BODOLAND UNIVERSITY

UG Draft Syllabus in Botany under Faculty of Science, BU
(NEP, 2020)

Department of Botany
Bodoland University
Kokrajhar-7833 70
BTAD, Assam

Meeting Proceeding: Committee for Curriculum and Syllabus

Date: 18-5-2023

Venue: Botany Department, Bodoland University

Attendees:

Hemen Sarma (Convenor)

Committee Members (Names)

Agenda:

Discussion on the recently developed UG syllabus under the NEP 2020 guideline.

Proceedings:

The meeting of the Committee for Curriculum and Syllabus was held on 18-5-2023 at the Botany Department, Bodoland University. The meeting was convened by Dr. Hemen Sarma, the designated convener of the committee, to discuss the recently developed UG syllabus in accordance with the guidelines provided by the National Education Policy (NEP) 2020.

The committee members present at the meeting thoroughly examined the core courses and content of the proposed UG syllabus. They carefully reviewed each subject area and evaluated its alignment with the NEP 2020 guidelines. After a detailed and comprehensive analysis, the committee members collectively agreed that the syllabus met the necessary criteria and requirements.

It was decided during the meeting that the developed UG syllabus would be forwarded to the Academic Registrar of Bodoland University for further action. The committee recommended the registrar to initiate the necessary administrative processes, including obtaining the required approvals, conducting consultations with relevant stakeholders, and finalizing the syllabus for implementation.

Signed:

Hemen Sarma (Convenor)

Committee for Curriculum and Syllabus

Committee for Curriculum and Syllabi (CCS) Members,

Department of Botany, Bodoland University

Sl. No	Name		Signature of the member present in the meeting
1	Dr. Hemen Sarma, Associate professor & Head Department of Botany, Bodoland University.	Convenor	18/5/2023
2	Dr. Sanjib Baruah Assistant professor, Department of Botany, Bodoland University.	Member	18/05/23
3	Dr. Yutika Narzary Assistant professor, Department of Botany, Bodoland University.	Member	18/05/2023
4	Dr. Rebecca Daimari Assistant professor, Department of Botany, Bodoland University.	Member	18/5/2023
5	Mr. Dhananjay Narzary Assistant professor, Department of Botany, Kokrajhar Govt. College, Kokrajhar.	Member	
6	Dr. Sanjib Brahma Assistant professor, Department of Botany, Science College Kokrajhar	Member	18/05/2023 (Dr. Sanjib Brahma)
7	Mrs. Lily Devi Assistant professor Department of Botany, Bijni College	Member	
8	Dr. Anaru Boro Assistant professor Department of Botany, Tangla College	Member	Dr. Anaru Boro
9	Dr. Jahnovi Brahma Assistant professor Department of Botany, Science College, Kokrajhar	Member	(Dr. Jahnovi Brahma) Science College Kokrajhar.

Syllabus for Sciences

(1st -8th) Semester

Bachelor of Science

Botany

Under NEP 2020

PROGRAMME OUTCOME

Programme Outcome (PO)

PO1 -Develop a comprehensive understanding of botanical concepts and principles through research, leading to an enhanced knowledge base in the field of botany.

PO-2 Acquire advanced laboratory skills and research methodologies to investigate and,analyze plant specimens, contributing to scientific advancements in the field.

PO-3 Demonstrate critical thinking and problem-solving abilities by independently designing and executing botany research projects, resulting in the generation of new knowledge and insights.

PO-4 Communicate research findings effectively through written reports, presentations, and scientific publications, showcasing the ability to disseminate information to both academic and non-academic audiences.

SEMESTER	CORE COURSE	MINOR	IDC	AEC	SEC	VAC		TOTAL CREDIT	
SEM-I	BOTMAJ101-4 Microbes, Phycology, Mycology, and Lichenology	BOTMIN101-4 Biodiversity (Microbes, Algae, Fungi, Lichen and Archegoniates)	BOTIDC101-3 Agroforestry		BOTSEC101-3 Mushroom Culture Technology	BOTVAC101-4 Floriculture		20	Exit: Certificate in Plant Science (40 cardites and INTERNSHIP of 4 cardites) Students with major in Botany are ineligible to select the course [BOTMIN101-4]
SEM-II	BOTMAJ 102-4 Archegoniate	BOTMIN102-4 Plant Ecology and Taxonomy	BOTIDC102-3 Medicinal Botany		BOTSEC102-3 Biofertilizer	BOTVAC102-4 Intellectual Property Rights		20	
SEM-III	BOTMAJ 201-4 Biomolecules and Cell biology BOTMAJ202-4 Plant Taxonomy	BOTMIN201-4 Biomolecules and Cell biology	BOTIDC201-3 Natural resource management		BOTSEC201-3 Plant identification & Herbarium Technique			20	Exit: Diploma in Plant Science (80 cardites and INTERNSHIP of 4 weeks) [Students majoring in botany are ineligible to select the course BOTMIN 201-4
SEM-IV	BOTMAJ203-4 Plant Ecology and Phytogeography	BOTMIN301-4Analytical Techniques					INTERNSHIP [2]	20	

	BOTMAJ204-4 Anatomy of angiosperms	in Plant Sciences							
	BOTMAJ205-4 Genetics and Evolution								
SEM-V	BOTMAJ301-4Plant Physiology	BOTMIN5014 Plant Anatomy and Embryology						20	Exit: Bachelor degree in Plant Science (120 Cardites)
	BOTMAJ 302-4Molecular Biology								
	BOTMAJ303-4 Microbiology and Plant Pathology								
	BOTMAJ304-4 Analytical Techniques in Plant Sciences								
SEM-VI	BOTMAJ305-4 Reproductive Biology of Angiosperms	BOTMIN302-4 Plant Physiology and Metabolism							
	BOTMAJ306-4 Plant Biotechnology								
	BOTMAJ307-4 Bioinformatics								
	BOTMAJ 308-4Economic Botany								

SEM-VII	BOTMAJ401-4 Plant Metabolism BOTMAJ402-4 Plant Breeding and Tissue Culture BOTMAJ403-4 Industrial Microbiology and Immunology BOTREM404-4 Research Methodology	BOTMIN401-4 Bioresource Management						20	
SEM-VIII	BOTMAJ 405-4Environmental Biotechnology	BOTMIN 402-4 Ethnobotany						BOT DIS 401-12 Dissertation/ Research Project	4-year Bachelor's degree in Botany with honours and Research
OR									

SEM-VIII	BOTMAJ 405-4Environmental Biotechnology	BOTMIN402-4 Ethnobotany					BOT ADL 401-4Biochemistry BOT ADL 402-4Advanced Plant Pathology BOT ADL 403-4 Plant Pharmacology and Pharmacognosy		4-year Bachelor's degree in Botany with honours
	80	**32**	**9**	**8**	**9**	**6**	**12+4 =16**	**160**	
Note: There are two options for students depending on their choice of courses. Students who select BOT DIS 101-12 will be awarded with Bachelor's degree in Botany with honours and research. On the other hand, students who opt for the courses BOT ADL 401-4, 402-4, and 403-4 will earn a Bachelor's degree in Botany with honours.									

Semester-I

Paper Title: Microbes, Phycology, Mycology and Lichenology
(Major Courses) Paper code BOTMAJ101-4
(Paper credit :04(3T+1P)
Lectures: 60=45+15(L+P)Total marks: 100 (T 50+P20+IA 30)
Course objective:

To provide an in-depth understanding of the diversity, ecological roles, and economic significance of microbes and lower cryptogams, and develop practical skills and application.

Course learning outcome:

- Develop a comprehensive understanding of the diversity, ecological roles, and economic significance of microbes and lower cryptogams, and their applications in various fields.
- Acquire practical skills in laboratory techniques, critical analysis of scientific literature, and effective communication of research findings related to microbes and lower cryptogams.
- Understand the distribution, characteristic features and life cycles of microbes, algae and fungi.
- Know the economic importance of microbes, algae, fungi and lichens
- Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.
- Inculcate scientific skills to study the specimens of microbes, algae, fungi, and lichens in laboratory.

Unit 1: Introduction to Microbes (15 Class, 20 marks)

Overview of microbes ; Diversity, general characteristics and classification of bacteria and virus, Ecological roles of microbes and lower cryptogams in various ecosystems, Interactions with other organisms, including symbiotic relationships and pathogenicity; Nutrient cycling and decomposition processes facilitated by microbes and lower cryptogams. Economic significance and applications of microbes.

Unit 2: Algae (15 Class, 20 marks)

General characteristics of different groups of Algae; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food, flagella; methods of reproduction; Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only up to groups); Significant contributions of important phycologists; Role of algae in the environment, agriculture, biotechnology and industry.

Algae Life Cycle: General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of the following: **Cyanophyta and Xanthophyta:** *Nostoc, Anabaena* and *Vaucheria.;* Chlorophyta: *Chlamydomonas, Volvox,Oedogonium, Coleochaete* and *Chara.* Evolutionary significance of *Prochloron*; Bacillariophyta- (General account– Diatoms); **Phaeophyta**- *Ectocarpus;* **Rhodophyta**- *Batrachospermum, Polysiphonia*.

Unit 3: Fungi

General characteristics of different groups of Fungi; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification (Ainsworth, 1973); Economic importance. **Fungi Life cycle: Chytridiomycota and Zygomycota:** General characteristics and Lifecycles of *Synchytrium, Rhizopus*; **Oomycota:** General characteristics and Life cycle of *Phytophthora*; **Ascomycota:** General characteristics and life cycle of *Saccharomyces, Aspergillus, Penicillium, Peziza, Alternaria* & *Colletotrichum*; **Basidiomycota:** General Characteristics and life cycles of *Agaricus, Puccinia*.

Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance

Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction;

Unit 4: Practical (15 marks, 5 class=10 hours)

1. Types of Bacteria to be observed from temporary/permanent slides/photographs.
2. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
3. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Volvox, Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus* and *Polysiphonia*.
4. Study of vegetative and reproductive structures of *Aspergillus, Penicillium., Peziza, Alternaria, Puccinia*: spores of different stages, *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills, fairy rings and bioluminescent mushrooms to be shown.
5. Collection and identification of growth forms of locally available lichens.
6. Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides.
7. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)

Note:

1. The course includes practical components that are divided into five sessions, each spanning two hours, for a total of 10 hours of practical classes. Additionally, there will be a field study component that will require five hours of engagement. The practical sessions will be evaluated and carry a weightage of 15 marks, while the field study component will be assessed and contribute 5 marks towards the overall evaluation.
2. As part of the course, students will have the opportunity to go on a field trip to a location of botanical interest for the purpose of studying vegetation and plant forms. During the field trip, students will gather information and observations to prepare a report. This report will then be submitted during the practical examination, allowing students to demonstrate their understanding of the subject matter and their ability to apply their knowledge in a real-world setting.

Suggested readings:

- Microbes and Lower Cryptogams: Diversity, Ecology, and Applications" by R. N. Kothari and S. K. Shukla
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
- R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Algae, S. Chand. Delhi, India.
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley &Sons (Asia) Singapore. 4th edition.
- Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press,Cambridge. 3rd edition.
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010),. Fungi, S. Chand. Delhi, India.
- "Microbiology and Lower Cryptogams: An Indian Perspective" by S. P. Singh and S. K. Saini
- "Microbes, Algae, Fungi and Lichens: Diversity, Distribution, and Economic Significance" by B. K. Sharma and V. P. Sharma
- "Microbes and Lower Cryptogams in India: A Taxonomic and Ecological Overview" by P. K. Singh and R. K. Gupta
- "Microbial Diversity and Lower Cryptogams in Indian Ecosystems" edited by A. K. Pandey and M. S. Reddy

Paper Title: Biodiversity (Microbes, Algae, Fungi, Lichen and Archegoniates)

(Minor Courses) Paper code BOTMIN101-4
(Paper credit :04(3T+1P)
Total no Lectures: 60=45+15(L+P) Total marks: 100 (T 50+P20+IA 30)
Course objective:

To explore and study the biodiversity of microbes, algae, fungi, lichen, and archegoniates, examining their taxonomy, ecology, and evolutionary significance.

Course learning outcome:

- Identify and classify diverse microbial, algal, fungal, lichen, and archegoniate species, and understand their ecological roles and adaptations in different ecosystems.
- Analyse the evolutionary relationships and patterns of biodiversity among microbes, algae, fungi, lichen, and archegoniates, and assess their significance in ecosystem functioning and conservation efforts.

Unit 1: Introduction to Microbes (20 marks, 15 Classes)

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae and Fungi (20 marks, 15 Classes)

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia*. Economic importance of algae.

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota), *Penicillium, Alternaria* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota); Symbiotic Associations- Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 3: Introduction to Archegoniate(20 marks, 15 Classes)

Unifying features of archegoniates, Transition to land habit, Alternation of generations. Reproduction and classification of different genera of Bryophyta, pteridophyte, gymnosperm.

Unit 4: Practical (20 marks, 8 Classes)

The practical component of the course will focus on applying the theoretical knowledge gained in studying the anatomical, morphological, and reproductive characteristics of plant genera found in the north-eastern region of India.

Students will engage in hands-on activities to examine and analyse the plant specimens, gaining practical experience in understanding their intricate details. This practical approach will enhance students' understanding of the subject matter and enable them to explore the unique plant diversity specific to the north eastern region of India.

Field works (5 hours)

Field trip for studying vegetation and plant forms. Field Study of Lower Cryptogams: Conduct field trips to study lower cryptogams, including mosses, liverworts, and ferns. Observe their habitats, life cycles, and ecological roles. Document and identify different species encountered.

Suggested readings:

1. "Biodiversity of Microbes, Algae, Fungi, Lichen and Archegoniates: An Indian Perspective" by R. K. Sinha and A. K. Pandey
2. "Microbes, Algae, Fungi, Lichens and Archegoniates: Diversity and Conservation" by M. K. Sen and S. N. Singh
3. "Biodiversity and Ecology of Indian Microbes, Algae, Fungi, Lichens and Archegoniates" edited by P. K. Singh and R. K. Gupta
4. "Exploring Biodiversity: Microbes, Algae, Fungi, Lichens and Archegoniates in India" by S. K. Shukla and N. P. Singh
5. "Indian Microbial Biodiversity: Algae, Fungi, Lichens and Archegoniates" by V. P. Sharma and B. K. Sharma

Paper Title: Mushroom Culture Technology
(SEC Courses) paper code BOTSEC101-3
(Paper credit :03(2T+1P)
Total no Lectures: 45=30+15(L+P) Total marks: 50 (T 40+P10)

Course objective:

- Enhance skills and knowledge in mushroom culture technology, covering cultivation techniques, spawn production, substrate preparation, and post-harvest handling, to enable participants to engage in successful mushroom cultivation.

Course learning outcome:

- Develop proficiency in mushroom cultivation techniques, including spawn production, substrate preparation, and environmental control, resulting in the ability to independently establish and manage mushroom cultivation operations.
- Gain an understanding of post-harvest handling and quality control practices specific to mushroom cultivation, enabling participants to optimize harvest yields, maintain product quality, and extend shelf life for marketable mushrooms.

Unit1: Introduction to Mushroom Culture Technology (20 marks, 15 Classes)

History of mushroom, Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in Northeast India (*Agaricus, Pleurotus, Volvariella*).

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 2: Storage Food Preparation and nutrition:(20 marks, 15 Classes)

Types and techniques of storage: Short-term, long term (canning, pickles, papads, drying, storage in salt solutions). Nutritional composition-Proteins, amino acids, mineral elements, carbohydrates, crude fibre content, vitamins. Types of foods prepared from mushroom. Research Centres-National level and Regional level. Cost benefit ratio-Marketing in India and abroad, export value.

Unit 3: Practical (10 marks, 8 Classes= 2 hours)

- Spawn Production (Demonstration) and substrate preparation

- Mushroom Cultivation
- Harvesting, processing, and post-harvest management of mushrooms

Suggested readings:

1. "Mushroom Cultivation and Mushroom Culture Technology" by T. N. Kutty and N. K. Mahadevan
2. "Mushroom Culture Technology: Principles and Practices" by S. S. N. Rao and A. S. Rao
3. "Mushroom Cultivation: A Comprehensive Guide" by M. P. Srivastava and B. N. Tiwari
4. "Mushroom Production and Processing Technology" by R. C. Upadhyay and P. S. Singh
5. "Mushroom Culture and Biotechnology" by R. K. Sharma and S. K. Sharma

Paper title: Floriculture
Paper code:BOTVAC101-4
Paper credit: 04(T+P)
Total no Lectures: 60=45+15(L+P) Total marks: 100 (T 50+P20+IA 30)

Course Objectives: To impart knowledge about the principles and practices of floriculture and develop understanding of the scope and ways of value addition in flowers.

Course Learning Outcomes:

The students will be able to understand the scope and importance of floriculture. They will expertise in Identification, Cultivation, and their propagation. Students will also be well versed in post-harvest management, marketing and value addition of commercial ornamental plants.

Unit 1: Introduction of floriculture: (20 marks, 15 Classes)

History of Floriculture. Importance and scope of floriculture in India with reference to Assam and North eastern states. Classification and identification of floricultural plants based on growth habit (trees, shrubs, climbers and herbs). Identification and uses of various garden tools and implement (plough, cultivator, mower, budding-cum-grafting knife, spade, pruning secateurs).Scope of cut and loose flowers in global trade, global scenario of production, varietal wealth and diversity of floricultural plants in India.

Unit 2 Propagation and Commercial Flower Production (20 marks, 15 Classes)

Methods of Propagation: sexual (seed and seed germination) and asexual (rooting of cuttings in hotbeds, Layering – principle and method, Budding and grafting – selection of elite mother plants, establishment of bud wood bank, stock, scion and inter stock). Propagation in mist chambers, nursery management, pro-tray nursery under shade-nets, transplanting techniques. Types of protected structures – Greenhouses, poly-houses, shade houses, rain shelters.

Flower production – water and nutrient management, fustigation, weed management, thinning and pruning, disbudding, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes. Production of floricultural crops: Cut rose, cut Carnation, *Chrysanthemum*, *Gerbera*, *Gladiolus*, orchids, *Anthurium*, aster, lilies, ornamental ginger, bromeliads, dahlia, cut foliage, loose flower crops (Jasmine, marigold, crossandra, *Nerium*, *Hibiscus*), non-traditional flowers (*Tabernaemontana*, *Bougainvillea*, *Ixora*, Lotus, Champaka).

Unit 3: Advanced Post Harvest Technology in Floriculture (20 marks, 15 Classes)

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, pre-cooling, pulsing, packing, storage & transportation. Prolonging the vase life of flowers. Marketing and export potential of flowers, institutional support. Types of value added products, garlands, vein, floats, floral decorations, flower arrangement, bouquets, flower baskets, corsages, floral wreaths. Techniques in dry flower making – Drying, bleaching, dyeing, embedding, pressing. Significance of natural pigments; Types of pigments (carotenoids, anthocyanin, chlorophyll); Extraction methods and applications.

Indian floriculture industry: An overview; Practice and techniques of Bonsai plants, Miniature garden, Indoor plants. Trading flowers and potted plants. Cultivation of cacti, succulents, orchids, and water plants.

Unit 4: Practical(20 marks, 8 Classes=16hrs)

1. Anatomical studies in rooting of cutting and graft union.
2. Construction of propagation structures.
3. Study of vase life extension in cut flower using chemicals.
4. Preparation of bouquets, button-holes, flower baskets, corsages, floral wreaths, and garlands with fresh flowers.
5. Preparation of baskets, bouquets, pot-pour, wall hangings, button holes, greeting cards, wreaths with dry flowers.
6. Techniques in flower arrangement and floral decoration.
7. Practices and Identification of plants for dry flower making.
8. Extraction and Applications of pigments (carotenoids, anthocyanin, chlorophyll)
9. Study and description of botanical features of floricultural plants studied in theory paper.

Suggested readings

- "Floriculture Principles and Species" by Dhiman Mukherjee
- "Floriculture in India" by Jyotsna Singh and Ramesh Chandra
- "Floriculture: A Basic Guide" by K.V. Peter
- "Handbook of Flowering" by Jitendra Kumar
- "Commercial Floriculture: Principles and Practices" by A.P. Misra and V.P. Singh

Semester-II

Paper Title: Archegoniate
(Major Courses) Paper code BOTMAJ 102-4
(Paper credit :04(3T+1P)
Total no Lectures: 60=45+15(L+P) Total marks: 100 (T 50+P20+IA 30)

Course objective:

To study the taxonomy, morphology, life cycles, and ecological significance of archegoniates (including bryophytes and pteridophytes), and understand their role in plant evolution and ecosystem functioning.

Course learning outcome:

- Demonstrate a comprehensive understanding of the diversity, classification, and characteristics of archegoniates, including bryophytes and pteridophytes, and their evolutionary significance in the plant kingdom.
- Apply knowledge of archegoniate morphology, life cycles, and ecological adaptations to analyse and interpret their ecological roles, distribution patterns, and contributions to ecosystem processes.

Course contents:

Unit 1: Introduction: (15 Class, 20 marks)

Unifying features of archegoniates; Transition to land habit; Alternation of generations. General characteristics; Adaptations to land habit; Classification of Bryophytes, Pteridophytes and Gymnosperms (up to family).

Unit 2: Bryophytes: (15 Class, 20 marks)

Morphology, anatomy and reproduction of *Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum* and *Funaria*; Evolutionary trends in *Riccia, Marchantia, Anthoceros* and *Funaria*. Ecological and economic importance of bryophytes.

Unit 3: Pteridophytes and Gymnosperms (15 Class, 20 marks)

Early land plants (*Cooksonia* and *Rhynia*).Morphology, anatomy and reproduction of *Psilotum, Selaginella, Equisetum,Marsilea, Pteris.* Apogamy, and apospory, heterospory andseed habit, telome theory, stelar evolution; Ecological and economic importance.

Morphology, anatomy and reproduction of *Cycas, Pinus* and *Gnetum.*Ecological and economic importance.

Unit 4: Practical (5 Class= 10 hours, 15 marks)

1. Study of gametophyte structures of various archegoniates, such as liverworts, mosses, and ferns, using microscopes and prepared slides. Observe and identify the gametophyte structures, including archegonia, antheridia, and rhizoids.
2. Collection of spores from different archegoniate species and study their germination process. Create a suitable culture medium, provide optimal conditions for germination, and monitor the development of gametophytes from the spores.
3. Examine the sporangia of various ferns and other archegoniates. Observe the structure and arrangement of sporangia, and study their role in spore production and dispersal.
4. Study of rhizomes of ferns to understand their growth habits, anatomy, and branching patterns. Compare and contrast the rhizomes of different fern species, noting any variations or adaptations.

Feld works (5 marks)

1. Field trip to a location of botanical interest for the purpose of studying vegetation and plant forms.

Note:

1. The course includes practical components that are divided into five sessions, each spanning two hours, for a total of 10 hours of practical classes. Additionally, there will be a field study component that will require five hours of engagement. The practical sessions will be evaluated and carry a weightage of 15 marks, while the field study component will be assessed and contribute 5 marks towards the overall evaluation.
2. As part of the course, students will have the opportunity to go on a field trip to a location of botanical interest for the purpose of studying vegetation and plant forms. During the field trip, students will gather information and observations to prepare a report. This report will then be submitted during the practical examination, allowing students to demonstrate their understanding of the subject matter and their ability to apply their knowledge in a real-world setting.

Paper Title: Plant Ecology and Taxonomy
(Minor Courses) Paper code BOTMIN102-4
(Paper credit :04(3T+1P)
Total no Lectures: 60=45+15(L+P) Total marks: 100 (T 50+P20+IA 30)

Course objective:

- To explore the principles of plant ecology and taxonomy, examining the interactions between plants and their environment, and acquiring skills in plant identification and classification

Course learning outcome:

- Gain a comprehensive understanding of plant ecology, including the interactions between plants and their abiotic and biotic environments, and the influence of ecological factors on plant distribution and community dynamics.
- Develop skills in plant identification, classification, and taxonomy, including the ability to use taxonomic keys and field guides to accurately identify plant species and understand their evolutionary relationships.

Course contents:

Unit 1: Introduction to Ecology (15 Class, 20 marks)
Concept of Ecology;Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes; Plant communities, Characters; Ecotone and edge effect; Succession; Processes and types.

Unit 2: Ecosystem (15 Class, 20 marks)
Structure; energy flow trophic organization; Food chains and food webs, Ecological pyramids, production and productivity; Biogeochemical cycling: Cycling of carbon, nitrogen and Phosphorous; Principle of biogeographical zones; Endemism.

Unit 3: Introduction to Plant Taxonomy & Botanical Nomenclature (15 Class, 20 marks)
Identification, Classification, Nomenclature. Role of herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access; Taxonomic evidences from morphology, anatomy, palynology, cytology, phytochemistry and molecular data; Taxonomic hierarchy: Ranks, categories and taxonomic groups.

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (up to series), Engler and Prantl (up to series, Biometrics, numerical taxonomy and cladistics; Characters; variations; OTUs, character weighting and coding; cluster analysis; phonograms, cladograms (definitions and differences).

Botanical nomenclature Principles and rules (ICN); ranks and names; binominal system, Typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 4: Practical (5 Class= 10 hours, 15 marks)

1. Collect plant specimens from the field, press and dry them, and mount them on herbarium sheets following standard protocols. Label the specimens with relevant information, such as locality, habitat, and collection date.
2. Practice plant identification skills by examining live or dried plant specimens using taxonomic keys, field guides, or herbarium resources. Learn to recognize and differentiate plant species based on key morphological features.
3. Analyze the floral structures of different plant species. Dissect flowers to identify and study their various parts, such as sepals, petals, stamens, and pistils. Document the variations in floral morphology across different plant families.
4. Conduct field surveys to sample and analyze plant communities using appropriate vegetation sampling techniques. Measure plant density, cover, and species composition in different habitats, and analyze community structure and diversity.
5. Measure and analyze plant functional traits such as leaf area, and root-to-shoot ratio.
6. Collect soil samples from different habitats and analyze their properties, including pH, nutrient content, and organic matter.

Feld works (5 hours)

1.Field trip to a location of botanical interest for the purpose of studying vegetation and plant forms

Note:

1.The course includes practical components that are divided into five sessions, each spanning two hours, for a total of 10 hours of practical classes. Additionally, there will be a field study component that will require five hours of engagement. The practical sessions will be evaluated and carry a weightage of 15 marks, while the field study component will be assessed and contribute 5 marks towards the overall evaluation.

2.As part of the course, students will have the opportunity to go on a field trip to a location of botanical interest for the purpose of studying vegetation and plant forms. During the field trip, students will gather information and observations to prepare a report. This report will then be submitted during the practical examination, allowing students to demonstrate their understanding of the subject matter and their ability to apply their knowledge in a real-world setting.

Paper Title: Medicinal Botany
(IDC Courses) paper code BOTIDC 102-3
(Paper credit :03(2T+1P)
Total no Lectures: 45=30+15(L+P) Total marks: 50 (T 40+P10)

Course Objective:

To integrate botanical knowledge with pharmacology and traditional medicine practices, exploring the identification, cultivation, and therapeutic properties of medicinal plants for their application in healthcare and drug development.

Course learning outcome:

- Develop a comprehensive understanding of the identification, cultivation, and processing of medicinal plants, and their chemical constituents responsible for therapeutic properties, enabling the evaluation of their potential for drug development and healthcare applications.
- Explore the integration of traditional medicine practices, ethnobotany, and pharmacological principles in the study of medicinal plants, enabling the critical evaluation of their efficacy, safety, and cultural significance in different healthcare systems.

Course contents:

Unit 1: History, Scope and Importance of Medicinal Plants. (15 Class, 15 marks)

Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit 2: Conservation of Medicinal Plants & Ethnobotany (15 Class, 15 marks)

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.

Ethnobotany in India: Methods to study Ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.

Unit 3: Practical (8 Class= 16 hrs., 10 marks)

1. Medicinal Plant Collection: Identify and collect medicinal plant specimens from various habitats. Document relevant information such as plant parts used, traditional uses, and ecological characteristics.
2. Plant Extraction Techniques: Learn and practice different methods of plant extraction to obtain bioactive compounds. Explore solvent extraction, maceration, distillation, or other techniques commonly used in medicinal plant research.
3. Phytochemical Analysis: Conduct laboratory analyses to identify and quantify bioactive compounds present in medicinal plants. Use techniques like chromatography, spectrophotometry, or bioassays to determine the chemical composition and potential therapeutic properties.
4. Pharmacological Screening: Perform in vitro or in vivo assays to evaluate the biological activities of medicinal plant extracts. Assess their antimicrobial, antioxidant, anti-inflammatory, or other potential therapeutic effects.
5. Herbal Formulation Preparation: Gain hands-on experience in preparing herbal formulations, such as infusions, decoctions, tinctures, or extracts. Follow traditional methods or adapt modern techniques to create formulations for specific medicinal purposes.
6. Traditional Knowledge Documentation: Engage with local communities and traditional healers to document their knowledge of medicinal plants. Record their uses, preparation methods, and cultural significance, emphasizing the importance of preserving traditional knowledge.

Suggested readings

1. Medicinal Plants of India" by C.P. Khare
2. "Handbook of Medicinal Plants" by L.D. Kapoor
3. "Indian Medicinal Plants: An Illustrated Dictionary" by C.P. Khare
4. "Medicinal Plants in India: Conservation and Sustainable Utilization in the Emerging Global Scenario" edited by V.K. Gupta
5. "A Compendium of Medicinal Plants in India: An Introduction to Ayurveda" by S.L. Kochhar

Paper Title: Biofertilizer
(SEC Courses) paper code BOTSEC102-3
(Paper credit: 03(2T+1P)
Total no Lectures: 45=35+15(L+P) Total marks: 50 (T 40+P10)
Course Objective:

To understand the principles, production methods, and application of biofertilizers in sustainable agriculture, promoting the knowledge and skills necessary for the effective use of biofertilizers in enhancing soil fertility and plant nutrition.

Course learning outcome:

- Acquire knowledge and practical skills in the production, formulation, and application of biofertilizers, enabling participants to effectively utilize biofertilizers for improving soil fertility, nutrient availability, and plant growth in agricultural systems.

- Understand the ecological benefits and environmental impacts of biofertilizers, and evaluate their role in promoting sustainable agriculture practices, nutrient management, and reducing reliance on synthetic fertilizers, fostering a holistic approach towards soil health and crop productivity.

Course contents:

Unit1: General account about the microbes used as biofertilizer (15 Class, 15 marks)

Rhizobium–isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. Organic farming – Green manuring and organic fertilizers, recycling of bio- degradable municipal, agricultural and Industrial wastes – bio-compost making methods, types and method of vermicomposting – field application.

Unit 2: Isolation and identification of potential microbes for biofertilizer (15 Class, 15 marks)

Azospirillum: isolation and mass multiplication – carrier based inoculants, associative effect of different microorganisms. *Azotobacter*: classification, characteristics–crop response to *Azotobacter* inoculum, maintenance and mass multiplication. Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation. Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM –isolation and inoculums production of VAM, and its influence on growth and yield of crop plants.

Unit3: Practical (8 Class= 16 hrs., 10 marks)

1. Preparation of composting/ vermicomposting bed (demonstration).
2. Preparation of biofertilizer using *Azotobacter* and *Azospirillum.*
3. Isolation and identification of phosphate solubilizing bacteria from soil.
4. Preparation and application of biofertilizers in different crops.
5. Quantification of nitrogen fixation by *Rhizobium* using acetylene reduction assay.
6. Comparison of the effect of chemical fertilizers and biofertilizers on plant growth and yield.

Suggested readings:

- "Biofertilizers: A Manual on Commercial Production Technology" by M.C. Dash, G.B.K. Rao, and V.D. Patel
- "Biofertilizers in Agriculture: Indian Perspective" by R.K. Sinha and P.K. Mohapatra
- "Biofertilizers in Sustainable Agriculture: A Comprehensive Approach" edited by R. Selvakumar, S. Rajendran, and V. Prasad
- "Biofertilizers and Organic Farming: Towards a Sustainable Agriculture" by A. Mukherjee and S. Annapurna
- "Microbial Inoculants in Sustainable Agricultural Productivity: Vol 1: Research Perspectives" edited by D.P. Singh and S. Kumar

Paper Title: Intellectual Property Rights
(VAC Courses) paper code BOTVAC102-4
(Paper Credit: 04 (3T+1P)
Total no Lectures: 60=45+15(L+P) Total marks: 100 (T 50+P20+IA 30)

Course Objective:

To provide a comprehensive understanding of intellectual property rights (IPR), including patents, copyrights, trademarks, and trade secrets, and their role in protecting and managing innovations, creations, and intangible assets.

Course learning outcome:

- Develop a deep understanding of different forms of intellectual property rights (IPR), including patents, copyrights, trademarks, and trade secrets, and their legal frameworks, enabling participants to identify, protect, and manage intellectual property assets effectively.

- Acquire the skills to analyze and evaluate the commercial value and potential of intellectual property, including conducting patent searches, drafting patent applications, and understanding licensing and technology transfer agreements, facilitating informed decision-making and strategic management of intellectual property assets.

Course contents:

Unit 1: Introduction to Intellectual Property Rights (15 Class, 20 marks)

Definition and significance of intellectual property rights (IPR), Overview of different types of IPR, including patents, copyrights, trademarks, and trade secrets, Historical development and international frameworks for protecting IPR.

Unit 2: Understanding and Managing Intellectual Property (15 Class, 20 marks)

In-depth exploration of patents, including patentability criteria, patent filing procedures, and patent infringement issues; Copyright protection and management, including copyrightable works, fair use, and licensing; Trademarks and their registration process, trademark infringement, and brand protection strategies; Trade secrets and their importance, trade secret protection, and the role of confidentiality agreements.

Unit 3: Intellectual Property Commercialization and Legal Considerations (15 Class, 20 marks)

Technology transfer and licensing agreements, negotiation and drafting of license agreements; Commercialization strategies for intellectual property, start-ups, and strategic partnerships; International intellectual property law and global enforcement mechanisms; Ethical considerations and emerging issues in intellectual property, such as open-source software and intellectual property in the digital age.

Unit 4: Practical (8Class=15 hrs, 20 marks)

1. Conducting a patent search: Students can learn how to search for patents related to a specific technology or industry and analyze the patents found to gain a better understanding of the technology landscape.
2. Drafting a patent application: Students can learn how to draft a patent application for a new invention, including writing the patent specification, claims, and drawings.
3. Patent infringement analysis: Students can learn how to analyze a patent and compare it to a potentially infringing product or technology to determine whether infringement has occurred.
4. Trademark registration process: Students can learn how to register a trademark in India, including conducting a trademark search, filling out the application, and responding to objections or oppositions.
5. Copyright law case study: Students can analyze a recent copyright law case and discuss the implications of the decision for creators, users, and society as a whole.
6. Licensing agreements: Students can learn about the basics of licensing agreements, including the different types of licenses, key terms and provisions, and best practices for negotiation and drafting.
7. Trade secrets protection: Students can learn about the importance of trade secrets protection for businesses and the different strategies and tools available for protecting confidential information.
8. IP valuation: Students can learn how to value intellectual property assets, including patents, trademarks, and copyrights, and understand the different methods and factors that can impact the valuation.
9. IP enforcement strategies: Students can learn about the different strategies available for enforcing intellectual property rights, including litigation, mediation, and arbitration.
10. IP portfolio management: Students can learn how to manage a company's intellectual property portfolio, including identifying and evaluating IP assets, developing a portfolio strategy, and monitoring and maintaining the portfolio over time.

Suggested readings

- Intellectual Property Rights and Biotechnology by Shashikala Gurpur and Sreenivasulu N.S.
- Intellectual Property Rights and Plant Biotechnology by Ramanujam Srinivasan
- Intellectual Property Rights: An Overview by Arul George Scaria
- Intellectual Property Rights and Traditional Knowledge: Globalization of Ayurvedic Knowledge by Basavaraj S. Bennur and K.M. Nandini
- Intellectual Property Rights: Issues and Challenges in Pharmaceutical Industry by Swaroop Kumar M. Mohanty and Anas Rasheed
- Intellectual Property Rights and Agriculture by T. Ramakrishna and V. Venkateswarlu
- Intellectual Property Rights and Traditional Knowledge: A Case Study of Medicinal Plants by M. Santhosh Kumar and S. Rajeev
- Intellectual Property Rights and Biodiversity Conservation by Sudhir Kumar and Preeti Shrivastava
- Intellectual Property Rights and Sustainable Development: Issues and Challenges by S. Prabhakar and A. Sundaravadivelu.

Semester III

Paper title: Biomolecules and cell biology
(Major course) paper code: BOTMAJ201-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=45+15 (L+P) Total marks: 100 (T50+P20+IA30)

Course Objective: The objective of this paper is to help students acquire the conceptual knowledge of biomolecules and cell biology.

Course Learning Outcomes

The students will be able to learn the basics of biomolecules, bioenergetics, enzymes structural organization, components of cells, cell division and regulation. Knowledge on structure of enzymes. Students will able to learn about the cell, cell wall, plasma membrane and cell organelles.

Course Contents

Unit 1: Biomolecules (15 Class, 20 marks)
Types and significance of chemical bonds; Structure and properties of water; pH and buffers.
Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.
Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.
Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.

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

Unit 2: Bioenergetics and Enzymes (15 Class, 20 marks)

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

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

Unit 3: The cell, Cell wall, plasma membrane and Cell organelles (15 Class, 20 marks)

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory). Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.
Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.

Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semi-autonomous nature of mitochondria and chloroplast.

Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes.

Cell division

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

Unit 4: Practical (8 Class=15 hrs., 20 marks)

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.

2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo/Crinum*.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
8. Study the phenomenon of plasmolysis and deplasmolysis.
9. Study the effect of organic solvent and temperature on membrane permeability.
10. Study different stages of mitosis and meiosis.

Suggested Readings

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by ChurchillLivingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed.,W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H.Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson EducationInc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7thedition. Pearson Benjamin Cummings Publishing, San Francisco

Paper Title: Plant Taxonomy
(Major Course) Paper Code: BOTMAJ202-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=45+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course Objectives: Understanding of historical as well as modern approaches of plant systematics, knowledge on system of classification and nomenclature.

Course Learning Outcomes

Ability to understand basics of identification, classification and nomenclature, sources of taxonomic evidence, taxonomic structure, botanical nomenclature system and phylogeny and floral evolutions of angiosperm. Understand about the phylogeny of major orders of angiosperm.

Unit 1: Significance of Plant taxonomy/systematics (15 Class, 20 marks)

Introduction to Taxonomy/systematics; Plant identification, Classification, Nomenclature. Evidences from morphology, anatomy, palynology, cytology, phytochemistry and molecular data. Field inventory; Role of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; e-flora; Documentation: Flora, Monographs, Journals; botanical keys.

Unit 2: Taxonomic Hierarchy and Botanical Nomenclature (15 Class, 20 marks)

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

Botanical Nomenclature : Principles and rules (ICN); Ranks and names, Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Name of hybrids.

Unit 3: Classification Systems and Phylogeny of Angiosperms (15 Class, 20 marks)

Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG IV) classification. Terms and concepts (primitive and advanced, monophyly, Paraphyly, polyphyly). Origin and evolution of angiosperms; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Unit 4: Practical (8 Class=15 hrs., 20 marks)

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

   Ranunculaceae: *Ranunculus, Clematis*

   Magnoliaceae: *Magnolia*

   Brassicaceae: *Brassica*

   Myrtacea: *Eucalyptus, Callistemon*

   Umbelliferae:*Coriandrum /Centella /*

   Lamiaceae:*Leucus/Ocimum*

   Euphorbiaceae: *Euphorbia hirta/E.milii, Jatropha/Ricinus*

   Liliaceae: *Smilax/Lilium/Allium*

   Musaceae: *Musa*

   Poaceae: *Triticum/Hordeum/Panicum*

2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).
3. **Field visit (local)** – Subject to grant of funds from the university.

Suggested Readings

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

Paper Title: Biomolecules and Cell biology
(Minor Course) Paper Code: BOTMIN201-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=45+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course Objective: The course objective of Biomolecules and Cell Biology is to provide a comprehensive understanding of the structure, function, and interactions of biomolecules, as well as the fundamental principles and processes governing cellular organization and function.

Course Learning Outcomes

The students will be able to learn the basics of biomolecules, bioenergetics, enzymes structural organization, components of cells, cell division and regulation.

- Ability to understand the types and significance of chemical bonds, nucleic acid, and different form of DNA
- Knowledge on Cell, cell wall, plasma membrane, cell organelles, and cell division Knowledge on structure of enzyme and overview of membrane function etc.

Course Contents:

Unit 1: Biomolecules and Bioenergetics (15 Class, 20 marks)

Types and significance of chemical bonds; Structure and properties of water; pH and buffers. Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides. Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerates. Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; 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. Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as energy currency molecule.

Unit 2: Cell, cell wall, plasma membrane, cell organelles, and Cell division (15 Class, 20 marks)

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory). Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes.

Unit 3: Enzymes (15 Class, 20 marks)

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity. Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis. Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases.

Unit 4: Practical (8Class=15 hrs, 20 marks)

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Crinum.*
3. Demonstration of the phenomenon of protoplasmic streaming in Hydrilla leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using
8. Periodic Schiff's (PAS) staining technique.
9. Study the phenomenon of plasmolysis and deplasmolysis.
10. Study the effect of organic solvent and temperature on membrane permeability.
11. Study different stages of mitosis and meiosis.

Suggested Readings

- Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
- Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
- Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
- Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
- Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
- Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
- Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
- Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

Paper Title: Natural Resource Management
(IDC Course) Paper Code: BOTIDC201-3
Paper credit: 03(2T+1P)

Total number of lectures: 45=30+15(L+P) Marks: 50(T40+P10)

Course Objective: The course objective of Natural Resource Management is to develop knowledge and skills in effectively managing and conserving natural resources for sustainable use and environmental stewardship.

Course Learning Outcomes

- Understand the natural resources and their sustainable utilization.
- Knowledge on land, water, energy, and forest resources.
- Students will learn about the practices of natural resource management.
- Knowledge on the international and national efforts of natural resource management.

Course Contents

Unit 1: Definition and types of Natural resources (15 Class, 20 marks)

Biodiversity-definition and types; Significance; Threats and management strategies; Bio-prospecting and IPR; CBD and National Biodiversity Action Plan; Sustainable utilization concept and approaches (economic, ecological, and socio-cultural); Land and freshwater (rivers, lakes, groundwater, aquifers, watershed); Marine and estuarine ecosystems; Wetlands threats and management strategies; Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

Unit 2: Biological Resources Energy Forests Depletion; Resource Management. (15 Class, 20 marks)

Definition, Cover and its significance (with special reference to India); Major and minor forest products; National and international efforts in resource management and conservation, Renewable and non-renewable sources of energy Contemporary practices in resource management. EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

Unit 3: Practical (8 Class= 15 hrs, 10 marks)

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area. Measurement of dominance of woody species by DBH (diameter at breast height) method.
3. Calculation and analysis of ecological footprint. Ecological modelling

Suggested Readings

- Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
- Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
- Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

Paper Title: Plant Identification & Herbarium Technique
(SEC Course) Paper Code: BOTSEC 201-3
Paper credit: 03(2T+1P)
Total number of lectures: 45=30+15(L+P) Marks: 50 (T40+P10)

Course Objectives: The objectives of the paper are to provide identification skilled, and to knowing about the tools and techniques specimens and herbarium preparations.

Course Learning Outcomes

- Developed understanding of different concepts, categories and approaches of plant classification.
- Identify the sources of taxonomic characters in different disciplines
- Interpret the rules of ICN in relevant aspects of botanical nomenclature.
- Explain different forms of taxonomic literature.
- Learning the methods of plant identification of locally available plants.

Course contents:

Unit 1: Principles of Plant Identification, Nomenclature, Methods of identification (15 Class, 20 marks)

Aim and objectives, Concept and approach of different classification systems. Phenetic, Phyletic and APG in plant classification and identification.

ICN-salient features, rules and recommendations and related issues in plant nomenclature, concept of taxonomic rank.

Methods of identifications of different groups; Algae, Fungi, Lichen, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.

Unit-2 Tools and Techniques and Taxonomic literature (15 Class, 20 marks)

Field and herbarium techniques, preservation of museum and herbarium specimens, preservation techniques for lower and higher group of plants, Botanical keys. General reference, classical literatures, illustrations, icons; regional and India floras, journal, manual, monograph and revision.

Unit-3: Practical (8 Class= 15 hrs, 10 marks)

1. Tools and Techniques in identification.
2. Field and herbarium techniques and preservation of museum and herbarium specimens including the special types of plants.
3. Study and identifications of locally available plants.
4. Practical should be supported by practical records, specimens and herbarium.

Suggested readings

1. John, DM., Whitton, BA and Brook, A J (eds.)The freshwater algal flora of the British Isles: An identification guide to fresh water and terrestrial algae.
2. Vasistha, PC. Gymnosperms .
3. Dobson, F. (2011). Lichen an illustrated Guide to the British and Irish Species (6th edition). Richmond publishing.
4. Borthakur, SK, Deka, P. and Nath, KK.2001. Illustrated Manual of ferns of Assam. M/s Bishen Singh Mahendra Pal Singh.
5. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.
6. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi.3rd edition.

Semester IV

Paper Title: Plant Ecology and Phytogeography
(Major Course) Paper Code: BOTMAJ203-4
Paper Credits: 04 (3L + 1P)
Total number of lectures: 60=40+15(L+P) **Total Marks: 100 (T50+P20+IA30)**

Course Objectives:

The objective of this paper is to give conceptual knowledge of the ecology and to impart skills in understanding the ecosystem and maintaining ecological balance through theoretical and field studies in diverse habitats**.**

Course Learning Outcome:

1. **This course will make students familiar the different levels of ecological studies, components of environment and its interactions,** information on soil types and their properties, and an understanding about problem soils
2. **It will enable students to develop skills in population dynamic studies to maintain stability. global ecological crisis, Sustainable**
   development and pros and cons of human intervention.
3. **Enable the student to understand the structural and functional aspects of ecosystem and help them to design ecosystem models for sustainable development**
4. **Students will develop knowledge of different biomes scattered at different geographical regions and the principles governing them.**

Unit 1: Introduction to Abiotic factors (15 Class, 20 marks)

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 2: Biotic interactions (15 Class, 20 marks)

Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.
Population ecology: Characteristics and Dynamics. Ecological Speciation
Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Unit 3: Ecosystems, Functional aspects of ecosystem, Phytogeography (15 Class, 20 marks)

Structure; Processes; Trophic organisation; 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.
Phytogeography: 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.

Unit 4: Practical (5 Class= 10 hrs, 10 marks)

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Determination of biomass of herbaceous plant species of shady and sunny area.
4. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
5. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
6. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
7. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
8. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
   (b)Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
9. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
10. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
11. Quantitative analysis of herbaceous vegetation for density and abundance in the institutional campus.

Field studies (1 Class= 5 hrs, 5 marks)

Field visit to familiarise students with ecology of different climatic regions.

Suggested Readings

1. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
2. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
3. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
4. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
5. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

Paper Title: Anatomy of Angiosperms
(Major Courses) Paper Code: BOTMAJ204-4

Paper Credits: 04 (3P+ 1P)

Total number of lectures: 60=40+15(L+P) **Total Marks: 100 (T50+P20+IA30)**

Course Objectives:

The objective of this paper is to give conceptual knowledge on the development of internal structures of the plant body, function of different tissues and their applications.

Course Learning Outcome:

1. Provide basic knowledge on the structural development of the plant body, tissue differentiation, secondary growths, adaptive and protective characters of different tissue and tissue systems in different types of plants.
2. Understanding of the secondary growth in different plant bodies and its economic values.
3. Application of plant anatomy in different fields besides.

Unit 1: Plant Anatomy: Introduction, Scope, and Development (15 Class, 20 marks)

Applications in systematics, forensics and pharmacognosy, Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.

Unit 2: Tissues system (15 Class, 20 marks)

Classification of tissues; Simple and complex tissues; cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

Concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, Exodermis and origin of lateral root.

Unit 3: Vascular Cambium, Wood, and Adaptive/Protective Systems (15 Class, 20 marks)

Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels. Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and non-glandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

Unit 4: Practical (8 Class=15 hrs, 20 marks)

1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

Paper Title: Genetics and Evolution
(Major Courses) Paper Code: BOTMAJ205-4
Paper Credits: 04 (3P+ 1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course Objectives:

The course objective of Genetics and Evolution is to provide a comprehensive understanding of the principles and mechanisms underlying inheritance, variation, and the processes that drive evolutionary change.

Course Learning Outcome:

- Knowledge on fine structure of genes.
- Understanding of the phenomenon of inheritance along with deviations and sex determination
- Knowledge of type, occurrence and mechanism of genomic alterations and their evolutionary significance.
- Understand the concept of origin of life, and comprehend evolution based on theories and evidences.

Unit 1: Mendelian genetics, Linkage and Crossing over (15 Class, 20 marks)

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

Linkage and crossing over: Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numerical based on gene mapping; Sex Linkage.

Unit 2: Extrachromosomal Inheritance, Gene mutation and Chromosomal aberrations (15 Class, 20 marks)

Extrachromosomal inheritance: Cytoplasmic inheritance in plants, Variegation in Four o'clock plant; Cytoplasmic inheritance due to mitochondria; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramoecium.

Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation. DNA repair mechanisms. Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

Unit 3: Fine structure of gene, Population and Evolutionary Genetics (15 Class, 20 marks)

Classical vs molecular concepts of gene; Cis-Trans complementation test for functional alleles; Structure of Phage T4, rII Locus. Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

Unit 4: Practical (8 Class=15 hrs, 20 marks)

1. Meiosis through temporary squash preparation. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
2. Chromosome mapping using point test cross data.
3. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
5. Blood Typing: ABO groups & Rh factor.
6. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
7. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
8. Study of human genetic traits: Sickle cell anaemia, Xeroderma Pigmentosum, Albinism, red & green Colour blindness, Widow's peak, rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Paper title: Analytical techniques in Plant Science
Paper code: BOTMIN 202-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course Objectives: The course objective of Analytical Techniques in Plant Science is to develop proficiency in the application of various analytical methods and instruments for the accurate and precise analysis of plant samples, enabling students to obtain valuable scientific data for research and practical applications.

Course Learning Outcomes:

The students will be able to understand the working principles of biological tools and become expertise in applications of biological tools. Students will also be well versed in different plant analysis techniques.

Unit 1: Imaging and related techniques and Cell fractionation (15 Class, 20 marks)

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.

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 2: Spectrophotometry, Chromatography, Electrophoresis and radioisotopes (15 Class, 20 marks)

Principle and its application in biological research: Spectrophotometry; Paper chromatography, Column chromatography, Affinity chromatography, TLC, GLC, HPLC.

Characterizations of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE.

Radioisotopes: Principles and its application in biological research.

Unit 3: Biostatistics (15 Class, 20 marks)

Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Unit 4: Practical (8Class=15hrs, 20 marks)

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate amino acids by paper chromatography.
4. To separate chlorophyll pigments by TLC/ UV Spectrophotometer.
5. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
6. Preparation of permanent slides (double staining).
7. Common bio statistical calculations (mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit).

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw- Hill Publishing Co. Ltd. New Delhi. 3 rd edition.
2. Ruzin, S.E. (1999). Plant Micro technique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3 rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4 th edition

Semester V

Paper title: Plant Physiology
Paper code: BOTMAJ 301-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) **Total Marks: 100 (T50+P20+IA30)**

Course objective:

The course objective of Plant Physiology is to provide a comprehensive understanding of the physiological processes and mechanisms underlying plant growth, development, and responses to environmental factors, equipping students with knowledge applicable to plant-related research, agriculture, and environmental sciences.

Course Learning Outcomes:

- Gain a deep understanding of the fundamental physiological processes in plants, including photosynthesis, respiration, transpiration, and nutrient uptake, and their regulation.
- Develop the ability to analyze and interpret plant responses to environmental stimuli such as light, temperature, water availability, and stress, and comprehend the mechanisms involved.
- Acquire practical skills in conducting experiments and using various techniques to measure and analyze plant physiological parameters, enabling students to design and execute experiments in plant physiology research.

Unit 1: Plant-water relations and Mineral nutrition (15 Class, 20 marks)

Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement. 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 2: Translocation in the phloem and Plant growth regulators(15 Class, 20 marks)

Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship. Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

Unit 3: Physiology of flowering and sensory photobiology (15 Class, 20 marks)

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy, discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Unit 4 : Practical (8Class=15hrs, 20 marks)

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. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA Bioassay).
8. To study the induction of amylase activity in germinating barley grains.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/Avena coleptile bioassay (demonstration).

Suggested Readings

- Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
- Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
- Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Paper title: Molecular Biology
Paper code: BOTMAJ 302-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) **Total Marks: 100 (T50+P20+IA30)**

Course objectives:

The course objective of Molecular Biology is to provide a comprehensive understanding of the molecular mechanisms underlying biological processes in living organisms, including DNA replication, gene expression, protein synthesis, and genetic regulation, to equip students with the knowledge and skills necessary for research, biotechnology, and medical applications

Course Learning Outcome:

- Develop a solid understanding of the fundamental principles and concepts of molecular biology, including DNA structure, replication, transcription, and translation.
- Gain knowledge and proficiency in various laboratory techniques used in molecular biology, such as DNA isolation, PCR, gel electrophoresis, and recombinant DNA technology.
- Analyze and interpret experimental data in molecular biology, including DNA sequences, gene expression patterns, and protein interactions, to draw meaningful conclusions and contribute to scientific research.
- Apply molecular biology principles to address real-world problems and challenges in fields such as biotechnology, genetics, medicine, and agriculture, and recognize the ethical considerations associated with molecular biology research and applications.

Unit 1: Nucleic acids and Genetic materials (Structures of DNA and RNA) (15 Class, 20 marks)

Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase,Avery, McLeod & McCarty, Fraenkel-Conrat's experiment, DNA Structure: Miescher to Watson and Crick- historic perspective, Salient features of double helix, Types of DNA, Types of genetic material, RNA Structure, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes, , Organelle DNA -- mitochondria and chloroplast DNA. The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Unit 2: The replication of DNA(15 Class, 20 marks)

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi- conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.

Unit 3: Transcription, processing and modification of RNA, Genetic code, translation and regulation of gene action(15 Class, 20 marks)

Transcription in prokaryotes and eukaryotes. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicingpathways, group I and group II intron splicing, alternative splicing eukaryotic mRNAprocessing(5' cap, 3' polyA tail); Ribozymes; RNA editing and mRNA transport. Gene silencing. Central dogma: Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNAtemplate), Genetic code (deciphering & salient features). Translation: Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli.*

Unit 4: Practical (8Class=15hrs, 20 marks)

1. Preparation of LB medium and raising *E. Coli.*
2. Isolation of genomic DNA from *E. Coli.*
3. DNA isolation from cauliflower head.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery etal, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicingmechanism in group I & group II introns; Ribozyme and Alternative splicing.

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.

2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. BenjaminCummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to GeneticAnalysis. W. H. Freeman and Co., U.S.A. 10th edition.

Paper title: Microbiology and Plant Pathology
(Major Courses) Paper code: BOTMAJ 303-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course objectives:

The course objective of Microbiology and Plant Pathology is to provide a comprehensive understanding of the principles and concepts of microbiology, including the study of microorganisms and their interactions with plants, and the identification, diagnosis, and management of plant diseases, equipping students with knowledge applicable to agriculture, plant protection, and biotechnology.

Course Learning outcomes:

- Develop a comprehensive understanding of microorganisms, including bacteria, fungi, viruses, and their roles in plant diseases, and acquire the ability to identify and classify plant pathogens.
- Gain knowledge and skills in laboratory techniques used in microbiology and plant pathology, such as isolation and culturing of microorganisms, microscopy, and molecular diagnostics, enabling students to conduct accurate and reliable plant disease diagnosis.
- Apply the principles of plant pathology to effectively manage plant diseases, including the use of integrated pest management strategies, biocontrol agents, and sustainable disease management practices, contributing to the development of sustainable agriculture and plant health.

Unit 1: Introduction to microbial world(15 Class, 20 marks)

Discovery of microbial world, Landmark discoveries relevant to the field of microbiology; Controversy over spontaneous generation, theory and practice of sterilization, principles of Microbial nutrition, Microbial growth and growth curve, Pure culture techniques, Enrichment culture techniques for isolation of micro-organisms, Introduction of Microbial metabolism.

Unit 2: Viruses and Bacteria(15 Class, 20 marks)

Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases.

Discovery, general characteristics; Microbial taxonomy and its modern trends, Bergey's classification of bacteria; Types-Archaebacteria, Eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Unit 3: Phytopathology (15 Class, 20 marks)

Concept of plant disease, history of plant pathology, common symptoms of plant diseases.General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Concept of disease cycle, Inoculation, Pre penetration, Penetration and post penetration, Host-Pathogen relationships; Disease cycle and environmental relation; Epidemics, defence mechanisms; 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, vein clearing.

Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

Unit 4 : Practical (8Class=15hrs, 20 marks)

1. Techniques on cleaning and sterilization of equipment.
2. Preparation of media (Potato-dextrose Agar and Nutrient agar media).
3. Inoculation of microbes from air, water and soil.
4. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
5. Types of Bacteria to be observed from temporary/permanent slides/photographs.
6. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
7. Gram staining.
8. Endospore staining with malachite green using the (Endospores taken from soil bacteria).
9. Study of plant pathogenic fungi from diseased specimens (symptoms, causal organism and their morphological & reproductive characters), Early blight of potato, Black stem rust of wheat and White rust of crucifers, Brown spot disease in rice.
10. Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing.

Suggested Readings:

- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Dubey, R.C & D.K. Maheswari: A Text Book of Microbiology.
- Presscott, L. Harley, J. and Klein, D. (2005) Microbiology, 6th edition,Tata McGrawHill Co.New Delhi.
- Gupta, G.P.,2004, Text book of plant diseases, Discovery Publ.House ,New, Delhi
- Mehrotra, R.S. 1991, Plant Pathology, Tata McGraw Hill Co.Delhi
- Singh, R.S.2004, Plant Diseases, Oxford & IBH Publishing Co. Pvt. Ltd., Delhi.
- Trigiano, Windham and Windham, 2003, Plant pathology , Concepts and laboratory• exercises CRC Press London.

Paper Title: Analytical Techniques in Plant Sciences
(Major Courses) Paper Code: BOTMAJ304-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course objectives: The course objective of Analytical Techniques in Plant Sciences is to provide students with a comprehensive understanding of various analytical methods and instruments used in plant sciences, enabling them to acquire proficiency in the accurate and precise analysis of plant samples, and to apply these techniques in plant research, agriculture, and environmental studies.

Course Learning Outcomes:

1. Develop a solid understanding of different analytical methods and instruments used in plant sciences, including spectroscopy, chromatography, microscopy, and molecular techniques, and gain proficiency in their application for the analysis of plant samples.
2. Acquire practical skills in sample preparation, data collection, and data analysis using analytical techniques, enabling students to generate accurate and reliable results for plant-related research and practical applications.
3. Apply critical thinking and problem-solving skills to evaluate and select appropriate analytical techniques for specific research questions in plant sciences, and effectively communicate scientific findings and conclusions using appropriate scientific terminology and presentation formats.

Unit 1: Imaging techniques Centrifugation & Radioisotopes (15 Class, 20 marks)

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry; (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. Centrifugation: Theory and Principle of centrifugation, Differential and density gradient centrifugation, analytical centrifugation, ultracentrifugation. Radioisotopes: Concept and principle, use in biological research, auto-radiography, pulse chase experiment.

Unit 2: Spectrophotometry & Chromatography, Characterization of proteins and nucleic acids(15 Class, 20 marks)

Principle and its application of Spectrophotometry in biological research. Principle of Chromatography; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion- exchange chromatography; Molecular sieve chromatography; Affinity chromatography. Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit 3: Biostatistics (15 Class, 20 marks)

Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Unit 4: Practical (8Class=15hrs, 20 marks)

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

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw- Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Paper Title: Plant Anatomy and Embryology
(Minor Courses) Paper Code: BOTMIN301-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course objectives:

The course objective of Plant Anatomy and Embryology is to provide students with a comprehensive understanding of the structure, development, and reproductive processes of plants, enabling them to analyze and interpret the anatomical features of plant tissues and organs, and comprehend the principles and mechanisms underlying plant embryogenesis.

Course learning outcomes:

- Develop a thorough understanding of plant anatomy, including the structure and organization of plant tissues and organs, and the ability to identify and describe anatomical features through microscopic examination.
- Gain knowledge and comprehension of plant embryology, including the processes of fertilization, embryogenesis, and seed development, and the ability to interpret and analyze developmental stages and patterns in different plant species.
- Acquire practical skills in laboratory techniques used in plant anatomy and embryology, such as tissue sectioning, staining, and microscopy, enabling students to conduct hands-on experiments and analyze plant structures and developmental processes**.**

Unit 1: Meristematic, permanent tissues and Secondary Growth; Adaptive and protective systems (15 Class, 20 marks)

Root and shoot apical meristems; Simple and complex tissues , Structure of dicot and monocot root stem and leaf. Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood); Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 4: Structural and reproductive features of flower (15 Class, 20 marks)

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac, Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 7: Embryology (15 Class, 20 marks) (

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm relationship, Apomixis, Polyembryony: Definition, types and Practical applications.

Unit: 8 Practical (8Class=15hrs, 20 marks)

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.
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.
13. Calculation of percentage of germinated pollen in a given medium.

Suggested Readings

1. "Plant Anatomy: An Applied Approach" by Datta Madamwar and M. S. Jambhale
2. "Textbook of Plant Anatomy and Embryology" by Gopinath Halder
3. "Plant Anatomy and Embryology: Principles and Techniques" by B. P. Pandey and K. K. Biswal
4. "Plant Anatomy and Embryology: Concepts and Applications" by S. L. Puri and S. C. Gupta
5. "Plant Anatomy and Embryology: Fundamentals and Applications" by B. K. Kachroo and Neeru Narula

SEMESTER VI

Paper Title: Reproductive Biology of Angiosperms
(Major Courses) Paper Code: BOTMAJ 305-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course objectives: The course objective of Reproductive Biology of Angiosperms is to provide students with a comprehensive understanding of the reproductive processes and mechanisms in flowering plants, including pollination, fertilization, seed development, and fruit formation, enabling them to analyze and interpret the reproductive strategies and adaptations in different plant species.

Course learning outcomes:

- Develop a comprehensive understanding of the reproductive structures and processes in angiosperms, including flower development, pollination mechanisms, and the formation of seeds and fruits.
- Gain knowledge and comprehension of the reproductive strategies and adaptations in angiosperms, such as breeding systems, floral morphology, and reproductive barriers, and their implications for plant evolution and diversity.
- Acquire practical skills in the identification and classification of floral structures, pollen grains, and reproductive organs, enabling students to analyze and interpret reproductive characteristics in different plant species.
- Apply the knowledge of reproductive biology in angiosperms to address real-world challenges related to plant breeding, crop production, and conservation, and recognize the importance of reproductive biology in understanding and preserving plant biodiversity.

Unit 1: Development of reproductive structures (15 Class, 20 marks)

History of reproductive biology in Angiosperms (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and its scope. Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

Anther and pollen biology: 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; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit 2: Pollination Ovule and fertilization(15 Class, 20 marks)

Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and mega gametogenesis (details of Polygonum type); Organization and ultrastructure of mature embryo sac.

Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization. Self-incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids, in vitro fertilization

Unit 3: Embryo, Endosperm and Seed(15 Class, 20 marks)

Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in Paeonia. Seed structure, importance and dispersal mechanisms; Polyembryony and apomixes, Applications of Polyembryony and apomixes.

Unit 4 : Practical (8Class=15hrs, 20 marks)

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.

2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test.germination: Calculation of percentage germination in different media using hanging drop method.
3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
5. Intra-ovarian pollination; Test tube pollination through photographs.
6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

Suggested Readings

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands

Paper Title: Plant Biotechnology
(Major Courses) Paper Code: BOTMAJ306-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course objectives:

The course objective of Plant Biotechnology is to provide students with a comprehensive understanding of the principles and techniques of manipulating plant genetic material, enabling them to apply biotechnological approaches for crop improvement, genetic engineering, and sustainable agricultural practices.

Course learning outcomes:

1. Develop a solid understanding of the principles and concepts of plant biotechnology, including genetic engineering, tissue culture, and molecular breeding, and gain proficiency in the application of biotechnological techniques for plant improvement and crop production.
2. Acquire practical skills in laboratory techniques used in plant biotechnology, such as DNA isolation, gene cloning, transformation, and tissue culture, enabling students to carry out molecular and cellular experiments for plant genetic manipulation.
3. Apply critical thinking and problem-solving skills to analyze and interpret data obtained from plant biotechnology experiments, and effectively communicate scientific findings and concepts related to plant biotechnology through oral presentations and written reports.

Unit 1: Plant Tissue Culture (15 Class, 20 marks)

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 (15 Class, 20 marks)

Restriction Endonucleases (History,Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC). Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR.

Unit 3: Applications of Biotechnology (15 Class, 20 marks)

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 concern. Agrobacterium-mediated,Direct gene transfer by Electroporation Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit 4 : Practical(15 Class, 20 marks)

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. Demonstration of Isolation of protoplasts.
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. Restriction digestion and gel electrophoresis of plasmid DNA.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.

4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Paper Title: Bioinformatics
(Major Courses) Paper Code: BOTMAJ 307-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course objectives:

The course objective of Bioinformatics is to provide students with a comprehensive understanding of the application of bioinformatics tools and techniques in biological research, enabling them to analyze and interpret genomic, transcriptomic, and proteomic data for plant genetic analysis, functional genomics, and molecular breeding.

Course learning outcomes:

- Develop proficiency in utilizing bioinformatics tools and databases to retrieve, analyze, and interpret genomic, transcriptomic, and proteomic data relevant to plant biotechnology research.
- Acquire practical skills in data mining, sequence alignment, gene prediction, functional annotation, and phylogenetic analysis using bioinformatics software and algorithms, enabling students to extract meaningful information from plant genomic data.
- Apply bioinformatics approaches to study gene expression patterns, protein-protein interactions, and metabolic pathways in plants, and gain insights into the molecular mechanisms underlying plant growth, development, and stress responses.

Unit 1. Introduction to Bioinformatics(15 Class, 20 marks)

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics. Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System. National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.

Unit 2. Biological Databases and Sequence Alignments, Molecular Phylogeny (15 Class, 20 marks)

EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.Introduction, Concept of Alignment, Multiple Sequence Alignment

(MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM). Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Unit 3. Applications of Bioinformatics (15 Class, 20 marks)

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement

Unit 4: Practical (8 Classes= 15 hrs, 20 marks)

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley- Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

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Paper Title: Economic Botany
(Major Courses) Paper Code: BOTMAJ 308-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course objectives:

The course objective of Economic Botany is to provide students with a comprehensive understanding of the economic importance, utilization, and sustainable management of plant resources, enabling them to analyze and apply botanical knowledge in various industries, agriculture, and conservation practices.

Course learning outcomes:

Develop a comprehensive understanding of the economic value and utilization of plant resources, including medicinal plants, food crops, timber, fiber, and ornamental plants, and recognize their significance in local and global economies.

Acquire knowledge and skills to identify and classify economically important plant species, and understand their ecological requirements, cultivation techniques, and potential for sustainable utilization.

Apply critical thinking and problem-solving skills to analyze and evaluate the impacts of human activities on plant resources, and develop strategies for the conservation, sustainable management, and utilization of plant biodiversity.

Unit 1: Cultivated Plants: Cereal, Legumes(15 Class, 20 marks)

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.

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets. Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes.

Unit 2 Spice, sugars, and starches (15 Class, 20 marks)

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

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

Unit3: Beverages, oils, drug , rubber, fibre, and timber yielding plants (15 Class, 20 marks)

Tea, Coffee (morphology, processing & uses),General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses., Para-rubber: tapping, processing and uses., Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver

and Cannabis; Tobacco (Morphology, processing, uses and health hazards), General account with special reference to teak and pine. Classification based on the origin of fibres; Cotton, Coir and Jute (morphology, extraction and uses).

Unit 4: Practical (8 Classes=15 hrs, 20 marks)

1. Cereals: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests) Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. Legumes: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. Sources of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. Spices: Black pepper, Fennel and Clove (habit and sections).
5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. Sources of oils and fats: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
7. Essential oil-yielding plants: Habit sketch of Rosa, Vetiveria, Santalum and Eucalyptus
8. (specimens/photographs).
9. Rubber: specimen, photograph/model of tapping, samples of rubber products.
10. Drug-yielding plants: Specimens of Digitalis, Papaver and Cannabis.
11. Tobacco: specimen and products of Tobacco.
12. Woods: Tectona, Pinus: Specimen, Section of young stem.
13. Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

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.

Paper Title: Plant Physiology and Metabolism

(Minor Courses) Paper Code: BOTMIN 302-4
Paper credit: 04(3T+1P)

Total number of lectures: 60=40+15(L+P) **Total Marks: 100 (T50+P20+IA30)**

Course objectives:

The course objective of Plant Physiology and Metabolism is to provide students with a comprehensive understanding of the physiological processes and metabolic pathways in plants, enabling them to analyze and interpret plant growth, development, and response to environmental stimuli at the molecular, cellular, and organismal levels.

Course learning outcomes:

1. Develop a deep understanding of the physiological processes in plants, including photosynthesis, respiration, water and nutrient uptake, and hormone signaling, and their regulation at the molecular and cellular levels.
2. Acquire knowledge and skills to analyze and interpret plant responses to environmental factors such as light, temperature, water availability, and stress, and understand the mechanisms underlying plant adaptation and acclimation.
3. Apply critical thinking and experimental skills to design and conduct plant physiology experiments, collect and analyze data, and effectively communicate scientific findings through oral presentations and written reports.

Unit 1: Plant-water relations, Mineral nutrition and Translocation(15 Class, 20 marks)
Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps. Translocation in phloem: Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 2: Photosynthesis and Respiration(15 Class, 20 marks)

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C_3, C_4 and CAM pathways of carbon fixation; Photorespiration. Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 3: Enzymes and nitrogen metabolism, PGR, Photosensory (15 Class, 20 marks)

Enzyme: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition. Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation. PGR: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene. Photosensory: Phytochrome discovery and structure, Photoperiodism (SDP, LDP, Day neutral plants); Vernalization

Unit 4 Practical**(8 class =15hrs, 20 marks)**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

Demonstration experiments

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Suggested Readings

1. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th 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 VII

Paper Title: Plant Metabolism
(Major Courses) Paper Code: BOTMAJ 401-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course Objectives :

The course objective of Plant Metabolism is to provide students with a comprehensive understanding of the biochemical processes and metabolic pathways in plants, enabling them to analyze and interpret plant metabolism at the molecular, cellular, and physiological levels.

Course Outcome:

1. Develop a thorough understanding of the biochemical processes and metabolic pathways involved in plant metabolism, including photosynthesis, respiration, carbohydrate metabolism, lipid metabolism, and secondary metabolite biosynthesis.
2. Acquire knowledge and skills to analyze and interpret metabolic regulation and interactions in plants, and understand the physiological and ecological significance of plant metabolism in growth, development, and responses to environmental stimuli.
3. Apply critical thinking and problem-solving skills to evaluate and design experiments related to plant metabolism, and effectively communicate scientific findings and concepts related to plant metabolic pathways and their functional implications.

Unit 1: Concept of metabolism and Carbon assimilation(15 class, 20 marks)

Introduction, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).

Photosynthetic accessories, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4 pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.

Unit 2: Carbon Oxidation and ATP-Synthesis(15 class, 20 marks)

Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

Unit 3: Nitrogen and Lipid metabolism (15 class, 20 marks)

Nitrate assimilation, biological nitrogen fixation; Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Biosynthesis of amino acid and lipid.

Unit 4: Practical (8 class =15class, 20 marks)

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. Demonstration of fluorescence by isolated chlorophyll pigments.
7. Demonstration of absorption spectrum of photosynthetic pigments.

Suggested Readings

1. Verma SK and Verma Mohit *A Textbook of Plant Physiology, Chemistry and Biotechnology*
2. Malik CP and Srivastava A. *Text Book of Plant Physiology*
3. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. JohnWiley and Sons. U.S.A. 4th edition.
4. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology andDevelopment. Sinauer Associates Inc. USA. 6th edition.
5. Bala, M., Gupta, S., Gupta, N.K. and Sangha, M.K. (2013). Practicals in Plant Physiology and Biochemistry, Scientific Publishers (India).
6. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. NewYork.

Paper Title: Plant breeding and Tissue Culture
(Major Courses) Paper Code: BOTMAJ 402-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course Objectives:

The course objective of Plant Breeding and Tissue Culture is to provide students with a comprehensive understanding of plant breeding principles and techniques, as well as tissue culture methods, enabling them to develop improved plant varieties through controlled breeding and genetic manipulation in vitro.

Course Outcome

- Develop a solid understanding of the principles and techniques of plant breeding, including selection, hybridization, and genetic manipulation, and apply these concepts to develop improved plant varieties with desired traits.
- Acquire practical skills in tissue culture methods, including callus induction, somatic embryogenesis, and micropropagation, and apply these techniques for mass production of plants and clonal propagation.
- Apply critical thinking and problem-solving skills to analyze and evaluate plant breeding strategies and tissue culture protocols, and make informed decisions in selecting appropriate techniques for specific breeding goals and conservation efforts.

Unit-I Introduction to plant breeding (15hrs class, 20 marks)

Historical development, concept, nature and role of plant breeding, major achievements and future prospects;

Genetics in relation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male sterility- genetic consequences, cultivar options. Domestication, Acclimatization and Introduction; Centres of origin/diversity, components of Genetic variation; Heritability and genetic advance

Unit-II Principles, genetic basis and methods, Mass selection, pure line selection, clonal selection. (15hrs class, 20 marks)

Hybridization: Objectives. Procedure. Major achievements. Problems and causes of failure of hybridization. Handling of hybrids - Bulk method and pedigree method of selection. Distant hybridization - Role of interspecific and intergeneric hybridization in crop improvement. Role in crop improvement Types of male sterility: Gametic and zygotic sterility. Somatoplastic sterility. Cytoplasmic and genetic sterility. Methods to overcome incompatibility, Backcross breeding: Theory and procedure. Inbreeding: inbreeding consequences. Heterosis- Definition. Genetic and physiologic basis. Application in plant breeding. Steps in the production of single cross, double cross, three way cross, synthetic cross, multilines. Polyploidy breeding: induction of autopolyploidy and allopolyploidy. Centres of crop breeding: International and National.

Unit-III Plant Tissue Culture (15hrs class, 20 marks)

Historical perspective, Type, techniques and application of Callus, Suspension, Haploid Embryo, and Organ Culture. Embryogensis, organogenesis, synthetic seeds and Somoclonal variations. Micropropagation- Advantages, Disadvantages and factors influencing micropropagation. Different Methods and stages involved in micropropagation. Hairy root culture, multiple shoot culture and their applications. Protoplast culture, isolation and purification of protoplast. Method of Protoplast fusion and protoplast culture, Cryopreservation, Germplasm Conservation.

Unit 4 : Practical **(8 Class=15hrs , 20 marks)**

1. Emasculation; preparation of the inflorescence for crossing.
2. Estimation of pollen sterility and fertility percentage.
3. Pollen germination: in vitro and in vivo viability tests
4. Study of pollen types using acetolysed and non-acetolysed pollens

5. Developmental stages of anther, ovule, embryo and endosperm.

a. Preparation of MS medium.

b. Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.

6. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
7. Hands on sterilization techniques and preparation of culture media.
8. Isolation of protoplasts.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Raghavan V., 1976. Experimental embryogenesis in plants. Academic Press.

Paper Title: Industrial Microbiology and Immunology
(Major Courses) Paper Code: BOTMAJ 403-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course Objectives:

The course objective of Industrial Microbiology and Immunology is to provide students with a comprehensive understanding of the applications of microorganisms and immunological techniques in various industries, enabling them to analyze and apply microbial and immunological knowledge for industrial processes, product development, and disease diagnosis and prevention.

Course Outcome

- Develop a thorough understanding of the principles and applications of industrial microbiology, including microbial fermentation, biotechnology, enzyme production, and microbial control strategies in various industrial sectors.
- Acquire knowledge and skills in immunological techniques, including serological assays, immunoassays, and molecular diagnostics, and apply them for disease diagnosis, vaccine development, and immunotherapy in industrial and clinical settings.
- Apply critical thinking and problem-solving skills to analyze and evaluate industrial microbiology and immunology processes, and make informed decisions in selecting appropriate techniques and strategies for microbial product development, quality control, and disease prevention.

Unit 1:Scope of microbes in industry and environment, fermentation (15 class, 20 marks)

Introduction to Industrial Microbiology, Concept of Fermentation and Bio-processing ; Fermentation types: Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Fermentation equipment: Components of a typical bioreactor, Types of bioreactors-laboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

Unit 2: Microbial production of industrial products, enzyme and enzyme immobilization(15 class, 20 marks)

Concept of up-stream and downstream processing; Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying;

Industrial production of Organic acid (citric acid), alcohol (Ethanol) and antibiotic (Penicillin); Microbial Enzymes: Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes.

Unit 3: Immunology (15 class, 20 marks)

History of Immunology, Immunity-mechanism; Innate and adaptive immune system: cells and molecules involved in innate and adaptive immunity. Antigens, antigenicity and immunogenicity. B and T cell epitopes. Structure and function of antibody molecules, generation of antibody molecules, Antigen antibody interactions.

Unit 4 : Practical **(8 Class=15hrs , 20 marks)**

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.
3. Microbial Culturing and Media Preparation: Students will learn basic techniques for microbial culturing and prepare different types of growth media to support the growth of specific microorganisms.
4. Sterilization Techniques: Students will practice various methods of sterilization, such as autoclaving and filtration, to ensure aseptic conditions in the laboratory and prevent microbial contamination.
5. Enzyme Production and Assay: Students will isolate and culture microorganisms capable of producing specific enzymes, and perform enzyme assays to quantify enzyme activity and assess its industrial potential.
6. Antibiotic Sensitivity Testing: Students will conduct antibiotic sensitivity testing using standard methods, evaluating the susceptibility of bacterial strains to different antibiotics, and interpreting the

results for effective antibiotic selection.

Suggested Readings

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.
3. Pommerville, J. C. 2011. Alcamo's fundamentals of microbiology, 9th Edition.
4. Male, D., Brostoff, J., Roth, D. B. and Roitt, I. 2006. Immunology, 7th Edition. Elsevier Limited.

Paper Title: Research Methodology
Paper Code: BOTREM 404-4
Paper credit: 04(3T+1P)

Total number of lectures: 60=40+15(L+P) **Total Marks: 100 (T50+P20+IA30)**

Course Objectives

- To equip students with the necessary knowledge and skills to design, conduct, analyze, and communicate research effectively, fostering a strong foundation in research methodology across various disciplines.

Course Outcome

- Develop the ability to design research studies, including formulating research questions, selecting appropriate research methods, and designing data collection instruments, ensuring the integrity and validity of research findings.
- Acquire skills in data analysis, interpretation, and presentation, including the use of statistical techniques and software, enabling students to analyze research data effectively and communicate research findings in a clear and coherent manner.

Unit 1: Introduction to Research Methodology(15 class, 20 marks)

Understanding the nature and importance of research; Formulating research questions and objectives; Research ethics and responsible conduct of research; Overview of different research paradigms and approaches.

Unit 2: Research Design and Data Collection(15 class, 20 marks)

Types of research designs: experimental, observational, survey, and qualitative; Sampling techniques and sample size determination; Data collection methods: surveys, interviews, observations, and archival research, Designing data collection instruments: questionnaires, interview guides, and observation protocols.

Unit 3: Data Analysis, Interpretation and Research Communication (15 class, 20 marks)

Introduction to quantitative and qualitative data analysis methods; Statistical analysis techniques: descriptive statistics, inferential statistics, correlation, and regression; Qualitative data analysis approaches: thematic analysis, content analysis, and grounded theory; Interpreting and presenting research findings effectively

Writing research proposals and research reports; Creating effective research presentations; Scholarly writing conventions and citation styles; Peer review process and academic publishing

Unit 4: Practical (15 class, 20 marks)

1. Research Proposal Development: Students will learn how to develop a research proposal, including identifying research questions, formulating hypotheses, and designing an appropriate research methodology.
2. Data Collection Techniques: Students will practice various data collection techniques, such as surveys, interviews, observations, and experiments, to gather relevant data for their research projects.
3. Data Analysis and Interpretation: Students will learn statistical analysis techniques and software tools to analyze and interpret research data, drawing meaningful conclusions and identifying patterns or relationships.
4. Literature Review and Critical Analysis: Students will conduct a comprehensive literature review on their research topic, critically analyzing and synthesizing existing studies and identifying research gaps.

Suggested Readings

1. C.R. Kothari, Research Methodology: Methods and Techniques
2. Research Methodology: Tools And Techniques Dr. Prabhat Pandey Dr. Meenu Mishra Pandey

Paper Title: Bioresource Management

(Minor course) Paper Code: BOTMIN 401-4
Paper credit: 04(3T+1P)

Total number of lectures: 60=40+15(L+P) **Total Marks: 100 (T50+P20+IA30)**

Course Objectives

Bioresource Management - Gain knowledge and skills to effectively manage and sustainably utilize biological resources for various purposes, including conservation, economic development, and environmental stewardship.

Course Outcome

- Understand the principles and concepts of bioresource management, including the sustainable use and conservation of biological resources.
- Apply analytical and problem-solving skills to assess and manage bioresources in various contexts, considering ecological, economic, and social factors.
- Demonstrate knowledge of different bioresource management strategies and techniques, such as biodiversity assessment, habitat restoration, and sustainable harvesting practices.
- Evaluate the impacts of human activities on bioresources and develop strategies to mitigate negative effects and promote sustainable resource management

Unit 1: Biological Resources, Forests (15 class, 20 marks)

Biodiversity-definition and types; Significance; Threats; Management strategies;Bio-prospecting; IPR; CBD; National Biodiversity Action Plan). Definition, study of various forests of the world and India. Forest products – Major and minor. Influence of forest on environment. Consequence of deforestation and industrialization. Sustainable use of bioresources.

Unit 2: Energy, Contemporary practices in resource management (15 class, 20 marks)

Renewable and non-renewable sources of energy, EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasison carbon footprint, Resource Accounting; Waste management. National and international efforts in resource management and conservation.

Unit 3: Acts and policies (15 class, 20 marks)

Forest Conservation Act 1981; Environment (protection) Act 1986; Hazardous waste (Management and Handling) Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Environmental Impact Assessment (EIA); Environmental Management Plan (EMP) and Environmental Clearance for Establishing Industry (ECEI); National Biodiversity Action Plan National Biodiversity Act 2002.

Unit 4: Practical (15 class, 20 marks)

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modeling.

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.

3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

SEMESTER VIII

Paper Title: Environmental Biotechnology
(Major course) Paper Code: BOTMAJ 405-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=40+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course Objectives

- This course will cover indepth knowledge in Environmental Biotechnology, will emphasise its importance and working in Forensic Science Laboratory.

Course Outcome

- The Significance in Environmental Biotechnology.
- The fundamental principles, functions and application of industrial products like air, water, and soil pollution and waste in forensic Science.
- The use of tools and techniques in identification and recognition in forensic Science.
- The working of the Regulatory affairs in forensic Establishment in India.
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Unit 1: Introduction to environmental biology (15 class, 20 marks)

Basic components of environment, Concept of ecosystem, abiotic and biotic components. Environmental pollution: Air, water, and soil pollution. Environmental monitoring: Air, water and soil sampling, Analyses of samples by physical, chemical and biological methods; Environmental impacts and their assessments using bioindicators, Biomarkers, biosensors and toxicity testing.

Unit 2: Waste treatment strategies (15 class, 20 marks)

Classification and characterization of waste. Principles and mechanisms of waste treatment. Nitrification and denitrification – microbial fundamentals and application. Aerobic processes: Activated sludge, oxidation ditches, trickling filters, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic processes: Anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactor. Economics and special aspects of waste treatment. Examples of treatment schemes for waste waters of dairy, tannery, sugar and antibiotic industry.

Unit 3: Biodegradation and bioremediation, Environmental protection and conservation(15 class, 20 marks)

Principle and mechanism of biodegradation. Biodegradation of xenobiotic compounds (Lignin, Hydrocarbons, Detergents, Dyes and pesticides). Biodeterioration – Principles, prevention and control, phytoremediation of organic and metallic pollutants, use of microbes in bio-remediation, Microbial interaction with metallic elements, metal toxicity. Biosurfactants: Microbial production and application.

Status and Scope of biotechnology in environmental protection. Non-conventional energy sources. Various environmental standards: air, water and noise quality. Environment protection Act: environmental laws, policies, ethics. Environmental protection agencies.

Unit 4 : Practical (15 class, 20 marks)

1. Quantitative analysis of water conductivity, BOD, COD and pH.
2. Determination of turbidity of a given sample .
3. Quantitative analysis of water alkalinity.
4. Quantitative analysis of water acidity.
5. Quantitative analysis of water hardness.
6. Quantitative analysis of water chloride.
7. To prepare a report on various types of local industrial effluents.
8. Demonstration of composting techniques.
9. Demonstration of Microbiological quality of water **(**MPN test).

Suggested Readings

1. Environmental Biotechnology, Principles and Applications by Bruce E Rittman and Perry L McCarty, McGraw-Hill Higher education.
2. Environmental Biotechnology Edited by Hans-Joachim Jördening and J Winter, WILEY-VCH Verlag Gmbh & Co.
3. Bioremediation and Natural Attenuation by Pedro J Alvarage and Walter A Illman, Wiley Interscience.
4. Environmental Biotechnology, Vol 10 Handbook of Environmental Engineering, Edited by L K Wang et al, Humana Press.

Paper Title: Ethnobotany
(Minor course) Paper Code: BOTMIN 402-4
Paper credit: 04(3T+1P)
Total number of lectures: 60=45+15(L+P) Total Marks: 100 (T50+P20+IA30)

Course Objectives

Explore the interrelationship between plants and human cultures, including traditional knowledge, uses, and conservation of plants for medicinal, cultural, and economic purposes.

Course Outcome

- Understand the cultural significance of plants and their traditional uses in different societies, including medicinal, culinary, ceremonial, and economic purposes.
- Apply ethnobotanical research methods to document and analyze traditional knowledge related to plants, including indigenous practices, plant identification, and plant use patterns.
- Evaluate the conservation and sustainability of plant resources, considering the impact of human activities, climate change, and cultural dynamics, and propose strategies for their protection and management.

Unit-1 (15 class, 20 marks)

Introduction, relevance, scope and status. Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany.

Unit-2 (15 class, 20 marks)

Folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.

Unit-3 (15 class, 20 marks)

Centres of Ethno botanical studies in India, Ethnomedicine and Primary health care; Renewable plant products: Sustainable source of income; Protecting local resources. Commercialization and conservation: Sustainable development - Economic growth and resource

conservation. Role of Ethnobotany in conservation and sustainable development

Unit 4: Practical (15 class, 20 marks)

Field trip to tribal settlement to survey, document and frame hypothesis on people-plant relationship.

1. Collection, processing and preservation of ethnobotanical specimens in the institutional repository.
2. Identify and document plant parts used in preparation of crude drugs/herbal formulations.

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.
3. Jain, S. K. (1981). Glimpses of Indian Ethnobotany. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi
4. Cunningham, A. B. (2001). Applied Ethnobotany. Earthscan publishers Ltd. London & Sterling, VA, USA Cotton, C.M. (1996).
5. Ethnobotany-Principles and application. John Wiley& Sons Ltd., West Sussex, England

Paper Title: Dissertation
Paper Code: BOTDIS 401-12

Paper credit: 12

Total Marks: 100

- Topic Selection: Choose a research topic in your field of study that is relevant, interesting, and feasible to conduct within the given time and resources.
- Proposal Development: Prepare a detailed research proposal outlining the research objectives, methodology, and expected outcomes. Seek guidance from your supervisor to refine and finalize the proposal.
- Literature Review: Conduct a comprehensive review of relevant literature to gain a thorough understanding of the existing knowledge and research gaps related to your chosen topic.
- Data Collection: Collect data using appropriate research methods, which may include surveys, experiments, interviews, observations, or data analysis of existing datasets. Ensure the data collected is reliable, valid, and representative of the research objectives.
- Data Analysis: Analyze the collected data using suitable statistical or qualitative analysis techniques. Interpret the results to draw meaningful conclusions that address the research objectives.
- Discussion and Conclusion: Discuss the findings of your research in the context of existing literature and theories. Draw conclusions based on the results and discuss their implications for the field of study.
- Report Writing: Prepare a well-structured and organized dissertation report that includes an introduction, literature review, methodology, results, discussion, conclusion, and references. Adhere to the formatting and citation style specified by your institution.
- Presentation and Defense: Prepare a presentation summarizing your research findings and present it to an academic committee. Defend your dissertation by answering questions and addressing feedback from the committee members.
- Revision and Editing: Review and revise your dissertation based on the feedback received. Pay attention to grammar, spelling, and formatting errors. Seek assistance from your supervisor or peers to ensure the quality of your final document.
- Submission: Submit your final dissertation within the specified deadline, along with any additional required documents or forms.

Paper Title: Biochemistry

(Minor course) Paper Code: BOTADL 401-4
Paper credit: 04(3T+1P)

Total number of lectures: 60=40+15(L+P) **Total Marks: 100 (T50+P20+IA30)**

Course Objectives

Understand the fundamental principles and processes of biological chemistry, including the structure, function, and metabolism of biomolecules, and their roles in cellular and molecular processes.

Course Outcome

- Demonstrate a comprehensive understanding of the structure, properties, and functions of biomolecules, including proteins, carbohydrates, lipids, and nucleic acids, and their roles in cellular processes.
- Apply biochemical techniques and laboratory skills to perform experiments, analyze data, and interpret results related to biochemical processes and enzyme kinetics.
- Explain the principles of metabolic pathways, including energy metabolism, biosynthesis, and regulation, and their significance in cellular and organismal functions.

Unit 1 Enzyme (15 class, 20 marks)

Principle of catalysis, Kinetics and Mechanism.

Unit 2 Metabolism of Carbohydrates and Lipids (15 class, 20 marks)

Classification, synthesis and breakdown, citric acid cycle, fatty acid oxidation, Glycolysis, pentose phosphate, membrane lipids.

Unit 3 Membrane Biology and Bioenergetics Metabolism of Amino Acids and Proteins (15 class, 20 marks)

This subject deals in providing knowledge about Membrane biology, membrane structure, membrane transport, oxidative phosphorylation, ETC.

This subject includes amino acid metabolism, biosynthesis and catabolism of amino acids, biosynthesis of purine and pyrimidine nucleotides.

Unit 4 Practicals (15hrs class, 20 marks)

1. Safety practices in the laboratory.
2. Preparation and storage of solutions.
3. Concepts of solution concentration and storing solutions.
4. Concept of a buffer, Henderson-Hasselbach equation, working of a pH meter.
5. Quantitative transfer of liquids.

Suggested Readings

1. Principles of Biochemistry by Albert L. Lehninger
2. Harper's Illustrated Biochemistry by Robert K. Murray
3. Essentials of Biochemistry by Mushtaq Ahmad
4. Biochemistry by U. Satyanarayana
5. Lippincott's Illustrated Reviews: Biochemistry by Pamela C. Champe
6. Biochemistry (1998) by Geoffrey Zubay. Fourth edition, WC Brown Publishers, USA.
7. Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition.

Paper Title: Advanced Plant Pathology

(Minor course) Paper Code: BOTADL4 02-4
Paper credit: 04(3T+1P)

Total number of lectures: 60=45+15(L+P) **Total Marks: 100 (T50+P20+IA30)**

Course Objectives

Develop an in-depth understanding of plant diseases, their causes, mechanisms, and management strategies, and apply advanced diagnostic and research techniques in the field of plant pathology.

Course Outcome

1. Acquire advanced knowledge of plant pathogens, including their classification, biology, and pathogenicity mechanisms, and apply this knowledge in the diagnosis and management of plant diseases.
2. Develop expertise in the use of advanced techniques and methodologies for the identification, characterization, and quantification of plant pathogens, as well as the assessment of host-pathogen interactions.
3. Demonstrate the ability to critically analyze scientific literature and research findings in the field of advanced plant pathology, and effectively communicate research outcomes through oral presentations and written reports.

Unit 1(15 class, 20 marks)

The concept of plant diseases in plants, history of plant pathology, Abiotic and Biotic causes of plant diseases; diagnosis of plant diseases, Koch's postulate and germ theory of diseases, Parasitism and disease development**,** pathogenicity and host range; symptoms of plant diseases and dissemination. Epidemiology and disease forecasting, Effects of environmental factors on Epidemiology.

Unit 2 (15 class, 20 marks)

Plant virology: History of plant viruses, composition and structure of plant virus, symptoms, transmission, host virus interaction, management of plant viruses. Symptomatology, disease cycle, control measures and management of some important plant disease caused

by fungi, bacteria, nematode, fungal like organisms and flagellate protozoa. Diseases and change in physiological functions like photosynthesis, respiration, permeability, transcription and translation.

Unit 3 (15 class, 20 marks)

Plant defence mechanism, induced and non-induced structural and biochemical defence mechanism, systematic acquired resistance, induced resistance, plantibodies, Genetics of plant disease. Control of plant diseases: and biological disease control, Integrated disease management (IDM), IDM in important crops-rice, tea, mustard, pulses, and vegetable crops.

Unit 4 : Practical's (15hrs class, 20 marks)

1. Collection and identification of diseased plants and plant parts
2. Isolation and identification of plant pathogenic fungi from diseased plants.
3. Collection of soil, litter, water, leaf and seed from various sources for the isolation of fungi.
4. Techniques of isolation of fungi, dilution method, soil plate method, agar plate method and blotter method from soil, litter and seed.

Suggested Readings

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley &Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press,Cambridge. 3rd edition.

Paper Title: Plant Pharmacology and Pharmacognosy
(Minor course) Paper Code: BOTADL 4 03-4
Paper credit: 04(3T+1P)

Total number of lectures: 60=40+15(L+P) **Total Marks: 100 (T50+P20+IA30)**

Course Objectives

Gain a comprehensive understanding of the medicinal properties and therapeutic applications of plants, as well as the principles and techniques of pharmacognosy, for the development and evaluation of plant-based medicines.

Course learning outcome:

- Develop a deep understanding of the pharmacological properties of various plant compounds, including their mechanisms of action and potential therapeutic applications.
- Acquire knowledge and skills in the identification, collection, processing, and quality assessment of medicinal plants, as well as the extraction and isolation of bioactive compounds.
- Apply principles of pharmacognosy and pharmacological evaluation to assess the safety, efficacy, and quality of plant-based medicines, and critically analyze scientific literature in the field of plant pharmacology and pharmacognosy.

Course contents

Unit 1: Introduction to Plant Pharmacology and Pharmacognosy (15 class, 20 marks)

Overview of plant pharmacology and pharmacognosy, History of Pharmacology and pharmacognosy, Principles of pharmacology and drug discovery, Role of medicinal plants in healthcare practices.

Ethical considerations and sustainability in plant-based medicine

Unit 2: Phytochemical Analysis and Characterization (15 class, 20 marks)

Extraction techniques for plant bioactive compounds, Chromatographic separation methods, Spectroscopic techniques for compound identification, Structural elucidation of phytochemicals

Unit 3: Pharmacological Activities and Mechanisms of Action (15 class, 20 marks)

Bioassays for evaluating pharmacological activities, Pharmacodynamics and pharmacokinetics of plant compounds, Mechanisms of action of bioactive compounds, Interactions with cellular targets and signaling pathways

Unit 4 : Practical (8 class, 20 marks)

1. Study of microscopic structure of the plant tissues
2. Test for oil: Mustard, coconut, sunflower, castor.
3. Test for gums, resins and tannins.
4. Biochemical evaluation of medicinal plants.

Suggested Readings

1. Natural Products from plants, Ist edn, by Peter B. Kaufman, CRC press, Newyork, 1998 5.
2. Glimpses of Indian Ethanopharmacology by P. Pushpangadam,UIF Nyman, V.George, Tropical botanic Gardon and research institute., 1995

3. Text book of Pharmacognosy, by G.E.Treese nad W.C.Evans, 15th edn, W.B. Saunders Edenburg, NewYork.,
4. Text book of Pharmacognosy by C.K.Kokate, Purohit, Ghokhale, 5th edn nirali prakassan., 1996