SYLLABI FOR FOUR-YEAR UNDERGRADUATE PROGRAMME

IN

BOTANY

AS PER NATIONAL EDUCATION POLICY (NEP) 2020

Recommended by the 1st meeting of the Board of Studies (BoS), Department of Botany, and approved by the 1st meeting of the Academic Council of Lakhimpur Girls' College (A), held on 28 June 2026, vide Resolution No. AC/1/2026/05.

LAKHIMPUR GIRLS' COLLEGE (AUTONOMOUS)

NORTH LAKHIMPUR, LAKHIMPUR -787031, ASSAM

Endorsed syllabi of Dibrugarh University as model syllabi for the development of syllabi of the Department of Botany, Lakhimpur Girls' College (A) with necessary modifications and additions, keeping in view the context and academic requirements.

FOUR YEAR UNDER-GRADUATE PROGRAMME (FYUGP) IN BOTANY
LAKHIMPUR GIRLS' COLLEGE (AUTONOMOUS)

1. PREAMBLE:

Contemporary plant science represents a blend of traditional elements and advanced fields like biochemistry, molecular biology, and biotechnology. Plants are the only actual foundation for all scientific fields. Learning Botany is important because plants are vital for human survival, providing the food we eat, the oxygen we breath, and raw materials for medicine, construction, and energy like biofuels. It also plays a crucial role in environmental balance through phytoremediation, climate change mitigation, and maintaining ecosystems. Botany enables farmers to increase crop yields and develop disease resistance plants, which is vital for feeding a growing global population. In the current scenario, global over population, combined with the over-increasing problems of environmental pollution caused by adverse climatic changes, global warming, and natural disasters, is severely affecting the growth, development, and productivity of produce (particularly plants) at alarming rates.

Higher education in plant sciences should be supported for individuals with backgrounds in the life sciences, with a focus on using the most recent data, skills, and abilities from both basic and applied branches to find solutions for sustainable development. In light of this, the curriculum has been designed to provide students with the information and skills they will need to deal with environmental and human population concerns. To achieve these goals, every effort is made to ensure high educational standards by implementing a variety of strategies to improve the teaching-learning process, assessment and evaluation methods, and ensuring that students are holistically developed under the NEP 2020 goals and standards.

This syllabus demonstrates our commitment to academic excellence, innovation, and ongoing progress. We believe that by establishing a profound appreciation for the natural world and a sense of responsibility for environmental stewardship in our pupils, we will develop future leaders capable of addressing our planet's critical concerns.

Introduction:

The UG syllabus for Botany at Lakhimpur Girls' College (Autonomous) has been crafted in accordance with the national education policy-2020. This four year undergraduate program (FYUGP) in Botany includes Major (Core) subjects, Minor subjects, Multi-disciplinary generic elective course (GE), Ability enhancement courses (AEC), Value added

courses (VAC), Skill enhancement courses (SEC), Environmental education (EE), YOGA, Community engagement through initiatives like NCC/NSS, Digital and technological solutions, Internship experiences, Field studies, Research ethics, Research projects, and Discipline specific electives (DSE) to provide students with a well-
rounded understanding of plant resources, the environment, current biological issues and entrepreneurship.

The Bachelor of Science in Botany offered by Lakhimpur Girls' College (Autonomous) under NEP-2020 is designed with various exit points. Students will receive a UG certificate. UG Diploma, UG degree (Honors with Research) in Botany upon completing one, two or four years of study, respectively. It is anticipated that graduates of this four-year program possess skills in diverse areas related to the exploration and sustainable use of plants and natural resources in the North- East region of India.

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

1) To familiarize students with North-East India's abundant biodiversity.

2) Knowledge of recent trends in plant taxonomy, cytology, genetics and Plant breeding, plant physiology and biochemistry, microbiology, plant ecology, Mycology and plant pathology.

3) To enable the students to explore the potential of plant resources for human welfare and their use in a sustainable way.

3) To develop capabilities of students for critical valuation of contemporary issues related to environment and nature.

4) To produce human resources with the necessary skills for biological entrepreneurship.

3. Graduate Attributes of the FYUGP in Botany:

Disciplinary Knowledge

The graduates should have the ability to demonstrate comprehensive knowledge and understanding of both the theoretical and applied components of plant science and allied areas of study in a multidisciplinary context.

Students should have the ability to connect relevant disciplines, and recent trends in biological and contemporary issues.

Communication Skills

To effectively communicate any topic and pertaining to plants and nature, Botany graduates should be able to explain and express information, thoughts, experiments and result in a clear and succinct manner.

Moral and Ethical Awareness/Reasoning

Ability to recognize ethical issues that are pertinent to one's work and pledge not to engage in unethical behaviour such as plagiarism, copyright and infringement of intellectual property rights; ability to appreciate recent developments in various fields and one's research with honesty and integrity in all aspects.

Multicultural Competence

Ability to correlate and compare recent developments in various branches of plant science worldwide; ability to collaborate research in various fields of biology with other researchers from allied organizations; acquisition of knowledge on traditional practices of different ethnic communities.

Information/Digital Literacy

The graduates of Botany should have the ability to utilize Information and Communications Technology (ICT) tools, biological databases and computer and software in solving biological problems.

Reflective Thinking and Problem Solving:

After completion of graduation in Botany the students will be able to understand the value of plant resources, need for conservation of plant resources, bio-prospecting and sustainable utilization of plant resources for human welfare.

Critical Thinking

The graduates of Botany should be competent for critical analysis of problems related to plant and nature, sustainable uses of biological resources and their conservation strategies.

4. Programme Educational Objectives (PEOs)

1. Formulate strategies to achieve sustainable development in harnessing biological resources.
2. Evaluate environmental problems and design innovative solutions.
3. Demonstrate an attitude to employ multidisciplinary approaches for problem solving.

5. Programme Outcomes (POs)

1. To motivate the students for higher education and to take research as a career as well as to prepare them for a successful career in others jobs.
2. Formulate innovative strategies for conservation of biogenetic resources for human welfare.
3. To explore and validate ethno-biological knowledge of Northeast India.
4. To provide solutions for existing societal problems using biological knowledge.
5. Develop research skills to solve complex biological issues and achieving SDGs.
6. Execute good communication skills for disseminating knowledge of biological sciences.
7. To promote the attitude to work as a team appreciating ethical values

6. Programme Specific Outcomes (PSOs)

1. Evaluate the diversity and evolution of organisms
2. Analyze the fundamentals of life-sustaining processes
3. Design strategies for issues concerning public health and human welfare.
4. Critically analyze the environmental issues and develop strategies to address them.

5 Formulate measures to mitigate climate change effects.

COURSE STRUCTURE FYUGP BOTANY

Year	Sem	Code	Nature of Course	Title of the course	Credit
I	I	BOT-MAJ-4-101	MAJ-I	Cryptogams	4
		BOT-MIN-4-101	MIN-I	Cryptogams	4
		BOT-GEC-3-101	GEC-I	Natural resource Management	3
			AEC-I	Modern Indian Language	4
		BOT-SEC-3-101	SEC-I	Tea Plantation and Management	3
			VAC-I	Understanding India	2
		Total credit			**20**
	II	BOT-MAJ-4-201	MAJ-II	Morphology & Reproduction of Spermatophytes	4
		BOT-MIN-4-201	MIN-II	Morphology & Reproduction of Spermatophytes	4
		BOT-GEC-3-201	GEC-II	Plant diversity and Human Welfare	3
			AEC-II	English Language and Communication Skills	4
		BOT-SEC-3-201	SEC-II	Conservation and Cultivation of Orchids	3
			VAC-II	Environmental Science	2
		Total credit			**20**
		UG CERTIFICATE			
II	III	BOT-MAJ-4-301	MAJ-III	Cell biology	4
		BOT-MAJ-4-302	MAJ-IV	Plant Biochemistry & Molecular Biology	4
		BOT-MIN-4-301	MIN-III	Angiosperm Systematics	4
		BOT-GEC-3-301	GEC-III	Ethnobotany	3
		BOT-SEC-3-301	SEC-III	Nursery & Gardening	3
			VAC-III	Digital and Technological Solutions/ Digital Fluency	2
				Total credit	**20**
	IV	BOT-MAJ-4-401	MAJ-V	Plant Ecology & Phytogeography	4
		BOT-MAJ-4-402	MAJ-VI	Angiosperm Systematics	4
		BOT-MAJ-4-403	MAJ-VII	Plant anatomy &Embryology	4
		BOT-MAJ-4-404	MAJ-VIII	Genetics & Evolution	4
		BOT-MIN-4-401	MIN- IV	Plant Physiology and Metabolism	4
				Total Credit	**20**
			UG DIPLOMA		

NB- Highlight and * Marks indicate IKS Components

COURSE STRUCTURE

ITEP With Botany as 2nd Major

(Based on FYUGP Botany Syllabus)

Year	Sem	Code	Nature of Course	Title of th e Course	Credit
I	I	BOT-MAJ-4-101	MAJ-I	Cryptogams	4
		BOT- MAJ-4-301	MAJ -III	Cell Biology	4
	II	BOT-MAJ-4-201	MAJ -II	Morphology & Reproduction of Spermatophyte	4
		BOT-MAJ-4-402	MAJ- VI	Angiosperms Systematics	4
II	III	BOT-MAJ-04-302	MAJ - IV	Plant Biochemistry & Molecular Biology	4
		BOT-MAJ-4-501	MAJ - IX	Plant Physiology & Metabolism	4
		BOT- MAJ-4-502	MAJ - X	Plant Breeding & Crop Improvement	4
	IV	BOT-MAJ-4-401	MAJ -V	Plant Ecology & Phytogeography	4
		BOT-MAJ-4-403	MAJ - VII	Plant Anatomy & Embryology	4
		BOT-MAJ-4 404	MAJ -VIII	Genetics & Evolution	4
		BOT-MAJ-4-602	MAJ XIII	Economic Botany	4
III	V	BOT-MAJ-4-503	MAJ - XI	Microbiology & Immunology	4
		BOT- MAJ-4-701	MAJ - XVI	Environmental Biology	4
		BOT-MAJ-4- 702	MAJ - XVII	Advanced Cell biology & Genetics	4
	VI	BOT-MAJ-4-603	MAJ - XIV	Plant Biotechnology, Bioinformatics & Biostatistics	4
		BOT-MAJ-4- 604	MAJ - XV	Analytical Techniques in Plant Science	4
Total Credit					**64**

NB-Abbreviations
L= Lectures
P= Practical

SEMESTER-I

Course Title : Cryptogams
Nature of Course : Major-I
Course Code : BOT-MAJ-4-101
Total Credits : 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), Internal: 40]

Course outcomes:

1. Describe different groups of the plant kingdom like algae, fungi, bryophyte & pteridophyte.
2. Organize the organisms into different categories based on morphological characteristics.
3. Analyze the interrelationship among different species and genera within each group of plants.

Learning Outcomes:

1. Understand the various groups in the Kingdom up to pteridophytes.
2. Compare various organisms based on morphology and reproduction.
3. Classify different groups of plants.

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:

(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1) Continuous evaluation through in and end-semester theory and practical examinations
2) Field collection and identification of specimens
3) Submission of collected specimens
4) Practical record book.

Course content

Total Lectures- 45

Unit-1. Algae **Marks=12 (12 L)**

General characteristics, range of thallus organization, cell structure, pigment system, reserve food, methods of reproduction, Classification system of Fritsch and Lee,* role of algae with special reference to traditional use in Indian food system & agriculture, medicine, and industry.

A comprehensive knowledge of the following classes with special reference to its structure and life histories of the genera mention below:

(a) Myxophyceae: *Anabaena*
(b) Chlorophyceae: *Volvox*, *Oedogonium* and *Chara*
(c) Bacillariophyceae: A general account of Diatom and its importance
(d) Phaeophyceae: *Ectocarpus*
(e) Rhodophyceae: *Polysiphonia*

Unit-2. Fungi **Marks=12 (11L)**

Salient features, Classification, Thallus organization, Cell wall composition & Nutrition, Reproduction & fruiting bodies, of *Saccharomyces*, & *Agaricus*; Life cycles of *Phytophthora*, *Penicillium* & *Puccinia*. *Economic importance of fungi with emphasis on Indian food system, medicine and fermentation practices.

Mycorrhiza: Ectomycorrhiza, endomycorrhiza, VAM and their significance.

Lichen: A general account with particular reference to its internal structure, nutrition of lichen. *Ecological and economic importances.

Unit-3. Bryophytes **Marks=10 (11L)**

General features, classification, thallus organization, morphology, anatomy and reproduction of *Marchantia*, *Anthoceros*, *Sphagnum*; Reproduction and evolutionary trends in bryophytes. *Ecological importance of bryophytes

Unit-4. Pteridophytes **Marks=11(11 L)**

General features and Classification, Morphology, Reproduction of, *Psilotum*, *Selaginella*, *Equisetum,Ophioglossum* and *Marsilea*. Heterospory and seed habit, stelar evolution, Ecological importance of pteridophytes. *Economic importance of pteridophytes in traditional food sytem and ethnomedicine.

Course Title : Cryptogams
Course Code : BOT-MAJ-4 101-P
Marks : 15

No. of classes-15

1. Study of vegetative and reproductive structures of *Anabaena*, *Volvox*, *Oedogonium*, *Chara*, *Ectocarpus and Polysiphonia*.

2. Study of vegetative and reproductive structures of *Phytophthora*, *Agaricus Saccharomyces*, *Penicillium* and *Puccinia*.

3. Study of vegetative and reproductive structures of *Marchantia*, *Anthoceros*, and *Sphagnum*.

4. Study of vegetative and reproductive structures of *Selaginella*, *Equisetum, Ophioglossum* and *Marsilea*.

5. Morphological studies of different types of Lichen.

Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
3. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
4. 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.
5.Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition
6. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition
7.Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
8.Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
9. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
10.Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press
11.Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India

12. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
13. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
14.Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.

SEMESTER-I

Course Title : Cryptogams
Nature of Course : Minor-I
Course Code : BOT-MIN-4-101
Total Credits : 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), Internal: 40]

Course outcomes:

1. Describe different groups of the plant kingdom like algae, fungi, bryophyte & pteridophyte.
2. Organize the organisms into different categories based on morphological Characteristics.
3. Analyze the interrelationship among different species and genera within each group of plants.

Learning Outcomes:

1. Understand the various groups in the Kingdom up to pteridophytes
2. Compare various organisms based on morphology and reproduction
3. Classify different groups of plants

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 correlatio

Modes of internal assessment:

(i) Two theory-based internal Exams: 10+10 =20 Marks

(ii) One Viva-voce =5 Marks

(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks

(iv) Attendance = 5 Marks

Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations.
2. Field collection and identification of specimens
3. Submission of collected specimens
4. Practical record book

Course content

Total lectures: 45

Unit-1. Algae **Marks=12 (12 L)**

General characteristics, range of thallus organization, cell structure, pigment system, reserve food, methods of reproduction, Classification system of Fritsch and Lee.* role of algae with special reference to traditional use in Indian food system & agriculture, medicine, and industry.

A comprehensive knowledge of the following classes with special reference to its structure and life histories of the genera mention below:

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(b) Chlorophyceae: *Volvox*, *Oedogonium* and *Chara*

(c) Bacillariophyceae: A general account of Diatom and its importance

(d) Phaeophyceae: *Ectocarpus*

(e) Rhodophyceae: *Polysiphonia*

Unit-2. Fungi **Marks=12 (11 L)**

Salient features, Classification, Thallus organization, Cell wall composition & Nutrition, Reproduction & fruiting bodies, of *Saccharomyces*, & *Agaricus*; Life cycles of *Phytophthora*, *Penicillium* & *Puccinia*. *Economic importance of fungi with emphasis on Indian food system, medicine and fermentation practices.

Mycorrhiza: Ectomycorrhiza, endomycorrhiza, VAM and their significance,

Lichen: A general account with particular reference to its internal structure, nutrition of lichen. *Ecological and economic importances.

Unit-3. Bryophytes **Marks=10 (11 L)**

General features, classification, thallus organization, morphology, anatomy and reproduction of *Marchantia*, *Anthoceros*, *Sphagnum*; Reproduction and evolutionary trends in bryophytes. Ecological importance of bryophytes. *Ecological importance of bryophytes.

Unit-4. Pteridophytes **Marks=11 (11 L)**

General features and Classification, Morphology, Anatomy and Reproduction of *Psilotum*, *Selaginella*, *Equisetum*, *Ophioglossum* and *Marsilea*. Heterospory and seed habit , stelar evolution. Ecological importance of pteridophytes. *Economic importance of pteridophytes in traditional food sytem and ethnomedicine.

Course Title :Cryptogams
Course Code : BOT-MIN-4-101-P
Marks : 15

No. of classes-15

1. Study of vegetative and reproductive structures of *Anabaena*, *Volvox*, *Oedogonium*, *Chara, Ectocarpus*, and *Polysiphonia.*
2. Study of vegetative and reproductive structures of *Phytophthora*, *Agaricus*, *Saccharomyces*, *Penicillium*, and *Puccinia*.
3. Study of vegetative and reproductive structures of *Marchantia*, *Anthoceros*, and *Sphagnum*.
4. Study of vegetative and reproductive structures of *Selaginella*, *Equisetum, Ophioglossum* and *Marsilea*.
5. Morphological studies of different types of Lichen.

Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
3. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization.
Aravali International, New Delhi.
4. 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.
5. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition
6. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition
7. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
8. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.

9. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

10. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press

11. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India

12. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.

13. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

14.Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.

SEMESTER-I

Course Title : Natural Resource Management
Nature of Course : GEC-I
Course Code : BOT-GEC-3-101
Total Credits : 04
Marks : 100 [End: 60 (Theory: 60), Internal: 40]

Course outcome:

1. Distinguish between renewable and non-renewable resources
2. Analyse threats to natural and biological resources of NE India
3. Examine management strategies for sustainable utilization of resources

Learning outcomes:

1. Differentiate natural and biological resources of NE India
2. Identify the threats and issues related to the natural resources
3. Execute conservation and management strategies for 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:

(i) Two theory-based internal exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations
2. Field demonstration of natural resources
3. Demonstration of modern tools like GIS
4. Participation in seminar/Conference

Course content

Total Lectures: 45

Unit 1: Natural resources **Marks=10 (07 L)**

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

Unit 2: **Sustainable utilization of land and water resources** **Marks=20 (15 L)**

Soil degradation and management; water resources (Freshwater, marine, estuarine) wetlands; Threats and management strategies and their management.

Unit 3: Biodiversity **Marks=10 (08 L)**

Definition, types, significance, threats, *conservation and management strategies,* Hotspots of Indian Biodiversity and bioprospecting.

Unit 4: **Marks=20 (15 L)**

Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; *Waste management, National efforts in resource management and conservation.

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-I

Course Title : Tea Plantation and Management
Nature of Course : SEC-I
Course Code : BOT-SEC-3-101
Total Credits : 03
Marks : 100 [End: 60 (Theory: 30, Pract: 30), Internal: 40]

Course outcome:

1. Distinguish between different tea species and varieties
2. Analyse threats to tea plantation and management
3. Examine management strategies of small tea gardens

Learning outcomes:

1. Differentiate the tea species available in Assam
2. Identify the issues related to tea plantation management
3. Execute management strategies for small tea gardens

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:
(i) Two theory-based internal exams: 10+10 =20 Marks
(ii) Field visit= 10 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 5 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:
1. Continuous evaluation through in and end semester theory and practical examinations
2. Field demonstration of tea varieties
3. Participation in seminar/conference
4. Hands on practices.

Course Content

Total Lectures: 45

Unit 1: **Marks= 10 (L-10)**

*History of tea cultivation, classification; Climate , temperature, rainfall, humidity, sunshine, soil characteristics, organic matter, soil nutrients, nutrients application in tea production.

Unit 2: **Marks=10 (L-10)**
Weed and pest control, *Tea disease and control measure. Manuring, pruning, *tipping and plucking, importance of shade tree.

Unit 3: **Marks=10 (L-10)**
Production and processing of tea leaves: Black tea, Green tea and Oolong tea. *Preparation of Organic tea , instant tea, herbal tea with special reference to Assam . Health benefits of tea, employment generation.

Course Title : Tea Plantation and Management
Course Code : BOT-SEC-3-101-P
Marks : 30

No of Classes=15

1. Tea culture and Propagation techniques: seed *propagation, vegetative propagation.
2. Nursery management.
3. Selection of planting sites, land preparation, plant spacing and staking, irrigation,
4. Demonstration of tea nursery, *hands on training on cutting, pruning and skiffing, preparation of nursery beds.
5. Visit to tea processing industries and packaging of tea.

Suggested reading

1) Tea Cultivation in the Plains of North East India by A. P. Das, S. E. Kabir Regency Publications
2) Global Advance in Tea Science Paperback–June1, 2002 by N .K .Jain
3) James Norwood Pratt's Tea Dictionary by James Norwood Pratt and Devan Shah
4) Global tea science Current Status and Future Needs Editors

SEMESTER-II

Course Title : Morphology & Reproduction of Spermatophytes
Nature of Course : Major
Course Code : BOT-MAJ-4-201
Total Credits : 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), Internal: 40]

Course outcomes:

1. Describe different groups of gymnosperms and angiosperms
2. Examine the morphology and reproductive processes in gymnosperms and angiosperms.
3. Analyze the interrelationship among different species and genera of gymnosperms and angiosperms

Learning Outcomes:

1. Understand the various groups in gymnosperms and angiosperms
2. Compare various groups in gymnosperms and angiosperms based on morphology and reproduction
3. Examine the reproductive structure in various groups in 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:

(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations
2. Field collection and identification of specimens
3. Submission of collected specimens
4. Practical record book.

Course Content

Total Lectures:45

Unit-1. Gymnosperms **Marks-10 (8 L)**

General characteristics, classification, morphology, and reproduction of *Cycas*, *Pinus*, *Ginkgo* and *Gnetum*; *economic importance of gymnosperms.

Unit-2. Fossil plants **Marks=5 (6 L)**

Process of fossilization; early land plants (*Psilophyton* and *Rhynia*), *Cycadeoidea*, *Sphenophyllum*, Geological time scale, importance of fossil study.

Unit-3. Morphology of Angiosperms **Marks=5 (7 L)**

Morphology and types of root, stem, and leaves. Aestivation, Phyllotaxy and venation. Characteristics and functions of hairs and trichomes, Inflorescence and its types, Placentation and its types.

Unit-4. Anther and pollen biology **Marks=10(8 L)**

Anther wall: structure and functions, microsporogenesis, callose deposition and its significance; microgametogenesis; pollen wall structure, MGU (male germ unit) structure, NPC system; palynology and its scope (a brief account); pollen wall proteins; pollen viability, storage and germination. *Scope of palynology in ethnomedicine.

Unit 5: Ovule **Marks=5 (6 L)**

Structure and types of ovules; female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis.

Unit6: Pollination, fertilization and post fertilization developments **Marks=10 (10 L)**

Pollination types and significance; adaptations for pollination;* plant-pollinator relationship in traditional farming practice. Double fertilization; general pattern of development of dicot and monocot embryo and endosperm; suspensor: structure and functions; embryo-endosperm relationship; nutrition of embryo; polyembryony, apomixes and parthenocarpy, self-incompatibility.

Course Title : Morphology & Reproduction of Spermatophytes
Course Code : BOT-MAJ-4-201-P
Marks : 15

No. of Classes: 15

1. Study of morphology and reproductive parts of *Cycas*, *Pinus*, *Ginkgo* & *Gnetum.*
2. Study of Fossil plants (Photographs/specimen).
3. Study of morphology of leaf phyllotaxy (opposite, alternate, whorled); venation (reticulate, parallel); Inflorescence (Racemose, Cymose).
4. Mounting of five (5) properly dried and pressed specimens (wild) with label to be pasted in the record book.
5. Study of pollen morphology and pollen tube formation.
6. Study of types of embryos and endosperms (Permanent slides/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 Biologyof Flowering plants, Springer, Netherlands.
5. Johri,B.M.l(1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

SEMESTER-II

Course Title : Morphology & Reproduction of Spermatophytes
Nature of Course : Minor-II
Course Code : BOT-MIN-4-201
Total Credits : 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), Internal: 40]

Course outcomes:

1. Describe different groups of gymnosperms and angiosperms
2. Examine the morphology and reproductive processes in gymnosperms and angiosperms.
3. Analyze the interrelationship among different species and genera of gymnosperms and angiosperms

Learning Outcomes:

1. Understand the various groups in gymnosperms and angiosperms
2. Compare various groups in gymnosperms and angiosperms based on morphology and reproduction
3. Examine the reproductive structure in various groups in 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:

(i) Two theory-based internal exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations
2. Field collection and identification of specimens
3. Submission of collected specimens
4. Practical record book.

Course Content

Total Lectures:45

Unit 1: Gymnosperms **Marks=08 (08L)**

Marks=10 (8 L)

General characteristics, classification, morphology and reproduction of *Cycas*, *Pinus*, *Ginkgo* and *Gnetum*. *economic importance of gymnosperms.

Unit 2: Fossil plants **Marks=05 (05 L)**

Process of fossilization; early land plants (*Psilophyton* and *Rhynia*), Cycadeoidea, *Sphenophyllum*, Geological time scale, importance of fossil study.

Unit 3: Morphology of Angiosperms **Marks=08 (08 L)**

Morphology and types of root, stem, and leaves. Aestivation, phyllotaxy,and venation. Characteristics and function of hairs and trichomes, Inflorescence and its types; placentation and its types.

Unit 4: Anther and pollen biology **Marks=08 (08 L)**

Anther wall: structure and functions, microsporogenesis, callose deposition and its significance micro gametogenesis; pollen wall structure, MGU (male germ unit) structure, NPC system; palynology and scope (a brief account); pollen wall proteins; pollen viability, storage and germination. *Scope of palynology in ethnomedicine.

Unit 5: Ovule **Marks=08 (08 L)**

Structure and types of ovules; female gametophyte–megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis.

Unit6: Pollination, fertilization and post fertilization developments

Marks=08 (08 L)

Pollination types and significance; adaptations for pollination; *plant-pollinator relationship in traditional farming practices. Double fertilization; Structure, general pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; embryo-endosperm relationship; nutrition of embryo; polyembryony, apomixes and parthenocarpy, self-incompatibility.

Course Title : Morphology & Reproduction of Spermatophytes
Course Code : BOT-MIN-4-201-P
Marks : 15

No of Classes=15

1. Study of morphology and reproductive parts of *Cycas*, *Pinus*, *Ginkgo* & *Gnetum.*
2. Study of Fossil plants (Photographs/specimen).
3. Study of morphology of leaf phyllotaxy (opposite, alternate, whorled); venation (reticulate, parallel); Inflorescence (Racemose, Cymose).
4. Mounting of five (5) properly dried and pressed specimens (wild) with label to be pasted in the record book.
5. Study of pollen morphology and pollen tube formation.
6. Study of types of embryos and endosperms (Permanent slides/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, Netherlan

SEMESTER-II

Course Title : Plant Diversity and Human Welfare
Nature of Course : GEC-II
Course Code : BOT-GEC-3-201
Total Credits : 03
Marks : 100 [End:Theory: 60,), Internal: 40]

Course outcome

1. Differentiate the level of plant diversity
2. Examine the cause of the loss of biodiversity
3. Analyze the biodiversity conservation strategies
4. Evaluate the role of plants in 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 out comes 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:
(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Field visit (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:
1. Continuous evaluation through in and end semester theory and practical examinations
2. Field demonstration of local flora and fauna
3. Demonstration of biodiversity conservation models
4. Participation in seminar/ conference

Course Content

Total Lectures:45

Unit1: **Marks=15 (10 L)**

Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agro-biodiversity. Values and uses of Biodiversity: *Ethical and aesthetic values.

Unit 2: **Marks=15 (15 L)**

Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agro-biodiversity, *Projected scenario for biodiversity loss in NE India , Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations.

Unit3: **Marks=15 (10 L)**

Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, In situ and ex situ conservation, Social approaches to conservation, Biodiversity awareness programmes, *Sustainable development.

Unit4: **Marks=15 (10 L)**

Role of plants in relation to Human Welfare; a) *Importance of forestry their indigenous utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Use of microbes in alcoholic beverages preparation. Fruits and nuts: Important fruit crops their commercial importance.

Suggested Reading:

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

Semester-II

Title of the Course: : Conservation and Cultivation of Orchids
Nature of course : SEC-II
Course code : BOT-SEC-3-201
Total Credits : 03
Marks : 100 [End: 60 (Theory:30, Pract:30), In:40]

Course outcome :

1. Identify Locally available orchids
2. Organise locally available orchids based on their commercial value
3. Develop strategies for orchid culture and conservation.

Learning outcomes

1. Describe locally available orchids
2. Demonstrate the commercial and ecological importance of orchids
3. Examine the strategies for orchidculture and conservation

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		AVERAGE
CO1	3	2	2	2	2	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:

(i) Two theory-based internal exams: 10+10 =20 Marks
(ii) Field visit: 05 Marks
(iii) Field Report / Home assignment/ Group Discussion (any one activities): 10 Marks
(iv) Attendance: 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations.
2. Field demonstration of local flora and fauna
3. Demonstration of biodiversity conservation models
4. Participation in seminar/conference

Course Content

Total Lectures:45

Unit-I: Introduction to Orchids **Marks=10 (10 L)**

Salient features, habitat, origin and diversity, morphology and classification of orchids,

*Economic importance of Orchids in relevance to NE India.

Unit-II: **Marks=10 (10L)**

Common and endemic Orchids of North East India: status and distribution; *RET species of Orchids of India with special reference to NE India.

Unit-III **Marks=10 (10 L)**

Conservation of Orchids: *in-situ* and *ex-situ* conservation, Conservation of habitats and host plants.

Course Title : Conservation and Cultivation of Orchids
Course Code : BOT-SEC-3-201-P
Marks : 30

Total Classes=15

1. Exposure visit to Orchidarium and field report submission.
2. Identification of orchids. Propagation of Orchids: Different methods of propagation of orchids (cutting and hybridization),
3. Preparation of substrata for economically important orchids, nutritional and environmental requirement,
4. Maintenance of orchidarium.

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Semester-III

Title of the course : Cell Biology
Nature of course : Major-III
Course Code : BOT-MAJ-4-301
Total Credits : 04
Marks : 100 [End:60 (Theory: 45, Pract: 15), Internal: 40]

Course Outcomes:

1. Differentiate the structure and functions of cellular components.

2. Evaluate the cell division mechanism and cell cycle.

3. Analyze cell signalling mechanism.

Learning Outcomes:

1. Understand the cell structure and functions of cell organelles.

2. Analyze cell division and cell cycle mechanisms.

3. 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:

(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations.
2. Laboratory practices on cells, cellular organelles and cellular processes.
3. Practical record book/field book.
4. Seminar/group discussion.

Course Content

Total Lectures: 45

Unit 1: The cell **Marks=5 (6 L)**

Prokaryotic and eukaryotic cells; (Endosymbiotic theory). *Contribution of Indian Cytologists.

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

Structure and function of Plant cell wall; fluid mosaic model; Cell membranes and its function.

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

Structural organization and function of Nucleus, Chloroplast, Golgi apparatus, ER, mitochondria, ribosomes, lysosome, peroxisomes, Microtubules, microfilaments and intermediary filament; Semiautonomous nature of mitochondria and chloroplast.

Unit 4: Membrane transport and Protein sorting & targeting **Marks=10 (10 L)**

Mechanism of Membrane transport; Membrane channel and pore; protein glycosylation; Smooth endoplasmic reticulum and lipid synthesis, export of proteins and lipids.

Unit 5: Cell division **Marks=12 (11 L)**

Types of cell division: mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases, significance.

Title of the course : Cell Biology
Course Code :BOT-MAJ-4-301-P
Marks : 15

No. of Classes: 15

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

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 Education Inc. U.S.A. 8th edition. 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

Title of the course : Plant Biochemistry & Molecular Biology
Nature of Course : Major- IV
Course Code : BOT-MAJ-4-302
Total Credits : 04
Marks : 100 [End:60 (Theory: 45, Pract: 15), Internal: 40]

Course outcomes:

1. Differentiate the biomolecules of living organisms, their interactions for perpetuation of life.
2. Analyze structure-function relationships of nucleic acids and protein.
3. Distinguish between replication, transcription and translation in prokaryotes and eukaryotes.
4. Interpret the gene expression mechanisms.

Learner Outcome:

1. Identify the various biomolecules and understand their function.
2. Differentiate the cellular processes such as replication, transcription and translation.
3. 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:
(i) Two theory-based internal exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations.

2. Laboratory practices on biochemical and molecular biology processes.

3. Practical record book/field book.

4. Seminar/group discussion.

Course Content

Total Lectures: 45

Unit 1: Biomolecules: **Marks=10 (10 L)**

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 **Marks=05 (05 L)**

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

Unit 3: Enzymes **Marks=07 (07 L)**

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 **Marks=08 (07 L)**

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 **Marks=7 (07 L)**

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

Unit 6: Genetic codes & Translation **Marks=08 (08 L)**

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.*Contribution of Indian geneticist (Har Gobind Khorana, Lalji Singh, G.N. Ramachandran).

Title of the course : Plant Biochemistry & Molecular Biology
Course Code : BOT-MAJ-4-302-P
Marks : 15

No. of Classes: 15

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

Suggested Readings:

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.

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

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

Semester-III

Title of the Course : Angiosperm Systematics
Nature of Course : Minor-III
Course Code : BOT-MIN-4-301
Total Credits : 04
Marks :100 [End:60 (Theory: 45, Pract: 15), Internal: 40]

Course outcomes

1. Identify the diversity of angiosperms, including major families, genera, and species.

2. Develop proficiency in using taxonomic keys, morphological features, and molecular data to classify and identify angiosperms.

3. Ability to interpret phylogenetic trees and understand their implications for classification and evolution.

4. Evaluation of phylogenetic analyses, and taxonomic controversies within angiosperm.

Learning Outcomes:

1. Identify angiosperm taxa at the family, genus, and species levels using morphological, anatomical, and molecular characters.

2. Classify the local angiosperm flora based on their morphological, anatomical, and molecular characters.

3. Analysis of the evolutionary relationships among angiosperms and major clades of angiosperms.

4. 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:

(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations.

2. Field collection and identification of specimens.

3. Submission of collected specimens.

4.Practical record book.

Course Content

Total lectures: 45

Unit 1: Significance of Plant Systematics **Marks=7 (09 L)**

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data.*Field inventory; 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 **Marks=5 (05 L)**

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

Unit 3: Botanical nomenclature **Marks=5 (06 L)**

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

Unit 4: Systems of classification **Marks=10 (10 L)**

Major contributions of Theophrastus, Bauhin, Linnaeus, Adanson, de Candolle,Hutchinson, Takhtajan and Cronquist; * ancient taxonomic works of Charaka, Sushruta and Santapau Classification systems of Bentham and Hooker (upto order) and Engler and Prantl (upto order); Brief reference of Angiosperm Phylogeny Group (APG IV) classification.

Unit 5: Biometrics, numerical taxonomy and cladistics **Marks=8 (07L)**

Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences). Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Unit 6: Phylogeny of Angiosperms and Study of some important families

Marks=10 (08 L)

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.

Key feature of Magnoliaceae, Lamiaceae, Solanaceae, Fabaceae, Asteraceae, Orchidaceae, Zingiberaceae, & Poaceae.

Title of the course : Angiosperm Systematics
Course Code : BOT-MIN-4-301-P
Marks : 15

No. of Classes: 15

1. Study and dissection of floral parts of locally available wild plant species (minimum 07) (Lamiaceae, Solanaceae,Fabaceae Asteraceae, Poaceae, Zingiberaceae, Orchidaceae).
2. Mounting of few properly dried and pressed specimens (wild) with label to be pasted in the herbarium sheets.
3. Field Collection and identification of specimens

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-III
Title of the course	**: Ethnobotany**
Nature of Course	**: GEC-III**
Course Code	**: BOT-GEC-3-301**
Total Credits	**: 03**
Marks	**: 100 [End:60 (Theory: 60), Internal: 40]**

Course outcome:

1. Discuss the indigenous practices of ethnic groups of Northeast India.
2. Use of traditional knowledge system of the region for sustainable development.
3. Compare medicinal and agronomic values of biological resources of the region.
4. Protection of traditional knowledge through IPR.

Learning outcome:

1. Understand the traditional practices of ethnic communities of the region.
2. Implementation of IKS for sustainable development goals.
3. Apply the indigenous knowledge in daily life.
4. Analyze the IPR for protection of 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:

(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1) Continuous evaluation through in and end-semester theory and practical examinations.

2) Demonstration of traditional practices of ethnic communities (medicine, food, beverages).

3) Demonstration of traditional methods of conservation of food and beverages.

4) Participation in seminar/conference

Course Content

Total lectures-45

Unit-I: Ethnobotany **Marks=18 (15 L)**

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; *Major and minor ethnic groups or Tribals of North East-India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

Unit-II: Methodology of Ethnobotanical studies **Marks=12 (07 L)**

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

Unit-III: Medico-ethnobotanical sources in India **Marks=18 (15 L)**

*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) *Pongamia pinnata* f) *Cassia auriculata* g) *Indigofera tinctoria*.

*Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina, Artemisia, Withania*.

*Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit-IV: Ethnobotany and legal aspects **Marks=12 (08 L)**

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Semester-III

Title of the Course : Nursery and Gardening

Nature of course : SEC-III
Course code : BOT-SEC-3-301
Total Credits : 03
Marks : 100 [End: 60 (Theory:30, Pract:30), In:40]

Course outcome:

1. Demonstrate the nursery and gardening technique.
2. Implementation of nursery technique for entrepreneur.

Learning outcome:

1. Operate commercial nursery for livelihood.
2. Describe the value 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 1for lowest correlation.

Modes of internal assessment:

(i) Two theory-based internal exams: 10+10 =20 Marks

(ii) Field visit = 5 Marks

(iii) One Viva-voce = 5 Marks

(iv) Home assignment/ Seminar/ Group Discussion (any one activities) = 5 Marks

(v) Attendance = 5 Marks

Attainment strategies of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations.
2. Demonstration of established nurseries of the locality.
3. Demonstration of nursery bed preparation, cuttings and grafting.
4. Practical record book.

Course Content **Lectures:45**

Unit 1: **Marks=10 (10 L)**

Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.
Different types of gardening and landscaping.

Unit 2: **Marks=10(10 L)**

*Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings

Unit 3: **Marks=10 (10 L)**

Seed testing and certification; Hardening of plants-green house-mist chamber, shed root, shade house and glass house. Harvesting techniques and storage.

Course Title : Nursery and Gardening

Course Code : BOT-SEC-3-301-P

Total Marks : 30

Total Classes=15

1. *Gardening operations: preparation of soil and potting material, manuring, watering of seedlings.

2. Management of pests and diseases .

3*. Sowing/ raising of seeds and seedlings - Transplanting of seedlings.

4. Exposure visit to established nurseries, farms etc.
5.Preparation of cuttings/ seedlings of some important horticultural 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, Mc Graw Hill Book Co., New Delhi.

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Semester-IV

Title of the course :Plant Ecology and Phytogeography
Nature of Course :Major- V
Course Code : BOT-MAJ-4-401
Total Credits : 04
Marks : 100 (End;60 (Theory: 45, Pract: 15), Internal: 40)

Course outoutcomes:

1. Understanding Plant Ecological Principles
2. Interpret of Plant Adaptations
3. Examine Ecosystem Dynamics
4. Explain Phytogeographical Concepts.

Learning outcomes:

1. Describe the plant ecological concepts
2. Discuss plant adaptations concerning the environment
3. Interpret the dynamics of ecosystems
4. 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:

(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1) Continuous evaluation through in and end-semester theory and practical examinations
2) Field collection and identification of specimens
3) Submission of collected specimens
4) Practical record book

Course content **Total lectures: 45**

Unit I: Introduction to Ecology and Environmental Factors **Marks=10 (10L)**

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development, *Major soil types of India.

Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table. Light, temperature, wind and fire: Ecological factors and plant adaptation.

Unit II: Biotic Interaction **Marks=5 (08L)**

Trophic organization, basic source of energy; symbiosis, mutualism, commensalism, ammensalism, proto-cooperation, parasitism, predator-prey relationship; biomass and standing crop.

Unit III: Population Ecology **Marks=10 (09L)**

Characteristics and Dynamics. Population attributes- Density, natality, mortality and growth patterns

Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Unit IV: Ecosystems **Marks=10 (09L)**

Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids.

Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen, and Phosphorus.

Unit V: Phytogeography **Marks=10 (09L)**

Principles of phytogeography; Static and dynamic phytogeography; Theory of tolerance; Endemism; Major biomes of the world (one each from tropical, temperate & tundra); Phytogeographical division of India, *Vegetaion and Climate of NE India.

Title of Course : Plant Ecology and Phytogeography
Course Code : BOT-MAJ-4-401-P
Marks : 15

No. of Classes-15

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. 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. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

Course Outcome:

1. **Semester-IV**

Title of the course : Angiosperm Systematics
Nature of Course : Major-VI
Course Code : BOT-MAJ-4-402
Total Credits : 04
Marks : 100 [End:60 (Theory: 45, Pract: 15), Internal: 40]

Identify the diversity of angiosperms, including major families, genera, and species.

2. Develop proficiency in using taxonomic keys, morphological features, and molecular data to classify and identify angiosperms.
3. Ability to interpret phylogenetic trees and understand their implications for classification and evolution
4. Evaluation of phylogenetic analyses, and taxonomic controversies within angiosperm.

Learning Outcomes:

1. Identify angiosperm taxa at the family, genus, and species levels using morphological, anatomical, and molecular characters
2. Classify the local angiosperm flora based on their morphological, anatomical, and molecular characters
3. Analysis of the evolutionary relationships among angiosperms and major clades of angiosperms
4. 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:

(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Field collection and identification of specimens
3. Submission of collected specimens
4. Practical record book

Course Content

Total lectures: 45

Unit 1: Significance of Plant Systematics **Marks=10 (10L)**

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. * Field inventory; 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 **Marks=5 (4L)**

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

Unit 3: Botanical nomenclature **Marks=5 (6L)**

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

Unit 4: Systems of classification **Marks=10 (10L)**

Major contributions of Theophrastus, Bauhin, Linnaeus, de Candolle, Hutchinson, Takhtajan and*ancient taxonomic works of Charaka, Sushruta and Santapau; Classification systems of Bentham and Hooker (upto order) and Engler and Prantl (upto order); Brief reference of Angiosperm Phylogeny Group (APG IV) classification.

Unit 5: Biometrics, Numerical taxonomy and Cladistics **Marks=5 (7L)**

Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences). Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Unit 6: Phylogeny of Angiosperms and Study of some important families

Marks=10 (8L)

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.

Key feature of Magnoliaceae, Lamiaceae, Solanaceae, Fabaceae, Asteraceae, Fabaceae, Orchidaceae, Zingiberaceae, & Poaceae.

Title of Course : Angiosperm Systematics
Course Code : BOT-MAJ-4-402-P
Marks : 15

No. of Classes-15

1. Study and dissection of floral parts of locally available wild plant species (minimum10). (Lamiaceae, Solanaceae, Fabaceae, Asteraceae, Poaceae, Zingiberaceae, Orchidaceae).

2. *Field study of local flora or institutional visit and prepare field report to be submitted in examination.

3. Mounting of few properly dried and pressed specimens (wild) in herbarium sheets.

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) Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.

Semester-IV

Title of the course : Plant Anatomy and Embryology
Nature of Course : Major-VII
Course Code : BOT-MAJ-4-403
Total Credits : 04
Marks : 100 [End:60 (Theory: 45, Pract: 15), Internal: 40]

Course outcomes:

1. Recognize anatomical parts of plant and different embryological stages of plant
2. Explain the adaptive and protective systems of plants
3. Examine the developmental stages of
plants

Learning outcomes:

1. Understand the basic anatomical and embryological features of plants
2. Discuss the adaptive and protective systems of plants
3. Distinguish 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:

(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Field collection and identification of specimens
3. Submission of collected specimens
4. Practical record book.

Course Content **Total lectures: 45**

Unit 1: Differentiation of tissues and organs **Marks=12 (15L)**

Simple and complex tissues, Root and shoot apical meristems, Root development: organization of root apical meristem (RAM), initiation of lateral roots, Shoot development: organization of shoot apical meristem (SAM), Structure of dicot and monocot root, stem and leaf. Mechanism of vascular tissue differentiation, secondary growth, wood development in relation to environmental factors; Leaf growth and determination of phyllotaxy, differentiation of stomata & trichomes.

Unit 2: Adaptive and Protective Systems **Marks= 7 (7 L)**

Epidermis, cuticle, lenticels, hydathodes; *General account of adaptations in xerophytes and hydrophytes with special reference to NE India.

Unit 3: Structural organization of flower **Marks=8 (7 L)**

Flower is a modified shoot, differentiation of flower primordium, differentiation of anther and ovule and their hormonal control.

Unit 4: Pollination and fertilization **Marks=8 (8 L)**

Pollination mechanisms and adaptations; artificial pollination techniques, hormonal control of fertilization and artificial fertilization

Unit 5: Embryo and endosperm **Marks=10 (8 L)**

Applied aspects of embryology, embryo and pollen culture, taxonomic importance of pollen and embryo, hormonal control of embryo and endosperm development.

Title of Course : Plant Anatomy and Embryology
Course Code : BOT-MAJ-4-403-P
Marks : 15

No. of Classes-15

1. Study of meristems through permanent slides and photographs.
2.Study of tissues (parenchyma, collenchyma and sclerenchyma);and phloem (Permanent slides/photographs)
3. Stem antomy of : Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (Only Permanent slides).
4. Root anatomy of : Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (Only Permanent slides).
5. Leaf: Dicot and Monocot leaf (Only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8.Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous (permanent slides)
9. Study of epidermal appendage; Lithocysts , Raphides.
10. Study of anomalous anatomical growth (*Amaranthus sp, Nyctanthes sp , Mirabilis jalapa , Bougainvillea)*.

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

Title of the course : Genetics and Evolutionary Biology
Nature of Course : Major-VIII
Course Code : BOT-MAJ-4-404
Total Credits : 04
Marks : 100 [End:60 (Theory: 45, Pract: 15), Internal: 40]

Course outcomes:

1. To interpret the basic patterns of inheritance
2. To evaluate genetic disorders and mutations
3. To relate evolutionary forces leading to the variations and diversification of species
4. To examine evidences ranging from fossil records to molecular data and to establish phylogenetic relationships of species.

Learning Outcome:

1. To understand the concept of inheritance
2. To analyze mutations and genetic disorders
3. To examine forces of evolution
4. 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:

(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Field collection and identification of specimens
3. Practical record book

Course content **Total lectures: 45**

Unit-I: Mendelian genetics and its extension **Marks=10 (10 L)**

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.* Probability and Pedigree analysis.

Unit-II: Extrachromosomal Inheritance **Marks=5 (6 L)**

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

Unit-III: Linkage, crossing over, and chromosome mapping **Marks=10 (8 L)**

Linkage: Types, importance and mechanism; crossing over – types, significance and cytological basis of crossing over; Genetic mapping, Sex linked, Sex limited inheritances, quantitative traits/loci.

Unit IV: Chromosomal & gene mutation **Marks=10 (11 L)**

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); Detection of mutations: ClB method; Transposons

Unit V: Evolution: **Marks=10 (10 L)**

Theories: Lamarck's theory, Darwin's theory, Weismann's germplasm theory; Evolution in bacteria.

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

Title of Course : Genetics and Environmental Biology

Course Code : BOT-MAJ-4-404-P

Marks : 15

No. of classes-15

1. Meiosis/ mitosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using three point test cross data.
4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
5. Study of aneuploidy (examples)
6. .Photographs/ Permanent Slides showing Translocation Ring, Laggard and Inversion Bridge

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. Introduction to Genetic Analysis (Introduction to Genetic Analysis (Griffiths)) Hardcover – Import, 16 Feb 2007 Authors: Anthony J. F. Griffiths, Susan R. Wessler, Richard C. Lewontin, Sean B. Carroll Publisher: WH Freeman; 11th ed. 2016 edition (12 January 2015)

Semester-IV

Title of the course : Plant Physiology and Metabolism
Nature of Course : Minor-IV
Course Code : BOT-MIN-4-401
Total Credits : 04
Marks : 100 [End:60 (Theory: 45, Pract: 15), Internal: 40]

Course outcome

1. Ability to identify different physiological processes in plant.

2. Ability to discuss absorption, transpiration, photosynthesis, growth in plants.

3. Examine the metabolic process in plants

Learning outcomes:

1. Demonstrate physiological processes in plants
2. Explain the absorption, transpiration, photosynthesis, growth in plants
3. 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
AVARAGE	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:

(i) Two theory-based internal Exams: 10+10 =20 Marks
(ii) One Viva-voce =5 Marks
(iii) Home assignment/ Seminar/ Group Discussion (any one activities) = 10 Marks
(iv) Attendance = 5 Marks
Total=40

Attainment strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations.
2. Practical record book.

Course Content
Total Lectures: 45

Unit 1: Plant-water relations **Marks=10 (L-10)**

Water Potential and its components, water absorption by roots, aquaporins, the pathways of water movement - symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–cohesion-tension theory, transpiration.

Unit 2: Mineral nutrition & Nutrient Uptake **Marks=8 (L-8)**

Essential elements, macro and micronutrients, criteria of essentiality, mineral deficiency symptoms, chelating agents.

General account of ATP, carrier systems, proton ATPase pump, ion flux, uniport, co-transport, symport, antiport.* Traditional farming practices.

Unit 3: Carbon assimilation, Carbon, lipid, and nitrogen metabolism **Marks=10 (L-10)**

Mechanism of photosynthesis, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, photorespiration, C4-pathways; Crassulacean acid metabolism(CAM); Respiration: aerobic and anaerobic, glycolysis and Kreb cycle, ETS.

Lipid and fatty acid metabolism, Nitrogen metabolism: amino acid synthesis, transamination and deamination.

Unit 4: Translocation in the phloem **Marks=5 (L-5)**

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

Unit 5: Plant growth regulators **Marks=7 (L-7)**

Definition and structure of plant growth hormones, bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene.

Unit 6: Physiology of flowering **Marks=5 (L-5)**

Photoperiodism, flowering stimulus, florigen concept, vernalization and seed dormancy. Phytochrome, crytochromes and phototropins: photomorphogenesis, Low Energy Rresponses (LER) and High Irradiance Responses (HIR), mode of action.

Title of Course : Plant Physiology and Metabolism
Course Code : BOT-MIN-4-401-P
Marks : 15

No. of classes-15

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophytes.
4. To study the phenomenon of seed germination (effect of light).
5. Seperation of chloroplast pigments by paper chromatography/ TLC.
6. Seperation of chloroplast pigments by solvent extraction.
7. Quantitative analysis of absorption spectrum of photosynthetic pigments.

Suggested Readings

1. Taiz, L. and Zeiger, E., Plant Physiology, 5th edition (Sinauer Associates, USA, 2012).
2. URL: http://www.sinauer.com/media/wysiwyg/tocs/PlantPhysiology5.pdf
3. Lambers, H. and Chapin, F. S., Plant Physiological Ecology (Springer, 2000).
4. Mukherji, S. and Ghosh, A.K., Plant Physiology, 1st edition (New Central Book Agency Private Ltd. Kolkata, 2009).
5. http://www.annualreviews.org/journal/arplant
6. Hormones: http://nptel.ac.in/courses/102103012/27