Syllabus of FYUGP in Botany

Department of Life Sciences

Dibrugarh University

Approved in the BOS held on 28th Feb., 2025

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 FYUGP IN BOTANY

Year	Sem.	Code	Nature of course	Title of the course	Credit
I	I	BOT-C-01	Core-I	Algae, Fungi, Bryophyte &Pteridophyte	4
		BOT-MIN-01	Minor-I	Algae, Fungi, Bryophyte &Pteridophyte	4
		BOT-GEC-01	GEC-I	Natural resource management	3
			AEC-I	Modern Indian Language	4
		BOT-SEC-01-A/B	SEC-I	Tea plantation and management/Mushroom Culture technology	3
			VAC-I	Understanding India	2
		Total credit			**20**
	II	BOT-C-02	Core-II	Morphology and Reproduction of Spermatophytes	4
		BOT-MIN-02	Minor-II	Morphology and Reproduction of Spermatophytes	4
		BOT-GEC-02	GEC-II	Plant Diversity and Human Welfare	3
			AEC-II	English Language and Communication Skills	4
		BOT-SEC-02-A/B	SEC-II	Biofertilizers/Conservation and Cultivation of Orchids	3
			VAC-II	Environmental Science	2
		Total credit			**20**
		UG CERTIFICATE			
II	III	BOT-C-03	Core-III	Cell biology	4
		BOT-C-04	Core-IV	Plant Biochemistry & Molecular Biology	4
		BOT-MIN-03	Minor-III	Angiosperm systematics	4
		BOT-GEC-03	GEC-III	Ethnobotany	3
		BOT-SEC-03-A/B	SEC-III	Nursery and Gardening/Medicinal Botany	3
			VAC-III	Digital and Technological Solutions / Digital Fluency	2
				Total credit	**20**
	IV	BOT-C-05	Core-V	Plant Ecology & Phytogeography	4
		BOT-C-06	C ore-VI	Angiosperm systematics	4
		BOT-C-07	Core-VII	Plant anatomy & Embryology	4
		BOT-C-08	Core-VIII	Genetics & Evolution	4
		BOT-MIN-04	Minor-IV	Plant physiology and metabolism	4
		Total Credit			**20**
		UG DIPLOMA			
		BOT-C-09	Core-IX	Plant physiology & Metabolism	4
		BOT-C-10	Core-X	Plant breeding and crop improvement	4

III	V	BOT-C-11	Core-XI	Microbiology and immunology	4
		BOT-MIN-05	Minor-V	Economic botany	4
		BOT-FS/PRJ	Int./Comm./project	Field study/project	4
		Total credit			**20**
	VI	BOT-C-12	Core-XII	Plant pathology and crop protection	4
		BOT-C-13	Core-XIII	Economic Botany	4
		BOT-C-14	Core-XIV	Plant biotechnology, Bioinformatics & Biostatistics	4
		BOT-C-15	Core-XV	Analytical techniques in plant Sc.	4
		BOT-MIN-06	Minor-VI	Microbiology & Immunology	4
				Total credit	**20**
				UG DEGREE	
	VII	BOT-C-16	Core-XVI	Environmental Biology	4
		BOT-C-17	Core-XVII	Advanced cell biology & genetics	4
		BOT-C-18	Core-XVIII	Advanced molecular biology	4
		Research Methodology	RM	Research Methodology & Research Ethics	4
		BOT-MIN-07	Minor-VII	Advanced analytical techniques	4
					20
	VIII	BOT-C-19	Core-XIX	Intermediary metabolism	4
		BOT-C-20	CORE-XX	Biodiversity & Bioprospecting	4
		BOT-MIN-08	MIN-VIII	Biosafety, Bioethics and IPR	4
		Dissertation		Dissertation	8
		Or			
		DSE		Climate change & Biological Adaptations	4
		DSE		Computational biology	4
					20
Honours with Research degree					

Semester-I

Course Title: **Algae, Fungi, Bryophyte &Pteridophyte**
Nature of course: **Major/Core-I**
Course Code: **BOT-C-01**
Marks: **100 [End: 60 (Theory: 45, Pract: 15), In: 40]**

Course outcomes:

1) describe different groups of the plant kingdom like algae, fungi, bryophyte & pteridophyte

2) organize the organisms into different categories based on morphological Characteristics

3) analyze the interrelationship among different species and genera within each group of plants

Learning Outcomes:

1) understand the various groups in the Kingdom up to pteridophytes
2) compare various organisms based on morphology and reproduction
3) classify different groups of plants

Mapping of CO with Bloom's taxonomy

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

Mapping of Course outcomes to Programme outcomes

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

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

Modes of internal assessment:

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

Attainment strategies of Cos:

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

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 of *Volvox, Chara, & Anabaena*, and life cycles of *Oedogonium, Ectocarpus* and *Polysiphonia*, Diatoms and its importance

Unit-2. Fungi (11 lectures)

Salient features, Classification, Thallus organization, Cell wall composition & Nutrition, Reproduction & fruiting bodies, of *Saccharomyces, & Agaricus*; Life cycles of *Phytopthora, Penicillium* & *Puccinia*. 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 , *Selaginella, Equisetum and Ophioglossum, Marselia*. Life cycles of *Lycopodium, Selaginella* & *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
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Semester-I

Course Title: **Algae, Fungi, Bryophyte &Pteridophyte**
Nature of course: **Minor course-I**
Course Code: **BOT-MIN-01**
Total credit: **4**
Marks: **100 [End: 60 (Theory: 45, Pract: 15), In: 40]**

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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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

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Unit-1. Algae (12 lectures)

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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:	**BOT-GEC-01**
Total Credits:	**03**
Marks :	**100 [End: 60, In: 40]**

Course outcome:

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

Learning outcomes

1. Differentiate natural and biological resources of NE India
2. Identify the threats and issues related to the natural resources

3. Execute conservation and management strategies for natural resources

Mapping of CO with Bloom's taxonomy

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

Mapping of Course outcomes to Programme outcomes

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

Modes of internal assessment:

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

Attainment strategies of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations
2. Field demonstration of natural resources
3. Demonstration of modern tools like GIS
4. Participation in seminar/conference
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	**:**	**BOT-SEC-01-A**
Total Credits	**:**	**03**
Distribution of Marks	**:**	**100 [End: 60 (Theory: 45, Pract: 15), In: 40]**

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 strategies of Cos:

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

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	**:**	**BOT-SEC-01-B**
Total Credits	**:**	**03**
Distribution of Marks	**:**	**100 [End: 60 (Theory: 45, Pract: 15), In: 40]**

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 strategies 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 : BOT-C-02
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies of Cos:

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

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.

Lab activities

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 : BOT-MIN-02
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies of Cos:

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

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 :BOT-GEC-02
Total Credits 03
Distribution of Marks: 100 [End: 60, In: 40]

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 strategies of Cos:

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

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 : BOT-SEC-02-A
Total Credits 03
Marks :100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies of Cos:

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

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 : BOT-SEC-02-B
Total Credits 03
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

Course outcome

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

Learning outcomes

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

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

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 : BOT-C-03
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

Course Outcomes:

1) differentiate the structure and functions of cellular components
2) evaluate the cell division mechanism and cell cycle.
3) analyze cell signalling mechanism.

Learning Outcomes:

1) understand the cell structure and functions of cell organelles.
2) analyze cell division and cell cycle mechanisms.
3) interpret the cell signalling mechanisms**.**

Mapping of CO with Bloom Taxonomy

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

Mapping of Course outcomes to Programme outcomes

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

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

Modes of internal assessment

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

Attainment strategies of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations
2. Laboratory practices on cells, cellular organelles and cellular processes

3. Practical record book/field book
4. Seminar/group discussion

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 :BOT-C-04
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

Course outcomes:

1) differentiate the biomolecules of living organisms, their interactions for perpetuation of life
2) analyze structure-function relationships of nucleic acids and protein
3) distinguish between replication, transcription and translation in prokaryotes and eukaryotes
4) interpret the gene expression mechanisms

Learner Outcome:

1) identify the various biomolecules and understand their function
2) differentiate the cellular processes such as replication, transcription and translation
3) understand gene expression mechanism

Mapping of CO with Bloom's taxonomy

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

Mapping of Course outcomes to Programme outcomes

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

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

Modes of internal assessment

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

Attainment strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Laboratory practices on biochemical and molecular biology processes
3. Practical record book/field book
4. Seminar/group discussion

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 : BOT-MIN-03
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
Total 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 strategies of Cos:

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

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).Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

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

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

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
   h. Zingiberaceae
   i. Orchidaceae
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
Nature of the Course : GEC-III
Course Code : BOT-GEC-03
Total Credits 03
Marks : 100 [End: 60, In: 40]

Course outcome:

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

Learning outcome:

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

Mapping of CO with Bloom's taxonomy

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

Mapping of Course outcomes to Programme outcomes

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

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

Modes of internal assessment

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

Attainment strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Demonstration of traditional practices of ethnic communities (medicine, food, beverages)
3. Demonstration of traditional methods of conservation of food and beverages

4. Participation in seminar/conference

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 : BOT-SEC-03-A
Total Credits 03
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

Course outcome:

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

Learning outcome:

1. Operate commercial nursery for livelihood
2. Describe the value of plants in nursery and horticulture

Mapping of CO with Bloom's taxonomy

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

Mapping of Course outcomes to Programme outcomes

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

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

Modes of internal assessment

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

Attainment strategies of Cos:

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

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	**: BOT-SEC-03-B**
Total Credits	**03**
Marks	**: 100 [End: 60 (Theory: 45, Pract: 15), In: 40]**

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 strategies of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations
2. Demonstration of traditional practices of ethnic communities (medicine, food, beverages)
3. Demonstration of traditional methods of conservation of food and beverages
4. Participation in seminar/conference
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 : BOT-C-05
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies of Cos:

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

Course content

Unit I: Introduction to Ecology and Environmental Factors 09 classes

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

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

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 II: Biotic Interactions **09 classes**

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

Unit III: Population Ecology **09 classes**

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

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

Unit IV: Ecosystems **09 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 V: 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.

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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 :BOT-C-06
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
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 strategies of Cos:

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

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). Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

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

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

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
    o. Zingiberaceae
2. Orchidaceae 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 : BOT-C-07
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies of Cos:

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

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

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

Unit 4: Pollination and fertilization

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

Unit 5: Embryo and endosperm

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

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**
Nature of course	**: Core/Major-VIII**
Code	**: BOT-C-08**
Total Credits	**04**
Distribution of Marks	**: 100 [End: 60 (Theory: 45, Pract: 15), In: 40]**

Course outcomes:

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

Learning Outcome:

1) to understand the concept of inheritance
2) to analyze mutations and genetic disorders
3) to examine forces of evolution
4) to interpret evidence of evolution

Mapping of CO with Bloom's taxonomy

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

Mapping of Course outcomes to Programme outcomes

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

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

Modes of internal assessment:

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

Attainment strategies of Cos:

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

Course content

Unit-I: Mendelian genetics and its extension **10 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 **6 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 **6 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: **11 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.

Lab activities

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

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 : BOT-MIN-04
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies 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, Carbon, lipid, and nitrogen 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, ETS

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

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.

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 Physiology and Metabolism
Nature of course : Major/core-IX
Course code : BOT-C-09
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies of Cos:

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

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, Carbon, lipid, and nitrogen 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, ETS

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

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 : BOT-C-10
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
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 strategies of Cos:

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

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.

Lab activities

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
Nature of course :Major/CORE-XI
Code :BOT-C-11
Total Credits 04
Marks :100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies of Cos:

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

Course content

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
Nature of course : Minor-V
Course code : BOT-MIN-05
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies of Cos:

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

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).

Lab activities

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
Nature of course :Core/Major-XII
Code : BOT-C-12
Total Credits 04
Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies of Cos:

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

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

Lab activities

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
Nature of course : Major/ core-XIII
Code : BOT-C-13
Total Credits : 04
Distribution of Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]

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 strategies of Cos:

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

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).

Lab activities

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**
Nature of course	**:**	**Major/ core-XIV**
Code	**:**	**BOT-C-14**
Total Credits	**:**	**04**
Distribution of Marks	**:**	**100 [End: 60 (Theory: 45, Pract: 15), In: 40]**

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 strategies of Cos:

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

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
Nature of course : Major/ Core-XV
Code : BOT-C-15
Total Credits : 04
Distribution of Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
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 strategies 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

Lab activities

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
Nature of course : Minor VI
Code : BOT-MIN-06
Total Credits : 04
Distribution of Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
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 strategies of Cos:

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

Course content

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).

SEMESTER-VII

Title of the Course : Environmental Biology
Nature of course :Major/Core-XVI
Code : BOT-C-16
Total Credits : 04
Distribution of Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
Total classes : 60

COs:
1. Analyze ecological concepts and population dynamics
2. Evaluate environmental issues
3. Evaluate legislative measures and strategies for achieving SDGs.

Learning Outcomes:
1. Apply concepts of ecology to understand issues
2. Analyze problems and legislative measures
3. Apply strategies for SDG

Mapping of CO withBloom Taxonomy

Knowlege 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	2.14
CO2	3	2	2	2	2	2	2	2.14
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 strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Laboratory practices
3. Practical record book/field book
4. Seminar/group discussion

Unit I: **09 classes**

Scope of ecology; concepts of ecological factors; Ecosystem dynamics and management: structure and function, energy flow concept, the productivity concept and methods of measurement of productivity; diversity, stability and complexity of ecosystem; nutrient cycling with special reference to carbon, nitrogen & phosphorus cycles

Unit II: **09 classes**

Population dynamics: population attributes, biotic potential and environmental resistance, population growth forms, age structure, survivorship curves, population fluctuations, interactions and regulation of population; concept of ecological niche, fundamental and realized niche; niche width and overlap; concept of meta population, demes and dispersal.

Unit III: **09 classes**

Environmental degradation and management: Global environmental issues (deforestation, greenhouse effect, depletion of ozone layer); Concept of EIA; Use of GPS, GIS and remote sensing in environmental management.

Unit IV: **09 classes**

Sustainable Development Goals: India's National Action Plan on Climate Change; concept of ecotoxicology; International agreements and programmes: Earth Summit, UNFCCC, Montreal and Kyoto protocols.

Unit V: **09 classes**

Environment legislation in India: Wildlife Protection Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Forest (Conservation) Act 1980; Air (Prevention & Control of Pollution) Act, 1981; Environment Protection Act, 1986; Biological Diversity Act, 2002; Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

Lab activities

1. To record the atmospheric temperature, relative humidity (RH), light intensity.
2. To study the physical and chemical characteristics of soil (C, N, content, base deficiency and pH of soil by rapid soil test method.
3. To determine the minimum size and number of the quadrat necessary for sampling the flora and fauna by "species - area – curve" method.
4. To determine the frequency, density and abundance of the primary producers of a grassland community by quadrat method.
5. To determine the abundance and density of soil fauna.
6. To determine the standing crop biomass of a grassland ecosystem by harvest method.
7. Basic exercise to Calculate and Assess carbon footprint/ Solid waste generation/ water consumption for a specific duration at individual/ family/ University/ locality level.
8. Estimation of TS, TSS and TDS of water samples.
9. Estimation of Turbidity, acididy, alkalinity of water samples

Suggested readings:

1. Concepts of Ecology-by E.J. Karmondy
2. Ecology -by C. Krebs
3. Ecology Work Book - by R. Misra.
4. Environmental Chemistry-by A.K.Dey
5. Fundamentas of Ecology - by E.P. Odum.
6. General Animal Ecology by Ananthakrishnan, T.K.and T.R.Viswanathan (1978).
7. Climate and Plant Distribution – Woodword
8. Soil Conservation in India – Gupta & Whytri
9. Tropical Ecosystems: Ecology & Management – Shing & Singh
10. Field Biology and Ecology- Benthon & Weaver
11. Environmental Pollution – S.M. Shafi.
12. Remote Sensing – Sahu & Solanki
13. Handbook of Agricullture – ICAR
14. Modern Concept of Ecology-by H.D. Kumar
15. Plant Ecology and Soil sciences-by Sukla and Sandal
16. Population Ecology-by M. Begon & M. Mortimer.
17. Practical methods in Plant Ecology and Environmetal Sciences- by R.K. Trivedy.

SEMESTER-VII

Title of the Course : Advanced Molecular Biology
Nature of course :Major/ Core-XVII
Code : BOT-C-17
Total Credits : 04
Distribution of Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
Total classes : 60

COs:

1. Analyze the organization of genome in prokaryotes and eukaryotes
2. Evaluate molecular processes
3. Evaluate the expression of genes is regulated, the role of DNA repair and recombination

Learning Outcomes:

1. Discuss the structural and functional organization of genomes, mechanisms of DNA replication, transcription, translation, and gene regulation in both prokaryotic and eukaryotic systems.
2. Analyze the molecular mechanisms of DNA repair, recombination, and post-transcriptional/post-translational modifications, along with their significance in genome stability and cellular function.
3. Describe key molecular biology techniques such as DNA/RNA isolation, PCR, electrophoresis, cloning, and gene expression analysis, and apply them in research and biotechnological applications.

Mapping of CO withBloom 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	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
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, and1 for lowest correlation

Modes of internal assessment

Modes of internal assessment

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

Attainment strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Laboratory practices
3. Practical record book/field book

Unit I: Genome organization and replication **09 classes**

Genome organisation in prokaryotes and eukaryotes, Genome complexity: C-value paradox, Structural and regulatory genes; Enzymology of DNA replication, fidelity in replication, replication of single stranded circular DNA end replication problem, DNA synthesis by reverse transcriptase.

Unit II: Transcription and regulation of gene expression **09 classes**

DNA-dependent synthesis of RNA, Regulatory elements, promoter, operators; Transcriptional regulation, positive and negative regulation, Regulation of transcription of lac, trp, and ara operons. Eukaryotic promoters and enhancers, General Transcription factors, Activators and repressors.

RNA processing and splicing, exon shuffling, processing of tRNA, Transcriptional and post-transcriptional gene silencing, riboyme, RNA editing. Genetic imprinting, Regulatory RNAs: Ribo-switches, RNA interference, miRNA, siRNA

Unit III: Protein synthesis and degradation **09 classes**

Genetic code and it features, the translation machinery, tRNA, ribosomes, composition and assembly. Mechanism of initiation, elongation and termination of protein biosynthesis in prokaryotes and eukaryotes and its regulation, Co- and Post-translational transport of proteins and its degradation, post-translational modification of proteins.

Unit IV: DNA Repair and Recombination **09 classes**

Alteration in DNA molecule, repair of incorrect bases, DNA repair enzymes, repair of thymine dimers, recombination repair, SOS repair.

Recombination: homologous and non- homologous recombination, site specific recombination, Holliday structure.

Unit V: Basic methodologies of DNA and gene manipulation **09 classes**

Cutting, separating and visualising DNA, Southern blotting, foot printing, RFLP, DNA sequencing, polymerase chain reaction.

Lab activities

1. Estimation of RNA by orcinol method
2. Estimation of DNA by diphenylamine method
3. Isolation of DNA from biological samples.
4. To perform Agarose gel electrophoresis for detection of DNA
5. Calculate molecular mass of unknown DNA and protein fragments from gel pictures

Restriction digestion analysis of DNA using agarose gel electrophoresis

Suggested Readings

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
- Cooper G.M. and Robert E. Hausman R.E. *The Cell:A Molecular Approach***,** V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons.Inc.
- Lewin B. (2008). *Gene XI*, Jones and Bartlett

McLennanA., BatesA., Turner,P. and White M. (2015).*Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

SEMESTER-VII

Title of the Course : Advanced Cell Biology and Genetics
Nature of course : Major/Core-XVIII
Code : BOT-C-18
Total Credits : 04
Distribution of Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
Total classes : 60

COs:

1. Examine the internal structure and working of various cellular organelles.
2. Evaluate the concept of cell communication and cell signaling.
3. Explain Classical genetics and Population Genetics.

LearningOutcomes:

- Discuss the working of cell organelles
- Analyze the functioning cell communication and cell signaling
- Describe the concept of classical genetics and population genetics.

Mapping of CO with BloomTaxonomy

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

Mapping of Course outcomes toProgramme outcomes

CO/PO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	AVERAGE

CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
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, and1 for lowest correlation

Modes of internal assessment

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

Attainment stategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Laboratory practices
3. Practical record book/field book
4. Seminar/group discussion

Modes of internal assessment

5. One internal examination (theory)
6. One internal examination (Lab)
7. Viva-voce
8. Group discussion
7. Home assignments

Attainment of Cos:

Continuous evaluation through in and end-semester theory and practical examinations
Laboratory practices
Practical record book/field book
Seminar/group discussion

Course content

Unit-I: Membrane & Cytoskeleton: 07 classes

Membrane structure and function: Molecular organization of plasma membrane; Membrane lipids & Membrane fluidity; Cytoskeletons elements (structure & function), dynamics of microfilaments, Role of actin & microtubule cytoskeleton in cell shape, intracellular motility, motor proteins, mitosis & locomotion, Functions of intermediate filaments.

Unit-II: Cell communication, Cell cycle and Integration of cellular macromolecules

12 classes

General principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, integrins; Carriers & Channel Proteins; ATP driven pumps, Aquaporins, Ion channels and electrical properties of plasma membrane;
neurotransmission and its regulation. Regulation of hematopoiesis

Phases of cell cycle, checkpoints and regulators of cell cycle progression in eukaryotes, programmed cell death, autophagy, cellular senescence, fate of cells with regard to morphogen gradients, mechanisms of cell cycle regulation; Protein sorting and transport to the endoplasmic reticulum, Golgi body and lysosomes; protein glycosylation within Golgi body and protein secretion.

Unit-III: Cell signaling & Cancer biology **12 classes**

Key concepts on cellular signaling mechanism; Receptors, G-proteins and GTPase cycle and its regulation, G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways; bacterial and plant two component systems, light signaling in plants, Role of Calcium and NO in signal transduction.

Cancer: Genetic rearrangement in progenitor cells, oncogenes, tumor suppressor genes (pRB, p53, pAPC), cancer and the cell cycle, Oncogenesis; initiation, promotion, progression, cell behavior in oncogenesis, virus induced cancer, carcinogens, metastasis, interaction of cancer cell with normal cells, apoptosis, therapeutic intervention of uncontrolled cell growth.

Unit-IV: Deviations of Mendelism **07 classes**

Deviations of Mendelism, Sex Determination, Sex related characters, Extranuclear inheritance, Significance of Crossing over. Mutation at molecular level, Spontaneous and Induced mutation, Mutagens & their action, DNA damage & repair.

Unit-V: Population Genetics **07 classes**

Population Genetics: Importance of hardy Weinberg Equilibrium, Human genetics: Genetic disorders & Syndromes, Genetic counselling, Eugenics, euthenics, euphenics, HGP, Genomic library & Gene targeting.

Lab activities

1. Localization of neutral mucopolysaccharides in cell by periodic acid Schiff reaction.
2. Localization of general lipid by Sudan Black B method.
3. Study of cancer cells through permanent slides.
4. Localization of metachromatic substances in cells by Toluidine blue/Congo red technique.
5. Microtubules in vesicle transport in fish chromatophore.
6. Assignment on cell communication and signaling.

Practicals on Genetics to be included

SUGGESTED READINGS

- **Molecular Biology of the Cell** – Alberts B., Johnson A., Lewis J., Raff M., Roberts K., and Walter P. (Garland Science, 6th Edition, 2014)
- • **Cell Biology** – Pollard T.D., Earnshaw W.C., Lippincott-Schwartz J., and Johnson G.T. (Elsevier, 3rd Edition, 2016)
- • **The Cell: A Molecular Approach** – Cooper G.M. and Hausman R.E. (Sinauer Associates, 7th Edition, 2018)
- • **Lodish Molecular Cell Biology** – Lodish H., Berk A., Kaiser C.A., Krieger M., Bretscher A., Ploegh H., Amon A., and Martin K.C. (W.H. Freeman, 9th Edition, 2021)
- • **Karp's Cell Biology** – Iwasa J., Marshall W., and Karp G. (Wiley, 9th Edition, 2023)
- • **Principles of Genetics** – Snustad D.P. and Simmons M.J. (Wiley, 7th Edition, 2015)
- • **Genetics: Analysis and Principles** – Brooker R.J. (McGraw Hill, 7th Edition, 2023)
- • **Concepts of Genetics** – Klug W.S., Cummings M.R., Spencer C.A., and Palladino M.A. (Pearson, 12th Edition, 2018)
- • **Principles of Population Genetics** – Hartl D.L. and Clark A.G. (Sinauer Associates, 4th Edition, 2007)
- **Population Genetics** – Hamilton M.B. (Wiley-Blackwell, 1st Edition, 2009)

SEMESTER VII

Title of the Course : Research Methodology and Research Ethics
Course Code : BOT-RM
Nature of the Course : Compulsory
Total Credits : 04
Distribution of Marks : 40 (IA) + 60 (END) = 100
Total classes : 60

COs:

1. Apply research concepts for survey and data collection

2. Evaluate collected data through statistical tools

3. Discuss ethics of research and publication

Learning Outcomes:

1) Discuss research concepts for data collection
2) Analyze data through statistical tools
3) Understand research ethics and publication guidelines

Mapping of CO with Bloom's taxonomy

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

Mapping of Course outcomes to Programme outcomes

)/PO	1	2	)3	)4	)5	)6	)7	/ERAGE
)1								
)2								
)3								
/ERAGE								

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

MODES OF IN-SEMESTER ASSESSMENT:

- One Theory exam
- Group Discussion/Seminar/Viva/Assignments

Attainment strategy:

- Continuous evaluation through in and end semester theory examination

Unit 1: Fundamentals of Research Methodology: Introduction to Research in Life Sciences, Types of Research: Basic, Applied, and Translational, Formulating Research Questions and Hypotheses, Literature Review and Meta-Analysis

Unit 2: Experimental Design, Data Collection and Analysis: Principles of Experimental Design, Sampling Techniques and Sample Size Determination, Data Collection Methods: Surveys, Observations, and Experiments, Use of Statistical Tools and Software. Data Analysis and Interpretation

Unit 3: Research Ethics: Ethical Principles in Life Sciences Research, Responsible Conduct of Research (RCR), Avoiding Plagiarism and Misconduct, Guidelines for Animal and Human Research.

Unit 4: Publication Ethics and Communication: Writing Research Papers and Reports, Peer Review Process and Responding to Reviewers. Open Access Publishing and Predatory Journals. Presenting Research: Posters, Oral Presentations, and Conferences

Suggested Readings:

- CSIR Guidelines for Ethics in Research and in Governance - CSIR (2019)
- Ethics in Science Education, Research and Governance- Kambadur Muralidhar, Amit Ghosh, Ashok Kumar Singhvi - INSA (2019)
- Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by John W Creswell and J. David Creswell
- Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar
- Research Methology : methods and techniques by CR Kothari & Gaurav Garg
- Introducing Research Methodology: A Beginner′s Guide to Doing a Research Project by Uwe Flick

SEMESTER-VII

Title of the Course	**:**	**Advanced analytical techniques**
Nature of course	**:**	**Minor**
Code	**:**	**BOT-MIN-07**
Total Credits	**:**	**04**
Distribution of Marks	**:**	**100 [End: 60 (Theory: 45, Pract: 15), In: 40]**
Total classes	**:**	**60**

COs:

1. Analyze and compare different nucleic acid extraction and sequencing techniques
2. Investigate biological samples through the application of different bioimaging and biophysical tools and techniques
3. Examine genomic DNA and products of ts amplification

Learning Outcomes:

1. Demonstrate various analytical techniques used in biological sciences
2. Evaluate biological samples with the use of various analytical tools and techniques
3. Describe DNA structure and amplification

Mapping of CO with Bloom Taxonomy

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

Mapping of Course outcomes to Programme outcomes

CO/PO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation,2 for moderate correlation, and1 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 strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Laboratory practices
3. Practical record book/field book
4. Seminar/group discussion

Course content

Unit-I : 11 classes

Nucleic acid extraction and visualization, Agarose Gel Electrophoresis. Polymerase Chain Reaction (PCR)- principle and types, Plasmid isolation and purification

Unit II: 12 classes

Bioimaging techniques- electron microscopy principle, uses and sample preparation, fluorescent microscopy principle and uses, Flow cytometry – principle and application, Fluorescence in-situ hybridization, Genomic in-situ hybridization and Fluorescence-Activated Cell Sorting (FACS)

Unit III: **13 classes**

Biophysical Methods: High Performance Liquid Chromatography (HPLC), Fourier Transform Infrared Spectroscopy (FTIR), Nuclear Magnetic Resonance Spectroscopy (NMR), X-ray diffraction (XRD), Gas chromatography (GC), Mass Spectroscopy (MS)

Unit IV: **09 classes**

DNA sequencing techniques- Pyrosequencing, Nextgen sequencing, Genome editing – CRISPR

Lab activities

1. Nucleic acid extraction from biological samples
2. Visualization of DNA by Agarose gel electrophoresis
3. Nucleic acid amplification by PCR
4. Demonstration of HPLC, FTIR, NMR, XRD, etc.

Suggested Readings:

1.Principles of Biochemistry and Molecular Biology by K. Wilson and J. Walker, Cambridge University Press.

2.Principles of Instrumental analysis by D. A. Skoog and J. J. Leary, Saunders College Publishing, Philadelphia.

3.Textbook of Structural biology by Anders Lilgas, Lars Lilgas, JuiPiskur et al, World Scientific Publisher

SEMESTER-VIII

Title of the Course : Intermediary Metabolism
Nature of course : Major/Core-XX
Code : BOT-C-20

Total Credits : 04
Distribution of Marks: 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
Total classes : 60

COs:

1. Analyze the concept of bioenergetics and energy metabolism.
2. Evaluate the role of co-ordinated regulation of metabolism.
3. Explain the importance of metabolic pathways and regulation in the biological system.

Learning Outcomes:

- Discuss the mechanisms involved in energy metabolism
- Analyze lipid, nitrogen and nucleotide metabolism
- Describe the integration and regulatory strategies of metabolic pathways in the biological system.

Mapping of CO with Bloom 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	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
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, and1 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 strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Laboratory practices
3. Practical record book/field book
4. Seminar/group discussion

Course content

Unit- I: Bioenergetics and energy metabolism: 11 classes

Biological oxidation-reduction reactions, reduction potential and free energy, Electron transport chain, Structure of ATP and its phosphoryl transfer potential, ATP Synthesis and Chemiosmosis; Phosphorylation: substrate level and oxidative phosphorylation and its regulation. Photophosphorylation and carbon fixation reactions in chloroplast, photorespiration.

Unit-II: Lipid metabolism: 10 classes

Fatty acid transport, β-oxidation in mitochondria and peroxisomes, and its energetics, oxidation of saturated, and unsaturated fatty acids (odd and even number carbon atoms), Omega oxidation. Biosynthesis of fatty acid (Palmitate), chain elongation and desaturation, biosynthesis of eicosanoids, ketone bodies, and cholesterol, and their physiological significance.

Unit-III: Overview of nitrogen fixation in biological system: 12 classes

Overview of nitrogen fixation in biological system, Biosynthesis of amino acids (phenylalanine, arginine, histidine, tryptophan), Cofactors of amino acid metabolism. Metabolism of purine and pyrimidine (de novo and salvage pathway) and degradation of nucleotides, regulation of nucleotide biosynthesis, inborn errors of metabolism.

Unit IV: Integration and regulatory strategies of metabolic pathways: 12 classes

Citric acid cycle as metabolic hub, amphibolic and anaplerotic reactions. Co-ordinated regulation-glycolysis and gluconeogenesis, glycogen synthesis and breakdown; Co-ordinated regulation of fatty acid oxidation and biosynthesis.; hormonal integration of fatty acid and carbohydrate metabolism. Regulation reactions by allosteric and covalent modification.

Lab activities:

1. Fractionation of tissue by differential centrifugation.
2. Estimation of protein, carbohydrate, free phosphate in biological samples.
3. Estimation of ascorbic acid (Colourimetric).

4. Estimation of cholesterol.
5. Estimation of urea in biological samples.
6. Separation of protein and determination molecular mass by SDS-PAGE.

Suggested readings

1. Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.

2. Principles of Biochemistry (2013) 4th ed., Voet, Donald,Voet, Judith &Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.

3. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.

4. Berg, J.M., Tymoczko, J.L. and Stryer L., (2012) W.H. Biochemistry (7th ed.), Freeman and Company (New York), ISBN:10: 1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

SEMESTER-VIII

Title of the Course : Biodiversity & bioprospecting
Code : Core-XX
Total Credits : 04
Distribution of Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
Total classes: 60

COs:

1. Analyze the concept of bioprospecting
2. Evaluate microbial and entomological prospecting
3. Evaluate the potential of medicinal plant resources

Learning Outcomes:

1. Apply the knowledge of bioprospecting
2. Analyze biodiversity for bioprospecting

Mapping of CO with Bloom 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	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14

CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation,2 for moderate correlation, and1 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 stratagies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Laboratory practices
3. Practical record book/field book
4. Seminar/group discussion

Course content

Unit-I **11 classes**

Bioprospecting: Definition, Introduction, Current practices in Bioprospecting for conservation of Biodiversity and Genetic resources. Bioprospecting Act: Introduction, Phases of Bioprospecting, Exemption to Act. Fields of Bioprospecting.

Unit-II **11 classes**

Renowned medicinal plants of India, Medicinal Plants Bioprospecting/ Pharmaceutical Bioprospecting: for new drugs, assays in Bioprospecting. Antioxidant assay – NO free radical scavenging assay, Antigenotoxicity assay – MTT assay, Antiviral activities of plants – SRB assay.

Unit-III **11 classes**

Entomological bioprospecting: concept and practices of entomophagy and entomotherapy. Insect peptides, Insect as fish feed, fish in mosquito control

Unit-IV **12 classes**

Microbial Bioprospecting: Isolation of Microbial metabolites and their bio-activity against multidrug resistant bacteria, Endophytic microbial products as Antibiotics, mushroom as a source of food and medicine, Lichen as a source of medicine

Lab activities

1. Antioxidant assay – by DPPH method.
2. Antibiotic bioassay
3. Chromatographic separation of plant extracts to determine active principles (Paper, TLC & Column)
4. Determination of phytochemicals in plant extracts
5. Determination of nutritive value in edible insects
6. Submission of herbarium of common medicinal plants
7. Submission of insects with therapeutic/food value
8. Field survey of medicinal plants/insects/mushroom

Suggested readings

1. Arora, R.K. and Nayar, E.R. (1984), Wild relatives of crop plants in India, NBPGR Science MonographNo.7.

2. Baker, H.G. (1978), Plants and civilization. Ill Ed. (A. Wadsworth, Belmount).

3. Bole, P.V. and Vaghani, Y. (T986). Field guide to common Indian trees, Oxford University Press, Mumbai.

4. Thakur, R.S., Puri, H.S. and Husain, A. (1969). Major medicinal plants of India, Central Institute of medicinal and aromatic plants, Lucknow.

5. Swaminathan, M.S. and Kocchar, S.L. (Es.) (1989). Plants and Society, MacMillan Publication Ltd.,

6. Sharma, O.P. (1996). Hills Economic Botany, Tata McGraw Hill co., Ltd., New Delhi,

7. Kocchar, S.L. (1998). Economic Botany of the tropics, II Edn. MacMillan India Ltd.,

8. CSIR (1986), The useful plants of India Publication and Information directorate, CSIR^ New Delhi. 9. CSIR (1948 - 1976) The wealth of India, 53

SEMESTER VIII

Title of the Course : Bioethics, Biosafety, and IPR
Nature of course : MINOR-VIII
Code : BOT-MIN-08
Total Credits : 04
Distribution of Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
Total classes : 60

Course outcomes

1. Analyze biosafety and ethical perspectives in research.
2. Evaluate various types of IPRs.
3. Discuss the various agreement and treaties.
4. Apply the knowledge to apply for a patent.

Learning Outcomes:

1. Describe the concept of biosafety and bioethics.
2. Analyze the IPR types.
3. Understand the agreement and treaties.
4. Discuss the patent filling process.
5. **Mapping of CO with Bloom Taxonomy**
6.

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

Mapping of Course outcomes to Programme outcomes

CO/PO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	AVERAGE
CO1	2	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	2	2
AVERAGE	2	2	2	2	2	2	2	

3 for highest correlation,2 for moderate correlation, and1 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 strategies of Cos:

1. Continuous evaluation through in and end-semester theory and practical examinations
2. Laboratory practices
3. Practical record book/field book
4. Seminar/group discussion

Course content

UNIT- I: 15 classes

Biosafety and Bioethics: Biosafety in Laboratories. Historical perspective of Bioethics, Conflicting issue (GMO, GMP, Cloning, environmental hazards), Principles and guidelines for research in human and animals. Indigenous knowledge system and biopiracy

UNIT- II: 20 classes

Concept of Intellectual Property Rights (IPR) and its significance. Types of IPR- Patents, copyright, trademarks, industrial design, trade secrets and geographical indication

UNIT-III: 15 clases

Agreement and treaties: GATT & TRIPs Agreement, Madrid Agreement, Hague Agreement , WIPO Treaties.

UNIT-IV: 10 classes

Indian Patent Act 1970 and recent amendments patent cooperation treaty, Patent filling and granting procedure.

Suggested Readings:

- M K Sateesh .Bioethics and Biosafety. Kindle Edition
- Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013
- Private Power, Public Law: The Globalization of Intellectual Property Rights By Susan K. Sell Cambridge University Press, 2000
- Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition)

Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006

SEMESTER-VIII

Title of the Course : Climate change & biological adaptations
Code : DSE-I
Nature of course : DSE
Total Credits : 04
Distribution of Marks : 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
Total classes : 60

Mapping of CO with Bloom 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	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
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, and1 for lowest correlation

Modes of internal assessment

6. One internal examination (theory)
7. One internal examination (Lab)
8. Viva-voce
9. Group discussion
10. Home assignments

Attainment of Cos:

5. Continuous evaluation through in and end-semester theory and practical examinations
6. Laboratory practices
7. Practical record book/field book
8. Seminar/group discussion

Course content:

Unit-I: Fundamentals of Climate Change 11 classes

Introduction to climate systems and climate change, Greenhouse gases and Global warming, Climate change indicators and feedback loops, Historical climate patterns and predictions

Unit-II: Biological Responses to Climate Change 11 classes

Physiological adaptations in plants and animals, Behavioral changes in species, Evolutionary adaptations and natural selection, Phenological shifts (e.g., migration, flowering times)

Unit-III: Ecosystem level impacts 11 classes

Changes in biodiversity and species distribution, Ecosystem resilience and vulnerability, Impact on aquatic and terrestrial ecosystems, Role of keystone species

Unit-IV: Human Influence and Conservation, GIS & remote sensing 12 classes

Anthropogenic drivers of climate change, Conservation strategies for threatened species, Restoration ecology and habitat management, Policy and international agreements (e.g., Paris Agreement)

Introduction to Remote Sensing and GIS techniques: Satellites, Sensors, Platforms and Resolutions, Infrared and Microwave Remote Sensing: Principles and Applications, Interpreting Optical Remote Sensing Images, Projection of climate change scenarios and Tools for mapping and monitoring

GIS applications based on model outputs and GIS databases, Remote sensing technologies to monitor climate change processes (vegetation biomass, monitoring flooding, soil moisture and depth, surface micro topography etc.)

Lab activities

1. Effect of temperature in plant growth and germination
2. Effect of pH on aquatic ecosystem (plankton diversity and DO)
3. Study of butterfly diversity in different habitats
4. Study of the process of remote sensing & GIS (demonstration)
5. Study of plant adaptations in xeric and aquatic environment
6. Study of ant behavior in different temperature gradients
7. Study of life cycle of any insect under different temperature conditions

Suggested Reading:

1. "Climate Change Biology" by Lee Hannah
2. "The Sixth Extinction: An Unnatural History" by Elizabeth Kolbert
3. Research papers on climate change and adaptation from journals like Nature and Science.

SEMESTER VIII

Title of the Course : Computational Biology
Code : DSE-II
Nature of course : DSE
Total Credits : 04
Distribution of Marks: 100 [End: 60 (Theory: 45, Pract: 15), In: 40]
Total classes : 60

Mapping of CO with Bloom Taxonomy

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

Mapping of Course outcomes to Programme outcomes

CO/PO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14

CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	2	2	2	2	2.0
CO4	3	2	3	2	2	2	2	2.28
AVERAGE	3	2	2.5	2	2	2	2	

3for highest correlation,2 for moderate correlation, and1 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
3. Practical record book/field book
4. Seminar/group discussion

Course content

UNIT-I:

Scope of Computational Biology and Bioinformatics. Major biological databases and information retrieval. Conversion of file types. BLAST analysis and Primer designing. Computational Phylogenetic analysis.

UNIT-II:

Protein structure, protein folding and Ramachandran plot analysis. Protein structure prediction tools, homology modeling and structure validation. Molecule visualization tools.

UNIT-III:

Computer Aided Drug Designing- Pharmacokinetics and Pharmacodynamics, ADMET properties, Lipinski rule of 5, Molecular Docking analysis and OSAR.

UNIT-IV:

Concept of Molecular dynamics simulation – protein preparation, ligand preparation, forcefields, energy minimization. Steps of MD simulation. RMSD, RMSF.

Lab activities

1. Retrieval of sequences of nucleotides and amino acids, structure of proteins from databases
2. BLAST analysis
3. Phylogenetic tree construction
4. Primer designing
5. Protein structure prediction and validation
6. ADMET screening and Lipinski analysis
7. Active site dectection
8. Protein ligand docking analysis

Suggested Reading:

• Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press.

- Bioinformatics: Sequence and Genome Analysis by D.W. Mount, Cold Spring Harbor Laboratory
- Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by A.D. Baxevanis and B.F.F. Ouellette, Wiley-interscience.
- Understanding Bioinformatics by Marketa Zvelebil and Jeremy Baum, Garland Science.