

Department of Botany**Visva-Bharati**

Choice Based Credit System (CBCS) for 2-year M. Sc. Course in Botany

Courses	Full Marks	Credit
<u>Semester I</u>		
Theory		
Core Course (General): MBC-11 Group A – Microbiology Group B - Virology & Immunology	60	5
Core Course (General): MBC-12 Group A – Phycology Group B - Bryology	60	5
Core Course (General): MBC-13 Group A – Mycology Group B - Plant Pathology	60	5
Practical		
Core Course (General): MBC-14 [Based on theory course MBC-11]	40	3
Core Course (General): MBC-15 [Based on theory course MBC-12]	40	3
Core Course (General): MBC-16 [Based on theory course MBC-13]	40	3
Total		24
<u>Semester II</u>		
Theory		
Core Course (General): MBC-21 Group A – Cytology Group B - Genetics	60	5
Core Course (General): MBC-22 Group A – Plant Physiology Group B - Biochemistry	60	5
Core Course (General): MBC-23 Group A – Molecular Biology Group B - Plant Biotechnology	60	5
Practical		
Core Course (General): MBC-24 [Based on theory course MBC-21]	40	3
Core Course (General): MBC-25 [Based on theory course MBC-22]	40	3
Core Course (General): MBC-26 [Based on theory course MBC-23]	40	3
Total		24

Courses	Full Marks	Credit
<u>Semester III</u>		
Theory		
Core Course (General): MBC-31 Group A – Pteridology Group B - Gymnosperm & Palaeobotany	60	5
Core Course (General): MBC-32 Group A – Taxonomy of Angiosperms Group B - Palynology of Angiosperms	60	5
Core Course (Optional): MBC-33 [List given below]*	50	4
Elective Course (Choice based): MBE-31 [List given below]**	50	4
Practical		
Core Course (General): MBC-34 [Based on theory course MBC-31]	40	3
Core Course (General): MBC-35 [Based on theory course MBC-32]	40	3
Total		24
<u>Semester IV</u>		
Theory		
Core Course (General): MBC-41 Group A – Anatomy Group B - Embryology & Pharmacognosy	60	5
Core Course (General): MBC-42 Group A – Plant Ecology Group B - Environmental Botany	60	5
Practical		
Core Course (General): MBC-43 [Based on theory course MBC-41]	40	3
Core Course (General): MBC-44 [Based on theory course MBC-42]	40	3
Core Course (Optional): MBC-45 [Based on theory course MBC-33]	50	4
Project work***		
Core Course: MBC-46	50	4
Total		24

***List of Core Courses (Optional)**

[One course to be opted in Semester III]

1. Microbiology
2. Phycology
3. Mycology & Plant Pathology
4. Plant Physiology & Biochemistry
5. Cytogenetics
6. Plant Ecology
7. Pharmacognosy
8. Plant Biosystematics
9. Pteridology

****List of Elective Courses (Choice based)**

[One course to be opted in Semester III]

1. Applied Microbiology
2. Applied Phycology
3. Applied Mycology
4. Molecular Biology
5. Plant Biotechnology
6. Environmental Botany
7. Plant Anatomy
8. Palynology & Aerobiology
9. Applied Pteridology

***Project work (MBC-46) may be started from Semester III

Detailed Syllabus for M. Sc. Botany Semesters

(Choice Based Credit System)

Semester I

THEORY

Core Course (General): **MBC-11**

Full Marks: 60

Credit: 5

Group A – Microbiology

Soil Microbiology: Rhizosphere; Biological nitrogen fixation – symbiotic and nonsymbiotic; Nitrogenase enzyme, *nif* genes, leghemoglobin and hydrogenase; Root nodule formation: *nod* genes, Nod factors.

Air Microbiology: Microbial flora of air; Enumeration of aerial microbes: sampling methods; Air-borne human diseases.

Water Microbiology: Microbial flora of water; Winogradsky column, Microbiological analysis of water: Presumptive and confirmatory tests; TOC, COD and BOD; Indicator organisms; Water borne human diseases.

Microbial genetics: Genetic recombination: transformation, conjugation, transduction and sexduction, complementation; mapping genes by interrupted mating; Plasmid biology: Types, Replication (theta mode and rolling circle), partition, incompatibility and transfer; Regulation of gene expression: Lac operon.

Group B - Virology & Immunology

Virology: Cultivation of viruses; Virus purification and assays (hemagglutination and plaque assay); Principles of viral taxonomy; Replication of viral nucleic acids; One step growth curve; Lytic and Lysogenic cycle; early and late proteins; Virus related agents – viroids and prions; virus-induced cancer.

Immunology: Cells and organs of the immune system; Lymphocytes, Antigens, Antibodies, Immunoglobulin classes; Structure of Immunoglobulin G; Polyclonal and monoclonal antibodies; Interferon, Vaccine.

Immune diseases: AIDS: Human immunodeficiency virus – structure & genomic organization; Hypersensitivity; Autoimmune diseases.

Antigen-antibody reactions and its application in Immunodiagnostics: Agglutination (Widal test, latex agglutination test, Viral hemagglutination), Immunodiffusion (SRID), ELISA, Skin-prick test, Immunoelectrophoresis, Immunoprecipitation, RIA, Western Blotting, Immunofluorescence, Blood group test.

Group A – Phycology

Phycology: Algae in diversified habitats; Range in thallus organization, ultra-structure of algal cell; Physiology and biochemistry of algal cell; Endosymbiotic theory of origin of chloroplasts; Ecology, algal bloom; Reproduction; Phylogeny, evolutionary tendencies and economic importance.

Classification and phylogeny: Classification of algae; Salient features of Cyanobacteria, Chlorophyta, Heterokontophyta (Xanthophyceae, Bacillariophyceae, Phaeophyceae) and Rhodophyta with special emphasis on evolutionary tendencies and phylogeny.

Group B - Bryology

Bryology: Current concepts of bryophyte classification; Origin, evolution and fossil history of bryophytes; Ecology, physiology, culture and economic importance; Comparative study of the gametophyte and sporophyte of major groups with special reference to Indian forms; Role of bryophytes in plant succession and pollution monitoring.

Classification and phylogeny: Classification of mosses with Indian examples and distribution; Phylogenetic relationship and evolutionary tendencies exhibited by the group.

Lichenology: Systematic and general account of major forms; economic importance of lichens.

Group A – Mycology

Taxonomic status of fungi in living world: Cell structure, thallus organization, nutrition and reproduction - somatic structures and reproductive methods; Different patterns of life cycle; Modern system of classification.

Mastigomycotina and Zygomycotina: Diversity of thallus structure and spore forms; Evolutionary trends; Asexual and sexual reproduction, sex hormones; Classification.

Ascomycotina: Diversity of thallus structures and evolutionary trends in asexual and sexual reproductions, asci and their bearing on taxonomy; Development and types of ascocarps; Mechanisms of ascospore discharge.

Basidiomycotina: Somatic structures, reproduction; Mating system and classification; Origin and structures of basidiospores, basidia, and basidiocarps; Mechanism of basidiospore discharge.

Deuteromycotina: General account, conidial types & asexual fruit bodies, parasexual cycle.

Economic Importance: Role of fungi in industry, medicine, food and agriculture.

Group B - Plant Pathology

Plant pathology: History of plant pathology and its present status; Classification of plant diseases; Knowledge on the agents of infectious and non-infectious diseases; Role of environment in disease development.

Host-pathogen interaction: Initial recognition, genetic aspect; Entry of pathogen, role of enzymes, and toxins in pathogenesis; Host defense - biochemical and anatomical aspects.

Disease control: General principles, cultural, chemical and biological methods.

Study of some diseases: Late blight and early blight of potato, Downy mildew and powdery mildew of crop plants, Black stem rust of wheat, Loose smut of wheat, Brown spot and bacterial blight of rice.

PRACTICAL

Core Course (General): MBC-14

Full Marks: 40

Credit: 3

(Microbiology, Virology & Immunology)

1. Preparation of bacteriological culture medium and Sterilization methods
2. Differential Staining (Gram and endospore)
3. Isolation and study of rhizobia from root nodules
4. Study of bacterial growth by turbidometric method
5. Isolation of viable microorganisms from air
6. Isolation of viable microorganisms from water
7. Isolation of viable microorganisms from soil
8. Isolation of antibiotic resistant microbes from soil
9. Determination of quality of milk using methylene blue reduction methods
10. Antibiotics sensitivity test using paper disc method
11. Plaque assay of bacteriophage
12. Blood group determination using slide agglutination method

Core Course (General): MBC-15

Full Marks: 40

Credit: 3

(Phycology & Bryology)

1. Introduction to Microscopy, Micrometry techniques and documentation methods to study algal diversity
2. Algal Diversity Study: Identification of some members of (Cyanobacteria, Chlorophyta, Phaeophyta & Rhodophyta)
3. Seaweed Identification: Sectioning in microtome and seaweeds anatomical structures
4. Algal cell immobilization
5. Sampling and quantitative estimation of Phytoplankton
6. Bryophyte diversity study: identification of members of different groups
7. Lichen diversity

Core Course (General): MBC-16

Full Marks: 40

Credit: 3

(Mycology & Plant Pathology)

1. Knowledge and identification of molds, mushrooms and yeasts
2. Sterilization methods
3. Preparation of fungal growth media
4. Isolation of fungi from natural sources
5. Study of air-mycoflora
6. Isolation of starch solubilizing fungi
7. Isolation of plant pathogens from infected plant parts
8. Fungicide sensitivity test
9. Study of plant diseases by pathological sheets
10. Work out of the following materials: *Rhizopus*, *Ascobolus/ Peziza*, *Xylaria*, *Daldinia*, *Termitomyces*, *Lentinus*, *Schizophyllum*, White rust of crucifer by *Albugo candida*, Peach leaf curl by *Taphrina deformans*, Stem gall of coriander by *Protomyces macrosporus*, Rust of *Justicia* by *Puccinia thwaitessi*, Rust of *Ruellia* by *Puccinia ruelliae*

Semester II

THEORY

Core Course (General): MBC-21

Full Marks: 60

Credit:5

Group A – Cytology

Cell Nucleus: Ultrastructural organization and function of nuclear components; Nuclear envelope, nucleolus, chromatin, nucleoplasm and nuclear matrix; Molecular mechanism of transport of biomolecules across the nuclear envelope.

Biogenesis of ribosome: Role of nucleolus in ribosome biogenesis; Amplification of ribosomal RNA genes; Synthesis and processing of rRNA, joining of RNA with ribosomal proteins, Ribosome formation in prokaryotes.

Molecular organization of chromosome: DNA packaging in chromatin and chromosome, regulation of chromatin structure by histone n-terminal tails, ultra-structure of special chromosomes; Centromere & telomere: ultrastructure and function.

Unique and repetitive sequences of DNA in eukaryotic chromosomes: Characteristics and function.

Cell cycle: Biochemical and molecular events associated with the cell cycle, Molecular mechanism of cell cycle regulation.

Group B - Genetics

Extension of Mendelian genetic analysis: Gene interactions and modified Mendelian ratios; Multiple factor and polygenic inheritance.

Regulation of gene expression: Lac and Trp operon in prokaryotes, general regulatory process in eukaryotes.

Gene mutation & DNA repair: Types and causes of mutation, Molecular basis of spontaneous and induced mutation, site directed mutagenesis; Molecular mechanism of DNA repair.

Sex determination: Sex determination and Sex linked inheritance, dosage compensation.

Genetic code: Properties of genetic code with evidences, deciphering of genetic code (code assignment).

Mobile genetic elements: Transposable genetic elements in prokaryotes and eukaryotes, retro-transposons.

Core Course (General): MBC-22

Full Marks: 60

Credit: 5

Group A – Plant Physiology

Water relations of plants: Water potential & its components; Water movement through root, stem and leaf – passages and driving forces.

Photochemistry & Photosynthesis: Photosynthetic apparatus - organization and pigments, concept of photosystems and light energy harnessing mechanism, photosynthetic electron transport; Carbon assimilation and regulation in C₃ plants, CO₂ concentrating mechanism in C₄ and CAM plants.

Translocation of assimilates: Source-sink relationship and patterns of movement; Phloem transport – phloem loading and unloading; Mechanism of long distance transport.

Plant growth regulators: Chemistry, biosynthesis and physiological action of auxins, gibberellins, cytokinins, ethylene and abscisic acid.

Photoperiodism: Photoperiodic classes; Photoperiodic induction – importance of light and dark period; Mechanism of induction and role of phytochrome.

Senescence and abscission: Senescence and ageing, senescence syndrome – physiological and biochemical changes; Regulation of senescence and SAGs; Abscission – cytological, physiological and biochemical changes in abscission zone; Hormonal regulation.

Group B - Biochemistry

Protein structure: Primary structure – protein purification; Determination of amino acid sequence; Secondary structure – Configuration and conformation, α - helix and β - pleated sheet; Tertiary and Quaternary structure.

Intermediary metabolism: Carbohydrate metabolism – regulation of Glycolytic pathway and TCA cycle, Pentose Phosphate pathway; Protein metabolism – Transamination and deamination, pathways leading to acetyl CoA formation.

Bioenergetics: Concept of Gibbs free energy, calculation of standard free energy change (ΔG°) for hydrolysis; ATP as energy currency; Mechanism of oxidative phosphorylation.

Biochemistry of nucleic acids: DNA - molecular structure, physical and chemical properties.

Core Course (General): MBC-23

Full Marks: 60

Credit: 5

Group A – Molecular Biology

Recombinant DNA technology: Definition and properties of Plasmid, Lambda phage, Cosmid, Yeast artificial chromosome (YAC); Plasmid isolation, restriction enzyme, digestion, agarose gel electrophoresis and transformation.

Cloning strategies & screening of recombinant clones: Lac operon: Blue/white selection; Purification and characterization of recombinant plasmid DNA; Expression vector - over expression and expression analysis; Applications of recombinant DNA in agriculture and medicine.

Transcription: Molecular mechanisms of transcription; Regulation of gene expression with special reference to two component gene regulatory system; RNA processing.

Gene library: Construction of cDNA library and genomic library; Screening of libraries.

DNA hybridization & sequencing: Generation of radiolabeled probe and blotting techniques; Southern and Northern hybridization; DNA Sequencing methods.

DNA Replication: Basic mechanism of DNA replication.

Polymerase chain reaction: Principles & methods

Group B - Plant Biotechnology

Plant Biotechnology: Basic concept, principles and its scope.

Plant cell and tissue culture: General introduction, history, scope and methodology; Callus and cell suspension culture and its biotechnological applications.

Organogenesis and somatic embryogenesis: Techniques and application.

Shoot tip and shoot meristem culture: Techniques and applications.

Androgenesis: Techniques and utility.

Protoplast culture: Isolation, purification and culture of protoplast.

In vitro conservation of plants: Aim, methods of in vitro conservation of plant germplasm

PRACTICAL

Core Course (General): MBC-24

Full Marks: 40

Credit: 3

(Cytology & Genetics)

1. Study of somatic chromosomes from root tip tissues of *Allium cepa* / *Lens culinaris*
2. Preparation of karyotype and karyogram from somatic metaphase plates of plant materials.
3. Comparative determination of Mitotic indices from root meristem tissues and analysis of various stages of mitotic division.

4. Preparation of feulgen stain and study of somatic and meiotic chromosomes through feulgen staining.
5. Study of various stages of meiosis from flower buds.

Core Course (General): MBC-25

Full Marks: 40

Credit: 3

(Plant Physiology & Biochemistry)

1. Determination of water potential (ψ_w) by Liquid immersion method
2. Determination of efficiency of transpiration over evaporation
3. Effect of K^+ ions on stomatal opening
4. Determination of Q_{10} value for water absorption by seeds
5. Separation of photosynthetic pigments by paper chromatography
6. Determination of Hill activity by isolated chloroplasts
7. Preparation of standard curve and estimation of protein
8. Preparation of standard curve and estimation of amino acids
9. Preparation of standard curve and estimation of DNA
10. Preparation of standard curve and estimation of RNA

Core Course (General): MBC-26

Full Marks: 40

Credit:3

(Molecular Biology & Plant Biotechnology)

1. Quantitative estimation of DNA using UV spectrophotometer
2. Qualitative assay of proteins through agarose gel electrophoresis
3. DNA amplification study through PCR
4. Preparation of culture medium for initiation of callus culture (Demonstration).
5. Aseptic manipulation technique for initiation of shoot tip culture

Semester III

THEORY

Core Course (General): MBC-31

Full Marks: 60

Credit: 5

Group A – Pteridology

Major Fern groups: Systematic study of the distribution, structure, reproduction and evolutionary trends of the following groups:

a) Ophioglossales b) Marattiales c) Osmundales d) Filicales (generalised form of Simplicis, Gradatae and Mixtae types) e) Marsileales f) Salviniaceae.

Geological time scale & origin of land plants: Systematic study, structures, geological and geographical distribution and evolutionary trends of the following groups:

a) Rhyniopsida, b) Zosterophylloids, c) Trimerophytes and d) early Lycopods.

Progymnosperms: Characterisation and its role in gymnosperm evolution.

General Discussion: Heterospory and seed habit; Stelar evolution and soral evolution in ferns, apospory and apogamy.

Group B - Gymnosperm & Palaeobotany

Gymnosperms: Classification, economic importance and distribution in India; General account on the morphology, anatomy, reproduction and evolutionary trends of the following groups: a) Glossopteridales, b) Cycadales, c) Voltziales, d) Coniferales and e) Gnetales.

Paleobotany: Fossil and fossilization process; Relative and Absolute datings (C^{14} , Argon and Uranium dating), techniques for studying fossil plants (ground thin section, peel technique, transfer technique and microfossil analysis). Pre-Cambrian life forms, Continental drift hypothesis, Indian Gondwana system.

Palaeo-Palynology: Basic principle of palynology and its application in stratigraphy, palaeoclimate and oil exploration.

Core Course (General): MBC-32

Full Marks:60

Credit: 5

Group A – Taxonomy of Angiosperms

Principles of Taxonomy: modern systems of classification including Cronquist, Takhtajan and Thorne. APG classification

International Code of Botanical Nomenclature: General principle and important rules relating to the nomenclature types, priority, publication and name changes

Taxonomic evidences from anatomy, cytology, embryology, palynology and phytochemistry in taxonomy; Computer and GIS as taxonomic tool.

Major evolutionary trends: Trends in the Dicotyledons Interrelationships among the different groups of Dicotyledons and Monocotyledons.

Taxonomy and phylogeny of the important groups like Ranales, Tubiflorae, Campanulatae, Amentiferae, Helobiales and Scitamineae.

Concept of Phytogeography: Phytogeographical regions, Endemism, hotspots and hottest hotspots; plant exploration, invasions and introductions; local plant diversity and its socio-economic importance, conservation, sustainable utilization of bio-resources.

Group B - Palynology of Angiosperms

Palynology: its concept and scope, Symmetry, Polarity, Shape classes, Sporoderm stratification, sporoderm ornamentation, NPC classification, LO analysis, morphological characters of pollen and spores and their modern terminology; Primitive and advanced types of pollen grains; Analysis and chemistry of pollen wall.

Aeropalynology: principle, techniques and significance of airborne pollen grains and spores in allergic disorders.

Melissopalynology: definition and assessment of honey (qualitative and quantitative) in relation to vegetation study and adulteration.

Core Course (Optional): MBC-33

Full Marks:50

Credit: 4

[One course to be opted at the beginning of Semester III]

1. Microbiology

Microbial Taxonomy and Diversity: Introduction to Bergey's Manual, Microbial type culture collection centre; Numerical taxonomy, Molecular Taxonomy: molecular chronometers, 16S rDNA sequencing, DNA-DNA hybridization and G+C content; Bioinformatics and Microbial phylogeny: A brief idea about nucleic acid and protein sequence databases, sequence analysis, sequence alignment, Blast search, and phylogenetic tree.

Culture conditions and Growth: Bacterial culture medium, Enrichment culture; Isolation of pure cultures; Batch culture and Continuous culture; Measurements of bacterial growth - Generation time, mathematical expression of growth; Synchronized growth; Diauxic growth; Environmental factors influencing growth (pH and temperature); Biofilm formation and Quorum sensing.

Metabolism: Metabolic classes of microorganisms (autotroph, phototroph, chemotroph, heterotroph); Photosynthesis (anoxygenic and oxygenic), Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria; Chemosynthesis (sulfur oxidation, iron oxidation, hydrogen oxidation and nitrification); Methanotrophy; Anaerobic Respiration - nitrate respiration (denitrification), sulfate reduction, and methanogenesis.

Microbial genetics and Molecular biology: Origin of Spontaneous mutation, Transposons (Tn5); Regulation of gene expression - allosteric regulation, feed back inhibition, positive and negative control, catabolite repression, attenuation, antisense RNA control, antitermination; Polymerase chain reaction (PCR, RT-PCR, nested PCR, inverse PCR, degenerate PCR) and its applications; DNA sequencing by Sanger's dideoxy method and pyrosequencing; A brief idea about genomics, proteomics and transcriptomics of microbes; Molecular biology of the bacteriophage lambda, M13 and P1.

2. Phycology

General account of important groups: Glaucophyta, Haptophyta, Chrysophyta, Xanthophyceae, Eustigmatophyceae, Dinophyta, Euglenophyta.

Biology of Cyanobacteria: Classification, phylogeny, significance in origin of chloroplast; photosynthesis, nitrogen metabolism, nif genes, respiration, nature of genome, genetic recombination, genetic mapping, plasmids, gene cloning, cyanophages.

Algal Phylogeny: Phylogeny of green, brown, red algae and dinoflagellates, origin of various kinds of plastids in algae.

Ultrastructural features: Ultrastructural study of various cellular organelles, diversity in mitotic cell division in eukaryotic algae, nuclear organization and cell division in Dinophyceae, Cryptophyceae, Euglenophyceae and their phylogenetic significance.

Algal genetics: *Chlamydomonas* as a model genetic system, recombination and gene mapping, plastid inheritance; Gene expression in *Acetabularia*. Classical and modern concepts; Laboratory maintenance and protocol of cytogenetics; Evaluation of cytological data with relation to taxonomy of algae.

Eutrophication and Algal bloom: Causal factors, dynamics of fresh water and marine blooms.

Modes of carbon metabolism: autotrophic and heterotrophic growth and metabolism; Primary productivity of fresh water and marine algae; Methods of study of phytoplankton with brief knowledge of important phytoplankton of fresh water and marine habitat; Proton translocation and membrane potential; ATPases, K⁺ uptake and sodium extrusion, chloride uptake.

3. Mycology & Plant Pathology

Mycology:

Origin of fungi and their uniqueness in living world, and possible interrelationships among different groups.

Fungal cell structures including cell wall and flagella

Fungal metabolism including special metabolic pathways

Parasexuality and its significance

Plant Pathology:

History of plant pathology and its present status

Concept on different biotic agents affecting plant's health

Effect on environment and air-pollutants on plant health

Effect of pathogens on different physiological processes of plants

Host-pathogen interaction: Initial recognition, appressorial development, genetic aspects.

Penetration mechanism, role of enzymes in pathogenesis process.

Role of toxins in disease development

Host defence: constitutive or pre-existing structural & biochemical; Inducible defence: SAR & ISR; PR- proteins

Control of plant diseases: Chemical and biological

Identification of plant pathogens or their detection through molecular techniques

Host resistance: the traits and their characteristics

Integrated pest management: basic concepts and applications

Seed pathology: preservation techniques, seed borne pathogens and their management.

4. Plant Physiology & Biochemistry

Seed physiology: Orthodox and recalcitrant seeds; Seed germination – phases, physiology and control; Seed dormancy – types and significance, breaking of dormancy; Seed viability and seed longevity.

Sensory photobiology: Phytochrome – structure, physico-chemical properties and mode of action; Cryptochrome and blue light responses.

Plant movements: Gravitropism – sensing mechanism and reaction mechanism; Phototropism – fluence response curve, photoreceptor and mechanism.

Developmental physiology: Control of flowering – biochemical signaling in floral evocation, genetics of floral organ development; Fruit development and ripening – physiology and molecular biology.

PGRs and elicitors: Molecular mode of action of IAA, GA, cytokinin, ethylene and ABA – receptor(s), signal transduction and gene expression; Brassinosteroids and polyamines – brief outline of chemistry, biosynthesis and physiological action.

Stress physiology: Plant responses to drought, salinity and heat – stress injuries and resistance mechanisms; genetic engineering for tolerance.

Carbohydrate metabolism in plants: Photorespiration – metabolic pathway, significance and control; Cyanide resistant respiration.

Fat metabolism: Fatty acid oxidation – α -, β -, and ω - oxidation; fatty acid biosynthesis.

Nitrogen metabolism: Nitrate and ammonium assimilation in plants; Outline of amino acid biosynthesis.

Plant pigments: Classification – water-soluble and fat-soluble pigments; biosynthesis of chlorophylls.

5. Cytogenetics

Chromosome organization: Structural characteristics of viral, prokaryotic and eukaryotic chromosomes; Mechanism of chromosome movement.

Karyotype concept: Role in the study of phylogeny, evolution and systematic status.

Malignancy: Characteristics, cytodiagnosis, theories, genetic basis, tumour suppressor genes, their molecular characterization and function.

Mobile genetic elements: Transposable genetic elements in prokaryotic and eukaryotic systems

Gene mutation & DNA repair: Molecular basis; spontaneous and induced mutations; DNA repair mechanism.

Genetic code: Characteristics and properties of genetic code, deciphering of genetic code. Molecular maps of the genome: sequencing of human genome, human genome project.

6. Plant Ecology

Introduction: Origin and evolution of life on earth, life and life processes; Biological significance of carbon, hydrogen, nitrogen and oxygen.

Ecosystem: Concept, components, types of ecosystems and their problems, mechanism of transfer of energy, various ecological models, C, N, P and S biogeochemical cycles (pathways, processes and budgets) in terrestrial and aquatic ecosystems and human impact on them.

Community organization and development: Analysis of communities (analytical and synthetic characters), interspecific associations, ecological niche, changes during and mechanism of ecological succession.

Gene ecology: Interaction of gene and environment- structural and functional aspects with reference to heat stress and salt stress.

Production ecology: Primary and secondary productivity and their measurement, ecophysiological adaptations in Cyanobacteria and aquatic plants, C4 and CAM plants- morphological, biochemical and molecular aspects.

Biodiversity: Categories, status in India, significance, degeneration, measurement using ecological, RS and GIS tools, utilization and concern.

Conservation: Principles of conservation, conservation status of plants based on IUCN, strategies of conservation- in situ and ex-situ conservation.

7. Pharmacognosy

Pharmacognosy: Definition, history and scope; Brief account of Ayurvedic medicine system, Unani medicine system, Homoeopathic medicine system and Aromatherapy.

Herbal drugs: Classification; Factors (climate, genetic, collection, drying, etc) involved in herbal drug preparation; Storage and deterioration of crude drugs.

Drug adulteration: concept and various modes.

Drug evaluation: Organoleptic study of crude drugs – herbs, barks, wood, inflorescence, seeds and subterranean organs and exudates; Micromorphology, microchemistry and powder study of common herbal drugs.

Herbal products: *Volatile oils:* chemistry, extraction, sources and uses with reference to aromatherapy;

Phenols, tannins: Sources, therapeutic and common uses;

Alkaloids: structure, properties, classification, isolation, biosynthesis (brief outline) and therapeutic uses;

Glycosides: properties, classification, therapeutic uses;

Steroids: chemical characteristic, classification, extraction, biosynthesis (brief outline) and therapeutic uses.

Hallucinogens: hallucinogenic, allergenic, teratogenic and other toxic plants with reference to Indian hallucinogens.

Biopesticides: concept; chemistry, sources and uses of important biopesticides.

Biotechnology: Pharmacogenetics – application of genetics in plant drug improvement. Chemodemes and transgenic medicinal plants; Production and improvement of products through different plant biotechnological approaches (biotransformation, hairy root culture, elicitation, precursor feeding, etc).

Ethnobotany: concept and its role in drug discovery

8. Plant Biosystematics

Biosystematics and modern approaches of plant taxonomy: Population concept and Numerical taxonomy; Modern systems of classification and recent development; Phenetic and cladistic approach, Importance of nucleic acids and proteins in taxonomic delimitations; Application of chemotaxonomy and phytogeography; Computer aided taxonomic studies on Indian flora and its component.

Herbarium techniques: Field and herbarium techniques; Herbaria and Botanic Gardens of the world.

Important orders of Angiosperms: Study of important orders of Angiosperms with reference to their interrelationship evolutionary trends and present concept in the light of modern researches.

Indian flora: Indian flora with reference to endemism and foreign elements; Taxonomic literatures and floras.

Biodiversity: Biodiversity and conservations of natural resources.

9. Pteridology

(i) Origin of arborescent Lycopods.

(ii) Origin and evolutionary trends in the Sphenopsids

(iii) A brief account of the Paleozoic and Mesozoic Lycopods, Sphenopsids and Filicopsids found in India.

(iv) Distribution of pteridophytes in diversified ecological conditions - A brief mention of climates and flora of the past geological era.

(v) The contribution of pteridophytes to an understanding of the life history of vascular plants (sexuality in gametophytic growth; Significance of isolation in relation to cyclic alternation of generation, determination of femaleness in free homosporous plants; relationship between heterospory and anisospory; cyclical alternation in heterosporous plants).

(vi) Present status of distribution of pteridophytes in India. Endangered pteridophytes and their conservation.

(vii) Different systems of classification of major groups of Filicopsida.

(viii) Recent taxonomic circumscriptions of *Lycopodium*, *Selaginella*, *Equisetum* and Gleicheniaceae, Polypodiaceae.

(ix) Study of morphology, anatomy and ontogeny of petiole, rachis, stpmata, sporewall in various extant groups.

Elective Course (Choice based): MBE-31

Full Marks: 50

Credit: 4

[One course to be opted at the beginning of Semester III]

1. Applied Microbiology

Microbial growth control: Heat, ionization, and filter sterilization methods; Antiseptics, and disinfectants; Chemotherapy - classification of antibiotics, mode of action and antimicrobial spectra of antibacterial (Penicillins, Chloramphenicol, Streptomycin, Rifampicin, Tetracycline, Erythromycin, Nalidixic acid) and antifungal (Amphotericin B, Nystatin) antibiotics; Mechanism of antibiotic resistance in bacteria.

Bacterial fermentations and Food Microbiology: Bacterial Fermentation process (alcoholic, Entner-Doudoroff pathway; lactic acid); Role of microorganisms in the production of fermented dairy products (acidophilus milk), meat and fishery products (dry sausages and fish sauces), plant products (cocoa beans, soy sauce, and idli), breads; Applications of microbial enzymes in dairy industry [Protease]; Probiotics.

Industrial Microbiology: Primary and secondary microbial metabolites, properties of an industrial microorganism; Fermentation technology, Fermentor, Fermentation scale up; industrial production of alcohol (wine), organic acids (lactic acid, citric acid), amino acids (lysine and glutamic acid), antibiotics (penicillin), enzymes (protease, amylase); Biopesticides (*Bacillus thuringiensis*), biopolymers (bacterial plastics).

Environmental microbiology: Wastewater treatments - sewage and sludge, generalised plan of a sewage treatment plant - trickling and activated sludge treatment; Biodegradation of petroleum and xenobiotics; Biofertilizers; Biogas production.

2. Applied Phycology

Algal Culture: Axenic, synchronous and continuous culture, technical aspects of outdoor mass culture of microalgae, immobilized algal cells, culture collection and preservation of algal strains.

Algal Pigments: Production and application of algal biocolorant (Phycocyanin, Phycoerythrin, allophycocyanin, Astraxanthin, beta-carotene, UV-Pigments) and commercial potential of *Spirulina*, *Botryococcus*, *Dunaliella*, *Haematococcus* and *Porphyra*.

Survival strategies: Survival strategies of algae with reference to Chlorophyceae, Dinophyceae and Bacillariophyceae; physiological and biochemical basis of algal survival; Algal response to stress (Salinity, desiccation, temperature, light intensity, UV-B radiation); production and application of stress products; antioxidants in algae with response to stress (SOD, catalase, peroxidase); engineering algal strains against stress-tolerance through gene modification.

Biotechnological application: Secondary metabolites of algae, algae as source of pharmaceutical, cosmetic, anti aging products; Production and application of algal hydrocolloids (agar, alginates, carrageenan), Biodiesel and hydrogen production by algae; Algal techniques for restoration/maintenance of soil fertility, algal biofertilizer (BGA biofertilizer and seaweed liquid biofertilizer); Algal biosensors and role of algae in nanotechnology.

Algal pollution: Fresh water and marine algal pollution, ballast water and algal pollution, heavy metal pollution and monitoring of pollutants with the help of algal system; bio-manipulation for controlling eutrophication, algal toxins, bioindicators, algal biofouling of ships and its control.

Phycoremediation: Reclamation and purification of sewage by algae, sequestration of heavy metals of industrial effluent by algae, use of immobilized algal strains for metal recovery.

Algae and Environment: Environmental implications of DMS and NO production by algae, algae in carbon sequestration, ocean iron fertilization and global warming.

3. Applied Mycology

Mycorrhiza: types and application.

Fungal enzymes: production, purification and applications

Role of fungi in Pharmaceutical applications

Fungi as decomposer of cellulose and lignin materials

Fungi as source of food, fuel and biochemicals

A general account of mycotoxin

Mycoses: types and control

Fungal biotechnology: protoplast fusion, gene transformation.

Antifungal compounds: types, designing and mechanism of action

Culturing of fungi: mushrooms, moulds and yeasts

4. Molecular Biology

DNA protein interaction: Methods for studying DNA-binding proteins using variety of footprinting and protection experiments such as DNaseI footprinting, gel-shift techniques; Identification of protein-binding sites on DNA molecule; Purification of DNA-binding protein.

Proteomics: Fundamental concept of proteomics, tools to study proteome, peptide fragmentation and analysis by mass spectrometry; Protein modifications, relationship between proteomics and genomics

Protein modification: Site specific and PCR-based random mutagenesis, characterization of the mutants.

DNA damage and Repair: Kinds of DNA damage and its biological, molecular mechanisms of DNA repair with special reference to strand-specific DNA repair.

Recombinant DNA techniques: Restriction analysis and DNA fragment purification, Vector construction; Tools of recombinant DNA: restriction endonucleases and other enzymes; vectors; plasmid. Bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome

DNA finger printing: DNA markers Restriction fragment length polymorphism, random amplified polymorphic DNA, DNA finger printing, and their applications.

Antisense technology: RNAi antisense oligonucleotides, basic principles and mechanisms

5. Plant Biotechnology

Genetic manipulation of crop plants: strategies for plant transformation through gene transfer, gene manipulation with *Agrobacterium tumefaciens*, important achievements.

Micropropagation: technique in horticulture and crop improvement, advantage and disadvantage of micropropagation.

Protoplast culture: isolation, purification and culture of protoplasts, application of protoplast in plant biotechnology.

Protoplast fusion and somatic hybridization: methods of protoplast fusion; selection of heterokaryons; contribution of somatic hybridization in crop biotechnology.

Somaclonal variation: Source of somaclonal variation; selection of somaclones; application of somaclonal variation in crop improvement.

Production of virus free plants through in vitro techniques: methods of disease indexing.

Secondary metabolites: *In vitro* approaches for improved synthesis of secondary metabolites, biotransformation and its application in biotechnology.

In vitro conservation of germplasm: Strategies and techniques.

Anther and pollen culture: Basic technology; factors affecting androgenesis, dihaploid plants and their application in crop science.

6. Environmental Botany

Introduction: Categorization of pollutants; point and non-point source, bio-degradable and non-degradable pollutants.

Air pollution: Sources and effects on plants and animals, biomonitoring of air pollution, classical and photochemical smog, acid rain, environmental biopollution

Water pollution: Sources and effects on plants and animals, biomonitoring of air pollution, Heavy metal pollution, xenobiotics, bioaccumulation and biomagnification, oil spills, Household purification of water (small scale), waste water characteristics and its treatment (large scale).

Noise pollution: A brief account.

Environmental mutagenesis: categories of mutagens, identification of mutagenesis by conventional techniques.

Basic concept of Bioremediation, Bioindicators, Biosensors, Environmental Impact Assessment and Sustainable Development

Global environmental problems: Greenhouse effect and global warming, ozone depletion, Ozone hole- modern outlook, desertification, national and international organizations in monitoring global climate change

7. Plant Anatomy

Plant Anatomy: History, interdisciplinary approaches and applications in modern life.

Epidermis: General features, epidermal cells with special structure or content, stomata, and trichomes.

Sclereids: Characteristics, types, origin and differentiation, controlling factors in differentiation.

Fibers: Characteristics, types, origin and differentiation, controlling factors in differentiation.

Secondary Xylem: Origin, differentiation, structure and phylogeny; control of xylogenesis; vascular cambium, factors influencing cambial activity

Molecular aspects of Plant Anatomy: gene expression and anatomical traits, wilt-gene.

Systematic Plant Anatomy: concept and application of various anatomical features in plant systematic.

Ecological Plant Anatomy: ecological leaf anatomy, ecological wood anatomy, pollution anatomy (effects of air pollutants, ozone injury, acid rain).

Applied Plant Anatomy: Fibers – extraxylary fibers; xylary fibers and paper manufacture; forage fibers; Forensic Science - application of anatomical evidences in criminal and civil laws. Dendrochronology: concept and application.

8. Palynology & Aerobiology

Palynology and its Application: Role of pollen grains in the evolution of angiosperms; Pollination biology and pollen-pistil interaction; Pollen biotechnology and crop improvement; Pollen analysis- its principles and application; Pollen physiology and chemistry; Structure and chemical nature of pollen wall and tubic body.

Aerobiology: its practical applications; airborne biological materials, impact of aerobiological research; Aerobiology in India and abroad; impact of airborne materials on living system; Aerobiology and pollution control; Meteorology in relation to dispersal and deposition of airborne bioparticles; Aerobiology and biodeterioration.

9. Applied Pteridology

(i) Experimental approach in understanding ecology of pteridophytes – with special reference to introduction of new species.

(ii) Mycorrhizae, symbiotic association of *Azolla* with *Anabaena azollae*- an approach to biofertiliser.

(iii) Myrmecophily in the genus *Lecanopteris*- habitat for insects.

(iv) Biochemistry of toxin, biology and control of Braken fern.

(v) Cytogenetics of fern: Chromosome numbers, morphology; polyploidy and cytogenetic analysis of species complexes

(vi) Apospory, apogamy and apomixes; hybridization- An approach for rapid multiplication of economically important pteridophytes

(vii) Nature of fern breeding systems, homozygosity Vs heterozygosis, genetic load-for conservation of economically important pteridophytes

(viii) Experimental investigation of fern sporophyte development (shoot apical meristem, lateral primordia and leaf determination, Induction of sporogenous tissue- with special reference to conservation of economically important pteridophytes

(ix) Culture of fern gametophytes, Photomorphogenesis in Fern gametophytes

(x) Phytochemical analysis (quantitative and qualitative analysis) - total chlorophyll, carbohydrate, protein; screening tests for alkaloid, flavonoid, glycoside, tannin, steroid, saponins, anthroquinone etc.

PRACTICAL

Core Course (General): MBC-34

Full Marks: 40

Credit: 3

(Pteridology, Gymnosperms & Palaeobotany)

1. Study of Vegetative and reproductive structure of represented member of Ophiglossales, Marattiales, Osmundales, and Filicales (Simplices, Gradatae, Mixtae).
2. Study of Vegetative and reproductive structure of represented member of Cycadales, Coniferales and Gnetales.
3. Study of fossil members in different geological ages.

Core Course (General): MBC-35

Full Marks: 40

Credit: 3

(Taxonomy & Palynology of Angiosperms)

1. Description and identification of different plant taxa using keys.
2. Pollen morphological study of different plant taxa.
3. Preparation of safranine jelly.
4. Acetolysis of pollen grain.
5. Study of Pollen in honey sample.

6. Pollen sampling technique.
7. Preparation of Herbarium sheets.
8. Field study and collection of plant materials.

Semester IV

THEORY

Core Course (General): MBC-41

Full Marks: 60

Credit: 5

Group A – Anatomy

Differentiation: alternate pathway of development, totipotency, polarity, pattern formation, genetic control, environmental effect.

Cell wall: chemistry, ultrastructure, biosynthesis and phylogeny.

Laticifers: types, structure, development and economic importance of latex.

Xylem: ontogeny, ultrastructure and phylogeny.

Phloem: structure, p-protein, transcellular strands, ultrastructure, phylogeny.

Nodal anatomy: structure, evolutionary trends.

Bark: types, development and ultrastructure.

Transfer cells: distribution, function and phylogeny

Group B - Embryology & Pharmacognosy

Embryogenesis: classification of dicot embryogenesis; embryo development in dicot and monocot. Suspensor – types, development and function. Embryo culture– concept and application.

Endosperm: types, cytology and function; Endosperm culture: concept and application.

Polyembryony: types, cause, factors involved and application.

Pharmacognosy: Introduction & scope of pharmacognosy. Organoleptic, micromorphological and microchemical characters of crude plant drugs – *Cinchona*, *Digitalis*, *Strychnos*, *Rauwolfia* & *Adhatoda*.

Secondary plant metabolites: introduction; uses of bioactive secondary metabolites.

Core Course (General): MBC-42

Full Marks: 60

Credit: 5

Group A – Plant Ecology

Biomes: Life zones, major biomes and soil types of the world; Parameters delimiting individual biomes.

Population concepts: Population growth, carrying capacity, population regulation, r and k selection, population interactions.

Community Ecology: Concept of community and continuum; Mechanism of ecological succession (facilitation, tolerance and inhibition models); Changes in ecosystem properties during succession.

Ecosystem organization: Structure and functions, primary production (methods of measurement, global pattern, controlling factors); Energy dynamics (trophic organization, energy flow via grazing and detritus chains, ecological efficiencies); Litterfall and decomposition (mechanism, controlling factors).

Ecosystem stability: Concept (resistance and resilience), ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion.

Plant Biodiversity: concepts and status in India; Conservation: principles and strategies.

Group B - Environmental Botany

Introduction: Probiotic environment and origin of life; Interrelationship between the living world and the environment; Basic concept on hydrosphere, lithosphere and atmosphere.

Genes and environment: interaction of gene and environment with reference to heat stress and salt stress, ecotype.

Adaptation: eco-physiological adaptations of C₄ and CAM plants.

Impact of human activities: greenhouse effect and global warming, ozone depletion, desertification, acid rain, deforestation.

Environmental pollution: pollution of air, water and soil, prevention and control of pollution.

Biological control: Biomonitoring of air and water pollution, bio-indicators, bio-remediation.

PRACTICAL

Core Course (General): MBC-43

Full Marks: 40

Credit: 3

(Anatomy, Embryology & Pharmacognosy)

1. Comparative study of various types of stomata.
2. Study of various types of trichomes.
3. Study of different types of crystals.
4. Comparative study of stomatal indices of some selected plants.
5. Study of nodal anatomy – unilacunar, trilacunar & multilacunar types.
6. Wood anatomy of various groups of plant.
7. Macroscopic study of some important crude drugs of Indian Systems of Medicine.
8. Microscopic study of powder of some selected crude drugs.
9. Microchemical tests of some crude drugs and their extracts.

Core Course (General): MBC-44

Full Marks: 40

Credit: 3

(Plant Ecology & Environmental Botany)

1. Vegetation analysis (determination of optimum size and minimum number of quadrat required for studying a plant community; determination of frequency, density, abundance and IVI of a plant community).
2. Soil analysis (estimation of soil texture, moisture content, water holding capacity and organic carbon content of soils from cropland, grassland and forest ecosystems).
3. Water analysis (estimation of pH, electrical conductivity, free CO₂, chlorinity and salinity of different water samples).

Core Course (Optional): MBC-45

Full Marks: 50

Credit: 4

[Based on theory course MBC-33 & MBE-31]

1. Microbiology

- (i) Isolation of pure bacterial culture: streak-plate, pour-plate and spread-plate techniques
- (ii) Screening of microbes capable of producing extracellular enzyme: Protease, Amylase, Lipase, Cellulase
- (iii) Study of physiological and biochemical activities of bacteria (routine tests including liquefaction of gelatin; citrate utilization; fermentation/oxidation of sugars)
- (iv) Study of bacterial growth and determination of generation time
- (v) Determination of the influence of temperature, and pH on microbial growth
- (vi) Assay of antibiotics using tube dilution, and agar diffusion methods
- (vii) Enrichment and isolation of chemolithotrophic bacteria (sulfur oxidizing)
- (viii) Enrichment and isolation of endospore-forming bacteria, diazotrophic bacteria.
- (ix) Isolation of antibiotic-resistant spontaneous mutants
- (x) Demonstration of Conjugation of plasmids by plate mating method
- (xi) Demonstration of artificial bacterial transformation by CaCl₂ method
- (xii) Chromatographic separation: using paper and thin-layer
- (xiii) Purification of chromosomal / plasmid DNA and study of DNA profile
- (xiv) Agarose gel electrophoresis of DNA
- (xv) Bioinformatics: A brief idea about nucleic acid and protein sequence databases, 16S rRNA sequence based Blast search analysis, sequence alignment and Phylogenetic tree construction (using standard softwares)

2. Phycology

- (i) Algal diversity study and its taxonomy (up to species level)
(Students need to submit Voucher specimens in museum)
- (ii) Quantitative estimation of phytoplankton and study of algal bloom dynamics

- (iii) Estimation of water quality (Phosphate, nitrate, DO)
- (iv) Algal Chromosome study from *Chara* & filamentous green algae.
- (v) Isolation and culture of microalgae from various habitat, its preservation and Assignment of strain no (Each spl. Student needs to deposit a strain in the VBCCA)
- (vi) Mass culture of Algae
- (vii) Estimation of pigments in algae (Chlorophyll, Carotenoids, Accessory pigments)
- (viii) Estimation of Carbohydrate, Protein, Amino acid & Fatty acid analysis in algae
- (ix) Extraction of Agar-Agar & Carragenan
- (x) Antioxidant activity in Algae
- (xi) Extraction of Genomic DNA and Agarose Gel Electrophoresis
- (xii) RAPD of selected algal strains

3. Mycology, Plant Pathology

- (i) Knowledge and identification of molds, mushrooms and yeasts
- (ii) Preparation of fungal growth media
- (iii) Isolation of fungi from natural sources
- (iv) Study of air-mycoflora of specified area
- (v) Study of fungal amylase and protease enzymes
- (vi) Isolation of pure culture of pathogens from different plant infections
- (vii) Estimation of sugar from the culture filtrate of fungus
- (viii) Estimation of protein from mycelial/ mushroom extract
- (ix) Identification of amino acids from mushroom extract
- (x) Estimation of phenolics/catechol from healthy and infected leaves
- (xi) Determination of phosphate solubilizing ability of plant growth promoting rhizobacteria
- (xii) Study of antifungal activity of fluorescence pseudomonads
- (xiii) Determination of MIC value of fungicides
- (xiv) Determination of MIC value of antibiotics against phytopathogenic bacteria
- (xv) Assay of peroxidase and phenyl alanine ammonia lyase from leaves of pathogen induced plants
- (xvi) Study of fungal protein by gel electrophoresis
- (xvii) Study of fungal DNA through agarose gel

4. Plant Physiology & Biochemistry

- (i) Chloride ion estimation in leaves of aquatic and terrestrial plants
- (ii) Determination of chlorophyll and protein contents in leaves of different physiological stages.
- (iii) Determination of soluble and insoluble carbohydrate contents in the cotyledons of germinating seeds
- (iv) Assay of catalase and peroxidase enzymes in leaves of different physiological stages.
- (v) Estimation of proline content in leaves under water stress
- (vi) Effect of IAA on elongation growth of coleoptiles

- (vii) Chromatographic separation and identification of amino acids
- (viii) Temperature and pH optima of enzyme activity
- (ix) Isolation of Genomic/Plasmid DNA from *E. coli* cells
- (x) Restriction digestion of DNA and its analysis by Agarose gel electrophoresis
- (xi) Transformation of *E. coli* cells with pDNA and Blue-White screening of recombinants
- (xii) Amplification of specific genes of *E. coli* by PCR

5. Cytogenetics

- (i) Preparation of aceto-orcein, aceto-carmin and feulgen stains
- (ii) Pre-treatment, fixation, staining and chromosome analysis of *Lens culinaris*, *Allium cepa* and *Aloe vera* for karyotype study and karyogram preparation
- (iii) Study of chiasma frequency and terminalization coefficient from meiotic cell division of grasshopper and *Allium cepa*
- (iv) Effect of chemicals on mitotic cell division as well as on chromosomes of *Allium cepa*;
- (v) Study of chromosome abnormalities induced by chemicals
- (vi) Preparation of standard curve of DNA and RNA and their quantitative estimation using UV Spectrophotometer
- (vii) Laboratory organization and preparation of culture medium.
- (viii) Aseptic manipulation: Culture initiation and maintenance in culture room.
- (ix) In vitro induction of callus from seedling explants of *Daucus carota*
- (x) Somatic embryogenesis: induction, development and germination into rooted plantlets.
- (xi) Micropropagation study through shoot tip culture

6. Plant Ecology

- (i) Vegetation analysis (study of plant community; determination of frequency, density, abundance and IVI of a plant community)
- (ii) Soil analysis (estimation of soil texture, moisture content, pH, alkalinity, salinity, inorganic phosphate, water holding capacity and organic carbon content of soils from different ecosystems)
- (iii) Water analysis (estimation of pH, electrical conductivity, free CO₂, alkalinity, chlorinity and salinity, inorganic phosphorus, COD, BOD of different water bodies)
- (iv) Volumetric study of air biocontaminants in intramural and extramural environments
- (v) Determination of air pollution index through the study of foliar water content, chlorophyll, protein, ascorbic acid and phenol contents
- (vi) Assay of catalase and peroxidase enzymes in leaves of different physiological stresses

7. Pharmacognosy

- (i) Comparative study of leaf epidermis, stomata, trichomes of various plant groups
- (ii) Study of stomatal index, trichome index and palisade ratio of different plants

- (iii) Comparative study of starch grains and crystals of different plants
- (iv) Study of wood anatomy (lower to higher groups of vascular plants)
- (v) Study of various types of fibers
- (vi) Xylem elements study of different wood types through maceration technique
- (vii) Study of various types of nodal anatomy
- (viii) Study of different laticiferous structures
- (ix) Macroscopic study of some important crude drugs commonly used in Indian Systems of Medicine (ISM)
- (x) Powder microscopy of some selected crude drugs
- (xi) Extraction of crude drug by Soxhlet apparatus
- (xii) Microchemical tests of different extracts of crude drugs
- (xiii) Histochemical study of medicinal plants
- (xiv) Extraction, isolation and separation of few selected phytochemicals
- (xv) Determination of ash value, water soluble ash, acid insoluble ash, etc of some selected medicinal plants
- (xvi) *In vitro* culture of medicinal plant (Demonstration)
- (xvii) Preliminary antimicrobial screening of medicinal plant (Demonstration)

8. Plant Biosystematics

- (i) Description and identification and comparative study of different plant taxa and preparation of artificial key.
- (ii) Description and identification from herbarium sheets.
- (iii) Preparation of glycerin jelly.
- (iv) Study of different pollen morphotypes: Acetolysis and temporary preparation.
- (v) Honey analysis.
- (vi) Pollen physiology and chemistry.
- (vii) Study of airborne pollen/spores.
- (viii) Preparation of herbarium sheets.
- (ix) Preparation of list of Indian species of some taxa using Index Kewensis.
- (x) Reproductive biology: pollen-pistil interaction.
- (xi) Field study and collection of plant materials.

9. Pteridology

- (i) Biodiversity study in different biozones.
- (ii) Macro-morphological study of different groups of Pteridophytes.
- (iii) Morpho-anatomical studies (Stomata, epidermal emergences, rhizome, petiole, root and spore) of the following families: Polypodiaceae, Thelypteridaceae, Pteridaceae, Davalliaceae, Hymenophyllaceae, Dryopteridaceae, Athyriaceae, Azollaceae.
- (iv) Cytological study (mitosis and meiosis).

(v) Phytochemical analysis (Quantitative and Qualitative analysis) total chlorophyll, carbohydrate, protein; screening tests for alkaloid, flavonoid, glycoside, tannin, steroid, saponins, anthroquinone etc.

(vi) Study of spore (Morphological, chemical, immunological)

PROJECT WORK

Core Course: MBC-46

Full Marks: 50

Credit: 4

Work related to this course has to be done during Semester III and IV, but the dissertation has to be submitted at the end of Semester IV and to be evaluated along with presentation and viva-voce.