, T.S./ L.S. Synangium (permanent slide), T.S. stem, T.S. rhizome (permanent slide).</p> <p><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).</p> <p><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).</p> <p><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).</p> <p><i>Marselia</i>- Morphology, T.S., L.S., V.S. Sporocarp, T.S. rhizome (permanent slide).</p> <p>Comparative study of stele system through T.S. of above specimens and/ or through permanent slides.</p> <p>Photographs/ preserved specimens of Fossils.</p> <p><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).</p> <p><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).</p> <p><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).</p> <p>Note: Any other relevant practical can be offered.</p> <p><b>Excursion Report:</b> Report on excursion tours with photographs, collection and preservation specimens related to Pteridophytes and Gymnosperms.</p>	30
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment</b>		<b>End Term Examination</b>
<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5</li> </ul>		<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Written Examination: 50</li> </ul> <p>➤ <b>Practicum</b></p>

<p>✓ Mid-Term Exam: 10</p> <p>➤ <b>Practicum</b></p> <p>✓ Class Participation: NA</p> <p>✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10</p> <p>✓ Mid-Term Exam: NA</p>	<p>✓ Practical Examination: 20</p>
<b>Part C - Recommended Books/ e-resources</b>	
<ul style="list-style-type: none"> <li>• Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010) Pteridophyta, S. Chand Publication. Delhi.</li> <li>• Parihar, N.S., (1977) The Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad, India.</li> <li>• Singh, V., Pande, P.C. and Jain D.K. (2017) Biodiversity (Microbiology, Fungi, Algae, Archegoniate: Bryophyta, Pteridophyta and Gymnosperms). Rastogi Publications. Meerut.</li> <li>• Bhatnagar, S.P. and Moitra, A. (1996) Gymnosperms. New Age International (P) Ltd. Publishers, New Delhi, India.</li> <li>• 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).</li> <li>• <a href="https://palaeobotany.org/">https://palaeobotany.org/</a></li> <li>• <a href="https://pteridoportal.org/portal/index.php">https://pteridoportal.org/portal/index.php</a></li> <li>• <a href="https://www.conifers.org/zz/gymnosperms.php">https://www.conifers.org/zz/gymnosperms.php</a></li> </ul>	

<b>Subject: Botany</b>									
<b>Semester II (Session 2024-25)</b>									
<b>Part A - Introduction</b>									
<b>Course Type and Remarks</b>	<b>Course Code</b>	<b>Name of the Course</b>	<b>Credit</b>		<b>Contact Hours/week</b>	<b>Internal Assessment</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (hrs.)</b>
DSEC-1 (4 Credits)  Scheme C	24L4.5- BOT-202	Paleobotany and Phytogeography	T	3	3	20	50	70	3
			P	1	2	10	20	30	4
<b>Level of the course (As per Annexure-I) – 100-199</b>									
<b>Pre-Requisite for the course (if any):</b>									
<b>Learning Objectives:</b> 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.									
<b>Course Learning Outcomes (CLO):</b> 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.									
<b>Part B - Contents of the Course</b>									
<b>Instruction for Paper Setter</b> 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.									
<b>Unit</b>	<b>Topics</b>								<b>Contact Hours</b>
I	<b>Palaeontology:</b> Introduction and types of Megafossils and microfossils, modes of preservation of fossils, radiometric dating. General account on Gondwana flora and fauna and its importance. Paleobotanists of India. Brief account on Birbal Sahni Institute of Palaeo Sciences. <b>Index fossils:</b> Introduction and significance. Reconstruction and nomenclature and Taphonomy.								11
II	<b>Colonization of Plants:</b> Early vascular plants to early spore producing tree; Early spore producing trees to early seed producing trees (gymnosperms). Origin of ovule, hydrasperman reproduction with fossil evidence. Fossil evidences for early								11

	flowering plants.	
III	<b>Phytogeography:</b> Introduction, scope and importance, continental drift; theory of tolerance; endemism- types and causes. <b>Plant Geography region:</b> Principle biogeographical zones worldwide and in India.	12
IV	<b>Flora and Vegetation of Haryana;</b> Biogeographic zones and vegetation pattern of India; adaptation of plants in arid regions and desert ecosystem.	11
V	<b>Suggested Practical works</b>	
	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. <b>Excursion Report:</b> Project work on any nearby area to study soil/ rock types.	30
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment</b>		<b>End Term Examination</b>
<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: 5</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 5</li> <li>✓ Mid-Term Exam: 10</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: NA</li> <li>✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 10</li> <li>✓ Mid-Term Exam: NA</li> </ul>		<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Written Examination: 50</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Practical Examination: 20</li> </ul>
<b>Part C - Recommended Books/ e-resources</b>		
<ul style="list-style-type: none"> <li>• 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).</li> <li>• Pelletier, J.D. (2008) Quantitative Modeling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago.</li> </ul>		

- Charles, C.P., Diane, H.C. and Lisa H. (2016) *Physical Geology*, 15<sup>th</sup> Edn., McGraw-Hill Education.
- Emiliani, C. (1992). *Planet Earth, Cosmology, Geology and the Evolution of Life and Environment*, Cambridge University Press.
- Stewart, W.N. and Rothwell, G.W. (2005). *Paleobotany and the Evolution of Plants*. Cambridge University Press, New York.
- <https://palaeobotany.org/>

<b>Subject: Botany</b>									
<b>Semester II (Session 2024-25)</b>									
<b>Part A - Introduction</b>									
<b>Course Type and Remarks</b>	<b>Course Code</b>	<b>Name of the Course</b>	<b>Credit</b>		<b>Contact Hours/ week</b>	<b>Internal Assessment</b>	<b>End Term Marks</b>	<b>Max. Marks</b>	<b>Exam Duration (hrs.)</b>
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
<b>Level of the course (As per Annexure-I) – 100-199</b>									
<b>Pre-Requisite for the course (if any):</b>									
<b>Learning Objectives:</b> Student will gain the knowledge about the practical aspects related to identification, structure, economic values of microorganisms, algae, fungi, bryophytes, pteridophytes gymnosperms, and angiosperms.									
<b>Course Learning Outcomes (CLO):</b> 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.									
<b>Part B - Contents of the Course</b>									
<b>Instruction for Paper Setter</b>									
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.									
<b>Unit</b>	<b>Topics</b>								<b>Contact Hours</b>
I	<b>Morphology and Economic Importance of:</b> Food plants - Cereals (rice, wheat and maize); Pulses - gram, arhar and pea.								4
II	<b>Botanical Description and Processing of:</b> Vegetables- potato, tomato and onion; Fiber- cotton; Oils- mustard and coconut.								4
III	<b>Morphology and Economic Importance of the Following:</b> Spices- turmeric, coriander, ginger and cloves								3
IV	<b>Medicinal Plants:</b> <i>Cinchona</i> , <i>Opium</i> , <i>Cannabis</i> , <i>Withania</i> , Neem. <b>Beverages:</b> Tea, coffee								4
V	<b>Suggested Practical works</b>								30



	<p>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.</p> <p>Collection and preparation of reports on various crops and economically important plants being cultivated/wildly available in your area.</p> <p>Note: Any other relevant practical can be offered.</p>	
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment</b>	<b>End Term Examination</b>	
<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: 4</li> <li>✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: NA</li> <li>✓ Mid-Term Exam: 6</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Class Participation: NA</li> <li>✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 5</li> <li>✓ Mid-Term Exam: NA</li> </ul>	<p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>✓ Written Examination: 20</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>✓ Practical Examination: 15</li> </ul>	
<b>Part C - Recommended Books/ e-resources</b>		
<ul style="list-style-type: none"> <li>• Singh, V., Pande, P.C. and Jain, D.K. (2018) Economic Botany, Rastogi Publications, New Delhi.</li> <li>• Kocchar, S.L. (2016) Economic Botany: A Comprehensive Study, 5<sup>th</sup> Edn., Cambridge India.</li> <li>• Wickens, G.E. (2001) Economic Botany: Principles and Practices, Springer.</li> <li>• Daubenmire, R.F. (2017) Plants &amp; Environment (2<sup>nd</sup> Edn.,) John Wiley &amp; Sons., New York.</li> <li>• Rajan. S.S. (2007) College Botany Vol-V, Part 1: Taxonomy and Economic Botany Himalaya Publishing House.</li> <li>• Mukharjee, S.K. (2004) College Botany Vol-III. New Central Book Agency, London.</li> </ul>		

<b>Subject: Botany</b>									
<b>Semester II (Session 2024-25)</b>									
<b>Part A - Introduction</b>									
Course Type and Remarks	Course Code	Name of the Course	Credit		Contact Hours/ week	Internal Assessment	End Term Marks	Max. Marks	Exam Duration (hrs.)
			T	P					
MDC-2 (3 Credits)		Plants for Human Welfare	T	2	2	15	35	50	3
Scheme A, B, C & D			P	1	2	05	20	25	3
<b>Level of the course (As per Annexure-I) – 100-199</b>									
<b>Pre-Requisite for the course (if any):</b>									
<b>Learning Objectives:</b> Students will acquire the knowledge about the economic valuable plants and their products.									
<b>Course Learning Outcomes (CLO):</b> After completing this course, the learner will be able to									
1. acquire a foundational understanding of plant diversity.									
2. develop a conceptual grasp of plants utilized for human welfare.									
3. gain knowledge about the origins of certain cultivated plants.									
4. acquire a conceptual understanding of the utilization of fruits, nuts, and other plant components for human welfare.									
5. gain the knowledge about the practical aspects related to identification, structure, economic values of microorganisms, algae, fungi, bryophytes, pteridophytes gymnosperms, and angiosperms..									
<b>Part B - Contents of the Course</b>									
<b>Instruction for Paper Setter</b>									
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	<b>Understanding Biodiversity:</b> Level of plant diversity in India, agrodiversity. Values and uses of Biodiversity. Role of plants in relation to Human Welfare.								8
II	<b>Agroforestry:</b> Economic and ecological Importance of agro and social forestry. Ornamental plants of India.								7
III	<b>Crop Plants:</b> Origin of cultivated plants, morphology and economic importance of food plants - Cereals (rice/ wheat and maize); Pulses - gram and pea.								7
IV	<b>Fruits and Nuts:</b> Important fruit crops and their commercial importance. Spices and condiments. Wood and its uses.								8

V	<b>Suggested Practical works</b>	
	Identification and study of some important medicinal plants. Identification and study of some common ornamental plants. Identification and study of some important cereals. Identification and study of some important pulses. Identification and study of some important spice yielding plants. Study of different types of woods. Study of different fruit types.  Note: Any other relevant practical can be offered. <b>Excursion Report:</b> Collection and classification of different plants useful for humans.	30
<b>Suggested Evaluation Methods</b>		
<b>Internal Assessment</b>		<b>End Term Examination</b>
> <b>Theory</b> ✓ Class Participation: 4 ✓ Seminar/ Presentation/ Assignment/ Quiz/ Class Test/ Peer-group discussion etc.: 4 ✓ Mid-Term Exam: 7  > <b>Practicum</b> ✓ Class Participation: NA ✓ Seminar/ Demonstration/ Viva-voce/ Lab records etc.: 5 ✓ Mid-Term Exam: NA		> <b>Theory</b> ✓ Written Examination: 35  > <b>Practicum</b> ✓ Practical Examination: 20
<b>Part C - Recommended Books/ e-resources</b>		
<ul style="list-style-type: none"> <li>• Singh, V., Pande, P.C. and Jain, D.K. (2018) Economic Botany, Rastogi Publications, Delhi.</li> <li>• Kocchar, S.L. (2016) Economic Botany: A Comprehensive Study, 5<sup>th</sup> Edn., Cambridge India.</li> <li>• Wickens, G.E. (2001) Economic Botany: Principles and Practices, Springer.</li> <li>• Daubenmire, R.F. (2017) Plants &amp; Environment, 2<sup>nd</sup> Edn., John Wiley &amp; Sons., New York.</li> <li>• Rajan. S.S. (2007) College Botany Vol-V, Part 1: Taxonomy and Economic Botany Himalaya Publishing House.</li> <li>• Mukharjee, S.K. (2004) College Botany Vol-III. New Central Book Agency, London.</li> </ul>		