Syllabus

Four Year Undergraduate Programme (FYUGP) in Botany

Effective from academic year 2024-2025

Dhakuakhana College (Autonomous),

Lakhimpur-787055, Assam

Introduction:

The undergraduate Botany syllabus at Dhakuakhana College (Autonomous) is structured in alignment with the National Education Policy (NEP) 2020. The Bachelor of Science in Botany program under NEP-2020 offers multiple exit options, allowing students to earn a UG Certificate, UG Diploma, UG Degree, or UG Degree (Honours with Research) upon the successful completion of one, two, three, or four years, respectively. By completing this four-year program, students are expected to develop expertise in multidisciplinary approaches for the exploration and sustainable utilization of plant and natural resources in the Northeastern region of India.

Aims of Four Year Under-Graduate Programme (FYUGP) in Botany:

i) To familiarize students with the rich biodiversity of Northeast India.

ii) To empower students to explore the potential of plant resources for human welfare and promote their sustainable utilization.

iii) To enhance students' ability to critically evaluate contemporary environmental and nature-related issues.

iv) To develop skilled human resources for biological entrepreneurship.

Programme Educational Objectives (PEOs)

i) Develop strategies for the sustainable utilization of biological resources.

ii) Analyse environmental challenges and propose innovative solutions.

iii) Exhibit a mindset that integrates multidisciplinary approaches to address problems effectively.

Programme Outcomes (POs)

i) Generate ideas to assess and catalogue the biological resources of the region.

ii) Devise innovative strategies for conserving biogenetic resources to benefit human welfare.

iii) Explore and validate the ethnobiological knowledge of Northeast India.

iv) Provide biological knowledge-based solutions to address societal challenges.

v) Develop research skills to tackle complex biological issues and contribute to achieving Sustainable Development Goals (SDGs).

vi) Cultivate strong communication skills for effectively disseminating knowledge in biological sciences.

vii) Foster a collaborative mindset that values teamwork and upholds ethical principles.

Programme Specific Outcomes (PSOs)

i) Assess the diversity and evolutionary patterns of organisms.

ii) Examine the core processes that sustain life.

iii) Develop strategies to address public health challenges and enhance human welfare.

iv) Critically evaluate environmental issues and devise effective solutions.

v) Propose measures to mitigate the impacts of climate change.

Department of Botany

Outline of the Course

Year	Sem.	Course Code	Nature of the course	Title of the course	Credit
I	1st	BOTMJ101	Major	Algae, Fungi, Bryophyte and Pteridophyte	4
		BOTMN101	Minor	Algae, Fungi, Bryophyte and Pteridophyte	4
		SEC103	SEC	Mushroom Culture Technology	3
		GEC103	GE	Natural Resource Management	3
	2nd	BOTMJ201	Major	Morphology and Reproduction of Spermatophytes	4
		BOTMN201	Minor	Morphology and Reproduction of Spermatophytes	4
		SEC203	SEC	Biofertilizers	3
		GEC201	GE	Plant Diversity and Human Welfare	3
II	3rd	BOTMJ301	Major	Cell Biology	4
		BOTMJ302	Major	Plant Biochemistry and Molecular Biology	4
		BOTMN301	Minor	Angiosperm Systematics and Plant Ecology	4
		SEC303	SEC	Nursery and Gardening	3
		GEC301	GE	Ethnobotany	3
	4th	BOTMJ401	Major	Angiosperm Systematics	4
		BOTMJ402	Major	Plant Anatomy & Embryology	4
		BOTMJ403	Major	Genetics and Evolutionary Biology	4
		BOTMJ404	Major	Plant Ecology and Phytogeography	4
		BOTMN401	Minor	Plant Physiology and Metabolism	4

Abbreviations:

T=Theory

P=Practical

IA= Internal Assessment

L= Lectures

Semester-I
Major/Core – I
Course Code: BOTMJ101
Title: Algae, Fungi, Bryophyte & Pteridophyte
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course Outcomes:

i) Explain the various groups within the plant kingdom, including algae, fungi, bryophytes, and pteridophytes.
ii) Classify organisms into distinct categories based on their morphological characteristics.
iii) Investigate the interrelationships among different species and genera within each plant group.

Learning Outcomes:

i) Gain an understanding of the different divisions of the Plant Kingdom up to Pteridophytes.
ii) Compare various organisms based on their morphology and reproductive methods.
iii) Classify and identify distinct plant groups based on their morphological characteristics.

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2,CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2,4
CO2	3	2	2	2	2	2	2	2.4
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total lectures- 60

Unit-1. Algae **(15 L; 11 Marks)**

Introduction to algae, including their characteristic features, thallus organization, cellular structure, pigment system, reserve food materials, and modes of reproduction. Discussion on endosymbiosis and an overview of Fritsch and Lee's classification systems, along with the key characteristics of each major group.

Exploration of the characteristics, distribution, reproductive methods, morphology, and life cycles of specific genera such as *Anabaena, Chlorella, Volvox, Diatoms, Vaucheria, Oedogonium, Chara, Fucus, Ectocarpus, Batrachospermum, and Polysiphonia*.

Ecological and economic significance of algae.

Unit-2. Fungi **(17 L; 12 Marks)**

Introduction to fungi, including their characteristic features, Classification, Organization of thallus, Composition of Cell wall, Fungal Nutrition and their types, Reproduction in Fungi, Symbiotic association – Mycorrhiza and their significance.

Study of some major groups of Fungi: Characteristics of Myxomycetes, Phycomycetes, Ascomycetes, Basidiomycetes, and Deuteromycetes.

Life cycle of *Synchytrium, Phytophthora, Rhizopus, Saccharomyces, Penicillium, Puccinia, Agaricus*.

Ecological and Economic importance of fungi.

Lichen: Characters, Classification, ecological and economic importance

Unit-3. Bryophyte **(13 L; 11 Marks)**

Overview of bryophytes, including their introduction, characteristic features, classification, thallus organization, and modes of reproduction. Detailed study of the morphology, anatomy, and reproduction in genera such as *Riccia, Marchantia, Anthoceros, Sphagnum, and Polytrichum.*

Study of the evolution of sporophytes in bryophytes, along with their ecological and economic significance.

Unit-4. Pteridophyte **(15 L; 11 Marks)**

Introduction to pteridophytes, including their characteristic features, classification; telome theory, homospory and heterospory; evolution of the stele.

Detailed exploration of the morphology, anatomy, and reproduction in genera such as *Psilotum, Selaginella,Lycopodium, Equisetum, Ophioglossum, and Marselia*.

Discussion of the ecological and economic significance of pteridophytes.

Practical

- Study of the vegetative and reproductive structures of *Anabaena, Volvox, Oedogonium, Chara, Vaucheria, Fucus, Ectocarpus, Batrachospermum, and Polysiphonia.*
- Study of the vegetative and reproductive structures of *Phytophthora, Albugo, Saccharomyces, Aspergillus, Penicillium, Alternaria, and Puccinia.*
- Study of the vegetative and reproductive structures of *Riccia, Marchantia, Anthoceros, Sphagnum, and Polytrichum.*

- Study of the vegetative and reproductive structures of *Selaginella, Lycopodium, Equisetum,Ophioglossum, and Marselia.*

Suggested Readings

1. Botany for Degree students : Dutta, A.C.
2 A Text Book of Botany – Algae: Pandey, B.B; S. Chand & Co. (P) Ltd, New Delhi.
3. Studies in Botany: J.N. Mitra
4. Cryptogamic Botany (Vol. I-Algae, Fungi & Lichens): Smith, G.M. ;Mc Graw Hill Book Co, New York
5 An Introduction to Mycology: Mehrotra R.S. and Aneja K.R; Wiley, Eastern Limited, New Delhi.
6. An introduction of Fungi: Srivastava, J.P. ; Central Book Depot,Allahabad.
9. Botany for degree students –Algae: Vashishta, B.R; S. Chand & Co. Ltd., New Delhi. 3
8.Botany for Degree students. Part II. Fungi.: Vashista, B.R. S.Chand and Co. New Delhi
9.Cryptogamic Botany (Vol. I-Algae, Fungi & Lichens): Smith, G.M. ;Mc Graw Hill Book Co, New York.
10. Text Book of Algae: Sharma. O.P, Tata Mc Graw Hill Publishing Co, Ltd., New Delhi.
11. Text Book of Fungi: Sharma, O.P. Tata McGraw Hill Publishing Co.,New Delhi.
13. Introductory Phycology: Kumar, H.D ; Affiliated East West Press (P) Ltd., New Delhi.
14. An Introduction to Bryophyta: Parihar, N.S., Central Book Depot, Allhabad,
15. An Introduction to Pteridopyta : Rashid, A., Vikas publ. Co. New Delhi.
16. Botany for degree student –Bryophyta:Vashishta, B.R.; S. Chand & Co, New Delhi.
17. Botany for Degree Students, Vol IV – Vascular Cryptogams (Pteridophyta): Vashishta. P.C. ; S.Chand & Co.
18. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
19. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
20. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition

Semester-I
Minor – I
Course Code: BOTMN101
Title: Algae, Fungi, Bryophyte & Pteridophyte
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course Outcomes:

i) Explain the various groups within the plant kingdom, including algae, fungi, bryophytes, and pteridophytes.
ii) Classify organisms into distinct categories based on their morphological characteristics.
iii) Investigate the interrelationships among different species and genera within each plant group.

Learning Outcomes:

i) Gain an understanding of the different divisions of the Plant Kingdom up to Pteridophytes.
ii) Compare various organisms based on their morphology and reproductive methods.
iii) Classify and identify distinct plant groups based on their morphological characteristics

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2,CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2,4
CO2	3	2	2	2	2	2	2	2.4
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total lectures- 60

Unit-1. Algae **(15 L; 11 Marks)**

Introduction to algae, including their characteristic features, thallus organization, cellular structure, pigment system, reserve food materials, and modes of reproduction. Discussion on endosymbiosis and an overview of Fritsch and Lee's classification systems, along with the key characteristics of each major group.

Exploration of the characteristics, distribution, reproductive methods, morphology, and life cycles of specific genera such as *Anabaena, Chlorella, Volvox, Diatoms, Vaucheria, Oedogonium, Chara, Fucus, Ectocarpus, Batrachospermum, and Polysiphonia*.

Ecological and economic significance of algae.

Unit-2. Fungi **(17 L; 12 Marks)**

Introduction to fungi including their characteristic features, Classification, Organization of thallus, Composition of Cell wall, Fungal Nutrition and their types, Reproduction in Fungi, Symbiotic association – Mycorrhiza and their significance.

Study of some major groups of Fungi: Characteristics of Myxomycetes, Phycomycetes, Ascomycetes, Basidiomycetes, and Deuteromycetes.

Life cycle of *Synchytrium, Phytophthora, Rhizopus, Saccharomyces, Penicillium, Puccinia, Agaricus*,

Ecological and Economic importance of fungi.

Lichen: Characters, Classification, ecological and economic importance.

Unit-3. Bryophyte **(13 L; 11 Marks)**

Overview of bryophytes, including their introduction, characteristic features, classification, thallus organization, and modes of reproduction. Detailed study of the morphology, anatomy, and reproduction in genera such as *Riccia, Marchantia, Anthoceros, Sphagnum, and Polytrichum.*

Study of the evolution of sporophytes in bryophytes, along with their ecological and economic significance.

Unit-4. Pteridophyte **(15 L; 11 Marks)**

Introduction to pteridophytes, including their characteristic features, classification, telome theory, homospory and heterospory, and the evolution of the stele.

Detailed exploration of the morphology, anatomy, and reproduction in genera such as *Psilotum, Selaginella, Lycopodium, Equisetum, Ophioglossum, and Marsilea*.

Discussion of the ecological and economic significance of pteridophytes.

Practical

- Study of the vegetative and reproductive structures of *Anabaena, Volvox, Oedogonium, Chara, Vaucheria, Fucus, Ectocarpus, Batrachospermum, and Polysiphonia.*
- Study of the vegetative and reproductive structures of *Phytophthora, Albugo, Saccharomyces, Aspergillus, Penicillium, Alternaria, and Puccinia.*
- Study of the vegetative and reproductive structures of *Riccia, Marchantia, Anthoceros, Sphagnum, and Polytrichum.*

- Study of the vegetative and reproductive structures of *Selaginella, Lycopodium, Equisetum,Ophioglossum, and Marsilea.*

Suggested Readings

1. Botany for Degree students : Dutta, A.C.
2 A Text Book of Botany – Algae: Pandey, B.B; S. Chand & Co. (P) Ltd, New Delhi.
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5 An Introduction to Mycology: Mehrotra R.S. and Aneja K.R; Wiley, Eastern Limited, New Delhi..
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9.Cryptogamic Botany (Vol. I-Algae, Fungi & Lichens): Smith, G.M. ;Mc Graw Hill Book Co, New York.
10. Text Book of Algae: Sharma. O.P, Tata Mc Graw Hill Publishing Co, Ltd., New Delhi.
11. Text Book of Fungi: Sharma, O.P. Tata McGraw Hill Publishing Co.,New Delhi.
13. Introductory Phycology: Kumar, H.D ; Affiliated East West Press (P) Ltd., New Delhi.
14. An Introduction to Bryophyta: Parihar, N.S., Central Book Depot, Allhabad,
15. An Introduction to Pteridopyta : Rashid, A., Vikas publ. Co. New Delhi.
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Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley& Sons (Asia) Singapore. 4th edition

Semester-I
Skill Enhancement Course
Course Code: SEC103
Title: Mushroom Culture Technology
Marks:100 {(40T+20P)=60; IA=40}
Total Credits: 3

Course Outcomes:

i) Identify and differentiate between edible and non-edible mushrooms.
ii) Practice the cultivation of commercially valuable mushroom species.

Learning outcomes:

i) Recognize commercially valuable and edible mushroom species.
ii) Implement management strategies for the commercial cultivation of mushrooms.

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1,		
Procedural			CO2			
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2,4
CO2	3	2	2	2	2	2	2	2.4
AVERAGE	3	2	2.0	2.0	2.0	2.0	2.0	

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total lectures- 45

Unit 1. Introduction **(6 L; 6 Marks)**

1.1 Introduction and history of mushrooms; Ecology and distribution.
1.2 Structure and life cycle of mushrooms with special reference to *Agaricus* and *Morchella*
1.3 Nutrition, nutraceutical and pharmaceutical value of mushrooms
1.4 Poisonous mushrooms, Mycorrhizal association of mushrooms with higher plants

Unit 2. (Mushroom) Cultivation Technology (15L; 12 Marks)

2.1 Infrastructure: Substrates (locally available), Polythene bag, vessels, inoculation hook, inoculation loop, low cost stove, sieves, culture racks

2.2 Mushroom bed preparation- Paddy straw, wheat straw, sugarcane trash, maize and banana leaves, Factors affecting the mushroom bed preparation

2.3 Composting technology in mushroom production (low cost technology)

Unit 3. Cultivation, Storage and Diseases (17 L; 15 Marks)

3.1 Cultivation practices of *Agaricus bisporus, Pleurotus ostreatus, P. citrinopileatus, Volvariella volvacea*

3.2 Storage: Short term storage (Refrigeration upto 24 hours), Long term storage (canning, pickels, papads), drying, storage in salt solutions

3.3 Diseases, infections and pest of mushrooms (Pre and post harvest)

Unit 4. Nutraceutical value and Mushroom Recipes (7 L; 7 Marks)

1.1 Composition and nutritional value: Proteins, amino acids, carbohydrates, fats, fibre contents, vitamin, mineral elements

1.2 Types of food prepared from mushroom

1.3 Scope of mushroom for rural upliftment

1.4 Mushroom production and marketing

Unit 5. Practical

Identification of edible mushroom, Demonstration of Spawn Preparation, Demonstration of Culture and Packaging technique of mushroom

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (199 Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II

SEMESTER-I
Generic Elective Course
Course Code: GEC101
Title: Natural Resource Management
Marks:100 {60T; IA=40}
Total Credits: 3

Course outcomes:

- Differentiate between renewable and non-renewable resources.
- Analyze the threats to the natural and biological resources of Northeast India.
- Evaluate management strategies for the sustainable use of resources.

Learning outcomes:

- Distinguish between natural and biological resources in Northeast India.
- Recognize the threats and challenges associated with these natural resources.
- Implement strategies for the conservation and management of natural resources.

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2, CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2,4
CO2	3	2	2	2	2	2	2	2.4
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

Modes of internal assessment

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total Lectures: 45

Unit 1: Natural resources: **(7 L; 11 Marks)**

Definition and types. Natural resources of NE India. Renewable and non-renewable sources of energy.

Unit 2: Sustainable utilization of land and water resources: (15 L; 16 Marks)
Soil degradation and management; water resources (Freshwater, marine, estuarine) wetlands; Threats and management strategies and their management.

Unit 3: Biodiversity: (8 L; 17 Marks)
Definition, types, significance, threats, management strategies, CBD, Bioprospecting, Conservation of biodiversity, Causes of extinction, endemism, Hot Spots of Indian biodiversity

Unit 4: (15 L; 16 Marks)
Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting;Waste management. National and international efforts in resource management and conservation. In-situ and Ex-situ Conservation, Forest Protection Act, National Parks,Biosphere Reserves, Role of NGOs.

Suggested Readings:

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.

Semester-II
Major/Core
Course Code: BOTMJ201
Title: Morphology and Reproduction of Spermatophytes
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course outcomes:

i. Explain the various groups of gymnosperms and angiosperms.
ii. Investigate the morphology and reproductive processes in gymnosperms and angiosperms.
iii. Analyze the interrelationships among different species and genera within gymnosperms and angiosperms.

Learning outcomes:

i. Gain an understanding of the different groups within gymnosperms and angiosperms.
ii. Compare the diverse groups of gymnosperms and angiosperms based on their morphology and reproductive strategies.
iii. Examine the reproductive structures across various groups of gymnosperms and angiosperms.

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2,CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	1	1	1.8
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	2	1	1	2	2	1.8
AVERAGE	3	2	2.0	1.7	1.7	1.7	1.7	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total Lectures: 60

Unit-1. Gymnosperms (8 L; 8Marks)

Characteristic features, classification, patterns of embryo development in gymnosperms. economic importance; Morphology, anatomy and reproduction of *Cycas, Pinus, Ginkgo and Gnetum*.

Unit. 2. Fossil plants (6 L;6 Marks)

Fossilization process; Geological time scale, importance of fossil study; Study of early land plants *Rhynia , Horneophyton, Psilophyton,* Cycadeoidea, and *Sphenophyllum*.

Unit. 3. Morphology of Angiosperms (7 L; 7 Marks)

Morphology and types of roots, stems, and leaves; patterns of phyllotaxy and venation; characteristics of hairs and trichomes; types of inflorescence; aestivation. Organization and types of floral reproductive structures, along with the types of placentation.

Unit. 4. Anther and pollen biology (8 L; 8 Marks)

Structure and functions of the anther wall; process of microsporogenesis, callose deposition, and its importance; microgametogenesis; structure of the pollen wall; male germ unit (MGU) organization.

NPC system; an overview of palynology and its scope; pollen wall proteins; pollen viability, storage methods, and germination process.

Unit 5: Ovule (6 L; 6 Marks)

Structure and classification of ovules; development of the female gametophyte, including megasporogenesis (monosporic, bisporic, and tetrasporic types) and the process of megagametogenesis.

Unit 6: Pollination, fertilization and post fertilization developments (10 L; 10 Marks)

Pollination types and their significance, adaptations for pollination, and the process of double fertilization; structure and different types of embryos and endosperms; general developmental patterns of dicot and monocot embryos and endosperms; structure and function of the suspensor; the relationship between the embryo and endosperm; nutrition of the embryo; polyembryony, apomixis, parthenocarpy, and self-incompatibility.

Practical

1. To study the morphology and reproductive structures of *Cycas, Pinus, Ginkgo, and Gnetum.*
2. Analysis of fossil plants using photographs or specimens.
3. Study of various root types focusing on their morphological characteristics.
4. Study of leaf types, including venation patterns, hairs, trichomes, phyllotaxy, inflorescence, and aestivation.
5. Identification and preparation of temporary slides for types of placentation and ovules.
6. Analysis of pollen morphology and observation of pollen tube formation.
7. Study of different embryo and endosperm types through permanent slides or photographs.

Suggested readings

1. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
2. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
3. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
4. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
5. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Botany for Degree students : Dutta, A.C.

Semester-II
Minor
Course Code: BOTMN201
Title: Morphology and Reproduction of Spermatophytes
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course outcomes:

i. Explain the various groups of gymnosperms and angiosperms.
ii. Investigate the morphology and reproductive processes in gymnosperms and angiosperms.
iii. Analyze the interrelationships among different species and genera within gymnosperms and angiosperms.

Learning outcomes:

i) Gain an understanding of the different groups within gymnosperms and angiosperms.
ii) Compare the diverse groups of gymnosperms and angiosperms based on their morphology and reproductive strategies.
iii) Examine the reproductive structures across various groups of gymnosperms and angiosperms.

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
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Conceptual		CO1		CO2,CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

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CO1	3	2	2	2	2	1	1	1.8
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	2	1	1	2	2	1.8
AVERAGE	3	2	2.0	1.7	1.7	1.7	1.7	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

1. Two theory-based internal exams: 10+10 Marks
2. Seminar/group discussion: 10 Marks
3. Home assignments: 05 Marks
4. Attendance: 05 Marks

Course content

Total Lectures: 60

Unit-1. Gymnosperms (8 L; 8Marks)

Characteristic features, classification, patterns of embryo development in gymnosperms. economic importance; Morphology, anatomy and reproduction of *Cycas, Pinus, Ginkgo and Gnetum*.

Unit. 2. Fossil plants (6 L;6 Marks)

Fossilization process; Geological time scale, importance of fossil study; Study of early land plants *Rhynia , Horneophyton, Psilophyton,* Cycadeoidea, and *Sphenophyllum*.

Unit. 3. Morphology of Angiosperms (7 L; 7 Marks)

Morphology and types of roots, stems, and leaves; patterns of phyllotaxy and venation; characteristics of hairs and trichomes; types of inflorescence; aestivation. Organization and types of floral reproductive structures, along with the types of placentation.

Unit. 4. Anther and pollen biology (8 L; 8 Marks)

Structure and functions of the anther wall; process of microsporogenesis, callose deposition, and its importance; microgametogenesis; structure of the pollen wall; male germ unit (MGU) organization.

NPC system; an overview of palynology and its scope; pollen wall proteins; pollen viability, storage methods, and germination process.

Unit 5: Ovule (6 L; 6 Marks)

Structure and classification of ovules; development of the female gametophyte, including megasporogenesis (monosporic, bisporic, and tetrasporic types) and the process of megagametogenesis.

Unit 6: Pollination, fertilization and post fertilization developments (10 L; 10 Marks)

Pollination types and their significance, adaptations for pollination, and the process of double fertilization; structure and different types of embryos and endosperms; general developmental patterns of dicot and monocot embryos and endosperms; structure and function of the suspensor; the relationship between the embryo and endosperm; nutrition of the embryo; polyembryony, apomixis, parthenocarpy, and self-incompatibility.

Practical

- To study the morphology and reproductive structures of *Cycas, Pinus, Ginkgo, and Gnetum.*
- Analysis of fossil plants using photographs or specimens.
- Study of various root types focusing on their morphological characteristics.
- Study of leaf types, including venation patterns, hairs, trichomes, phyllotaxy, inflorescence, and aestivation.
- Identification and preparation of temporary slides for types of placentation and ovules.
- Analysis of pollen morphology and observation of pollen tube formation.
- Study of different embryo and endosperm types through permanent slides or photographs.

Suggested readings

1. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) LtdPublishers, New Delhi, India.
2. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, VikasPublishing House. Delhi. 5th edition.
3. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH PublishingCo. Pvt. Ltd. Delhi.
4. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
5. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
6. Botany for Degree students : Dutta, A.C.

Semester-II
Skill Enhancement Course
SEC203
Title: Biofertilizers
Marks:100 {(40T+20P)=60; IA=40}
Total Credits: 3

Course outcomes:

i. To identify microorganisms utilized as biofertilizers
ii. Adoption of organic farming practices through the use of biofertilizers
iii. Evaluation of strategies for the production of biofertilizers

Learning outcomes:

i. Describe biofertilizers and their importance
ii. Analyse the issues involve in organic agriculture
iii. Understand the strategies for biofertilizer production

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1				
Procedural		CO3		CO2		
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	1	1	1.8
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	2	1	1	2	2	1.8
AVERAGE	3	2	2.0	1.7	1.7	1.7	1.7	

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total Lectures:45

Unit 1: **(7 L; 10 Marks)**

General account about the microbes used as biofertilizer (nitrogen fixers, phosphate solubilizers, PGPR); Factors affecting plant growth; essential nutrients.

Unit 2: **(7 L; 10 Marks)**

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azo*llae association, nitrogen fixation, blue green algae and *Azolla* in rice cultivation.

Unit 3: **(8 L; 10 Marks)**

Mycorrhizal association, types of mycorrhizal association; colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 4: **(8 L; 10 Marks)**

Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes– biocompost making methods, types and method of vermicomposting – field Application.

Practical

Demonstration/field visit to biofertilizer producing units, identification of some common biofertilizers.

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand& Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. EmkayPublication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, NewDelhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic FarmingAktaPrakashan, Nadiad

SEMESTER-II
Generic Elective Course
Course Code: GEC201
Title: Plant Diversity and Human Welfare
Marks:100 {60T; IA=40}
Total Credits: 3

Course outcomes:

i. Distinguish between different levels of plant diversity
ii. Investigate the causes of biodiversity loss
iii. Assess strategies for biodiversity conservation
iv. Evaluate the contribution of plants to human welfare

Learning outcomes

1. Distinguish the biodiversity levels
2. Analyse threats to biodiversity
3. Understand the conservation strategies for biodiversity
4. Examine the role of plants, in human welfare

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1				
Procedural			CO3	CO4		CO2
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.1
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	3	1	1	2	2	2.0
CO4	3	3	2	2	2	1	1	2.0
AVERAGE	3.0	2.2	2.2	1.7	1.7	1.7	1.7	

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total Lectures:45

Unit 1: **(12 L; 12 Marks)**

Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Uses of plants, Uses of microbes.

Unit 2: **(13 L; 15 Marks)**

Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity information management and communication.

Unit 3: **(10 L; 15 Marks)**

Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity; In situ and ex situ conservation, Biodiversity awareness programmes, Sustainable development.

Unit 4: **(10 L; 18 Marks)**

Role of plants in relation to Human Welfare; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Uses of wood.

Suggested Readings

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

Semester-III
Major/Core
Course Code: BOTMJ301
Title: Cell Biology
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course outcomes:

i. Compare the structure and functions of cellular components
ii. Assess the mechanisms of cell division and the cell cycle
iii. Examine the mechanisms of cell signalling

Learning Outcomes:

i) understand the cell structure and functions of cell organelles.
ii) analyse cell division and cell cycle mechanisms.
iii) interpret the cell signalling mechanisms.

Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO3	CO2	
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.1
CO2	3	2	2	2	3	2	2	2.3
CO3	3	2	3	3	3	2	2	2.4
AVERAGE	3.0	2.0	2.3	2.3	2.7	2.0	2.0	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total Lectures: 60

Unit 1: The Cell **(6 L; 6 Marks)**

Structure and function of cell as a unit; cell theory; Characteristic features of prokaryotic and eukaryotic cells; Endosymbiotic theory.

Unit 2: Cell wall and plasma membrane **(6 L; 6 Marks)**

Structure, chemistry and function of Plant cell wall; Overview of fluid mosaic model; Chemical composition of membranes; membrane function.

Unit 3: Cell organelles **(12 L; 12 Marks)**

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, organization of chromatin, nucleolus. Role and structure of microtubules, microfilaments and intermediary filament. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast; Ribosomes- types, components and function; Lysosomes.

Unit 4: Membrane transport and Protein sorting & targeting **(12 L; 11 Marks)**

Membrane transport mechanisms: Passive, active and facilitated transport, the roles of membrane channels, gates and pores; endocytosis and exocytosis; protein glycosylation, Endoplasmic Reticulum: Structure and function of RER and SER; protein sorting and export from Golgi apparatus; protein folding & processing; export of proteins and lipids.

Unit 5: Cell division **(9 L; 10 Marks)**

Overview of cell division, Phases of cell cycle, stages and processes of mitosis and meiosis; checkpoints and role of protein kinases in cell cycle regulations.

Practical

- Study of plant cell structure with the help of epidermal peel mount of Onion and Rheo.
- Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf, *Vallisnaria*
- Measurement of cell size by of micrometric method.
- Cell counting using haemocytometer (Yeast/pollen grains).
- Study of cell and its organelles with the help of electron micrographs (Demonstration).
- Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
- Study the phenomenon of plasmolysis and deplasmolysis.
- Study of different stages of mitosis.

SUGGESTED READINGS:

1. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.

2. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson EducationInc. U.S.A. 8th edition.

3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Semester-III
Major/Core
Course Code: BOTMJ302
Title: Plant Biochemistry & Molecular Biology
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course outcomes:

i. Compare the biomolecules in living organisms and their interactions for sustaining life
ii. Examine the structure-function relationships of nucleic acids and proteins
iii. Differentiate between replication, transcription, and translation in prokaryotes and eukaryotes
iv. Interpret the mechanisms of gene expression

Learning outcomes:

i. identify the various biomolecules and understand their function
ii. differentiate the cellular processes such as replication, transcription and translation
iii. understand gene expression mechanism

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual			CO4	CO1, CO2, CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.1
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	3	1	1	2	2	2.0
CO4	3	3	2	2	2	1	1	2.0
AVERAGE	3.0	2.2	2.2	1.7	1.7	1.7	1.7	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total Lectures:60

Unit 1: Biomolecules: (10 L; 8 Marks)

Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.

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

Unit 2: Bioenergetics (5 L; 6 Marks)

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as energy currency molecule.

Unit 3: Enzymes (5 L; 6 Marks)

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

Unit 4: Genetic material and its organization (7 L; 7 Marks)

DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & Mc Carty experiment); denaturation and renaturation of DNA; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. RNA Structure; Organelle DNA-mitochondria and chloroplast DNA.

Unit 5: Replication and Transcription of DNA (10 L; 10 Marks)

General principles – bidirectional, semi-conservative and semi discontinuous replication; Various models of DNA replication, replication of linear ds-DNA. Transcription in prokaryotes and eukaryotes; Post Transcriptional modification of RNA; Operon concept: Lac operon and its regulation.

Unit 6: Genetic codes & Translation (8L; 8 Marks)

Genetic codes: salient features; Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, factors involve in initiation, elongation and termination of polypeptides; Post-translational modifications of proteins.

Practical

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Estimation of plant proteins by Biuret/Lowry method.
3. Estimation of reducing and non-reducing sugars in plant samples.
4. Isolation of genomic DNA
5. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
6. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
7. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
8. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
9. Understanding the mechanism of RNAi by photographs.

Suggested Readings

1. Fundamentals of Molecular Biology: RastogiV.B. ; Ane Books, India.

2. Molecular Biology: Arora,M.P. and Chandrakanta

3. Cell biology, Genetics and Molecular Biology: Kar, D.K., S. Haldar

4. Fundamentals of Biochemistry: Jain,J.L.; S.Chand and Co., New Delhi.

5. Introduction to Plant Biochemistry : Goodwin Y.W., and Mercer E.I. ; CBS Publishers

6. Lehninger- Principles of Biochemistry : David L; Nelson and Michael M Cox ; Macmillon

Semester-III
Minor
Course Code: BOTMN301
Title: Angiosperm Systematics and Plant Ecology
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course outcomes:

i) to identify the diversity of angiosperms, including major families, genera, and species
ii) to develop proficiency in using taxonomic keys, morphological features, and molecular data to classify and identify angiosperms
iii) to understand plant ecological principles and interpretation of plant adaptations.
iv) to understand ecosystem dynamics

Learning Outcomes:

i. identify angiosperm taxa at the family, genus, and species levels using morphological, anatomical, and molecular characters
ii. classify the local angiosperm flora based on their morphological, anatomical, and molecular characters
iii. Describe the plant ecological concepts
iv. Discuss plant adaptations concerning the environment
v. Interpret the dynamics of ecosystems

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1				
Procedural		CO4	CO3			CO2
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.4
CO2	3	2	2	2	2	2	2	2.4
CO3	3	2	3	1	1	2	2	2.0
CO4	3	2	3	2	2	2	2	2.3
AVERAGE	3	2	2.5	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total lectures: 60

Unit 1: **(9 L; 8 Marks)**

Introduction to systematics; Biosystematics; Plant identification, Classification, Nomenclature. Preparations and Functions of Herbarium. Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access. Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept(taxonomic, biological, evolutionary).

Unit 2: **(8 L; 7 Marks)**

Angiosperm morphology; History, Principles and rules (ICN); Ranks and names; principles of numerical taxonomy, Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree).

Unit 3: **(10 L; 12 Marks)**

Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG IV) classification.

Unit 4: **(9 L; 9 Marks)**

Basic concept of ecology; Levels of organization, inter-relationships between the living and non-living world, dynamism and homeostasis. Structure and functions of ecosystem; Trophic organization; Principles and models of energy flow; Food chains and Food webs; Production and productivity; Ecological pyramids.

Unit 5: **(9 L; 9 Marks)**

Definition, classification and characteristics of Plant Communities; Habitat and niche; Ecotone and edge effect; Succession- processes and types. Definition, attributes of population ecology; population interaction; Ecological speciation

Practical

- Study of vegetative and floral characters of the following families as per the availability of local specimens (Description with economic importance, floral diagram, floral formula and systematic position according to Bentham & Hooker system of classification):
  Dicots: Brassicaceae, Malvaceae, Lamiaceae, Solanaceae, Apocynaceae
  Monocots: Poaceae, Musaceae

- Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

- Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method.

- Quantitative analysis of herbaceous vegetation for density, frequency and abundance in the college campus

Suggested Readings

1. Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.

2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.

3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.

4. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi.

5. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi.5th edition.

6. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.

7. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.

Semester-III
Skill Enhancement Course
SEC303
Title: Nursery and Gardening
Marks:100 {(40T+20P)=60; IA=40}
Total Credits: 3

Course outcomes:

1. Showcase nursery and gardening techniques
2. Apply nursery techniques for entrepreneurial ventures

Learning outcomes:

i. Manage a commercial nursery as a means of livelihood.
ii. Explain the importance of plants in nursery and horticulture.

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual			CO2			
Procedural			CO1			
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.4
CO2	3	2	2	2	2	2	2	2.4
AVERAGE	3	2	2.0	2.0	2.0	2.0	2.0	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total Lectures:45

Unit 1: **(4 L; 8 Marks)**

Nursery: Definition, objectives, scope, and development of nursery infrastructure; planning and seasonal activities; Planting: Methods including direct seeding and transplanting.

Unit 2: **(6 L; 9 Marks)**

Seed Storage: Seed banks, factors influencing seed viability, and genetic erosion; Seed Production Technology: Techniques and practices for effective seed production; Seed Testing and Certification.

Unit 3: **(7 L; 8 Marks)**

Vegetative Propagation: Techniques such as air-layering and cutting, including selection of cuttings, cutting treatments, and preparation of rooting mediums Greenhouse Structures: Mist chambers, shed roofs, shade houses, and glasshouses; Planting and Maintenance: Planting cuttings and hardening plants

Unit 4: **(6 L; 7 Marks)**

Gardening: definition, objectives and scope; Types of Gardening: landscape and home gardening; Parks and its components; plant materials and design. Gardening Operations: Preparing soil, applying manure, watering, pest and disease management, and harvesting;

Unit 5: **(7 L; 8 Marks)**

Seed and Seedling Management: Sowing seeds, raising seedlings, and transplanting them effectively. Study of cultivation of cabbage, onion and tomatoes. Marketing procedures.

Practical: Field visit to established nurseries, farms etc., preparation of cuttings/seedlings of horticultural important crops.

Suggested Readings

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.

2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.

3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.

4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.

5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.

6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

SEMESTER-III
Generic Elective Course
Course code: GEC301
Title: Ethnobotany
Marks:100 {60T; IA=40}
Total Credits: 3

Course outcome:

i. Examine the indigenous practices of ethnic groups in Northeast India
ii. Utilize the traditional knowledge system of the region for sustainable development
iii. Compare the medicinal and agronomic significance of biological resources in the region
iv. Safeguard traditional knowledge through intellectual property rights (IPR)

Learning outcome:

i. Explore the traditional practices of the region's ethnic communities
ii. Integrating Indigenous Knowledge Systems (IKS) into Sustainable Development Goals
iii. Incorporating indigenous knowledge into everyday life
iv. Evaluating the role of Intellectual Property Rights (IPR) in safeguarding traditional knowledge

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1			CO4	
Procedural			CO2	CO3		
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	2	2	3	3	2	2	2	2.3
CO2	2	2	3	3	2	2	2	2.3
CO3	2	2	3	3	2	2	2	2.3
CO4	2	2	3	3	2	1	1	2.0
AVERAGE	2.0	2.0	3.0	3.0	2.0	1.8	1.8	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance:05 Marks

Course content

Total lectures-45

Unit1: Ethnobotany (15 L;15 Marks)

Overview, idea, parameters, and goals; The multidisciplinary science of ethnobotany. The relevance of ethnobotany in the present context; Major and minor ethnic groups of India, and their life styles. Plants used by the tribals.

Unit 2: Methods of Ethnobotanical study (8 L;15 Marks)

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

Unit 3: Medico-ethnobotanical sources in India (15 L; 18 Marks)

Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo.* d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special reference to *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia* and *Withania.* Role of ethnic groups in conservation of plant genetic resources.

Unit 4: Ethnobotany and legal aspects (7 L; 12 Marks)

Ethnobotany as a tool to protect interests of ethnic groups. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Suggested readings

1. Gupta , R., Rajpal , T., (2012) Concise R.,(2011) , Plant Taxonomy past Present and Future . TERI Press
2. Jain, S.K. (1995). Manual of Ethnobotany. Rajasthan: Scientific Publishers

Semester-IV
Major/Core
Course Code: BOTMJ401
Title: Angiosperm Systematics
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course Outcomes:

i. Identify the diversity of angiosperms, including key families, genera, and species
ii. Develop expertise in using taxonomic keys, morphological traits, and molecular data for classifying and identifying angiosperms
iii. Interpret phylogenetic trees and understand their significance in classification and evolution
iv. Evaluate phylogenetic analyses and taxonomic debates within angiosperms

Learning Outcomes:

i. identify angiosperm taxa at the family, genus, and species levels using morphological, anatomical, and molecular characters
ii. classify the local angiosperm flora based on their morphological, anatomical, and molecular characters
iii. analysis of the evolutionary relationships among angiosperms and major clades of angiosperms
iv. examine the phylogenetic analyses, and taxonomic controversies within angiosperm

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1				
Procedural			CO3	CO4		CO2
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.4
CO2	3	2	2	2	2	2	2	2.4
CO3	3	2	3	1	1	2	2	2.0
CO4	3	2	3	2	2	2	2	2.3
AVERAGE	3	2	2.5	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total lectures: 60

Unit 1: Significance of Plant Systematics (9 L; 7 Marks)

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Preparations and Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access.

Unit 2: Taxonomic hierarchy (5 L; 5 Marks)

Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

Unit 3: Morphology and Botanical nomenclature (9 L; 6 Marks)

Angiosperm morphology; History, Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication,rejection of names, principle of priority and its limitations; Names of hybrids.

Unit 4: Systems of classification (10 L; 11 Marks)

Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker(upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG IV) classification.

Unit 5: Biometrics, numerical taxonomy and cladistics (7 L; 8 Marks)

Characters; Variations; OTUs, character weighting and coding; Biosystematics; Cluster analysis; principles of numerical taxonomy, Phenograms, cladograms (definitions and differences).

Unit 6: Phylogeny of Angiosperms (8 L; 8 Marks)

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree).

Practical

1. Study of vegetative and floral characters of the following families as per the availability of local specimens (Description with economic importance, floral diagram, floral formula and systematic position according to Benthan Hooker system of classification):
    a. Dicots: Brassicaceae, Malvaceae, Lamiaceae, Solanaceae, Asteraceae, Apocynaceae, Rubiaceae
    b. Monocots: Poaceae, Musaceae, orchidaceae, zingiberaceae
2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

3. Field visits to familiarise students with identification of plant species and vegetation or Visit to Research or Academic Institutions.

Suggested Readings

1. Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.

2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.

3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.

4. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi.

Semester-IV
Major/Core
Course Code: BOTMJ402
Title: Plant Anatomy and Embryology
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course outcomes:

1. Identify the anatomical structures of plants and the various embryological stages
2. Describe the adaptive and protective mechanisms of plants
3. Investigate the developmental stages of plants

Learning outcomes:

i. Understand the basic anatomical and embryological features of plants
ii. Discuss the adaptive and protective systems of plants
iii. Compare the developmental patterns of plants

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1				
Procedural			CO2	CO3		
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2,4
CO2	3	2	2	2	2	2	2	2.4
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total Lectures:60

Unit 1: Tissue and tissue system (6L; 6 Marks)

Tissue classification; Simple and complex tissues, Tissue systems, Structure of dicot and monocot root, stem and leaf, Types of Vascular bundles, Kranz anatomy, Root and Shoot apical meristem.

Unit 2: Differentiation of tissues and organs (10L; 10 Marks)

Shoot development: Organization of shoot apex; Apical cell theory, Histogen theory and Tunica Corpus theory. Root development: Organization of root apex; Apical cell theory, Histogen theory, Korpe-Kappe theory and Quiescent centre theory; initiation of lateral roots, root cap. Mechanism of Vascular tissue differentiation; Origin and development of leaves, Leaf growth and determination of phyllotaxy; differentiation of stomata and trichomes.

Unit 3: Development of cambium and wood (7L; 7 Marks)

Cambium: structure and function; seasonal activity of cambium; Secondary growth; wood development in relation to environment factors; Heartwood and Sapwood, Early and Late wood; ring and diffuse porous wood; periderm composition and development; tylosis, rhytidome; Anomalous secondary growth.

Unit 4: Adaptive, Protective and Secretory systems (6L; 6 Marks)

Epidermis and appendages, cuticle, wax, stomata, lenticels, hydathodes, lithocysts, laticifers, Ergastic substances; Abscission; Hydrophytic, xerophytic and epiphytic anatomical adaptation.

Unit 5: Organization and development of floral structures (8L; 8 Marks)

Floral primordia: Floral Meristem; ABC Model of flower development. Structure of anther and pollen; pollen tube; Structure and types of ovules; Embryo sac: types, organization and ultrastructure.

Unit 6: Fertilization and post-fertilization structures (8L; 8 Marks)

Double fertilization; Endosperm types, structure and function; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Nutrition of embryo; embryo – endosperm relationship; Polyembryony and apomixis.

Practical

- Study of meristems through permanent slides and photographs.
- Study of Tissues (Parenchyma, collenchyma and sclerenchyma); Xylem and Phloem elements (through Permanent slides; Photographs)

- Study of Stem anatomy: Dicot and Monocot (Permanent slide preparation).
- Study of Root anatomy: Dicot and Monocot (Permanent slide preparation).
- Study of Leaf anatomy: Dicot and Monocot (Permanent slide preparation).
- Study of Adaptive anatomy: Xerophyte (*Nerium* leaf, *Euphorbia* Stem); Hydrophyte (*Hydrilla* stem, *Eichhornia* stem); Epiphyte (Orchid root, *Pothos* root).
- Study of structure of anther; tapetum (Permanent slides).
- Study of types of ovules: anatropous, orthotropous, circinotropous, amphitropous, campylotropous (Permanent slides).
- Study of Anomalous anatomical growth (*Amaranthus* sp; *Nyctanthes* sp; *Mirabilis jalapa*; *Boerhavia diffusa*; *Bignonia* sp; *Bougainvillea* sp; *Barleria* sp).
- Dissection of embryo/endosperm from developing seeds.
- Study of epidermal appendages; lithocysts; raphides.

Suggested readings

1. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

2. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.

Semester-IV

Major/Core

Course Code: BOTMJ403

Title: Genetics and Evolutionary Biology

Marks:100 {(45T+15P)=60; IA=40}

Total Credits: 4

Course Outcomes:

1. Interpret the fundamental patterns of inheritance
2. Evaluate genetic disorders and mutations
3. Relate evolutionary forces to the variation and diversification of species
4. Examine evidence from fossil records to molecular data to establish phylogenetic relationships among species

Learning Outcomes:

i. to understand the concept of inheritance
ii. to analyze mutations and genetic disorders
iii. to examine forces of evolution
iv. to interpret evidence of evolution

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1		
Procedural				CO3,CO4	CO2	
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	3	2	2	2	2	2	2.3
CO2	3	3	2	2	3	2	2	2.4
CO3	3	2	3	2	3	2	2	2.3
CO4	3	3	3	3	2	2	2	2.6
AVERAGE	3.0	2.5	2.5	2.2	1.5	2.0	2.0	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content **Total Lectures:60**

Unit 1: Mendelian genetics and its extension (10 L; 9 Marks)

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits; Polygenic inheritance.

Unit 2: Extrachromosomal Inheritance (6L; 6 Marks)

Chloroplast mutation: Variegation in Four o'clock plant; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium*.

Unit 3: Linkage, crossing over, and chromosome mapping (9 L; 10 Marks)

Linkage and crossing over- Cytological basis of crossing over; two point and three point crosses, interference and coincidence; gene mapping; Sex linked, Sex influenced, Sex limited inheritances, quantitative traits/loci.

Unit 4: Chromosomal & gene mutation (11 L; 10 Marks)

Chromosomal mutation: Deletion, Duplication, Inversion, Translocation, Position effect,Euploidy and Aneuploidy.

Gene mutations: Types of gene mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Transposons.

Unit 5: Population and evolutionary genetics: (9 L; 10 Marks)

Molecular evolution: Mutation in organisms, mechanisms, mutation rate, theories of molecular evolution (selection, neutral, nearly neutral).

Population genetics: Hardy Weinberg equilibrium, factors influencing the Hardy Weinberg's equilibrium. role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

Practical

- To prepare temporary slides of root tips and flower buds of Onion *(Allium cepa)* by squash method*;* drawing, description of the mitotic and meiotic stages.
- Study of Mendel's law through seed ratios.
- Study of gene interaction through seed ratios.
- To study/list human dominant and recessive traits and to observe the listed physical traits among the students present in the class.
- Numericals based on Hardy-Weinberg law.

- To study colour blindness among students.

Suggested readings

1. Genetics: Analysis & Principles Author: Robert J. Brooker Publisher: McGraw-Hill Science Engineering; 4 edition (21 January 2011)

2. Concepts of Genetics Authors: William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Darrell KilliannPublisher: Benjamin-Cummings Pub Co; Student edition (19 November 2014)

3. Genetics: Analysis of Genes and Genomes Authors: Daniel L. Hartl and Bruce Cochrane Jones and Bartlett Publishers, Inc; 9th Revised edition edition (30 November 2017)

Semester-IV
Major/Core
Course Code: BOTMJ404
Title: Plant Ecology and Phytogeography
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course outcomes:

i. Comprehend the principles of plant ecology
ii. Interpret plant adaptations
iii. Analyze ecosystem dynamics
iv. Explain phytogeographical concepts

Learning outcomes:

i. Describe the plant ecological concepts
ii. Discuss plant adaptations concerning the environment
iii. Interpret the dynamics of ecosystems
iv. Explain the concept of natural resources
v. Explain the concept of vegetation in different geographical regions

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1				
Procedural		CO4	CO2	CO3		
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	2	3	2	3	2	2	2	2.3
CO2	2	3	2	3	3	2	2	2.8
CO3	3	3	2	2	3	2	2	2.8
CO4	2	3	2	2	2	2	2	2.3
AVERAGE	2.2	3.0	2.0	2.5	2.5	2.0	2.0	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content **Total Lectures:60**

Unit 1: Introduction (3 L; 4 Marks)

Basic concept of ecology; Levels of organization, inter-relationships between the living and non-living world, dynamism and homeostasis.

Unit 2: Environmental factors (8 L; 6 Marks)

Soil: Origin, formation and composition of soil; Physical; Chemical and Biological properties; Soil profile.
Water: Importance, States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

Unit 3: Ecosystems (10 L; 10 Marks)

Structure and functions of ecosystem; Trophic organization; Principles and models of energy flow; Food chains and Food webs; Production and productivity; Ecological pyramids; Ecological efficiencies; Standing crop; Biogeochemical cycles; Cycling of Carbon, Nitrogen, and Phosphorus.

Unit 4: Plant Communities (7 L; 7 Marks)

Definition, classification and characteristics; Habitat and niche; Ecotone and edge effect; Dynamics; Succession- processes, types; Climax concepts.

Unit 5: Population Ecology (8 L; 6 Marks)

Definition, attributes; population interaction; Ecological speciation.

Unit 6: Natural resources (5 L; 5 Marks)

Renewable and non-renewable resources with special reference to N.E. India; Conservation of natural resources.

Unit 7: Phytogeography (9L; 7 Marks)

Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

Practical

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
3. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
4. Study of morphological adaptations of hydrophytes and xerophytes (four each).
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method.
6. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.

Suggested Readings

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi.5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation.Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8thedition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach.Oxford University Press. U.S.A.

Semester-IV
Minor
Course Code: BOTMN401
Title: Plant Physiology and Metabolism
Marks:100 {(45T+15P)=60; IA=40}
Total Credits: 4

Course outcomes:

i. Ability to recognize various physiological processes in plants.
ii. Ability to explain the processes of absorption, transpiration, photosynthesis, and growth in plants.
iii. Ability to analyze the metabolic processes occurring in plants.

Learning outcomes:

i. Demonstrate physiological processes in plants
ii. Explain the absorption, transpiration, photosynthesis, growth in plants
iii. Evaluate the metabolic activities of plants

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual			CO1			
Procedural				CO2		
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	3	2	3	3	2	2	2.6
CO2	3	3	2	3	3	2	2	2.6
CO3	3	3	3	3	3	2	2	2.7
AVERAGE	3.0	3.0	2.3	3.0	3.0	2.0	2.0	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

Modes of internal assessment:

- Two theory-based internal exams: 10+10 Marks
- Seminar/group discussion: 10 Marks
- Home assignments: 05 Marks
- Attendance: 05 Marks

Course content

Total Lectures: 60

Unit 1: Plant-water relations (8L; 7 Marks)

Water Potential and its components, imbibition, osmosis, diffusion, water absorption by roots, aquaporins, the pathways of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, and mechanism of stomatal movement.

Unit 2: Mineral nutrition & Nutrient Uptake (8L; 9 Marks)

Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements.

Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems,proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

Unit 3: Carbon assimilation & metabolism (15L; 12 Marks)

Photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4-pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction. Respiration: aerobic and anaerobic, glycolysis and Kreb cycle.

Unit 4: Translocation in the phloem (4L; 5 Marks)

Experimental evidence in support of phloem as the site of sugar translocation, mechanism of translocation in phloem, Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

Unit 5: Plant growth regulators (6L; 7 Marks)

Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin,Gibberellins, Cytokinin, Abscisic acid, Ethylene.

Unit 6: Physiology of flowering (4L; 5 Marks)

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. Phytochrome.

Practical

- To determine osmotic potential of plant cell sap by plasmolytic method.
- To determine water potential of given tissue (potato tuber) by weight method.
- To calculate stomatal index and stomatal frequency from the two surfaces of leavesof a

mesophyte and xerophyte.

- To study the phenomenon of seed germination (effect of light).
- To separate chloroplast pigments by paper chromatography

Suggested Readings

1. Taiz, L. and Zeiger, E., Plant Physiology, 5th edition (Sinauer Associates, USA, 2012).
2. Lambers, H. and Chapin, F. S., Plant Physiological Ecology (Springer, 2000).
3. Mukherji, S. and Ghosh, A.K., Plant Physiology, 1st edition (New Central Book AgencyPrivate Ltd. Kolkata, 2009).