

As per the NEP 2020
Bachelor of Science
Botany

(Effective from Academic Year 2024-2025 onwards)



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Semester – I

Learning Objectives:

- This course will help the student to understand the diversity of plants and evolutionary process in plant kingdom

Learning outcomes:

By studying this course, the students will be able to:

- Understand the diversity among plants.
- Develop conceptual skill about identifying algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.
- Understand the plant body structure, economic importance and life cycle of algae, fungi, lichen, bryophyte, pteridophyte and gymnosperms.

Course Title:	Diversity of Plant Kingdom	Course Code: 24BBO5101T
Total Lecture hour 45		
Unit I	Algae: General characteristics, Classification (Fritsch) up to classes. Diverse habitat. Range of thallus structure, pigments and reproduction in Algae. Important features, structures and life history of <i>Nostoc</i> (Cyanophyceae); <i>Chara</i> (Chlorophyceae); <i>Polysiphonia</i> (Rhodophyceae); Economic importance of Algae. Fungi: General characteristics; Thallus organization; Cell wall composition; Nutrition; Reproduction. Classification (Alexopoulos); Heterokaryosis and Parasexuality; Economic importance. Type studies <i>Albugo</i> (Oomycota); <i>Peziza</i> (Ascomycota); <i>Agaricus</i> (Basidiomycota).	13
Unit II	Lichen - General characteristics; Morphology and reproduction. Economic importance of lichens. Bryophytes: General characteristics, Classification (up to classes); Morphology and Reproduction of <i>Marchantia</i>, <i>Anthoceros</i>, <i>Funaria</i>. Ecological and economic importance of bryophytes.	11
Unit III	Pteridophytes: General Characteristics; Classification (up to classes by Smith), Fossil pteridophytes (<i>Rhynia</i>). Morphology and Reproduction of <i>Selaginella</i> and <i>Marsilia</i> .; Stelar evolution, Heterospory and seed habit in Pteridophytes. Economic importance of Pteridophytes.	11
Unit IV	Gymnosperms: General Characteristics and Classification by Sporne, 1965. Type studies: Life histories of <i>Cycas</i>, <i>Ephedra</i> (Developmental details not to be included). Economic importance of gymnosperms. Angiosperms: General characters, Differences between Monocotyledons and Dicotyledons, Typical life cycle of Angiosperm.	10
Suggestive Readings:		
1	Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.	
2	Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition	
3	Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.	
4	Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.	
5	Singh V., Pandey P. C., Jain D. K. A textbook of botany.	
6	Pandey B.P. (2022). Algae, Bryophytes and Lichens, S. Chand Publication.	

Learning Objectives

- To provide practical experience in identifying and understanding the diversity of plant

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forms and structures, including their classification and ecological roles.

- To explore the evolutionary relationships and adaptations of various plant groups.

Learning outcomes

- Students will learn to carry out practical work in the laboratory.
- Students will learn to study and describe the morphology and anatomy of various groups of plants.

Course Title:	Botany Practical –I	Course Code: 24BBO5101P
1. Algae 1. Study of vegetative and reproductive structures of <i>Nostoc</i> , <i>Chara</i> and <i>Polysiphonia</i> through temporary preparations and permanent slides.		
2. Fungi 1. <i>Albugo</i> : Asexual stage from temporary mounts and sexual structures through permanent slides. 2. <i>Peziza</i> : Micropreparation and study of vegetative structure and ascocarp 3. <i>Agaricus</i> : Specimens of button stage and full-grown mushroom; Sectioning of gills of <i>Agaricus</i> .		
3. Lichens Study of growth forms of lichens through specimens and permanent slides (crustose, foliose and fruticose)		
4. Bryophyta 1. <i>Marchantia</i> - morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides). 2. <i>Anthoceros</i> - morphology of thallus, w.m. rhizoids, v.s. thallus, t.s. and l.s. of sporophyte. 3. <i>Funaria</i> - morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule.		
5. Pteridophyta 1. <i>Selaginella</i> - morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, (temporary slides), l.s. strobilus (permanent slide). 2. <i>Marsilea</i> - morphology, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, l.s. sporocarp (permanent slide).		
6. Gymnosperms 1. <i>Cycas</i> - morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, tv.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), specimen megasporophyll, l.s. ovule (permanent slide). 2. <i>Ephedra</i> - morphology t.s. stem, l.s. male and female cone (temporary slides).		
7. Angiosperms Study of monocot and dicot flowers and seeds.		
8. Viva-voce		
9. Practical Record		
10. Visit local garden/pond/field study of plants		
Suggestive Readings:		
1. A text book of Practical Botany: Bendre & Kumar - Rastogi Publications, Delhi.		
2. Practical Botany: H. N. Srivastava – Pradeep Publications, Jalandhar.		

Semester – II

Learning Objectives:

- To provide basic knowledge on the concepts of cell structure, cell organelles, cell cycle, Inheritance, linkage, sex determination and plant breeding.

Course Outcomes:

Upon completion of this course, the students will be able to:

- Understand the concept on the cellular and molecular mechanisms involved in heredity and variation.
- Understand the patterns of inheritance in different organisms.
- Outline basics of linkage of genes, sex determination and quantitative inheritance.
- Understand the inheritance pattern of extranuclear genes.
- Understand the application of principles and modern techniques in plant breeding.
- Explain the procedures of selection and hybridization for improvement of crops.
- Solve problems related to genetics.

Course Title:	Cell Biology, Genetics and Plant Breeding	Course Code: 24BBO5201T
Total Lecture Hours 45		Hours
Unit I	Cell Structure: Eukaryotic and Prokaryotic cell, a brief account of ultra-structure of a plant cell. Structure and function of cell organelles: Cell wall, Plasma membrane, Nucleus, Mitochondria, Chloroplast, Ribosome, Peroxisomes, Lysosomes, Golgi bodies and Endoplasmic reticulum. Chromosomes: structure; euchromatin and heterochromatin, types Lampbrush chromosomes, B chromosomes, polytene chromosomes. Cell cycle: mitosis and meiosis.	12
Unit II	Mendelian Genetics: Mendelian Principles of inheritance, deviations (Incomplete dominance, codominance and lethality); Epistasis; Polygenic inheritance; Chloroplast and Mitochondrial inheritance in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramecium. Brief introduction to sex determination. Linkage and crossing over: Linkage and crossing over, three factor crosses.	12
Unit III	Chromosomal aberrations: Structural chromosomal aberrations: Deletion; Duplication; Inversion; Translocation; Numerical chromosomal aberrations: Euploidy and aneuploidy, Monoploidy and Polyploidy and their role in evolution of plants. Mutations: Types of mutation; Molecular basis of mutations; Chemical mutagens (Base analogs, deaminating, hydroxylating, alkylating and intercalating agents) and Physical mutagens (Ionising and Non-ionising radiations).	11
Unit IV	Plant Breeding: Introduction and objectives. Methods of plant breeding (a) Introduction and acclimatization (b) Selection- Mass, Pure line and Clonal selection (c) Hybridization techniques in self and cross-pollinated crops (d) Male sterility and its significance (e) Mutation breeding Inbreeding depression and heterosis: History, genetic basis of inbreeding depression and heterosis; Applications.	10
Suggestive Readings:		
1	Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons, Inc	
2	Animal Cytology and Evolution- MJD, White Cambridge University Publications	
3	Molecular Cell Biology-Daniel, Scientific American Books	
4	Celi Biology - Jack D Bruke, The William Twilkins Company	
5	Principles of Gene Manipulations- Old & Primrose, Black Well Scientific Publications	
6	Ambrose & Dorothy. Cell Biology, N4 Easty, ELBS Publications	
7.	Sharp L.W. Fundamentals of Cytology, McGraw Hill Company	
8.	P.K. Gupta. Genetics, Rastogi Publication, Meerut, India	
9.	Powar C.B. 2010. Cell Biology, Himalaya Publishing House.	
10.	Shukla, R. S. and P. S. Chandel. 2007. Cytogenetics, Evolution, Biostatistics and Plant Breeding. S.Chand & Company Ltd., New Delhi.	
11.	Verma, P. S. and V. K. Agrawal. 2004. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S.	

	Chand & Company Ltd., New Delhi.
12.	Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
13.	Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
14.	Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

Course objective:

The objective of this course is:

- To give practical experience in understanding different cell structures, its organelles and multiplication.
- To learn the laws of heredity with a practical emphasis on inheritance.

Learning outcomes

After successful completion of this practical course, the student shall be able to:

- Show an understanding of techniques for demonstrating Mitosis and Meiosis in the laboratory and identify different stages of cell division.
- Identify and explain with a diagram the cellular parts of a cell from a model or picture and prepare models
- Solve the problems related to crosses and gene interactions.
- Demonstrate plant breeding techniques such as emasculation and bagging.

Course Title:	Botany Practical- II	Course Code: 24BBO5201P
1.	1. Study of plant cell structure with the help of epidermal peel mount of Onion/ <i>Rhoeo/Crinum</i> . 2. Demonstration of the phenomenon of protoplasmic streaming in <i>Hydrilla</i> leaf. Study of ultra structure of plant cell and its organelles using Electron microscopic Photographs/models. 3. Observation of growth and differentiation in single cells (pollen grains) by hanging drop culture 4. Count the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains). 5. Mounting of polytene chromosomes	
2.	1. Isolation of plant cellular DNA 2. Demonstration of Mitosis in <i>Allium cepa/Aloe vera</i> roots using squash technique; observation of various stages of mitosis in permanent slides. 3. Demonstration of Meiosis in P.M.C.s of <i>Allium cepa</i> flower buds using squash technique; observation of various stages of meiosis in permanent slides. 4. Study of structure of DNA and RNA molecules using models. 5. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.	
3.	1. Solving problems monohybrid, dihybrid, back and test crosses. 2. Solving problems on gene interactions (at least one problem for each of the gene interactions in the syllabus). 3. Chromosome mapping using 3- point test cross data.	
3.	1. Demonstration of emasculation, bagging and artificial pollination techniques for hybridization. 2. Study of self and cross-pollinated plants; vegetative propagation 3. Pollen viability test	
Suggestive Readings:		
1.	Debarati Das. Essential Practical Handbook of Cell Biology & Genetics, Biometry & Microbiology A Laboratory Manual (2017), 1st Edition	
2.	Laboratory Manual for Molecular Genetic Tests (2014), 1St Edition by Chowdhury, Jaypee Brothers Medical Publishers.	

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Semester – III

Learning Objectives

- This course will help the student to understand the whole taxonomic description of plants and their economic values.

Learning outcomes

By studying this course, the students will be able to:

- Understand the variety of plants.
- Develop conceptual skill about classifying angiosperms.
- Understand the plant floral diversity, economic importance and systematics.

Course Title:	Taxonomy and Economic Botany		Course Code: 24BBO6301T
Total Lecture Hours: 45			Hours
UNIT-I	Systematics: Identification, classification, nomenclature; Functions of Herbarium; Important herbaria and botanical gardens of the world and India. Important flora, Botanical Nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations. Classification: artificial, natural and phylogenetic. Bentham and Hooker (up to series) and Hutchinson classification.		12
UNIT-II	Diversity of flowering plants illustrated by members and economic importance of the following: Ranunculaceae, Papaveraceae, Malvaceae, Brassicaceae, Fabaceae, Apiaceae, Asteraceae, Solanaceae, Apocyanaceae, Asclepidiaceae, Lamiaceae, Euphorbiaceae, Liliaceae, Poaceae.		12
UNIT-III	Economic Botany: Basic concept of center of origin of cultivated plants. Cultivation, production and uses of Cereals: Wheat and maize, Legumes: Groundnut, Black gram, Spices and condiments: Cumin, clove, cardamom and black pepper, Beverages: Tea, coffee (including processing). Study of the plants with botanical names, family, part used, and economic uses yielding Rubber, Vegetable oil: Mustard; Dyes: Henna; Timber: Sal, Teak, Shisham, Rohida.		11
UNIT-IV	Fibers: Classification based on the origin of fibers, Cotton and Jute (morphology, extraction and uses). Medicinal plants - Ocimum, Adhatoda, Turmeric, Ashwgandha, Neem, Giloy, Ghritkumari, Senna, Isabgol, Safed musli. General account on vegetables and fruits. Ethnobotany: Introduction, scope and significance. Ethnobotany in context of Rajasthan.		10
Suggestive Readings:			
1. Taxonomy of Angiosperms – V.N. Nair (1995) TMH Publishing Company Limited New Delhi.			
2. Plant Taxonomy – Sushella M. Das (2003) Dominant Publishers and Distributors, New Delhi.			
3. Introduction to the Principles of Plant Taxonomy V.V. Sivarajan (1984) Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.			
4. Plant systematics. Gureharan Singh (2001) Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.			
5. Trivedi, P.C.; N. Sharma and J.L. Sharma (2003) Structure, Development and Reproduction in Flowering. Plants. Ramesh Book Dept, Jaipur.			
6. Essentials of Economic Botany- R.L.Prasad, B P Nautiyal, Medtech Publishers (2018) 1st edition.			
7. A Textbook of Modern Economic Botany, CBS Publishers and Distributors, Sambamurty A.V.S.S.			
8. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.			
9. B.P. Pandey (2007). Economic Botany, S. Chand & Company Ltd. New Delhi. 17/e.			

Learning Objectives:

- To develop hands-on skills in identifying, classifying, and documenting plant species using taxonomic principles and tools.
- To explore the economic significance of various plants, understanding their uses in agriculture, medicine, and industry through practical applications and case studies.

Learning outcomes

- Students will learn to carry out practical work in the laboratory and field.
- Students will learn to study and describe the floral features and economic importance of plants.
- To study about Pollination in nature.

Course Title:	Botany Practical- III	Course Code: 24BBO6301P
1.	Taxonomy – Description of specimen from representative, locally available families - Ranunculaceae, Papaveraceae, Malvaceae, Brassicaceae, Fabaceae, Apiaceae, Asteraceae, Solanaceae, Apocyanaceae, Asclepidiaceae, Lamiaceae, Euphorbiaceae, Liliaceae, Poaceae. Types of inflorescences and fruits. Study of specimens with special reference to Wheat and maize, Groundnut, Black gram, Cumin, clove, cardamom and black pepper, Tea, coffee. Study of economy of plant with special reference to Rubber, Vegetable oil: Mustard; Dyes: Henna; Timber: Sal, Teak, Shisham, Rohida.	
3.	Study of Fibers - Cotton and Jute. Study of Ocimum, Adhatoda, Turmeric, Ashwgandha, Neem, Giloy, Ghritkumari, Senna, Isabgol, Safed musli with special reference to cure. Prepare 5-5 specimens of vegetables and fruits. Ethnobotany: Collection of locally used ethnobotanical plant species of the Shekhawati region.	
4.	Field trips within and around the campus, compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated as are abundant.	
Suggestive Readings:		
1.	A Textbook of Practical Botany 2, Bendre and Kumar, Rastogi Publications, 7 th Edition.	
2.	Practical Taxonomy of Angiosperms, R.K. Sinha, 2 nd Edition, Tech Sar Pvt Ltd	

Semester – IV**Course Objectives:**

- This course deals with physical, chemical and biological functioning of plants. It is designed to survey current aspects of plant processes, biochemistry and functions with emphasis on recent research progress in related fields.

Learning Outcomes:

- Describe the various physiological aspects in plants.
- Examine the role, structure and importance of biomolecules associated with plant life.
- Preliminary understanding of the basic functions and metabolism in a plant body.
- Evaluate the role of enzymes in plant life.
- To understand the importance of nutrients in plant metabolism and crop yield.

Course Title:	Plant Physiology and Biochemistry	Course Code: 24BBO6401T
Total Lecture Hours: 45		Hours
UNIT-I	Plant water relations - Diffusion, imbibition, osmosis, OP, DPD, TP; water potential - concepts and components (pressure potential, gravity potential, osmotic potential and matric	

	potential). Absorption of water - active and passive, pathway of water movement - apoplastic and symplastic pathway. Ascent of sap: cohesion-tension theory. Transpiration - types, mechanism, theories (Starch-sugar, Proton-K ⁺ ion exchange), significance; anti-transpirants. Guttation. Mineral nutrition: Role of major and minor elements in plant nutrition, deficiency symptoms of essential nutrients; mineral uptake - passive (ion exchange) and active (carrier concept).	12
UNIT-II	Translocation of solutes: pathway of phloem transport, mechanism - pressure flow, mass flow hypothesis; phloem loading and unloading. Photosynthesis: Photosynthetic pigments, Light reaction; red drop and Emerson enhancement effect. Photosystems - components and organization; cyclic and non-cyclic photophosphorylation; carbon assimilation pathways - C3, C4 plants, CAM. Photorespiration. Factors affecting photosynthesis. Respiration: anaerobic and aerobic; glycolysis, Krebs's cycle, mitochondrial electron transport system - components, oxidative phosphorylation, ATPase. RQ - significance. Factors affecting respiration.	12
UNIT-III	Nitrogen fixation: Biochemistry of nitrogen fixation, nitrogenase, nitrogen fixation in legumes, nitrate assimilation, ammonium assimilation. Plant hormones: Biosynthesis, physiological effects of auxins, gibberellins, cytokinins, ABA, and ethylene. Plant movements: tropic movements - geotropism and phototropism; nastic movements - seismonastic and nyctinastic movements. Physiology of flowering - phytochrome, photoperiodism, vernalization.	11
UNIT-IV	Carbohydrates: General structure and functions, Classification- mono (glucose and fructose), di (maltose and sucrose) and Polysaccharides (starch and cellulose) Lipids: Classification and Structure, Fatty acids - saturated and unsaturated; fatty acid derivatives - fats and oils; compound lipids (brief study only). Proteins: General properties, Classification of Amino Acids, denaturation and renaturation, structural organization of proteins primary, secondary, tertiary and quaternary structures. Enzymes: Structure and properties; Mechanism of enzyme action, coenzymes, allosteric enzyme, isozymes, enzyme inhibition.	10
Suggestive Readings:		
1.	Dayananda B, 1999. Experiments in Plant Physiology. Narosa Publishing House, New Delhi.	
2.	Hopkins WG, Norman PA, Huner, 2008. Introduction to plant physiology. John Wiley and sons. New York.	
3.	Jain JL, Sanjay Jain, Nitin Jain, 2005. Fundamentals of Biochemistry. S Chand, New Delhi.	
4.	Salisbury F B, Ross C W, 1992. Plant Physiology. CBS Publishers and Distributors, Delhi.	
5.	Pandey S N, Sinha BK, 2006. Plant Physiology. Vikas Publishing House Pvt. Ltd.	
6.	Srivastava H S, 2005. Plant Physiology. Rastogi Publications, Meerut.	
7.	Lehninger AL, 1961. Biochemistry. Kalyan publishers, Ludhiana.	
8.	Verma V, 2007. Text book of Plant Physiology. Ane Books India, New Delhi.	
9.	Nelson DL, Cox MM, 1993. Principles of Biochemistry. Mac Millan Publications.	
10.	Taiz L, Zeiger E, 2003. Plant Physiology (III Ed). Panima Publishing Corporation, New Delhi.	
11.	Sadasivam S, Manickan A, 1996. Biochemical Methods. New Age International Ltd. New Delhi.	

Learning Objective:

- To gain practical experience in investigating and analyzing the physiological processes in plants, including growth, photosynthesis, respiration, and nutrient uptake.
- To apply biochemical techniques to study plant metabolism, enzyme activity, and the roles of

biomolecules in plant function and adaptation.

Learning outcomes:

- Understand plant structures in the context of physiological functions of plants.
- They will be able to understand the physiological details of photosynthesis, respiration, growth, enzyme activity etc.

Course Title:	Botany Practical- IV	Course Code: 24BBO6401P
1.	1. Experiment to demonstrate osmosis by using potato osmoscope, exosmosis and endosmosis. 2. To determine the osmotic pressure of the cell sap of <i>Rheo/Tradescantia</i> leaf epidermal peeling by plasmolytic method. 3.. Determination of water potential of given tissue (potato tuber) by weight method. 4. Study the effect of organic solvent and temperature on membrane permeability. 5. To compare the rate of transpiration from the two surfaces of leaf by cobalt chloride paper method. 6. Effect of light intensity on transpiration using Ganong's photometer 7. Determination of stomatal frequency using leaf epidermal peelings/impressions. 8. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte. 9. Demonstration of root pressure by Manometer. 10. Mineral deficiency- Detailed study of Micronutrients and macronutrients.	
2.	11. To demonstrate that oxygen is liberated in the process of photosynthesis. 12. Identification of C3, C4 and CAM plants 13. To determine the rate of photosynthesis by using Wilmott's bubbler. 14. Effect of carbon di oxide concentration on the rate of photosynthesis 15. Effect of monochromatic light on the rate of photosynthesis 16. Separation of photosynthetic pigments by solvent method and by using paper chromatography and measuring their Rf values 17. Estimation of total chlorophyll content by Arnon method. 18. To isolate and identify the amino acids from a mixture using paper chromatography. 19. To prove that carbon dioxide is released during respiration by using Ganong's respiroscope 20. Measurement of respiration rate using germinating seeds and flower buds with simple respiroscope 21. Demonstration of anaerobic respiration	
3.	22. To measure the rate of growth of a plant using arc auxanometer. 23. To show that the negative geotropism of shoot is due to unilateral effect of gravity. 24. To study the effect of different concentrations of IAA on <i>Avena</i> coleoptile elongation (IAA Bioassay). 25. To Study of Phototropism.	
4.	26. Qualitative test for Starch, Protein, Reducing Sugars and Lipids. 27. Qualitative test for Starch, Protein, Reducing Sugars and Lipids. 28. Determination of catalase activity using potato tubers 29. To study the enzymatic activity of amylase	
Suggestive Readings:		
1.	Plummer DT, 1988. An introduction to practical biochemistry. Tata Mc Graw -Hill Publishing Company, New Delhi.	
2.	Shivkumar R., Bhoominathan P., Chandrasekhar, C.N. (2015): Practical Plant Physiology, Narendra Publishing	
3.	Pandey B. P. (2023). Botany for B. Sc. Students (Theory/ Practical) S. Chand & Company Ltd. New Delhi.	

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Semester – V

Course Objectives:

- This course will help the students understand the fundamental concepts of plant anatomy, embryology, and ecology, and analyse their interrelationships to explain plant structure, development, and interaction with the environment.

Course Outcomes:

After completing the course, students will be able to:

- Differentiate between monocot and dicot anatomy based on internal structures.
- Explain the processes of plant reproduction and development from gametogenesis to seed formation, highlighting key embryological stages.
- Analyse ecological principles and plant-environment interactions, including adaptations, succession, ecosystem dynamics and conservation issues.

Course Title:	Plant Anatomy, Embryology and Ecology	Course Code: 24BBO7501T
Total Lecture Hour 60		Hours
Unit I	Meristems and Tunica-Corpus theory (shoot apical meristem), Histogen and Quiescent Center theory (root apical meristem), Simple, complex and secretory tissues and their functions, tissue systems. Primary internal structure (root, stem and leaves), structure of leaf epidermis, trichomes and stomata. Origin of lateral roots, growth rings; sapwood and heartwood, periderm. Secondary growth (dicot root and stem). Primary anomalous internal structure and secondary anomalous growth in roots and stems with special reference to Nyctanthus, Bignonia, Boerhavia and Dracaena.	15
Unit II	Overview of angiosperm reproductive structures. Structure of anther, microsporogenesis, tapetum types and functions, development of male gametophyte, structure of pollen grains. Types of ovules, Megasporogenesis, development of female gametophyte (Embryo sac). Pollination and its types, Fertilization, double fertilization and its significance. Development of dicot and monocot embryos. Endosperm and its Types, Polyembryony, Induced polyembryony, Parthenocarp, Apomixis.	15
Unit III	Definition and Scope of Ecology. Atmosphere (four distinct zones viz, stratosphere, troposphere, mesosphere and thermosphere). Abiotic factors: light, temperature, water, soil. Biotic factors and plant adaptations (hydrophytes, xerophytes, halophytes). Ecosystem Ecology: Structure and function of ecosystems. Energy flow (food chains, food webs, ecological pyramids). Biogeochemical cycle (nitrogen). Population Ecology: Characteristics of populations. Growth models: exponential and logistic.	15
Unit IV	Community Ecology: Community structure and stratification. Ecological succession. Plant Interactions: Interspecific relationships (competition, mutualism, predation, allelopathy). Concept of ecological niche. Biomes: Major terrestrial biomes (tropical forest, grassland, desert, tundra). Vegetation types of Rajasthan, Endangered plants of Rajasthan. Conservation Ecology: Biodiversity (levels, values, threats). Conservation strategies: in situ & ex situ	15
Suggestive Readings:		
- Cutter, E.G. 1969. Part I: Cells and Tissues. Edward Arnold, London. - Cutter, E.G. 1971. Plant Anatomy: Experiment and interpretation, part II, organs. Educated Arnold; London. - Esau, K. 1977. Anatomy of Seed Plants, 2nd edition, John Wiley & Sons, New York. - Fahn, A. 1985. Plant Anatomy, Pergamon Press, Oxford. - Manseth, J.D. 1988. Plant Anatomy. The Benjamin/Cummings Publishing Co., Inc. Menlo Park, California, USA. - Trivedi, P.C.: N. Sharma and J.L. Sharma (2003) Structure, Development and Reproduction in Flowering Plants. Ramesh Book Depot, Jaipur. - Bhojwani, S.S. and Bhatnagar, S.P. (2000) The embryology Angiosperms 4th Edition Vikas Publishing House, New Delhi. - Johri, B.M. (2011). Embryology of Angiosperms. Springer-Verlag, Berlin. - An Introduction to the Embryology of Angiosperm. Maheshwari, P. (1950) New Delhi.		

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10. Recent Advances in the Embryology of Angiosperms. Ed. Maheshwari, P. (1963) New Delhi.
11. Maheshwari, P. (1971). An Introduction to Embryology of Angiosperms. McGraw Hill— Book Co., London.
12. Pandey, A. K. (2000). Introduction to Embryology of Angiosperms. CBS Publishers— & Distributors Pvt. Ltd., New Delhi.
13. Pandey, S. N., Chadha, A. (2009). Plant Anatomy and Embryology. Vikas Publishing House Pvt Ltd., New Delhi.
14. Sharma, P.D. (2009). Ecology and Environment. Rastogi Publications, Meerut.
15. Odum, E.P. (2005). Fundamentals of Ecology. Cengage Learning India Private Limited, Delhi

Suggested Laboratory Exercises:

1. Life forms exhibited by flowering plants (by visiting a forest or a garden).
2. L.S. of shoot tip to study the organization of meristem and origin of leaf primordia.
3. Anatomy of primary and secondary growth in monocots and dicots using handout sections of sunflower, maize, cucurbita stem and roots.
4. Anomalous secondary growth in stem: *Salvadora*, *Bignonia*, *Bougainvillea*, *Bauhinia*, *Nyctanthes*, *Leptadenia*, *Dracaena*.
5. Internal structure of Dorsiventral and isobilateral leaves; study of stomata types.
6. Examination of seed (monocot and dicot). Structure, seed viability test.
7. T. S. of anther, to study the wall layers and pollen sac with pollen grains.
8. Study the various types of ovules, draw the diagrams.
9. Study the various types of placentations.
10. Study the germination of pollen grain in situ and observe the path of pollen tube.
11. Study of various stages of embryo (Raphanus fruit)
12. Study frequency and density, abundance of plant species of campus vegetation by quadrat method.
13. Variation in soil moisture in relation to depth.
14. To estimate the porosity of grassland and woodland soil sample.
15. To determine moisture content of grassland and wood land soil.
16. To measure dissolved oxygen content in polluted and unpolluted water samples.
17. To measure temperature of different water bodies.
18. Water holding capacity of the soil.
19. Find out pH of soil sample by Universal Indicator method.
20. Find out pH of water sample by pH meter.
21. Find out transparency of a waterbody by Secchi disk.
22. Study morphology (external and internal) of hydrophytes (*Hydrilla* stem, *Typha* leaf and *Nymphaea* / *Eichhornia* petiole) and xerophytes (*Calotropis*, *Capparis* and *Casuarina* stem, *Nerium* leaf) with special reference to their adaptations.

Semester-V Practical

Course Objectives:

To develop a practical understanding of structural, developmental, and ecological aspects of plants through hands-on observation, experimentation, and analysis, reinforcing theoretical knowledge with experiential learning.

Course Outcomes:

By the end of the practical course, students will be able to:

- Develop the ability to identify and describe the internal and external structures of plants through microscopic and macroscopic examination.
- Understand the stages of plant development from gamete formation to seed germination, using slides and experimental setups.
- Analyze ecological interactions, environmental factors, and biodiversity through field-based and laboratory investigations.


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S.No.	Practical
1.	(i) Embryological Exercise (ii) T. S. of anther/ Study of various stages of embryo
2.	(i) Anatomical exercise on anomalous secondary growth (ii) Anatomy of root/leaf/study of stomatal types.
3.	(i) Ecological exercise based on quadrat method (ii) Ecological Anatomy (iii) Ecological Exercise related to soil and water
7.	Comment upon spots (1-5).
8.	Viva-Voce
9.	Practical record

Semester – VI

Course objectives:

- This course deals with microscopic studies of various biological organisms, diseases caused by plant pathogens and tissue culture studies using Recombinant DNA Technology

Course outcomes:

By studying this course, the students will be able to

- To understand the historical perspective of microbiology
- Learn about the structure and reproduction in bacteria, mycoplasma and viruses
- Examine the symptoms and life history of various organisms in plant diseases
- Develop conceptual skills about plant tissue culture studies

Course Title:	Microbiology, Plant Pathology and Biotechnology	Course Code: 24BBO7601T
Total Lecture hour 60		Hours
Unit I	Brief history of Microbiology, Salient features of Microbiology of water, soil and food Eubacteria - Characteristics, structure, nutrition and reproduction, Gram's staining and economic importance Viruses - General characteristics and importance, structure of TMV, structure and multiplication of bacteriophages Mycoplasma - Characteristics, structure and economic importance General account of viroid's and prions.	15
Unit II	Principles of plant pathology, important symptoms caused by fungi, bacteria, viruses and MLOs Brief account, structure, importance, life history and control measures of the following plant diseases: green ear disease of Bajra, Downy mildew of Bajra, Loose and covered smut of Wheat/Barley, Black rust of Wheat, White rust of Wheat, Citrus canker, little leaf of Brinjal, Yellow vein mosaic of Bhindi.	15
Unit III	Biotechnology : Functional definition, instruments used in tissue culture laboratory, basic aspects of plant tissue culture, basal medium, media preparation and aseptic culture technique, concept of cellular totipotency, callusing, differentiation and morphogenesis, micropropagation; tissue culture and its applications, protoplast culture, anther culture, embryo culture and their applications.	15
Unit IV	Recombinant DNA Technology : Tools and techniques used in r-DNA technology; Restriction enzymes, vectors for gene transfer: Bacteriophage, plasmids, Cosmids and Artificial chromosome, C-DNA technology, gene amplification, Polymerase Chain Reaction (PCR), applications of PCR technique, DNA fingerprinting and its uses, applications of biotechnology and transgenic plants.	15
Suggestive Readings:		

- Marjorie, Kelly and Cowan, Heidi Smith. (2017). Microbiology: A Systems Approach. McGraw Hill New York, 5th edition.
- Pelczar M.J., Chan E.C.S and Kreig N.R. (1997). Microbiology. Tata MacGraw Hill.
- Tortora, G.J., Funke, B.R., Case, C.L. (2011). Microbiology: An Introduction, Pearson Benjamin Cummings,


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U.S.A. 13th edition.

4. Willey, J M., Sherwood, L.M. and Woolverton, C.J. (2017). Prescott's Microbiology, 11th Edition, McGraw-Hill, USA.
5. Principles of Plant Pathology, R.S. Singh (1988), 3rd Ed., Oxford & IBH Co., New Delhi.
6. Plant Pathology, R.S. Mehrotra, (1989), Tata McGraw Hill Publishing Company, New Delhi.
7. G. Rangaswami and A. Mahadevan, (1999). Diseases of Crop Plants in India, Printice Hall of India Publications.
8. Gail L. Schumann and Cleora J. D'Arcy C H Dickinson , J A Lucas, (2006). Essential Plant Pathology
9. K. S. Bilgrami and H. C. Dube, (1996). A Text books of Modern Plant Pathology Vikas Publishing House Pvt. Ltd.
10. James G. Horsfall and Ellis B. Cowling, (1977), Plant Disease: An Advance Treatise Second Edition, Academic Press, London.
11. Gamborg OL and Philips, 1995. Plant cell, Tissue and Organ culture.
12. Razdan, MK, 1993. An Introduction to Plant Tissue Culture. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
13. Mascarenhas, AF, 1998. Handbook of Plant Tissue Culture. Publication & Information Div., ICAR, New Delhi.
14. Purohit, SS and Mathur, SK, 1996. Biotechnology fundamentals and applications. Agro Botanical Publishers, Bikaner.
15. Rana, SVS, 2012. Biotechniques theory & practice (third ed.). Rastogi Publications, Meerut.
16. Slater, A and Scott, N, 2008. Plant Biotechnology: The Genetic Manipulation of Plants (2nd ed.). Oxford publisher.
17. Brown, TA, 2020. Gene Cloning and DNA Analysis: An Introduction (8th ed.). Wiley- Blackwell publisher.

Semester-VI Practical

Course objective

- To gain practical experience in various tools and methods used in microbiology and biotechnology laboratory
- Identification of various diseases caused by different microorganisms

Course Outcomes:

- By studying this course students will be able to learn how to prepare media for fungi and bacteria, Gram's staining technique and various culture techniques
 - Obtain knowledge about symptoms of plant diseases and their slide preparation
 - Gain knowledge of various instruments used in biotechnology and DNA isolation technique
1. Study of bacteria using curd or any other suitable material, Gram's staining technique
 2. Study of Mycoplasma, TMV, bacteriophage (photographs/3-D models)
 3. Study of symptoms of plant diseases- Green ear disease of Bajra, Downy mildew of Bajra, Citrus canker, Mosaic of Bhindi
 4. Study of specimen, permanent slides and by making suitable temporary slides- Albugo-white rust; Sclerospora-downy mildew, green ear; Ustilago- loose smut of wheat, covered smut of barley; Puccinia- Black rust of wheat
 5. Media preparation- Potato dextrose agar, Nutrient agar
 6. Culture techniques of fungi and bacteria
 7. Visit local gardens/ field study of plants in farmers field/agricultural stations
 8. Elementary knowledge of principles and uses of various instruments in molecular biology and biotechnology- Laminar Air flow, Centrifuge, Autoclave, Oven, Incubator, Spectrophotometer, pHmeter, Gel electrophoresis unit
 9. Aseptic culture techniques
 10. Explant culture- shoot tip, nodal segment
 11. DNA isolation from plant parts
 12. Gel electrophoresis technique
 13. To isolate different microorganisms from soil
 14. To isolate different microorganisms from water


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S.No.	Practical
1.	1. (a) Gram's staining or any culture technique for bacteria and fungi- (b) Media preparation/ study of Mycoplasma or TMV or Bacteriophage
2.	Identify, comment and draw a well labelled diagram of given pathological material
3.	Study the given pathological material by making temporary slide
4.	Comment on the biotechnology technique/ DNA Isolation
5.	Comment on the any one tissue culture technique
6.	Comment upon spots (1-5)
7.	Viva-Voce
8.	Practical Record
Suggestive readings Gour, L., Sharma, R. and Rama Krishnan R.S., 2020. Fundamentals of Plant Biochemistry and Biotechnology- A Practical Book, Akinik publications. Purohit, S.S., 2021. A Laboratory Manual of Plant Biotechnology, Agrobios publisher (ISBN: 9788177542226). Bendre and Kumar, Practical Botany: Vol-I, 2019. Rastogi publication, Meerut	


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