CRITERIA 1.1.2

The Programmes offered by the institution focus on employability/entrepreneurship/ skill development and their course syllabi are QM adequately revised to incorporate contemporary requirements.

Programme-

M.SC BOTANY

Color Coding: -

1) **EMPLOYABILITY**

2) **ENTREPRENEURSHIP**

3) **SKILL DEVELOPMENT**

Syllabus

For

M.Sc. Botany

(2018 onwards)

Department of Botany

Netaji Subhas University

Head
Department of Botany
Netaji Subhas University

NETAJI SUBHAS UNIVERSITY Jamshedpur

Dean Academics
Netaji Subhas University
Jamshedpur, Jharkhand

Mapping of M.Sc. Botany Syllabus for Employability, Entrepreneurship, and Skill Development

Paper Code	Paper Name	(EM)	(EN)	(SD)
Semester - I				
101	Microbiology (Bacteria, Viruses, and Lichens)	✓	✓	✓
102	Phycology	✓	✓	✓
103	Mycology	✓	✓	✓
104	Bryology and Pteridology	✓		✓
Semester - II				
201	Gymnosperms and Palaeobotany	✓		✓
202	Taxonomy of Angiosperms	✓	✓	✓
203	Plant Morphology, Anatomy, and Embryology	✓		✓
204	Cell and Molecular Biology	✓	✓	✓
Semester - III				
301	Plant Ecology	✓	✓	✓
302	Cytogenetics and Plant Breeding	✓	✓	✓
Elective -1	Plant Biotechnology	✓	✓	✓
	Computer Application	✓	✓	✓
Elective -2	Forest Ecology	✓	✓	✓
	Plant Pathology	✓	✓	✓
Semester - IV				
401	Plant Physiology and Biochemistry	✓		✓
402	Plant Resource, Utilization, and Conservation	✓	✓	✓
Elective -3	Environmental Botany	✓	✓	✓
	Lichenology	✓	✓	✓
Elective -4	Bryology	✓	✓	✓
	Ethnobotany, Traditional Knowledge, and Intellectual Property Rights	✓	✓	✓

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M.Sc. Botany Syllabus

SEMESTER-I

Code	Theory/Practical	Credit	Examination Scheme		
			External	Internal	Total
101	Microbiology (Bacteria, Viruses and Lichens)	4	70	30	100
102	Phycology	4	70	30	100
103	Mycology	4	70	30	100
104	Bryology and Pteridology	4	70	30	100
Practical -1	Practical (Based on Theory Paper 101 &102)	4	75	25	100
Practical -2	Practical (Based on Theory Paper 103 &104	4	75	25	100
		24			**600**

SEMESTER-II

Code	Theory/Practical	Credit	Examination Scheme		
			External	Internal	Total
201	Gymnosperms and Palaeobotany	4	70	30	100
202	Taxonomy of Angiosperms	4	70	30	100
203	Plant Morphology, Anatomy and Embryology	4	70	30	100
204	Cell and Molecular Biology	4	70	30	100
Practical -3	Practical (Based on Theory Paper 201 &202)	4	75	25	100
Practical -4	Practical (Based on Theory Paper 203 &204	4	75	25	100
		24			**600**

SEMESTER-III

Code	Theory/Practical	Credit	Examination Scheme		
			External	Internal	Total
301	Plant Ecology	4	70	30	100
302	Cytogenetic and Plant Breeding	4	70	30	100
Elective -1	Plant Biotechnology OR	4	70	30	100
	Computer Application				
Elective -2	Forest Ecology OR	4	70	30	100
	Plant Pathology				
Practical -5	Practical (Based on Theory Paper 301 &302)	4	75	25	100
Practical -6	Practical (Based on Elective -1 & 2)	4	75	25	100
		24			**600**

Semester-IV

Code	Theory/Practical	Credit	Examination Scheme		
			External	Internal	Total
401	Plant Physiology and Biochemistry	4	70	30	100
402	Plant Resource, Utilization and Conservation	4	70	30	100
Elective -3	Environmental Botany OR Lichenology	4	70	30	100
Elective -4	Bryology OR Ethno botany, Traditional Knowledge and Intellectual Property Rights	4	70	30	100
Practical -5	Practical (Based on Theory Paper 401 & 402)	3	75	.....	75
Practical -6	Practical (Based on Elective -4 & 5)	3	75	.....	75
	Dissertation/ Field Report	2	50	.....	50
		24			**600**

The students have to select four papers of specializations (electives); each of two will be taught in third and fourth semesters:

A. Forest Ecology
B. Plant Pathology
C. Ethno botany, Traditional Knowledge and Intellectual Property Rights
D. Bryology
E. Environmental Botany
F. Plant Biotechnology
G. Lichenology

(The Students will opt any one elective course for Dissertation /Project)

Semester -1

101- Microbiology (Bacteria, Viruses and Lichens)

This course aims to:

1. Introduce fundamental concepts of microbiology, including microbial diversity, structure, and function.
2. Explore microbial classification, physiology, genetics, and metabolism.
3. Analyze the role of microorganisms in human health, agriculture, and industry.
4. Study the ecological significance of microbes and their applications in biotechnology.
5. Develop laboratory skills in microbial isolation, identification, and analysis.

Microbiology (Bacteria, Viruses and Lichens)

Unit 1. General account of Microorganisms: History of microbiology, characteristic features of bacteria and actinomycetes, classification of microorganisms- five kingdom classification, Ainsworth classification.

Unit 2. Culture Study of Microorganisms: Methods of isolation and culture of microorganisms; measurement of microbial growth; microbial genetics.

Unit -3. Morphology and structure of Bacterial cells: Morphology of Bacterial cells based on size, shape and arrangement, fine structure of bacterial cells (of both Gram-negative and Gram-positive Bacteria)- capsule cell wall, cell appendages (flagella, fimbrae and pilli), structure of plasma membrane, cytoplasmic inclusions- mesosomes, chlorosome.

Unit 4. Morphology and structure of viruses: History, morphology, fine structure, shape and classification of viruses. Microphages and Prions, Tobacco mosaic virus (TMV), T4, Bacteriophage and HIV- their fine structure, genome organization and multiplication, bacteriophage therapy.

Unit 5. Role of microorganism: Root nodules, nif gene organization, role of microorganisms in soil (decomposition and nutrient cycling), water and air; role in industry- production of antibiotics, bio-fertilizers and bio-pesticides.

Unit 6. General account of lichens: Occurrence, classification, morphology, anatomy, reproduction and their importance.

Suggested readings:

1. Madigan, M.T., J.M. Martink and J. Parker (1997). Brock Biology of Microorganism. Printice hall International, Inc., New, Jersey.

2. Prescott (2000). Microbiology.

3. Cruezer, W. and A. Cruezer (1990). A Textbook of Industrial Microbiology.

4. Alexander, M. (1977). Soil Microbiology. John Wiley and Sons, New York.

5. Dubey, R.C. and D.K. Maheshwari (2010). A Textbook of Microbiology. S. Chand and Co. Pvt. Ltd. New Delhi.

Course Outcome(Cos)
Aims to:

CO-1: Learn methods in microbiology, including sterilization, isolation, culture, and preservation of microbes, developing theoretical and technical microbiological skills.

CO-2: Understand the structure of bacteria, viruses, and lichens, along with their classification, diversity, and growth.

CO-3: Study applied aspects of microbial diversity in various fields like pharmaceuticals and agriculture.

CO-4: Comprehend the role of microorganisms in soil, water, air, and industries (e.g., antibiotic production, biofertilizers, and biopesticides).

COs-POs Mapping (Key: 3 = Strong correlation **2** = Moderate correlation **1** = Weak correlation **-** = No correlation)

Cos/Pos	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	1	2	1	1	1	1	1	1	-	1	1	1	1	2
CO-2	2	2	1	2	1	1	-	1	1	-	-	-	-	-	1
CO-3	2	2	2	1	-	-	1	1	1	-	1	1	1	2	1
CO-4	1	2	1	1	2	1	-	1	1	1	1	-	-	-	1
Average	2	1.8	1.5	1.3	1.3	1	1	1	1	1	1	1	1	1.5	1.3

102 -Phycology

Course Objectives (COs):

This course aims to:

1. Provide knowledge about the diversity, classification, and morphology of algae.
2. Explore the ecological roles of algae in aquatic and terrestrial ecosystems.
3. Study the physiological, biochemical, and reproductive mechanisms in algae.
4. Analyze the economic importance of algae in industries, agriculture, and biotechnology.
5. Develop skills in the identification, cultivation, and sustainable utilization of algae.

Phycology

Unit1. History and Classification of Algae: Criteria of classification, important systems of classification.

Unit 2. Ecology of Algae: Diversified habitats of algae, eutrophication, water blooms and phytoplanktons.

Unit 3. Basic concept of Cyanophages.

Unit 4. Importance of Algae: Useful and harmful aspects of algae.

Unit 5. A detailed study of following orders with emphasis on given genera:

- Cyanophyta: Chroococcales (Chroococcus, Gleocapso, Microcystis); Oscillatoriales (Oscillatoria); Nostocales (Nostoc, Anabaena, Spirulllina), Scytonematales (Scytonema;) Rivulariales (Gloeotrichia).
- Chlorophyta: Chlamydomonadales (Chlamydomonas); Volvocales (Volvox) Chlorococcales (Chlorella); Oedogoniales (Oedogonium) Ulvales (Ulva); Cladophorales (Cladophora) Chaetophorales (Chaetophora), Fritschiales (Fritschiella), Zygnemetales (Zygnema).
- Charophyta: Charales (Chara).
- Xanthophyta: Heterosiphonales (Botrydium, Vaucheria)
- Bacillariophyta: Pennales and Centrales
- Phaeophyta: Ectocarpales (Ectocarpus); Laminariales (Laminaria); Fucales (Fucus, Sargassum).
- Rhodophyta: Gigartinales (Gracillaria); Gelidiales (Gelidium).

Suggested readings:

1. Fritsch, F.E. 1979. The structure and Reproduction of Algae Vol. I & II. Bishan Singh, Mahendra Pal Singh, Dehradun.

2. Kumar, H.D. 1988. Introductory Phycology: Affiliated East-West Press Ltd. N. Delhi.

3. Morris, I. 1986. An introduction of Algae. Cambridge University Press U.K.

4. Prescott, G.W. 1984. Algae: A review, Bishan Singh, Mahendra Pal Singh. Dehradun.

Course Outcomes (COs)

After completing this course, students will:

1. **CO-1**: Understand the criteria for algal classification and compare different classification systems.
2. **CO-2**: Learn about the diversity, morphology, structure, reproduction, and life cycles of major algal groups.
3. **CO-3**: Study the ecological significance of algae, including their role in eutrophication, water blooms, and phytoplankton communities.
4. **CO-4**: Explore the applied aspects of algae in biotechnology, industry, and environmental management.

CO-PO-PSO Mapping

Cos/Pos	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	1	2	1	1	1	1	1	1	-	2	1	1	1	2
CO-2	3	2	2	1	1	1	-	1	1	-	2	2	1	-	1
CO-3	2	2	3	1	1	1	2	1	1	-	1	1	1	2	1
CO-4	2	2	2	1	2	2	3	1	1	1	1	1	-	1	2
Average	2.5	1.75	2.25	1	1.25	1.25	2	1	1	1	1.5	1.25	1	1.3	1.5

103 - Mycology

This course aims to:

1. Provide an understanding of fungal diversity, classification, and taxonomy.
2. Explore the morphology, structure, and reproduction of fungi.
3. Analyze the ecological roles of fungi in nutrient cycling, symbiosis, and decomposition.
4. Examine the economic and industrial importance of fungi in agriculture, medicine, and biotechnology.
5. Develop laboratory skills in fungal isolation, identification, and cultivation.

Mycology

Unit 1. General characteristics and classification of fungi.

Unit 2. Reproduction (vegetative, asexual and sexual). Heterothallism; heterokaryosis parasexuality. Recent trends in classification.

Unit 3. Phylogeny of fungi.

Unit 4. Importance of Fungi.

Unit 5. General account of the following classes of fungi with emphasis on the given genera:

- Myxomycotina: Stemonitis, Physarum.
- Mastigomycotina: Allomyces, Plasmodiophora.
- Oomycotina: Saprolegnia, Pythium, Phytophthora, Peronospora.
- Zygomycotina: Mucor, Entomophthora, Syncephalastum.
- Ascomycotina: Saccharomyces, Aspergillus, Talaromyces (Penicillium), Taphrina, Peziza, Cordiceps (Yarsa gambu), Mycrophora, Claviceps.
- Basidiomycotina: Puccinia, Ustilago, Amanita,Ganoderma, Tiletia, Uromyces.
- Deuteromycotina: Fusarium, Cercospora, Pyricularia, Colletotrichum, Trichoderma, Helminthosporium.

Suggested Readings:

1. Mehrotra, R.S. and K.R. Aneja. 1999. An introduction to Mycology.
2. Alexopoulas and Mims. 1979. Introductory Mycology.
3. Webster, I. 1979. Introductory Mycology.
4. Ainsworth, G.C. 1976. Introduction to the history of Mycology.
5. Webster, J. 1985. Introduction to Fungi.

Course Outcome

After completing this course, students will be able to:

CO-1: Understand the general characteristics, classification, and life cycles of fungi.

CO-2: Learn about fungal reproduction, including vegetative, asexual, and sexual methods, as well as heterothallism, parasexuality, and recent classification trends.

CO-3: Analyze the phylogenetic relationships of fungi and their evolutionary significance.

CO-4: Evaluate the ecological and economic importance of fungi in agriculture, medicine, industry, and biotechnology.

CO-5: Identify and describe important fungal genera and their significance in plant pathology.

CO-PO-PSO Mapping

Cos/Pos	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO1	3	1	2	1	1	1	1	1	1	-	2	1	1	1	2
CO2	3	2	2	1	1	1	-	1	1	-	2	2	1	-	1
CO3	2	2	3	1	1	1	2	1	1	-	1	1	1	2	1
CO4	2	2	2	1	2	2	3	1	1	1	1	1	-	1	2
CO5	3	1	3	1	2	2	2	1	1	1	2	1	2	2	2
Average	2.6	1.6	2.4	1	1.4	1.4	2	1	1	1	1.6	1.2	1.25	1.5	1.6

104- Bryology and Pteridology

The course aims to:

1. Provide knowledge on the morphology, anatomy, and developmental patterns of bryophytes (mosses, liverworts, hornworts) and pteridophytes (ferns and related groups).
2. Explain the evolutionary trends in lower plants, including their ecological and economic significance.
3. Study the reproductive mechanisms and life cycle patterns of bryophytes and pteridophytes.
4. Explore the structural adaptations of these plants in response to different environmental conditions.
5. Emphasize the role of bryophytes and pteridophytes as indicators of environmental changes.

Bryology and Pteridology

Unit 1. Origin, relationship and evolutionary trends in Bryophytes, fossil, Bryology in India.

Unit 2. General idea about the morphological, cytological and ecological characteristics of Bryophytes.

Unit 3. Economic importance of Bryophytes, Bryophytes as monitors of mineral deposition, Air Pollution Indicators.

Unit 4. Modern systems of classification of Bryophytes and salient features of the following groups with emphasis on the given genera:

- ➢ Hepaticopsida:
- Sphaerocarples: Sphaerocarpus
- Marchantiales: Marchantia , Conocephalum,
- Jungermanniales: Frullania, Porella.
- ➢ Anthocerotopsida:
- Anthocerotales: Anthoceros, Notothylas.
- ➢ Bryopsida:
- Sphagnales: Sphagnum.
- Eubryales: Funaria, Polytrichum.

U nit 5. Pteridology

- A brief account of origin of pteridophytes, classification of pteridophytes, heterospory and seed habit, evolution of steler system, telome theory, evolution of sorus, apogamy, apospory and apomixis.
- A brief account of the following classes with emphasis on the given genera:
- Psilophytopsida: Rhynia.
- Psilotopsida: Psilotum.
- Lycopsida: Lycopodium, Lepidodendron, Selaginella.
- Sphenopsida: Calamites, Equisetum.
- Pteropsida: a. Leptopteris ,Pteris

  b. Marsilea, ,Salvinia, Azolla.

Suggested Readings:

1. Kashyap, S.R. 1968. Liverworts of the Western Himalayas and Punjab Plain. The Chronica. Botanic. Delhi.

2. Watson, 1975. Bryophytes. Hutchinson Library, Series, London.

3. Puri, P. 1980. Bryophytes, Alma Ram & Sons, Delhi.

4. Parihar, N.S. 1991. Bryophyta. Central Book Depot. Allahabad.

5. Smith, G.M. 1971.Cryphogamic Botany Vol I.

6. Beddom, R.H. 1966. The ferns of British India 2 Vol. Oxford and IBH, N. Delhi.

7. Eams, A.J. 1969 Morphology of Lower Vascular Plants.

Course Outcomes (COs):

After completing this course, students will:

CO-1: Understand the origin, relationship, and evolutionary trends of bryophytes and their classification.

CO-2: Gain knowledge of the morphology, cytology, and ecological characteristics of bryophytes and their economic importance.

CO-3: Learn about the classification, reproduction, and developmental biology of pteridophytes.

CO-4: Study the structural and physiological adaptations of lower plants to different ecological conditions.

CO-5: Comprehend the importance of lower plants in ecosystem dynamics, conservation, and bio-monitoring.

CO-PO-PSO Mapping

Cos/Pos	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	1	2	1	1	1	1	1	1	-	3	2	1	1	2
CO-2	3	2	2	1	1	1	-	1	1	-	3	3	1	-	1
CO-3	2	2	3	1	1	1	2	1	1	-	2	2	2	2	1
CO-4	2	2	2	1	2	2	3	1	1	1	2	2	-	1	2
CO-5	3	2	3	2	2	2	3	2	2	2	3	2	2	2	3
Average	2.6	1.8	2.4	1.2	1.4	1.4	2.25	1.2	1.2	1.5	2.6	2.2	1.5	1.5	1.8

SEMESTER –II

201-Gymnosperms and Palaeobotany

Course Objectives (CO)

The course aims to:

1. Introduce students to the classification, structure, and reproduction of gymnosperms.
2. Provide an understanding of fossil plants and their significance in plant evolution.
3. Explore the paleoenvironmental and geological significance of gymnosperms.
4. Train students in identifying and interpreting fossilized plant remains.
5. Correlate fossil evidence with phylogenetic relationships and evolutionary trends.

Theory

Unit 1. Introduction: History, classification, distribution and evolution of Gymnosperms.

Unit 2. Brief account of the families of Pteridospermales and Cycadeoideales.

Unit 3. General account of Cordaitales.

Unit 4. General account of Pentoxylales.

Unit 5. Morphology, anatomy and reproduction in Cycadales, Ginkgoales and Coniferales.

Unit 6. General account of Ephedrales, Welwitschiales and Gnetales.

Palaeobotany

Unit 7. Preservation of fossil plants. Types of fossils, modes of formation of different kinds of fossils, Gondwana flora.

Suggested Readings:

1. Bhatnagar, S.P. and A. Mitra. 1996. Gymnosperm, New Age International Pvt. Ltd. N. Delhi.

2. Chamberlian, CJ. 1955. Gymnosperms: Structure and Evolution. Chicago.

3. Andrews, H.N. 1961. Studies in Palaeobotany, N. York.

4. Arnold, C.A. 1947. An introduction to Palaeobotany, N. York.

5. Seward, A.C. 1919.Fossil plants for students of Botany and Geology. 4 vols. Cambridge.

Course Outcomes (COs)

After completing this course, students will be able to:

CO1: Explain the morphology, anatomy, and reproduction of different gymnosperm groups.

CO2: Differentiate between extinct and extant gymnosperms based on structural characteristics.

CO3: Describe major fossilized plants and their role in evolutionary biology.

CO4: Analyze the role of palaeobotany in understanding geological time scales.

CO5: Interpret fossil records and their implications for plant evolution and phylogeny.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	2	1	3	2	1	3	2	1	3	2	1
CO2	3	3	2	2	2	2	3	3	2	3	3	2	3	3	2
CO3	2	3	3	2	2	2	3	3	3	3	3	2	3	3	3
CO4	3	3	2	3	2	2	3	2	3	3	3	2	3	2	3
CO5	3	3	3	3	2	1	3	3	3	3	3	1	3	3	3
Average	2.8	2.8	2.6	2.4	2	1.6	3	2.6	2.4	3	2.8	1.6	3	2.6	2.4

202-Diversity and Taxonomy of Angiosperms

Course Objectives (COs):

1. To understand the diversity, classification, and evolution of angiosperms.
2. To familiarize students with the principles of plant taxonomy and nomenclature.
3. To study the morphological, anatomical, and reproductive characteristics of major angiosperm families.
4. To apply taxonomic tools and techniques for plant identification.
5. To develop practical skills in herbarium preparation and field-based plant identification.
6. To explore the ecological significance and conservation strategies of angiosperms.

Diversity and Taxonomy of Angiosperms

Unit 1. Important system of classifications of angiosperms (Bentham and Hooker, .I. Hutchinson and A. Takhtajan).

Unit 2. Salient features of International Code of Botanical Nomenclature.

Unit 3. Origin of intra-population variation: Population and the environment, ecads, ecotypes, evolution and differentiation of species.

Unit 4. The species concepts: Taxonomic hierarchy, species, genus, family.

Unit 5. Origin and evolution of angiosperms: Fossil history, types of inflorescences and their origin.

Unit 6. Taxonomic Tools: Herbarium, Flora, histological, cytological, phytochemical, serological, biochemical and molecular techniques.

Unit 7. Concepts of Phytogeography: Endemism, plant migration, invasions and introduction.

Unit 8. Distinguishing features only of the following families and their economic importance: Ranunculaceae, Rutaceae, Fabaceae, Rosaceae, Apiaceae, Acanthaceae, Rubiaceae, Solanaceae, Orchidaceae, Zingiberaceae, Cyperaceae and Poaceae.

Suggested Readings:

1. Babu, C.R. 2004. Herbaceous Flora of Dehradun. CSIR, N. Delhi.

2. Bensen, L 2003. Plant classification. Reprint. Oxford and IBH. N. Delhi.

3. Core, A.J. 1999. Numerical Taxonomy, Academic Press, London.

4. Cronquist. A. 1981. An integrated System of classification of flowering Plants. Columbia University Press, N. York.

5. Davis, P.H. and Heyhood, V.H. 1993. Principles of Angiosperms taxonomy. Robert E. Kreign Pub. Co., N. York.

6. Gaur, R.D. 1999. Flora of District Garhwal; N.W. Himalaya Transmedia, Srinagar. Garhwal.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1: Explain the diversity, evolution, and classification systems of angiosperms.

CO2: Apply principles of plant taxonomy and binomial nomenclature for classification.

CO3: Identify and describe important families of angiosperms based on key morphological features.

CO4: Use taxonomic tools like herbarium preparation, dichotomous keys, and molecular techniques for plant identification.

CO5: Analyze the ecological and economic importance of angiosperms and their role in biodiversity conservation.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2	1	3	2	1	2	1	1	3	2	1
CO2	2	3	3	2	2	2	3	3	2	3	2	2	3	3	2
CO3	2	2	3	2	2	2	3	3	3	3	2	2	3	3	3
CO4	3	3	2	3	2	2	3	2	3	2	2	2	3	2	3
CO5	2	2	3	3	2	1	3	3	3	3	1	1	3	3	2
Average	2.4	2.4	2.6	2.4	2	1.6	3	2.6	2.4	2.6	1.6	1.6	3	2.6	2.2

203 -Plant Morphology, Anatomy and Embryology

The course aims to:

1. Introduce students to the fundamental concepts of plant morphology, anatomy, and embryology.
2. Explain the structural organization of plants at macroscopic and microscopic levels.
3. Develop an understanding of the functional and adaptive significance of plant structures.
4. Study the developmental processes of reproductive structures and their role in plant life cycles.
5. Provide hands-on experience in analyzing plant tissues, organs, and embryological features.

Plant Morphology, Anatomy and Embryology

Unit 1. Morphology: Morphology of flower, stamen and carpel.

- Plant adaptations and their morphological nature.

Unit 2. Shoot Development: Organization of the shoot apical meristem (SAM); wood development in relation to environmental factors and wood anatomy.

Unit 3. Leaf growth and differentiation (structural development and classification of stomata and trichomes).

Unit 4. Root development: Organisation of root apical meristem (RAM); vascular tissue differentiation; lateral roots; root hairs.

Unit 5. Male gametophyte: Structure of anther; microsporogenesis; pollen germination, pollen allergy; pollen embryos.

Unit 6. Female gametophyte: Ovule development; megasporogenesis; development and organization of the embryo sac.

Unit 7. Pollination and fertilization: Floral characteristics, pollination mechanism and vectors; structure of the pistil; pollen stigma interactions, sporophytic and gametophytic

self-incompatibility (cytological, biochemical and molecular aspects); double fertilization; in vitro fertilization.

Unit 8. Seed development and fruit growth, polyembryony; apomixis, embryo culture.

Unit 9. Latent Life-dormancy: Importance and types of dormancy; bud dormancy.

Unit 10. Tissue - General account

- Stem anatomy - Dicot and Monocot
- Root anatomy - Dicot and Monocot
- Anamolous Secondary Growth
- Periderm formation.

Suggested Readings:

1. Bhojwani, S. S. and Bhatnagar, S. P. 2000. The embryology of Angiosperms. Vikas Publ. House, New Delhi.

2. Aghwan, V. 1999. Molecular embryology of flowering plants. Cambridge Univ. Press, Camp.

3. Shivanna, K. R. and Sawhney, V. K. 1999. Pollen biotechnology for crop production and improvement Cambridge Univ. Press

Course Outcomes (COs):

After completing this course, students will be able to:

CO1 Describe the external morphology of different plant organs and their modifications.

CO2 Explain the anatomical organization of plant tissues and their functions.

CO3 Analyze the structural and functional adaptations of plants in different environments.

CO4 Illustrate the stages of reproductive development, including embryogenesis.

CO5 Apply practical techniques for studying plant tissues, organs, and embryological structures.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	3	1	3	2	1	2	1	1	1	2	1
CO2	2	3	3	2	2	2	2	3	1	3	2	2	3	3	2
CO3	2	2	3	2	1	2	3	2	3	3	1	1	2	3	3
CO4	1	3	2	3	2	2	1	2	3	2	2	2	2	2	3
CO5	2	2	3	3	1	1	3	3	3	3	1	1	1	3	2
Average	2	2.4	2.6	2.4	1.8	1.6	2.4	2.4	2.2	2.6	1.4	1.4	1.8	2.6	2.2

204 - Cell and Molecular Biology

The course aims to:

1. Provide a comprehensive understanding of the structure and functions of cells at the molecular level.
2. Explain the organization, composition, and regulatory mechanisms of cellular components.
3. Explore the molecular basis of genetic material, its replication, transcription, and translation.
4. Understand cell signaling, cellular interactions, and the regulation of gene expression.
5. Develop practical skills in molecular biology techniques and their applications in biotechnology and research.

Cell and Molecular Biology

Unit 1. Structure and functions, biogenesis. Cell wall .

Unit 2. Plasma Membrane: Structure, models and functions, plasmodesmeta and their role in movement of molecules and macromolecules

Unit 3. Chloroplast: Structure and genome organization and transcription.

Unit 4. Mitochondria: Structure, genome organization, biogenesis, RNA editing.

Unit 5. Plant vacuoles: Tonoplast membrane, ATPase, storage organelles.

Unit 6. Nucleus: Structure, DNA structure, A, B and Z forms, nuclear pores, nucleosome organization.

Unit 7. Ribosomes: Structure, protein synthesis, mechanism of translocation, Initiation and termination.

Unit 8. Cell shape and motility: The cytoskeleton, organization and role of microtubules and microfilaments.

Unit 9. Cell cycle and Apoptosis: Role of cyclins and cyclin-dependent kinases, cytokinesis and cell plate formation.

Unit 10. Other cellular organelles: Structure and functions of microbodies, Golgi apparatus, lysosomes, endoplasmic reticulum.

Unit 11. Techniques in cell biology: Immunotechniques, FISH, GISH, confocal microscopy.

Suggesting Readings:

1. Wolfe, S. L. 1993. Molecular and Cellular Biology.

2. Buchanan, B. B. Greuissem, W. and Jones, R. L. 2000. Biochemistry and Molecular Biology of plants.

3. Kleinsmith, L. S. and Kish, V. M. 1998. Principles of cell and Molecular Biology.

4. Krishnamurthy, K. V. Methods in cell wall cytochemistry.

5. Lewin, B. 2000. Genes-VII. Oxford Univ. Press. New York, U. S. A.

CO-PO-PSO Mapping:

Cos/Pos	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO10	PSO-1	PSO-2	PSO-3	PSO-4	PSO5
CO-1	3	1	2	1	1	1	1	1	1	2	1	1	1	2	1
CO-2	2	2	1	2	1	1	-	1	1	3	-		-	1	2
CO-3	2	2	2	1	-	-	1	1	1	3	1	1	1	1	3
CO-4	1	2	1	1	1	1	1	1	1	2	1	-	1	1	3
CO-5	-	1	1	-	-	1	-	1	1	3	3	1	2	1	2
Average	2	1.6	1.4	1.3	1	1	1	1	1	2.6	1.5	1	1.3	1.2	2.2

III Semester

301- Plant Ecology

Course Objectives (COs):

The course aims to:

1. Introduce the fundamental concepts of plant ecology and environmental interactions.
2. Explain the structure, function, and dynamics of plant communities and ecosystems.
3. Analyze ecological factors affecting plant distribution, growth, and adaptations.
4. Explore biogeochemical cycles, energy flow, and ecosystem productivity.
5. Develop an understanding of biodiversity conservation, ecological sustainability, and climate change impacts.

Theory

Unit 1. Climate, soil and vegetation patterns of the world: Major biomes and vegetation types and environmental factors.

Unit 2. Population dynamics: Characters, r and k strategies.

Unit 3. Vegetation organization: Concepts of community and continuum; community character, concept of ecological niche.

Unit 4. Ecological succession: Causes, mechanism and types, concepts of climax.

Unit 5. Ecosystem: Structure and functions; primary production; energy dynamics (Trophic organization, energy flow pathways); global biogeochemical cycles of C, N, P and S ; hydrological cycle.

Unit 6. Biological diversity: Concept and levels; species richness, diversity indices, concept of α and β diversity, role and application of biodiversity in ecosystem function; speciation and extinction; IUCN categories of threat; distribution and global patterns of biodiversity, hot spots; inventory.

Unit 7. Environmental pollution: Kinds; sources, quality parameters; effects on plants and ecosystems and remedies.

Unit 8. Climate change: Greenhouse gases sources, trends and role; ozone layer and ozone hole; consequences of climate change.

Suggested Readings:

1. Odum, H.T. 1983. Basic Ecology.

2. Odum, E. P. 1999. Fundamentals of Ecology.

3. Heywood, V. H. and Watson, R. T. 1995. Global Biodiversity Assessment.

4. Barbour, M. G.; Burk, J. H. and Pitts, W. D. 1998. Terrestrial Plant Ecology.

5. Smith, R. L. 2006. Ecology and Field Biology.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the principles of plant ecology and ecological interactions.

CO2 Analyze plant communities, population dynamics, and ecosystem functioning.

CO3 Assess the influence of biotic and abiotic factors on plant distribution and adaptations.

CO4 Interpret ecological cycles, energy flow, and environmental sustainability.

CO5 Evaluate conservation strategies and the impact of climate change on plant biodiversity.

CO-PO-PSO Mapping

Cos/Pos	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO10	PSO-1	PSO-2	PSO-3	PSO-4	PSO5
CO-1	3	1	2	1	1	1	1	1	1	2	1	2	1	2	1
CO-2	2	2	1	2	1	2	-	2	1	3	-	3	3	3	2
CO-3	2	2	2	1	-	2	1	1	1	3	1	3	2	3	3
CO-4	1	2	1	1	1	2	1	2	1	2	1	2	2	2	3
CO-5	-	1	1	-	-	1	-	1	1	3	3	3	1	3	2
Average	2	1.6	1.4	1.3	1	1	1	1	1	2.6	1.5	1	1.3	1.2	2.2

302 - Cytogenetics and Plant Breeding

Course Objectives (COs):

This course aims to:

1. Provide an understanding of the principles of cytogenetics, chromosome structure, and genetic variation.
2. Explain the mechanisms of inheritance, genetic recombination, and mutation in plants.
3. Introduce the concepts and methods of plant breeding for crop improvement.
4. Develop skills in genetic analysis, hybridization, and molecular breeding techniques.
5. Explore the applications of biotechnology in plant genetics and breeding programs.

Cytogenetics and Plant Breeding

Unit 1. Chromosome structure: Chromatin organization: and packaging of DNA; molecular organization of centromere and telomere; nucleolus and ribosomal RNA genes; euchromatin and heterochromatin; karyotype analysis; specialized types of chromosomes; ploytene, lampbrush, B-chromosomes and sex chromosomes.

Unit 2. Structural and numerical alterations in chromosomes: Origin, meiotic behaviour and consequences of duplication, deficiency, inversion and translocation, heterozygotes; characteristics and types of aneuploids, role of polyploidy in crop evolution.

Unit 3. Genetics of prokaryotes and eukaryotic organisms: Phage phenotypes; genetic recombination in bacteria; genetic transformation, conjugation and transduction in bacteria; cytoplasmic male sterility; exploitation of hybrid vigour.

Unit 4. Gene structure and expression: Genetic fine structure; cistrons test; introns and exons RNA splicing; regulation of gene expression in prokaryotes and eukaryotes; split genes.

Unit 5. Genetic recombination and gene mapping: Recombination, independent assortment and crossing over; molecular mechanism of recombination; chromosome mapping; linkage groups.

Unit 6. Mutation: Spontaneous and induced mutations; physical and chemical mutagens; molecular basis of mutation; transposable elements in prokaryotes and eukaryotes; mutations induced by transposons.

Unit 7. Cytogenetics of aneuploids and structural heterozygotes: Effect of aneuploidy on phenotypes in plants; transmission of monosomics and trisomics and their use in chromosome mapping.

Unit 8. Molecular Cytogenetics: Nuclear DNA content; C-value paradox; cot-curves and their significance; in situ hybridization.

Suggested Reading:

1. Albert, B. Lewis, D. Raff, J. Roberts, K. and Watson, J. D. 2004. Molecular Biology of the cell, 2nd Ed. by Garland Pub, Inc. New York.

2. Atherly, A.G.; Girton, J. R. and McDonald, J. F. 1999. The Science of Genetics. Saunders College Pub. Fort worth, USA.

3. Khush, G. S. 2003. Cytogenetics of Aneuploids. Academic Press, New York. London.

4. Krap. G. 1999. Cells and Molecular Biology; Concepts and Experiments. Wileys & sons Inc. USA.

5. Lewin, B. 2000, Gene. Vol. Vii. Oxford Univ. Press, New York, USA.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the structure, function, and behavior of chromosomes in plant genetics.

CO2 Analyze the principles of Mendelian and non-Mendelian inheritance.

CO3 Apply cytogenetic techniques for studying genetic variation and mutations.

CO4 Demonstrate knowledge of conventional and molecular breeding methods.

CO5 Evaluate the role of plant breeding in crop improvement and food security.

CO-PO-PSO Mapping

Cos/Pos	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	3	3	2	2	2	2	1	1	1	1	1	1	1	1
CO-2	3	2	1	2	3	1	0	2	-	1	1	2	2	1	2
CO-3	2	1	1	1	1	1	2	1	1	1	-	1	1	2	2
CO4	1	2	2	1	1	1	1	2	1	1	1	0	1	1	1
CO-5	2	2	2	2	1	2	2	1	3	1	-	1	2	1	1
Average	2	2	1.8	1.6	1.6	1.4	1.4	1.4	1.5	1	1	1	1	1	1

Semester – IV

401-Plant Physiology and Biochemistry

Course Objectives (COs):

This course aims to:

1. Provide an understanding of fundamental physiological processes in plants.
2. Explain the biochemical pathways involved in plant metabolism.
3. Analyze plant responses to environmental factors and stress physiology.
4. Explore the role of plant hormones and secondary metabolites in growth and development.
5. Develop knowledge of enzymology, bioenergetics, and molecular mechanisms in plants.

Plant Physiology and Biochemistry

Unit 1. Membrane transport and translocation of water and solutes: Plant-water relations, mechanism of water transport through xylem, phloem loading and unloading, passive and active solute transport, membrane transport of proteins.

Unit 2. Enzymology: General aspects, allosteric mechanism, regulatory and active sites, isozymes, kinetics of enzymatic analysis, Michaelis-Menten equation and its significance.

Unit 3. Signal transduction and sensory photobiology: Receptors, phospholipids signalling, phytochromes and cryptochromes.

Unit 4. Photosynthesis: General concepts and historical back ground, steps of photosynthesis, Calvin cycle, photorespiration and its significance, C4 cycle, CAM pathway.

Unit 5. Respiration: Glycolysis. TCA cycle, electron transport chain and ATP synthesis, pentose- phosphate pathway, glyoxylate cycle.

Unit 6. Nitrogen fixation and metabolism: Biological nitrogen fixation, mechanism of nitrate uptake and reduction, ammonium assimilation.

Unit 7. Plant growth regulators: auxins, gibberellins, cytokinins, ethylene, abscisic acid, polyamines, jasmonic acid, hormone receptors , vitamins and hormones.

Unit 8. Photoperiodism and vernalization: Photoperiodism and its significance, vernalization.

Unit 9. Stress physiology: Plant responses to biotic and abiotic stress, mechanism of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress.

Unit 10. Carbohydrates: Monosaccharide's, oligosaccharides, polysaccharides.

Unit 11. Lipids: Fat metabolism (Simple lipids, compound lipids, derived lipids).

Unit 12. Alkaloids: Structure and classification of alkaloids.

Suggested Readings:

1. Devi, P. 2000. Principles and methods of Plant Molecular Biology, Biochemistry and Genetics.

2. Dennis, D. T.; D. H. Turpin; D. D. Lefebvre and D. B. Layzell. Plant Metabolism.

3. Scott, R. P. W. 1995. Techniques and Practice of Chromatography.

4. Hopkins, W. G. 1995. Introduction to plant physiology.

5. Salisbury & Ross 2003. Plant Physiology.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the principles of plant water relations, mineral nutrition, and transport mechanisms.

CO2 Describe photosynthesis, respiration, and other metabolic pathways in plants.

CO3 Analyze the role of plant hormones and signal transduction in growth regulation.

CO4 Evaluate plant responses to environmental stress and adaptation mechanisms.

CO5 Apply biochemical techniques to study plant metabolism and enzymatic activity.

CO-PO-PSO Mapping

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO-5
CO1	3	2	1	1	1	1	1	1	1	1	3	2	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	2	3	1	1	2
CO3	2	2	3	2	2	1	1	1	1	1	1	2	3	2	2
CO4	1	1	2	3	3	2	1	1	1	1	1	1	2	3	1
CO5	1	1	1	2	3	3	2	2	3	3	1	1	1	3	1
Average	2	1.8	1.8	1.8	2	1.6	1.2	1.2	1.4	1.4	1.6	1.8	1.6	2	1

402 - Plant Resource Utilization and Conservation

Course Objectives (COs):

This course aims to:

1. Provide an understanding of plant resources, their economic importance, and sustainable utilization.
2. Explain the principles and strategies of plant conservation.
3. Analyze the impact of overexploitation, habitat destruction, and climate change on plant biodiversity.
4. Explore traditional and modern techniques in plant resource management.
5. Develop awareness about conservation policies, biotechnological approaches, and their role in biodiversity conservation.

Plant Resource Utilization and Conservation

Unit 1. Sustainable development: Basic concepts. World centres of primary and secondary diversity of domesticated plants.

Unit 2. Uses of important plants (i) Food, forage, fodder and fibre crops. (ii) Medicinal and aromatic plants and (iii) Vegetable oil yielding plants (iv)Important fire-wood and timber-yielding plants and non-timber forest products (NTEPs) such as bamboos, rattans, raw materials for paper-making, gums, tannins, dyes, resins and fruits.

Unit 3. Green revolution: Benefits and adverse circumstances.

Unit 4. Conservation of plant biodiversity: Principles of conservation, extinction, environmental status of plants based on international Union for conservation of Nature (IUCN). Strategies for in-situ conservation; Strategies for ex-situ conservation.

Suggested Readings:

1. Heywood, V. H. and Watson, R. T. 1995. Global Biodiversity Assessment. Paroda, R. S. and Arora, R. K. 1991. Plant genetic resources Conservation and Management.

2. Frankel, O. H.; Brown, A. D. H. and Burdon, J. J. 1995. The conservation of Plant Diversity.

3. Technical guidelines for the safe movement of Germplasm by FAO/IBPGR.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the economic and ecological significance of plant resources.

CO2 Analyze the causes and consequences of biodiversity loss and plant resource depletion.

CO3 Apply conservation strategies for sustainable plant resource management.

CO4 Evaluate the role of biotechnology and ex-situ/in-situ conservation methods.

CO5 Demonstrate knowledge of conservation policies, laws, and global initiatives.

CO-PO-PSO Mapping

Cos/Pos	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	3	3	2	2	2	2	-	-	1	-	1	1	1	1
CO-2	3	2	1	2	3	1	0	-	-	1	-	2	2	1	2
CO-3	2	1	1	1	1	1	2	-	1	1	-	1	1	2	2
CO4	1	2	2	1	1	1	1	1	-	2	1	0	1	1	1
CO-5	3	2	3	2	1	2	2	-	1	1	-	1	2	1	1
Average	2.2	2	2	1.6	1.6	1.4	1.4	1	1	1.2	1	1	1.4	1	1

Elective Course

Course Outcomes

Plant Biotechnology

Students are able to:

1. Learns about the Nucleic acids: Structure and form of DNA, Circular DNA in bacteria and chloroplast, packaging of DNA, DNA melting (Tm), DNA annealing, cot curves, repetitive, unique and satellite DNA, C- value paradox.
2. Understands about the Gene Replication: DNA replication in prokaryotes and eukaryotes (initiation, elongation and termination).
3. Learns the gene Mutation: Mutagenic agents, mechanisms of mutagenesis, DNA damage and repair mechanism, uses of mutation, Gene Recombination: Mechanism of recombination in viruses, bacteria and fungi.
4. Learns about the genetic Code , regulation of Gene Expression and Genetic Engineering
5. Learns about plant tissue and Organ Culture: Micropropagation somaclonal variation, haploid production, protoplast culture and somatic hybridization.

Unit 1. Biotechnology: Principle and scope, bio-safety guidelines.

Unit 2. Plant cell and tissue culture: Concept of cellular differentiation and totipotency, applications of cell and tissue culture.

Unit 3. Callus culture, cryopreservation, clonal propagation, organ culture, protoplast culture, organogenesis, somatic embryogenesis, somatic hybridization, artificial seed, hybrids and cybrids, and somaclonal variation.

Unit 4. Recombinant DNA technology: Tools of genetic engineering; enzyme, vectors; plasmids, cosmids, lamda phage vectors, shuttle vectors. BACs and YACs. Cloning strategies, genomic libraries, CDNA libraries, single gene cloning.

Unit 5. Detection and characterization of transformants: Screening and selection for transformants: Hybridizations - colony, Southern, Northern, Western. DNA sequencing techniques, expression vectors in bacteria and eukaryotes; expression of industrially important products.

Unit 6. Genetic engineering of plants: Aims, tools, strategies for development of transgenic plant with suitable example, alien gene transfer and applications.

Unit 7. Elementary Knowledge of next generation sequencing, intellectual property rights, genomics and proteomics.

Unit 8. Biological databases (gene and protein). DNA restriction map analysis, DNA and protein sequence alignment. BLAST, and FASTA.

Suggested Readings:

1. Bhojwani, S.S. (1990). Plant Tissue Culture: Applications and Limitations. Elsevier Science Publisher, New York (U.S.A).

2. Glazer, A.N. and Nikido, H. (1995). Microbial Biotechnology. W.H. Freeman and Company, New York (USA).

3. Shantharam, S. and Montgo Mery, J.F. (1999). Biotechnology, Biosafety and biodiversity. Oxford and IBH Publishing Company. Pvt. Ltd. New Delhi.

4. S.B. Primrose and R. M. Twyman. Principles of Gene Manipulation and Genomics.

5. Arthur Lesk. Introduction to Bioinformatics.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the fundamentals and applications of plant biotechnology.

CO2 Describe plant tissue culture techniques and their applications.

CO3 Analyze genetic engineering techniques for crop improvement.

CO4 Evaluate the role of molecular markers and genome editing technologies.

CO5 Assess the ethical, legal, and environmental aspects of plant biotechnology.

CO-PO-PSO Mapping

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1	1	1	1	1	1	3	2	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	2	3	1	1	1
CO3	2	2	3	2	2	1	1	1	1	1	1	2	3	2	1
CO4	1	1	2	3	3	2	1	1	1	1	1	1	2	3	2
CO5	1	1	1	2	3	3	2	2	3	3	1	1	1	3	1
Average	2	1.8	1.8	1.8	2	1.6	1.2	1.2	1.4	1.4	1.6	1.8	1.6	2	1.2

Elective Course : Forest Ecology

Course Objectives:

This course aims to:

1. Understand basic overview of ecosystem components, processes and functions of ecosystems introduced in Forest Ecology.
2. Knows structure and functioning of major forests types of world.
3. Review some current ecological issues relevant to forest stewardship and sustainability.
4. Know about global climate changes and forests.

Elective Course :Forest Ecology

Unit 1. General aspects of forests: Forest ecology and forest ecosystem, importance of forests in environmental conservation, wildlife, and biodiversity.

Unit 2. Forest biomass, productivity and energy flow: Methods of estimating biomass and productivity across the forests of world, allocation of biomass and productivity to different tree components, production efficiency of leaves particularly in relation to leaf-span and other related leaf characters (e.g., leaf area and specific lea" mass) both at individual leaf and stand levels.

Unit 3. Forest litter: Types of litter and coarse woody debris, litter fall, forest floor litter mass, litter decomposition and factors affecting such as microbes, fauna, abiotic factors and litter characters.

Unit 4. Water cycle in a forested area: Impact of forest on precipitation apportionment, water discharge from watersheds, water's role in nutrient cycling.

Unit 5. Nutrient cycling: Concept of inter and intra system cycling and tree-internal cycling;, nutrients uptake and nutrient return from vegetation to soil subsystem, nutrients retention by vegetation, role of microbes, especially of nitrogen-fixers and mycorrhiza in forest nutrient cycling.

Unit 6. Succession: An idea of forest succession with particular reference to Himalaya, attributes of species of different successional stages, recovery measures of disturbed sites, species selection for disturbed sites in Himalaya. Relationship between man and forest in the Himalaya.

Unit 7. Structure and functioning of major forests types of world: Tropical rain forests, monsoon forest, temperate coniferous, temperate deciduous forest, boreal forest, tundra's and timber line areas in India. Major forest types of India.

Unit 8. Linkages between subsistence hill and agriculture and living and forests and other non- cultivated land, shifting cultivation, acute vs. chronic human disturbance, regeneration status of major forest trees and related problems. Global climate changes and forests.

Suggested Readings:

1. Perry, D. A. 1999. Forest Ecosystems.

2. Waring, R. H. and Schlesinger, W. H. 1985. Forest Ecosystem: Concepts and Management.

3. Singh, J. S. and Singh, S. P. 2003. Forests of Himalaya.

4. Puri, G.S., V.M. Mehar-Homji, R.K. Gupta and R.K. Purl (1960). Forest Ecology. Oxford and IBH Pub. Co. New Delhi.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the fundamental principles of forest ecology and ecosystem interactions.

CO2 Analyze the structure, composition, and function of forest ecosystems.

CO3 Assess the effects of environmental factors on forest growth and biodiversity.

CO4 Evaluate conservation strategies and sustainable forest management practices.

CO5 Interpret the role of climate change, policies, and human activities in forest conservation.

CO-PO-PSO Mapping

COs \POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1	1	1	1	1	1	3	2	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	2	3	1	1	1
CO3	2	2	3	2	2	1	1	1	1	1	1	2	3	2	2
CO4	1	1	2	3	3	2	1	1	1	1	1	1	2	3	3
CO5	1	1	1	2	3	3	2	2	3	3	1	1	1	3	3
Average	2	1.8	1.8	1.8	2	1.6	1.2	1.2	1.4	1.4	1.6	1.8	1.6	2	2

Elective Course: Plant Pathology

This course aims to:

1. Provide an understanding of plant diseases, their causes, and effects on crops.
2. Explain the principles of plant-microbe interactions and disease development.
3. Analyze various plant pathogens, including fungi, bacteria, viruses, and nematodes.
4. Explore methods for plant disease diagnosis, prevention, and management.
5. Develop awareness of integrated disease management (IDM) and biotechnological approaches to plant disease control.

Theory

Unit 1. History of plant pathology in India: Losses caused by pathogens and pests; types of pathogens; symptoms of different diseases; Inoculum.

Unit 2. Plant-microbe interaction: Molecular basis of host recognition, pathogenesis: prepenetration, penetration and post penetration events, and factors affecting disease development (host factors, environmental factors, virulence and susceptibility); Dissemination of pathogens.

Unit 3. Genetics of host parasite interactions: Concepts of compatibility and specificity, gene- for-gene relationship, genetics of resistance, sources of resistance, inheritance of resistance in the host.

Unit 4. Enzymes and toxins: Enzymes involved in disease development; toxins and their role in plant health.

Unit 5. Physiology of diseased hosts: Changes in physiological processes, e.g., respiration, photosynthesis and disturbance in other metabolic pathways. Disease resistance; Disease control.

Unit 6. Seed pathology: Seed borne pathogens, mechanism of seed infection in field and during storage, transmission of pathogens through seeds, seed health testing methods, storage disease of seeds and their control, market diseases of fruits and vegetables

Unit 7. Brief account, structure, importance, disease cycle and control of the following: (i) Damping off, (ii) Wilt, (m) Root, stem, and fruit rot, (iv) Mildews (powdery and downy), (v) Rusts, (vi) Smuts, (vii) Leaf spots and leaf blights.

Unit 8. General characteristics, importance, disease cycle and control of the following: (i) bacterial disease, (ii) viral disease, (m) mycoplasma disease.

Suggested Readings:

1. Mehrotra R.S. Plant Pathology. Tata Mc Grow Hill Publishing Co. Ltd. New Delhi.
2. Agrios, G.N. Plant Pathology.
3. Mehrotra and Agrawal. Plant Pathology.
4. Bouarab, N.K., N. Bissow and F. Daayf. Molecular Plant Microb Interactions.
5. Narayansamy, P. Plant Pathogen detection and disease diagnosis.
6. Butler, EJ. Fungi and Diseases in Plants.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the fundamental concepts of plant pathology and disease etiology.

CO2 Identify major plant pathogens and their modes of infection.

CO3 Analyze the mechanisms of plant defense against diseases.

CO4 Evaluate different disease management strategies, including chemical, biological, and cultural control.

CO5 Apply integrated disease management (IDM) and molecular techniques for plant disease control.

CO-PO-PSO Mapping

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1	1	1	1	1	1	3	2	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	2	3	1	1	1
CO3	2	2	3	2	2	1	1	1	1	1	1	2	3	2	1
CO4	1	1	2	3	3	2	1	1	1	1	1	1	2	3	1
CO5	1	1	1	2	3	3	2	2	3	3	1	1	1	3	2
Average	2	1.8	1.8	1.8	2	1.6	1.2	1.2	1.4	1.4	1.6	1.8	1.6	2	1.2

Elective Course: Bryology

Course Objectives:

This course aims to:

1. Provide an understanding of the classification, morphology, and life cycle of bryophytes.
2. Explain the ecological significance and economic importance of bryophytes.
3. Analyze the diversity, distribution, and adaptation strategies of bryophytes.
4. Explore the role of bryophytes in environmental monitoring and ecosystem functions.

5. Develop awareness of bryophyte conservation and modern research in bryology.

Elective Course: Bryology

Unit 1. Distribution of bryophytes in India, the bryogeographical units, Rare and Endangered liverworts of Himalaya.

Unit 2. Taxonomic methodology in the identification of some common West Himalayan mosses, distinguishing features of the following orders families and genera:

Polytrichaceae- Pogonatum

Dicranales:

Dicranaceae- Dicranum

Pottiales:

Pottiaceae- Hyophila

Grimmiales:

Grimmiaceae- Grimmia

Bryales:

Bryaceae- Bryum

Bartramiaceae- Philonotis

Isobryales:

Orthotrichaceae- Macromitrum

Neckeraceae- Neckera

Hypnobryales:

Thuidiaceae- Thuidium

Hypnaceae- Hypnum.

Unit 3. Bryophyte ecology: Habitats, growth forms; the role of bryophytes in succession; bryophytes as bioindicators and uptake of mineral elements, response to air pollution.

Unit 4. Physiology of bryophytes: General idea of conduction and water relations in bryophytes, conduction system in bryology, cells involved in conduction, ecto, endo and mesohydric groups, desiccation and dehydration, desiccation tolerance.

Unit 5. Culture of bryophytes: A general idea of culture techniques; Chemistry of Bryophytes.

Suggested Reading:

1. Gangulee, H.C. Mosses of Eastern India and adjacent regions Vol. I-III.
2. Chopra, R. N. and Kumra, P. K. Biology of Bryophytes.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the classification, structure, and reproduction of bryophytes.

CO2 Describe the ecological roles and economic applications of bryophytes.

CO3 Analyze the physiological and structural adaptations of bryophytes to different environments.

CO4 Evaluate the role of bryophytes in environmental monitoring and bioindication.

CO5 Apply conservation strategies and biotechnological approaches in bryology research.

CO-PO-PSO Mapping

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1	1	1	1	1	1	3	2	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	2	3	1	1	1
CO3	2	2	3	2	2	1	1	1	1	1	1	2	3	2	2
CO4	1	1	2	3	3	2	1	1	1	1	1	1	2	3	3
CO5	1	1	1	2	3	3	2	2	3	3	1	1	1	3	3
Average	2	1.8	1.8	1.8	2	1.6	1.2	1.2	1.4	1.4	1.6	1.8	1.6	2	2

Elective course: Ethnobotany

Course Objectives (COs):

This course aims to:

1. Introduce the fundamental concepts of ethnobotany and its significance in human societies.
2. Explore the relationship between plants and indigenous cultures, including traditional knowledge.
3. Analyze the medicinal, nutritional, and economic importance of ethnobotanical plants.
4. Understand conservation strategies for ethnobotanical resources and intellectual property rights.
5. Develop research skills to document and assess the sustainable use of ethnobotanical knowledge.

Elective course : Ethnobotany

Unit 1. Ethnobotany, Traditional Knowledge and Intellectual Property. Its Concept, Scope and Relevance.

Unit 2. Ethnobotany in India: Retrospect and prospects.

Unit 3. Methods of research in Ethnobotany. Role of Ethnobotany in primary health care programmes and development of new drugs.

Unit 4. Ethnobotany on development and conservation on bio resources. Traditional knowledge of Jharkhand (With special reference to food and medicine).

Unit 5. Basic concepts of Intellectual Property Rights (IPRs). Intellectual Property Rights with particular reference to Traditional Knowledge and Biowealth.

Suggested Readings:

1. Paroda, R. S. & P. K. Arora. 2006. Plant Genetic Resources Conservation and Management concepts and approaches. New Delhi.

2. Jain, S. K. 1989. Methods of Approaches in Ethnobotany, Lucknow.

3. Jain, S. K. 1991. A manual of Ethnobotany, Jodhpur.

4. Jain S. K. & V. Mudgal. 1999. A handbook of Ethnobotany, Dehradun.

5. Martin, G. J. 1994. Ethnobotany: A Method Manual, London.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the scope and importance of ethnobotany in human culture and society.

CO2 Identify plants of ethnobotanical importance and their uses in traditional medicine, food, and industry.

CO3 Analyze the role of indigenous knowledge in plant-based healthcare and sustainable resource use.

CO4 Evaluate conservation approaches, biodiversity protection, and legal aspects of ethnobotanical research.

CO5 Apply field research techniques to document and study ethnobotanical practices.

CO-PO-PSO Mapping

COs \ Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1	1	1	1	1	1	3	2	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	2	3	1	1	1
CO3	2	2	3	2	2	1	1	1	1	1	1	2	3	2	1
CO4	1	1	2	3	3	2	1	1	1	1	1	1	2	3	2
CO5	1	1	1	2	3	3	2	2	3	3	1	1	1	3	3
Average	2	1.8	1.8	1.8	2	1.6	1.2	1.2	1.4	1.4	1.6	1.8	1.6	2	1.6

Elective Course: Environmental Biology

1. Understand organism and population concept, interactions among populations.
2. Knows concept of ecosystem, ecosystem energetic, environmental pollution.
3. Understand the importance of environmental awareness.
4. Learn environmental pollution in relation to air, water and soil. Use of fertilizer, pesticides and other chemicals in agriculture and hygiene and their disposal.
5. Knows strategies of conservation: In situ conservation & Ex situ conservation measures, IUCN categories.
6. Knows various act related to Bio Diversity conservation and protection and international conventions.

Elective Course : Environmental Biology

Course Objectives (COs):

This course aims to:

1. Provide an understanding of the fundamental concepts of environmental biology and ecology.
2. Analyze the interactions between organisms and their environment, including biotic and abiotic factors.
3. Explore the impact of human activities on ecosystems and biodiversity.
4. Study environmental pollution, climate change, and sustainability strategies.
5. Develop skills in conservation biology and environmental management approaches.

Unit 1. Environment: Definition, major components of physical environment, Geosphere, lithosphere, hydrosphere, atmosphere and outer space. Impact of man on physical environment and vice-versa.

Unit 2. Resource and Energy Conservation: Concepts of resource, renewable and non-renewable resources, resource conservation, soil, water and forest resources, wild life resources, wild life management laws and principle, wild life sanctuaries, national parks and biosphere reserves. Introduction to various energy resources such as solar, wind, biomass, thermal, nuclear and biogas. Energy conservation pattern and strategies.

Unit 3. Environmental monitoring: Meaning and scope, Environmental monitoring as a tool to environmental management concept of bio-monitoring and biological indicator, biodiversity indices, environmental monitoring system.

Unit 4. Ecotoxicology: Branches and its significance, types of toxicants, toxic elements; organometallics and organometalliods, toxic inorganic and organic compounds, toxic natural products. National and International laws of toxicology, Radiation, Ecology and recycling.

Unit 5. Environmental Pollution: Definition types and causes of pollution, Air pollution, carbon sulphur and nitrogen pollution, acid rains, ozone fluorocarbons, Hydrocarbons, Metal photochemical, products, water pollution sources of pollution and the pollutants, solid waste pollution, degradation and cycling of water, Noise pollution, radio-active pollution and the pollutants, global warming and climate change, legal aspect of environmental pollution. Indian laws and policies for control of environmental pollution.

Unit 6. Environmental Impact Assessment: Scope, importance and application of EIA process. Its role in protection and conservation of environment and economic resources, Environmental and socio-economic aspects, Environmental priorities in India.

Unit 7. Environmental Management: Definition and basic concepts, sustainable development, Environmental issues, challenges and strategies in management, eco-planning, National and international Organizations and policies on environmental management, Environmental management with special reference to land, water and forest resources, environmental education and awareness. Environmental laws.

Suggested Readings:

1. Energy, Environment and Natural Resources- J.S. Singh, S.P. Singh and S.R. Gupta.
2. Environmental Sciences- G.T. Miller
3. Environmental Science R.T. Wright
4. Environmental Science- Piyush Malviya and Pratibha Singh
5. Environmental Science and Impact Assessment- S.C. Santra.
6. Fundamental of Ecology- E.P. Odum.
7. Ecology and Environment- P.D. Sharma

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the principles of environmental biology and ecological interactions.

CO2 Analyze the role of biotic and abiotic factors in ecosystem functioning.

CO3 Assess the impact of human activities on biodiversity and the environment.

CO4 Evaluate environmental issues such as pollution, climate change, and habitat loss.

CO5 Apply conservation strategies and sustainable practices for environmental protection.

CO-PO-PSO Mapping

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1	1	1	1	1	1	3	2	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	2	3	1	1	2
CO3	2	2	3	2	2	1	1	1	1	1	1	2	3	2	3
CO4	1	1	2	3	3	2	1	1	1	1	1	1	2	3	2
CO5	1	1	1	2	3	3	2	2	3	3	1	1	1	3	1
Average	2	1.8	1.8	1.8	2	1.6	1.2	1.2	1.4	1.4	1.6	1.8	1.6	2	1.8

Elective Course: Computer Application

Course Objectives (COs):

This course aims to:

1. Introduce fundamental concepts of computer applications and their role in various domains.
2. Develop proficiency in using software tools for data processing, analysis, and presentation.
3. Familiarize students with programming concepts, database management, and networking.
4. Explore applications of computers in scientific research, business, and education.
5. Enhance problem-solving skills through hands-on experience with computing tools and technologies.

Unit 1. Basics of Computer, Characteristics of Computers, Evolution of computers, computer memory, computer generations, Basic computer organization; System software, Application software, introduction to operating system.

Unit 2. Data Communication and Networks Data communication concepts, local area network, wide area network, internet, intranet, extranet, website. E-mail, search engines

Unit 3. Using Internet for Research. The Internet: quick look, what is internet, Use of Internet, major internet services, electronic mail, www, downloading super tools for better computing Internet and the society.

Unit 4. Data processing and plotting, Excel, presentations and drawings.Power point and word processors.

Unit 5. MS-Office and its application, File handing in window, various versions of MSOffice, Research publishing tool- MS-Word, Adobe acrobat, Graphics.

Suggested reading:

1. Young, S. S. Computerized data acquisition & Analysis for life Sciences: A Hands-on guide. Cambridge University Press, 2001.
2. Snedecor ,G.W and Cochran, W.G. Statistical Methods. Ed VI. Oxford and IBH Publishing co, New Delhi, 1967.
3. Higgins, D & Taylor, W (Eds). Bioinformatics Sequence, Structure. Chapman & Hall, 1995

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the basic structure, functions, and applications of computers.

CO2 Use software tools such as word processors, spreadsheets, and databases for various applications.

CO3 Develop basic programming skills for problem-solving and automation.

CO4 Analyze the role of computer networks, internet technologies, and cybersecurity.

CO5 Apply computational tools for data analysis, visualization, and research applications.

CO-PO-PSO Mapping

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1	1	1	1	1	1	3	2	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	2	3	1	1	1
CO3	2	2	3	2	2	1	1	1	1	1	1	2	3	2	2
CO4	1	1	2	3	3	2	1	1	1	1	1	1	2	3	3
CO5	1	1	1	2	3	3	2	2	3	3	1	1	1	3	3
Average	2	1.8	1.8	1.8	2	1.6	1.2	1.2	1.4	1.4	1.6	1.8	1.6	2	2

Elective Course : Lichenology

Course Objectives (COs):

This course aims to:

1. Provide an understanding of the classification, morphology, and biology of lichens.
2. Analyze the ecological roles of lichens as bioindicators and their symbiotic relationships.
3. Explore the economic and medicinal significance of lichens.
4. Study the physiological and biochemical adaptations of lichens to diverse environments.
5. Develop research and fieldwork skills for lichen identification, conservation, and utilization.

Elective Course: Lichenology

Unit 1. History of Lichenology, Biogeographical distribution, Habitat and Growth form of lichens, Classification; Identification and Symbiosis in lichens

Unit 2. Reproduction: Asexual and sexual means, Lichenized and non-lichenized Diasporas, Isidia, Soredia, Conidia, Perithecia and Apothecia.

Unit 3. Chemistry: Chemical Composition of Lichens, Primary and Secondary Metabolites, Major pathways of secondary metabolite formation.

Unit 4. Physiology: Nutrients, elemental accumulation and Mineral cycling, Nitrogen Metabolism and Lichen sensitivity to air pollution.

Unit 5. Role of lichens in environmental monitoring: Pollution, ' Succession, Lichenometry, Pedogenesis and Bio-deterioration. Importance of Lichens: As food, medicine, dyes, perfumery etc.

Unit 6. An elementary idea of Lichen Tissue Culture . Tools and techniques used in identification of some common Lichen Families and their representative genera-

Parmeliaceae, Lecanoraceae, Teloschistaceae, Ramalinaceae, Physciaceae, Collemataceae, Candelariaceae, Pertusariaceae, Peltigeraceae

Unit 7. Lichen Flora of Jharkhand : General Account.

Suggested Readings:

1. Awasthi, D.D. (2000), handbook of Lichens, Bishen Singh Mahendra Pal Singh: Dehradun, India.

2. Awasthi, D.D. (2007). A Compendium of the Macrolichens of India, Nepal and Sri Lanka, Dehradun, Bishen Singh Mahendra Pal Singh: Dehradun, India.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1 Explain the taxonomy, structure, and reproduction of lichens.

CO2 Analyze the ecological significance of lichens as bioindicators and in nutrient cycling.

CO3 Identify the economic and medicinal applications of lichens.

CO4 Evaluate the physiological and biochemical adaptations of lichens to extreme habitats.

CO5 Conduct field-based identification and conservation studies on lichen diversity.

CO-PO-PSO Mapping

COs \ POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	1	2	1	1	1	1	1	1	-	1	1	1	-	2
CO-2	2	2	1	2	1	1	-	1	1	-	-		-	-	1
CO-3	2	2	2	1	-	-	1	1	1	-	1	1	1	-	1
CO-4	1	2	1	1	2	1	-	1	1	1	1	-	-	1	1
CO-5	-	1	-	-	2	-	-	1	1	1	3	1	2	1	1
Average	1.8	1.5	1.4	1.2	1.4	1	1	1	1	1.4	1	1.3	1.2	1	1