Syllabus of FYUGP in Botany

Dibrugarh University

Approved in the BOS held on 04th June 2024

DIBRUGARH UNIVERSITY

Dibrugarh, Assam

786004

FOUR YEAR UNDER-GRADUATE PROGRAMME (FYUGP) IN BOTANY, DIBRUGARH UNIVERSITY

1. The Preamble:

Present-day plant science is a fusion of the traditional components with the modern aspects of biochemistry, molecular biology and biotechnology. Over the years, plant science (Botany) has shown enormous gain in information and applications owing to tremendous inputs from research in all its aspects. With the global need for conservation, field plant biologists have contributed significantly in assessing and exploring newer dimensions for plant diversity. New insights have been gained in functional and structural aspects of plant development by utilizing modern tools and techniques for botanical research. Challenging areas of teaching and research have emerged in ecology and reproductive biology. Concern for ever-increasing pollution and climate change is at its highest than ever before. Keeping the above-mentioned advancements and rich plant resources in North East India in view, a revised curriculum is offered by Dibrugarh University at the undergraduate level as per the National Education Policy-2020 so that the undergraduate Botany students of Dibrugarh University shall have the benefit of a balanced, carefully-crafted course structure taking care of different aspects of plant science, namely plant diversity, physiology, biochemistry, molecular biology, reproduction, anatomy, taxonomy, ecology, economic botany and the impact of environment on the growth and development of plants. All these aspects have been given due weightage over the eight semesters. It is essential for the undergraduate students to acquaint themselves with various tools and techniques for exploring the world of plants up to the sub- cellular level. Keeping view of employment entrepreneurship, applied courses have also been introduced. These courses shall provide the botany students hands on experience and professional inputs. On the whole, the curriculum is a source of lot of information and is supported by rich resource materials. It is hoped that a student graduating in Botany with the new curriculum will be able to explore the rich plant diversity of North East India.

2. Introduction:

Dibrugarh University UG syllabus of Botany is designed as per the guidelines of National Education Policy-2020. This Four Year Under Graduate Programme (FYUGP) in Botany consists of Major (Core) disciplines, Minor disciplines, Multi Disciplinary Generic Elective Courses (GE), Ability Enhancement Courses (AEC), Value Added Courses (VAC), Skill Enhancement Courses (SEC), Environmental Education (EE), YOGA, Community Engagement like NCC/NSS, Digital and Technological solutions, Internship, Field Studies, Research Ethics, Research Projects and Discipline Specific electives (DSE) to acquaint the

students with balanced knowledge on the plant resources, environment, contemporary issues and entrepreneurship.

The Bachelor of Science in Botany of Dibrugarh University under NEP-2020 is a programme with multiple exit options. UG certificate, UG Diploma, UG Degree and UG Degree (Honours with Research) in Botany will be awarded to students after successful completion of one, two, three and four years respectively. It is expected that, on successful completion of this four yearprogramme students will be skilled in multidisciplinary aspects for exploration and sustainable utilization of plant/natural resources of NE region of India.

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

1. To introduce the students with the rich biodiversity of North east India.

2. 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 evaluation of contemporary issues related to environment and nature.

4. To generate skilled human resource for biological entrepreneurship.

4. Graduate Attributes of the FYUGP in Botany:

Disciplinary Knowledge

The graduates should have the ability to demonstrate comprehensive knowledge and understanding of both the theoreticaland 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

The graduates in Botany should have the ability to present and express information, thoughts, experiments and results clearly and concisely for effective communication of any issues related to plant and nature.

Moral and Ethical Awareness/Reasoning

Ability to recognise ethical issues that are pertinent to one's work and pledge not to engage in unethicalbehaviour such as plagiarism, copyright and infringement of intellectual property rights; ability toappreciate 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 organisations; 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 softwares 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.

5. 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.

6. Programme Outcomes (POs)

1) Develop ideas to assess and inventorize existing biological resources of this region
2) Formulate innovative strategies for conservation of biogenetic resources for human welfare

3) To explore and validate ethnobiological 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

7. 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

Year	Sem.	Corse code	Title of the course	Credit
I	I	Core-I	Algae, Fungi, Bryophyte &Pteridophyte	4
		Minor-I	Algae, Fungi, Bryophyte &Pteridophyte	4
		GEC-I	Natural resource management	3
		AEC-I	Modern Indian Language	4
		SEC-I	Tea plantation and management/Mushroom Culture technology	3
		VAC-I	Understanding India	2
		Total credit		**20**
	II	Core-II	Morphology and Reproduction of Spermatophytes	4
		Minor-II	Morphology and Reproduction of Spermatophytes	4
		GEC-II	Plant Diversity and Human Welfare	3
		AEC-II	English Language and Communication Skills	4
		SEC-II	Biofertilizers/Conservation and Cultivation of Orchids	3
		VAC-II	Environmental Science	2
		Total credit		**20**
		UG CERTIFICATE		
	III	Core-III	Cell biology	4
		Core-IV	Plant Biochemistry & Molecular Biology	4
		Minor-III	Angiosperm systematics	4
		GEC-III	Ethnobotany	3
		SEC-III	Nursery and Gardening/Medicinal Botany	3
		VAC-III	Digital and Technological Solutions / Digital Fluency	2
			Total credit	**20**
		Core-V	Plant Ecology & Phytogeography	4
		C ore-VI	Angiosperm systematics	4

II	IV	Core-VII	Plant anatomy & Embryology	4
		Core-VIII	Genetics & Evolution	4
		Minor-IV	Plant physiology and metabolism	4
		Total Credit		**20**
		UG DIPLOMA		
III	V	Core-IX	Plant physiology & Metabolism	4
		Core-X	Plant breeding and crop improvement	4
		Core-XI	Microbiology and immunology	4
		Minor-V	Economic botany	4
		Int./Comm./project	Field study/project	4
		Total credit		**20**
	VI	Core-XII	Plant pathology and crop protection	4
		Core-XIII	Economic Botany	4
		Core-XIV	Plant biotechnology, Bioinformatics & Biostatistics	4
		Core-XV	Analytical techniques in plant Sc.	4
		Minor-VI	Microbiology & Immunology	4
		Total credit		**20**
UG DEGREE				

Semester-I

Course Title: **Algae, Fungi, Bryophyte &Pteridophyte**
Nature of course: **Major/Core-I**
Course Code:
Marks: **60+40=100**

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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Total lectures- 60

Unit-1. Algae (12 lectures)

General characteristics, range of thallus organization, cell structure, pigment system, reserve food, methods of reproduction, Classification system of Fritsch and Lee, Role of algae in the environment, agriculture, biotechnology, and industry.

Characteristics, Occurrence, Mode of reproduction, Morphology and life cycles of *Volvox, Oedogonium, Chara, Ectocarpus, Anabaena, and Polysiphonia*, Diatoms and its importance

Unit-2. Fungi (11 lectures)

Salient features, Classification, Thallus organization, Cell wall composition & Nutrition, Reproduction & fruiting bodies, Life cycle of *Phytophthora, Saccharomyces, Penicillium, Paccinia, Agaricus*, Economic importance of fungi, Mycorrhiza: ectomycorrhiza, endomycorrhiza, VAM and their significance, Lichen: types, internal structure & Significance

Unit-3. Bryophytes (11 lectures)

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

Unit-4. Pteridophytes (11 lectures)

General features and Classification, Morphology, Anatomy and Reproduction of *Psilotum, Selaginella, Equisetum and Ophioglossum, Marselia*. Heterospory, stelar evolution, Ecological and economic importance.

Lab activities

1. Study of vegetative and reproductive structures of *Anabaena, Nostoc, Volvox, Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, and Polysiphonia*
2. Study of vegetative and reproductive structures of *Phytophthora, Albugo, Saccharomyces, Aspergillus, Penicillium, Alternaria, and Peziza*.
3. Study of vegetative and reproductive structures of *Riccia, Marchantia, Anthoceros, Sphagnum, Funaria and Polytrichum*
4. Study of vegetative and reproductive structures of *Selaginella, Equisetum and Ophioglossium, Marselia*

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. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
13. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition
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Semester-I

Course Title: **Algae, Fungi, Bryophyte &Pteridophyte**
Nature of course: **Minor course-I**
Course Code:
Total credit: **4**
Marks: **60+40=100**

Total lectures- 60

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
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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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion

5. Home assignments

Attainment of Cos:

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4. Practical record book

Unit-1. Algae (12 lectures)

General characteristics, range of thallus organization, cell structure, pigment system, reserve food, methods of reproduction, Classification system of Fritsch and Lee, Role of algae in the environment, agriculture, biotechnology and industry.

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5. Study of vegetative and reproductive structures of *Phytophthora, Albugo, Saccharomyces, Aspergillus, Penicillium, Alternaria, and Peziza*.
6. Study of vegetative and reproductive structures of *Riccia, Marchantia, Anthoceros, Sphagnum, Funaria and Polytrichum*
7. Study of vegetative and reproductive structures of *Selaginella, Equisetum and Ophioglossium, Marselia*

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SEMESTER-I

Title of the Course:	**Natural Resource Management**
Nature of course :	**GEC-I**
Course code:	
Total Credits:	**03**
Marks :	**60+40=100**

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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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
5. Practical record book

Course content

Total Lectures: 45

UNIT-I: Natural resources: **07 classes**

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

UNIT-II: Sustainable utilization of land and water resources: **15 classes**

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

UNIT-III: Biodiversity: **08 classes**

Definition, types, significance, threats, management strategies, CBD, Bioprospecting

UNIT IV: **15 classes**

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.

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

Title of the Course	**:**	**Tea plantation and management**
Nature of course	**:**	**SEC-I**
Course code	**:**	
Total Credits	**:**	**03**
Distribution of Marks	**:**	**60+40=100**

Course outcome:

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

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Lectures: 45

Unit 1: (10 lectures)

History of tea cultivation, classification; Botany of tea plant, morphology and anatomy of tea plants; Climate and tea production, temperature, rainfall, humidity, sunshine, shade trees, soil characteristics, organic matter, soil nutrients, nutrients application.

Unit 2: (10 lectures)

Tea culture and Propagation techniques, seed propagation, vegetative propagation, grafting, nursery management; Selection of planting sites, land preparation, plant spacing and

staking, irrigation, weed and pest control, Tea disease and control measure. Manuring, pruning, tipping and plucking, shade tree.

Unit 3: (10 lectures)

Production and processing of tea leaves: Black tea, Green tea and Oolong tea, chemistry of tea manufacturing and tea quality; tea grades; storing of tea; Organic tea preparation, instant tea, herbal tea. Cheapest hygienic beverage, health benefits of tea, employment generation, revenue earner.

Lab activities

Demonstration of tea nursery, hands on training on cutting and vegetative propagation of tea, pruning and skiffing, preparation of nursery bed, 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 – June 1, 2002 by N. K. Jain
3. James Norwood Pratt's Tea Dictionary by James Norwood Pratt and Devan Shah
4. Global tea scienceCurrent Status and Future Needs Editors

SEMESTER-I

Title of the Course	**:**	**Mushroom Culture Technology**
Nature of course	**:**	**SEC-I**
Course code	**:**	
Total Credits	**:**	**03**
Distribution of Marks	**:**	**60+40=100**

Course outcome:

1. Distinguish between edible and nonedible mushrooms
2. Execute the cultivation of commercially important mushrooms

Learning outcomes

1. Identify the commercial and edible mushrooms
2. Execute management strategies for commercial production 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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Field demonstration of mushrooms
3. Participation in seminar/conference
4. Practical record book
5. Hands-on practice

Lectures: 45

Unit 1: (08 Lectures)

Introduction, Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.Types of edible mushrooms available in India – *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus.*

Unit 2: (15 Lectures)

Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw,

banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, composting technology in mushroom production.

Unit 3: (7 Lectures)

Storage: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in saltsolutions.

Unit-4. Practical

Identification of edible mushroom, Demonstration of spawn preparation, Demonstration of culture & 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-II

Title of the Course : Morphology and Reproduction of Spermatophytes
Nature of course : Core/Major-II
Course code :
Total Credits : 04
Distribution of Marks: 60+40=100

Course outcomes:

1) describe different groups of gymnosperms and angiosperms
2) examine the morphology and reproductive processes in gymnosperms and angiosperms

Characteristics

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 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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Total Lectures: 60

Unit-1. Gymnosperms (8 lectures)

General characteristics, classification, morphology, anatomy and reproduction of *Cycas, Pinus, Ginkgo and Gnetum*; Patterns of embryo development in gymnosperms. Ecological and economic importance.

Unit. 2. Fossil plants (6 lectures)

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

Unit. 3. Morphology of Angiosperms (7 lectures)

Morphology and types of root, stem, and leaves phyllotaxy and venation, hairs and trichomes, inflorescence and its types; aestivation. Arrangement and types of reproductive parts of flower, placentation and its types.

Unit. 4. Anther and pollen biology (8 lectures)

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

Unit 5: Ovule (6 lectures)

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

Unit 6: Pollination, fertilization and post fertilization developments (10 lectures)

Pollination types and significance; adaptations for pollination; Double fertilization; Structure and types; 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.

Practical

1. Study of morphology and reproductive parts of *Cycas*, *Pinus, Ginkgo* & *Gnetum.*
2. Study of Fossil plants (Photographs/specimen).
3. Study of different types of roots (Morphology only).
4. Types of leaves, venation, hairs and trichomes, phyllotaxy, inflorescence and aestivation.
5. Typesof placentation and ovule (Preparation of temporary slides)
6. Study of pollen morphology and pollen tube formation.
7. 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, Netherlands.

Semester-II

Title of the Course : Morphology and Reproduction of Spermatophytes
Nature of course : Minor-II
Course code :

Total Credits : 04
Distribution of Marks: 60+40=100

Course outcomes:

1) describe different groups of gymnosperms and angiosperms
2) examine the morphology and reproductive processes in gymnosperms and angiosperms

Characteristics

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 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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Total Lectures: 60

Unit-1. Gymnosperms (8 lectures)

General characteristics, classification, morphology, anatomy and reproduction of *Cycas, Pinus, Ginkgo and Gnetum*; Patterns of embryo development in gymnosperms. Ecological and economic importance.

Unit. 2. Fossil plants (6 lectures)

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

Unit. 3. Morphology of Angiosperms (7 lectures)

Morphology and types of root, stem, and leaves phyllotaxy and venation, hairs and trichomes, inflorescence and its types; aestivation. Arrangement and types of reproductive parts of flower, placentation and its types.

Unit. 4. Anther and pollen biology (8 lectures)

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

Unit 5: Ovule (6 lectures)

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

Unit 6: Pollination, fertilization and post fertilization developments (10 lectures)

Pollination types and significance; adaptations for pollination; Double fertilization; Structure and types; 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.

Practical

1. Study of morphology and reproductive parts of *Cycas, Pinus, Ginkgo* & *Gnetum.*
2. Study of Fossil plants (Photographs/specimen).
3. Study of different types of roots (Morphology only).

4. Types of leaves, venation, hairs and trichomes, phyllotaxy, inflorescence and aestivation.
5. Typesof placentation and ovule (Preparation of temporary slides)
6. Study of pollen morphology and pollen tube formation.
7. 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, Netherlands.

Semester-II

Title of the Course : Plant Diversity and Human Welfare

Nature of course : GEC-II
Course code :
Total Credits : 03
Distribution of Marks: 60+40=100

Course outcome

1. Differentiate the level of plant diversity
2. Examine the cause of the loss of biodiversity
3. Analyse 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 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:

1. One internal examination (theory)
2. Viva-voce
3. Group discussion
4. Home assignments

Attainment 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

Lectures: 45

Unit 1: (12 lectures)

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, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes.

Unit 2: (13 lectures)

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 legislation and conservations, Biodiversity information management and communication

Unit 3: **(10 lectures)**

Conservation of Biodiversity: Conservation of genetic diversity, speciesdiversity and ecosystem diversity, In situ and ex situ conservation, Socialapproaches to conservation, Biodiversity awareness programmes, Sustainable development.

Unit 4: **(10 lectures)**

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. Wood and its uses.

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-II

Title of the Course:	**Biofertilizers**
Nature of course :	**SEC-II**
Course code	**:**
Total Credits	**: 03**
Distribution of Marks:	**60+40=100**

Total Lectures: 45

Course outcome

1. Identify microbes used as biofertilizer
2. Implementation of organic cultivation using biofertilizers
3. Analyse the strategies for biofertilizer production

Learning outcomes

1. Describe biofertilizers and their importance
2. Analyse the issues involve in organic agriculture
3. 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:

1. One internal examination (theory)
2. Viva-voce
3. Group discussion
4. Home assignments

Attainment 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

Unit 1: (7 lectures)

Factors affecting plant growth; essential nutrients; microbes used as biofertilizer (nitrogen fixers, phosphate solubilizers, PGPR) biocontrol agents.

Unit 2: (7 lectures)

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

Unit 3: (8 lectures)

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

Unit 4: (8 lectures)

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. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming AktaPrakashan, Nadiad

Semester-II

Title of the Course : Conservation and Cultivation of Orchids

Nature of course : SEC-II
Course code :
Total Credits : 03
Distribution of Marks: 60+40=100

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 orchid culture 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	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:

1. One internal examination (theory)
2. Viva-voce
3. Group discussion
4. Home assignments

Attainment 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

Total Lectures: 45

Unit-I: Introduction to Orchids **(7 lectures**)

Salient features, habitat, origin and diversity, morphology and classification of orchids, Economic importance of Orchids.

Unit-II: **(7 lectures)**

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

Unit-III- **(8 lectures)**

Propagation of Orchids: Different methods of propagation of orchids (cutting and hybridization), Substratum/soil preparation of orchids, nutritional and environmental requirement maintenance of orchidarium, *In-vitro* propagation of orchids.

Unit-IV **(8 lectures)**

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

Unit-V

Practical- Identification of orchids, Demonstration of vegetative propagation of orchids, preparation of substrata for economically importance orchids, exposure visit to Orchidarium.

Semester-III

Title of the Course : Cell Biology

Nature of course : Core/Major-III

Course code :

Total Credits : 04

Distribution of Marks: 60+40=100

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

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Total Lectures: 60

Unit 1: The cell (6 lectures)

Cell as a unit of structure and function; cell theory, Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

Unit 2: Cell wall and plasma membrane (6 lectures)

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

Unit 3: Cell organelles (12 lectures)

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

Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, Golgi Apparatus.

Unit 5: Membrane transport and Protein sorting & targeting (12 lectures)

Membrane transport – Passive, active and facilitated transport, membrane channels, gates and pores; endocytosis and exocytosis; protein glycosylation, protein sorting and export from Golgi apparatus; protein folding & processing; Smooth endoplasmic reticulum and lipid synthesis, export of proteins and lipids.

Unit 6: Cell division (9 lectures)

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

Lab. activities

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, *Vallisnaria*
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 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

Title of the Course : Plant Biochemistry & Molecular Biology

Nature of course : Core/Major-IV
Course code :
Total Credits : 04
Distribution of Marks: 60+40=100

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

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Total Lectures: 60

Unit 1: Biomolecules: (10 lectures)

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 lectures)

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 (5 lectures)

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 theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

Unit 4: Genetic material and its organization (07 lectures)

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 lectures)

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

Unit 6: Genetic codes & Translation (08 lectures)

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.

Lab. activities

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 :
Total Credits : 04
Distribution of Marks: 60+40=100
Lectures: 60
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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Unit 1: Significance of Plant Systematics **9 classes**

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 **5 classes**

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

(taxonomic, biological, evolutionary).

Unit 3: Botanical nomenclature **06 classes**

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 classes**

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 classes**

Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

Unit 6: Phylogeny of Angiosperms **8 classes**

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, cladogram).

Lab activities

1. Study of vegetative and floral characters of the following families as per the availability of local specimens
   a. Magnoliaceae
   b. Brassicaceae
   c. Malvaceae
   d. Lamiaceae
   e. Solanaceae
   f. Asteraceae
   g. Poaceae
2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

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
Course Code :
Nature of the Course : GEC-III
Total Credits : 03
Distribution of Marks : 60+40=100

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

1. One internal examination (theory)
2. Viva-voce
3. Group discussion
4. Home assignments

Attainment 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

Total lectures-45

Unit-I: Ethnobotany **15 lectures**

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 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 **08 lectures**

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

Unit-III: Medico-ethnobotanical sources in India **15 lectures**

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 example Rauvolfia *sepentin*a, *Trichopus zeylanicus, 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 **07 lectures**

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 :
Total Credits : 03
Distribution of Marks: 60+40=100

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 1 for lowest correlation

Modes of internal assessment

1. One internal examination (theory)
2. Viva-voce
3. Group discussion
4. Home assignments

Attainment 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

Lectures: 45

Unit 1: (6 lectures)

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

Seed storage: Seed banks, factors affecting seed viability, genetic erosion- Seed production technology -

Unit 2: (6 lectures)

Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium.

Unit 3: (6 lectures)

Seed testing and certification; Greenhouse - mist chamber, shed root, shade house and glass house. Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house.

Unit 4: (6 lectures)

Gardening: Different types of gardening - landscape and home gardening - parks and its components - plant materials and design.

Unit 5: (6 lectures)

Gardening operations: soil preparation, manuring,watering, management of pests and diseases and harvesting.Sowing/raising of seeds and seedlings - Transplanting of seedlings.

Practical

Exposure visit to established nurseries, farms etc., 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, 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

Title of the Course : Medicinal Botany

Nature of course : SEC-III

Course code :

Total Credits : 03

Distribution of Marks: 60+40=100

Course outcome:

1. Discuss the indigenous medicinal plants of Northeast India
2. Use of traditional knowledge system in health care

Learning outcome:

1. Understand the traditional practices of ethnic communities
2. Implementation of IKS for healthcare

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	3.0	2.0	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

1. One internal examination (theory)
2. Viva-voce
3. Group discussion
4. Home assignments

Attainment 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
5. Practical works

Lectures: 45

Unit 1: (5 lectures)

History, Scope and Importance of Medicinal Plants. Conservation of endangered and endemic medicinal plants.

Unit 2: (5 lectures)

Ayurveda: History, origin, Pancha mahabhutas, Saptadhatu andTridoshaconcepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinalsystems, Basis of Siddha system, plants used in Siddha medicine.

Unit 2: (10 lectures)

Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; *Ex-situ* conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding

Unit 3: (5 lectures)

Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit 4: (5 lectures)

Ethnomedicinal practices in NE India

Practical: Identification, collection and conservation (Propagation and Plantation) of local medicinal plants.

Suggested Readings

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.

Semester-IV

Title of the Course : Plant Ecology and Phytogeography
Nature of course : Core/Major-V
Course code :
Total Credits : 04
Distribution of Marks: 60+40=100

Lectures: 60

Course outcomes:

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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion

5. Home assignments

Attainment 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

Unit I: Introduction **03 classes**

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

Unit II: Environmental factors **08 classes**

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

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 **:** Variations; adaptations of plants to their variation.

Unit III: Biotic interactions **07 classes**

Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.

Unit IV: Population Ecology **08 classes**

Characteristics and Dynamics. Ecological Speciation

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

Unit V: Ecosystems **10 classes**

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 VI: Phytogeography **09 classes**

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.

Lab/field activities

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.
4.Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

Semester-IV

Title of the Course : Angiosperm Systematics
Nature of course : Core/Major-VI
Course code :
Total Credits : 04
Distribution of Marks: 60+40=100

Lectures: 60

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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Unit 1: Significance of Plant Systematics **9 classes**

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 **5 classes**

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

Unit 3: Botanical nomenclature **06 classes**

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 classes**

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 classes**

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

Unit 6: Phylogeny of Angiosperms **8 classes**

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, cladogram).

Lab activities

1. Study of vegetative and floral characters of the following families as per the availability of local specimens
    h. Magnoliaceae
    i. Brassicaceae
    j. Malvaceae
    k. Lamiaceae
    l. Solanaceae
    m. Asteraceae
    n. Poaceae

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

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 : Core/Major-VII
Course code :
Total Credits : 04
Distribution of Marks: 60+40=100

Lectures: 60

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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Unit 1: Differentiation of tissues and organs

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

Epidermis, cuticle, lenticels, hydathodes; General account of adaptations in xerophytes and hydrophytes.

Unit 3: Structural organization of flower

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sacs.

Unit 4: Pollination and fertilization

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 5: Embryo and endosperm

Endosperm types, structure, and functions; Dicot and monocot embryo: structure and development, Embryo endosperm relationship, Apomixis, and polyembryony: definition, types and Practical applications

Lab activities

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: 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. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.

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**
Code	**:**	**Core/Major-VIII**
Total Credits	**:**	**04**
Distribution of Marks	**:**	**60+40=100**

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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Unit-I: Mendelian genetics and its extension **15 classes**

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-II: Extrachromosomal Inheritance 9 classes

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 9 classes

Linkage and crossing over-Cytological basis of crossing over; Genetic mapping, Sex linked, Sex influenced, Sex limited inheritances, quantitative traits/loci.

Unit IV: Chromosomal & gene mutation 12 classes

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: **15 classes**

Theories: Lamarck's theory, Darwin's theory, Weismann's germ plasm theory; Evolution in bacteria, experimental evolution.

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.

Textbook

1. 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)

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. CarrollPublisher: 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 :
Total Credits : 04
Distribution of Marks: 60+40=100

Course outcome

CO 1: Ability to identify different physiological processes in plant.

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

CO3: 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
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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment of Cos:

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

Total Lectures: 60

Unit 1: Plant-water relations

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 and factors affecting transpiration, antitranspirants, and mechanism of stomatal movement.

Unit 2: Mineral nutrition & Nutrient Uptake

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, chelating agents.

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

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

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

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

Unit 6: Physiology of flowering

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

Phytochrome, crytochromes and phototropins**:** Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Practicals:

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 xerophyte.
4. To study the phenomenon of seed germination (effect of light).
5. Separation of chloroplast pigments by paper chromatography/TLC
6. Separation 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

Semester-V

Title of the Course : Plant Physiology and Metabolism
Nature of course : Major/core-IX
Course code :
Total Credits : 04
Distribution of Marks: 60+40=100

Course outcome

CO 1: Ability to identify different physiological processes in plant.

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

Learning outcomes:

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

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Lectures: 60

Unit 1: Plant-water relations **08 lectures**

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 and factors affecting transpiration, antitranspirants, and mechanism of stomatal movement.

Unit 2: Mineral Nutrition & Nutrient Uptake **08 lectures**

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, chelating agents.

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 15 classes

Historical background, 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, C_4-pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction. Respiration: types, glycolysis and Kreb cycle

Unit 4: Translocation in the phloem 05 classes

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 and physiology of flowering 09 classes

Plant growth regulators: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

Physiology of flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization. Phytochrome , crytochromes and phototropins**:** Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action; seed dormancy.

Lab. activities:

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 xerophyte.
4. To study the phenomenon of seed germination (effect of light).
5. Separation of chloroplast pigments by paper chromatography/TLC
6. Separation 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

Semester-V

Title of the Course : Plant breeding and crop improvement
Nature of course : Major/core-X
Course code :
Total Credits : 04
Distribution of Marks: 60+40=100

Lectures: 60

Course outcomes:

1. Describe the methods used in plant breeding to improve crops
2. Demonstrate proficiency in classical and modern plant breeding techniques
3. Understand selection criteria and methods for breeding new varieties
4. Conduct laboratory work related to plant breeding

Learning outcomes:

1. Explain the fundamental principles of plant breeding and crop improvement
2. Discuss the advantages and limitations of different breeding approaches
3. Understand selection criteria and methods for breeding new varieties

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1				
Procedural		CO3	CO2		CO4	
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	2.4
CO2	3	3	3	3	3	2	2	2.6
CO3	3	2	3	2	2	2	2	2.3
CO4	3	3	3	3	3	2	2	2.7
AVERAGE	3.0	2.7	2.7	2.7	2.7	2.0	2.0	

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

Modes of internal assessment:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Unit 1: Plant Breeding **10 classes**

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

Unit 2: Methods of Crop Improvement **18 classes**

Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self-pollinated, cross-pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants: Procedure, advantages and limitations.

Unit 3: Inbreeding depression and heterosis **08 classes**

History, genetic basis of inbreeding depression and heterosis; Applications.

Unit 5: Crop improvement and breeding **09 classes**

Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Practicals:

1. Reproductive biology of self- and cross-pollinating plants
2. Vegetative reproduction – Cutting, Budding, , grafting and layering
3. Hybridization: Emasculation, bagging, pollination and production of hybrids
4. Pollen fertility – Tetrazolium test

Suggested readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2ndedition.

SEM-V

Title of the Course : Microbiology & Immunology
Code : Major/CORE-XI
Total Credits : 04
Distribution of Marks : 60+40=100

Course outcomes:

1) To classify microorganism based on different parameters
2) To demonstrate different processes involved in microbiology
3) To differentiate between microbial groups
4) To apply microbes for human welfare
5) to understand the basic immunological processes
6) to evaluate different antibiotics and vaccines

Learning Outcome:

1) To distinguish microbes based on different parameters
2) To understand different microbial processes for application in human welfare
3) To describe immunological concepts
4) To understand antibiotic classes and vaccines

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1, CO5				
Procedural			CO2, CO4	CO3	CO6	
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	1	2	2	1	2	1.7
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	2	1	1	1	1	1.5
CO4	2	3	3	2	2	1	1	2.0
CO5	2	2	2	2	2	1	2	1.8
CO6	2	3	3	2	2	1	1	2.0
AVERAGE	2.1	2.4	1.8	1.7	1.5	1.0	1.2	

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

Modes of internal assessment:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Unit I: Brief history and development of microbiology: **10 classes**

Introduction to study of Microbiology, conflict over spontaneous generation, role of microorganisms in disease, scope of microbiology, development of Koch's postulate.

Classification of microorganisms; morphological, biochemical and molecular characteristics; nutritional types in microorganisms; Culture media, microbial growth curve uncultured microbes.

Unit II: Prokaryotic cell structure: 07 classes

Bacterial cell wall, cytoplasmic structure and inclusions bodies, sporulation and spore, diversity in bacterial structure; actinomycetes, rickettsias, mycoplasma; archaea.

Unit III: Viruses: 08 classes

Basic structures, classification, double-stranded and single-stranded DNA and RNA viruses, replication strategies of DNA and RNA viruses; viroids and prions; bacteriphages with suitable examples.

Unit-IV: Application of microbes: 08 classes

Role of microbes in bio-geo-chenical cycling, Biological nitrogen fixation; Industrial application of microbes: alcohol, organic acids, vaccine, antibiotics; microbial biofilm; wastewater treatment; bifertilizer and biopesticides; Microbial diseases and their control: Host-pathogen relationship, mechanisms of virulence, quorum sensing, pathogenesis in plants and animals

Unit-V: Immunology 12 classes

Immune response, discrimination between self and non-self, innate and acquired immune response; Innate Immunity: Anatomic and Physiological Barriers, Inflammation, Toll receptors and PAMPs, DAMPs , Defensisns, and Complement system, NK Cells; Antigen: Antigenicity vs immunogenicity, B and T cell epitopes; Immunoglobulins: Basic structure, Ig fold and domains, Classes and subclasses of Ig, Biological activities of Igs, B cell receptor; MHC and Antigen Presentation; Cytokines and cytokine receptors; autoimmunity

Lab activities

1. Bacterial growth on solid and broth media, pure culture technique, slant preparation
2. Bacterial colony morphology and diversity
3. Gram staining of bacteria
4. Biochemical characterization of bacteria
5. Determination of coliform group in water samples by presumptive, confirmed and completed test.
6. Study of cells involved in immunology (Photograph/animation)

Textbooks

1. Willey, J., Sherwood, L. and WoolvertonC., Microbiology, 10th edition (McGraw-Hill Science, 2017).
2. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R., Microbiology, Publisher McGraw Hill Education (India) Private Limited, ISBN-10 0074623206, 5th Edition, 2001.
3. Tortora, G.J., Fernke, B.R. and Case, C.L., Microbiology – An Introduction, 9th Edition,
4. Basic Immunology: Functions and Disorders of the Immune System, Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai (Elseviers Saunders 4 th Edition).
5. Kuby Immunology, Thomas J. Kindt, Barbara A. Osborne, Richard A . Goldsby (W.H. Freeman Publishers, Sixth Edition).

Suggested Readings

1. M. T. Madigan, J. M. Martinko, K. S. Bender, D. H. Buckley, D. A. Stahl, T. Brock, Brock Biology of Microorganisms, 14th Edition , Pearson Hall International, 2017.
2. Molecular and Cell Biology (Schaum's Outlines series special Indian edition) by W. D. Stansfield, J. S.C. Colome, R. J. Cano and R. N. Sharan (2010), McGraw Hill Education

3. Delves, P., Martin, S., Burton, D., Roitt, I. Roitt's Essential Immunology (WileyBlackwell, 11th Edition).

SEM-V

Title of the Course : Economic Botany
Code : Minor-V
Total Credits : 04
Distribution of Marks : 60+40=100

Course outcomes:

1. Identify and classify economically important plant species based on their taxonomic characteristics.
2. Describe the diversity of plant species used by humans across different geographical regions.
3. Discuss agricultural and horticultural techniques used to cultivate economically important plants.
4. Evaluate sustainable practices for the production and management of economically significant crops

Learning outcomes:

1. Identify and classify economically important plant species based on their botanical characteristic
2. Describe the traditional, medicinal, industrial, and commercial uses of plants
3. Explain the anatomical and physiological features of plants that are relevant to their economic uses
4. Understand agricultural and horticultural techniques used in the cultivation and management of economically significant plants

Mapping of CO with Bloom's taxonomy

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

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	3	3	2	2	2.4
CO2	3	2	2	3	3	2	2	2.4
CO3	3	2	3	3	3	2	2	2.6
CO4	2	2	3	3	3	2	2	2.4
AVERAGE	2.7	2.0	2.5	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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Total lectures-60

Unit 1: **09 lectures**

Origin of Cultivated Plants**:** Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 2: **09 lectures**

Cereals: Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.

Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

Sugars and starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit 3: **09 lectures**

Spices: Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper

Beverages:Tea, Coffee (morphology, processing & uses)

Oils and fats: General description, classification, extraction, their uses and health implications; groundnut, coconut, soybean, mustard and coconut (Botanical name, family & uses).

Unit 4: **09 lectures**

Natural Rubber: Para-rubber: tapping, processing and uses.

Drug-yielding plants: *Cinchona, Digitalis, Papaver and Cannabis; Tobacco* (Morphology, processing, uses and health hazards).

Unit 5: **09 lectures**

Timber plants: General account with special reference to teak and pine.

Fibers**:** Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

Practicals

1. Collection and submission different cereals, pulses, spices, drug yielding plant parts and timber (in the form of albums)
2. Identification of locally available economically important plant species
3. Qualitative detection of protein, carbohydrate, and fat in plant samples

Suggested readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers**.**

SEM-VI

Title of the Course	**:**	**Plant Pathology & Crop Protection**
Code	**:**	**Core/Major-XII**
Total Credits	**:**	**04**
Distribution of Marks	**:**	**60+40=100**

Course outcomes:

1. Identify and describe major groups of plant pathogens
2. Understand the biology, life cycles, and modes of action of various plant pathogens
3. Learn integrated disease management strategies, including cultural, biological, chemical, and genetic approaches
4. Analyze disease cycles and the influence of environmental conditions on disease development.

Learning outcomes:

1. Classify major groups of plant pathogens
2. Describe the biology and life cycle of plant pathogens
3. Explain the plant disease management strategies
4. Evaluate disease cycles and development patterns

Mapping of CO with Bloom's taxonomy

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

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	3	3	2	2	2.4
CO2	3	2	2	3	3	2	2	2.4
CO3	3	2	3	3	3	2	2	2.6
CO4	2	2	3	3	3	2	2	2.4
AVERAGE	2.7	2.0	2.5	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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Total lectures-60

Unit-1. **10 lectures**

Phytopathology:Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation.

Unit 2. **12 lectures**

Prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, Bhendi yellow vein mosaic virus. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers. Diseases caused by phytoplasma-Little leaf of Brinjal

Unit 3. **12 lectures**

Cultural methods of plant protection – Tillage, crop rotation, trap crops, fertilizer applications, land fallowing, timely sowing, and proper soil selection. Mechanical methods – Field sanitation, Hand picking, Destruction of infected plants/plant parts, Destruction of egg masses, light traps, use of sticky bands, bagging for the pests, and Pheromone traps. Physical methods – Heat and soil solarisation

Unit 4. **11 lectures**

Chemical methods of plant protection –Definition, uses and examples of Bactericides, Fungicides, Insecticides, Nematicides, Acaricides , Molluscicides and Rodenticides

Biological methods – Definition, Important biocontrol agents. a) Fungi : (Trichoderma, Metarhizium, Verticillium) b) Bacteria : Pseudomonas, Bacillus c) Insect : Crysopyrilla / Trichogramma d) Virus 4c: Legal methods – Plant quarantine in India. 4d: Crop resistance – Uses of resistant varieties and their examples

Practicals

1. Study of common plant diseases:

   Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers, and other locally available diseases

   Bacterial diseases – Citrus canker and angular leaf spot of cotton and other locally available diseases

   Viral disease- tobacco mosaic virus, Bhendi yellow vein mosaic virus

2. Isolation of plant pathogen and establishment of Koch’s postulates.
3. Study of plant origin and chemical pesticides.
4. Preparation and submission of plant disease albums.

SEM-VI

Title of the Course : Economic Botany
Code : Major/ core-XIII
Total Credits : 04
Distribution of Marks : 60+40=100

Course outcomes;

1. Identify and classify economically important plant species based on their taxonomic characteristics.
2. Describe the diversity of plant species used by humans across different geographical regions.
3. Discuss agricultural and horticultural techniques used to cultivate economically important plants.
4. Evaluate sustainable practices for the production and management of economically significant crops

Learning outcomes:

1. Identify and classify economically important plant species based on their botanical characteristic
2. Describe the traditional, medicinal, industrial, and commercial uses of plants
3. Explain the anatomical and physiological features of plants that are relevant to their economic uses
4. Understand agricultural and horticultural techniques used in the cultivation and management of economically significant plants

Mapping of CO with Bloom's taxonomy

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

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	3	3	2	2	2.4
CO2	3	2	2	3	3	2	2	2.4
CO3	3	2	3	3	3	2	2	2.6
CO4	2	2	3	3	3	2	2	2.4
AVERAGE	2.7	2.0	2.5	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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion

5. Home assignments

Attainment 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

Total lectures-60

Unit 1: **09 classes**

Origin of Cultivated Plants**:** Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 2: **09 classes**

Cereals: Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.

Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

Sugars and starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit 3: **09 classes**

Spices: Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper

Beverages:Tea, Coffee (morphology, processing & uses)

Oils and fats: General description, classification, extraction, their uses and health implications; groundnut, coconut, soybean, mustard and coconut (Botanical name, family & uses).

Unit 4: **09 classes**

Natural Rubber: Para-rubber: tapping, processing and uses.

Drug-yielding plants: *Cinchona, Digitalis, Papaver and Cannabis; Tobacco* (Morphology, processing, uses and health hazards).

Unit 5: **09 classes**

Timber plants: General account with special reference to teak and pine.

Fibers**:** Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

Practicals

1. Collection and submission different cereals, pulses, spices, drug yielding plant parts and timber (in the form of albums)
2. Identification of locally available economically important plant species
3. Qualitative detection of protein, carbohydrate, and fat in plant samples

Suggested readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.

SEM-VI

Title of the Course : Plant Biotechnology, Bioinformatics, and Biostatistics
Code : Major/ core-XIV
Total Credits : 04
Distribution of Marks : 60+40=100

Course outcome

1. Understand the basic concepts and principles of plant biotechnology.
2. Comprehend the structure and function of genes, genomes, and genetic engineering techniques
3. Develop skills in plant tissue culture techniques, including micropropagation, callus culture, and somatic embryogenesis.
4. Apply tissue culture methods for plant breeding and conservation
5. Learn about biological databases, sequence alignment, and molecular evolution
6. Understand the basic concepts and principles of biostatistics.
7. Learn about probability, statistical distributions, and hypothesis testing

Learning outcomes:

1. Explain the basic concept of biotechnology
2. Demonstrate the tissue culture technique
3. Discuss the basic concepts of biostatistics

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1 CO5	CO2			
Procedural		CO6 CO7	CO3 CO4			
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	3	3	2	2	2.6
CO4	3	3	3	3	3	2	2	2.7
CO5	3	3	3	3	3	2	2	2.7
CO6	3	3	3	3	3	2	2	2.7
CO7	3	3	3	3	3	2	2	2.7
AVERAGE	3.0	2.6	2.7	2.7	2.7	2.0	2.0	

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

Modes of internal assessment:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Unit 1 : Plant Tissue Culture **10 lectures**

Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus

elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit 2 : Recombinant DNA technology and application of biotechnology 12 lectures

Steps involved in genetic engineering, restriction enzymes and cloning vectors, Methods of gene transfer, construction of genomic and cDNA libraries,

Application of biotechnology**:** Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products– Human Growth Hormone; Humulin; Biosafety concerns.

Unit 3: Introduction to Bioinformatics 12 lectures

Introduction to bioinformatics, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System. National Center for Biotechnology Information (NCBI), Basic Local Alignment Search Tool (BLAST), Concept of Alignment, Multiple Sequence Alignment, Phylogenetic Analyses

Unit-4: Biostatistics: 11 lectures

Frequency Distributions and Statistical Measures: mean, mode, median, variance, standard deviation, coefficient of variation, measures of skewness and kurtosis

Probability: Theory of Probability, Conditional Probability, Bayesian Rules, Random variable, Distributions of random variables, Binomial, Poisson Fundamental concepts in applied probability

Exploratory data analysis and statistical inference, Chi-square test for independence, P-value and z-score of the statistic, statistical software and their use for data analysis

Lab activities

1. Preparation of MS medium.
2. Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, Datura, Brassica etc.
3. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plasmid DNA.
8. Nucleic acid and protein databases.
9. Sequence retrieval from databases.
10. Sequence alignment.
11. Sequence homology and Gene annotation.

12. Construction of phylogenetic tree
13. Calculation of mean, median and mode
14. Chi-square test, t- test, ANOVA

SEM-VI

Title of the Course : Analytical techniques in plant science
Code : Major/ Core-XV
Total Credits : 04
Distribution of Marks : 60+40=100

Total lecture-60

Course outcomes:

CO1: Understanding the basic principles of the tools and techniques in plant science.

CO2: Ability to apply technologies to solve complex biological questions in Life Sciences.

CO3: Ability to operate sophisticated instruments used in biological science

Learning Outcome:

1. Describe the instruments used in modern biology
2. Demonstrate the instruments and techniques used in life sciences**.**

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
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:

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce
4. Group discussion
5. Home assignments

Attainment of Cos:

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

Unit 1 : Imaging and related techniques **12 lectures**

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2: Cell fractionation **08 lectures**

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Radioisotopes & Spectrophotometry **08 lectures**

Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment.

Spectrophotometry: Principle and its application in biological research.

Unit 4 : Chromatography **08 lectures**

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 5 : Characterization of proteins and nucleic acids **09 lectures**

Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Practicals:

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate sugars by thin layer chromatography.
4. Isolation of chloroplasts by differential centrifugation.
5. To separate chloroplast pigments by column chromatography.
6. To estimate protein concentration through Lowry’s methods.
7. To separate proteins using PAGE.
8. To separation DNA (marker) using AGE.
9. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).

Semester VI

Title of the Course : Microbiology & immunology
Code : Minor VI
Total Credits : 04
Distribution of Marks : 60+40=100

Total lectures-60

Course outcomes:

1) To classify microorganism based on different parameters
2) To demonstrate different processes involved in microbiology
3) To differentiate between microbial groups
4) To apply microbes for human welfare
5) to understand the basic immunological processes
6) to evaluate different antibiotics and vaccines

Learning Outcome:

1) To distinguish microbes based on different parameters
2) To understand different microbial processes for application in human welfare
3) To describe immunological concepts
4) To understand antibiotic classes and vaccines

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1, CO5				
Procedural			CO2, CO4	CO3	CO6	
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	1	2	2	1	2	1.7
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	2	1	1	1	1	1.5
CO4	2	3	3	2	2	1	1	2.0
CO5	2	2	2	2	2	1	2	1.8
CO6	2	3	3	2	2	1	1	2.0
AVERAGE	2.1	2.4	1.8	1.7	1.5	1.0	1.2	

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

Modes of internal assessment:

1. One internal examination (theory)
2. One internal examination (Lab)

3. Viva-voce
4. Group discussion
5. Home assignments

Attainment 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

Unit I: Brief history and development of microbiology: **10 classes**

Introduction to study of Microbiology, conflict over spontaneous generation, role of microorganisms in disease, scope of microbiology, development of Koch's postulate.

Classification of microorganisms; morphological, biochemical and molecular characteristics; nutritional types in microorganisms; Culture media, microbial growth curve uncultured microbes.

Unit II: Prokaryotic cell structure: **07 classes**

Bacterial cell wall, cytoplasmic structure and inclusions bodies, sporulation and spore, diversity in bacterial structure; actinomycetes, rickettsias, mycoplasma; archaea.

Unit III: Viruses: **08 classes**

Basic structures, classification, double-stranded and single-stranded DNA and RNA viruses, replication strategies of DNA and RNA viruses; viroids and prions; bacteriphages with suitable examples.

Unit-IV: Application of microbes: **08 classes**

Role of microbes in bio-geo-chenical cycling, Biological nitrogen fixation; Industrial application of microbes: alcohol, organic acids, vaccine, antibiotics; microbial biofilm; wastewater treatment; bifertilizer and biopesticides; Microbial diseases and their control: Host-pathogen relationship, mechanisms of virulence, quorum sensing, pathogenesis in plants and animals

Unit-V: Immunology **10 classes**

Immune response, discrimination between self and non-self, innate and acquired immune response; Innate Immunity: Anatomic and Physiological Barriers, Inflammation, Toll receptors and PAMPs, DAMPs , Defensisns, and Complement system, NK Cells; Antigen: Antigenicity vs immunogenicity, B and T cell epitopes; Immunoglobulins: Basic structure, Ig fold and

domains, Classes and subclasses of Ig, Biological activities of Igs, B cell receptor; MHC and Antigen Presentation; Cytokines and cytokine receptors; autoimmunity

Lab activities

1. Bacterial growth on solid and broth media, pure culture technique, slant preparation
2. Bacterial colony morphology and diversity
3. Gram staining of bacteria
4. Biochemical characterization of bacteria
5. Determination of coliform group in water samples by presumptive, confirmed and completed test.
6. Study of cells involved in immunology (Photograph/animation)

Textbooks

6. Willey, J., Sherwood, L. and WoolvertonC., Microbiology, 10th edition (McGraw-Hill Science, 2017).
7. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R., Microbiology, Publisher McGraw Hill Education (India) Private Limited, ISBN-10 0074623206, 5th Edition, 2001.
8. Tortora, G.J., Fernke, B.R. and Case, C.L., Microbiology – An Introduction, 9th Edition,
9. Basic Immunology: Functions and Disorders of the Immune System, Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai (Elseviers Saunders 4 th Edition).
10. Kuby Immunology, Thomas J. Kindt, Barbara A. Osborne, Richard A . Goldsby (W.H. Freeman Publishers, Sixth Edition).

Suggested Readings

1. M. T. Madigan, J. M. Martinko, K. S. Bender, D. H. Buckley, D. A. Stahl, T. Brock, Brock Biology of Microorganisms, 14th Edition , Pearson Hall International, 2017.
2. Molecular and Cell Biology (Schaum’s Outlines series special Indian edition) by W. D. Stansfield, J. S.C. Colome, R. J. Cano and R. N. Sharan (2010), McGraw Hill Education
3. Delves, P., Martin, S., Burton, D., Roitt, I. Roitt's Essential Immunology (Wiley-Blackwell, 11th Edition).