Department of Botany
Visva-Bharati

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

Course structure

Course	Full Marks	Credit
Core Courses (General)	1000 Theory (60 x 10 = 600) Practical (40 x 10 = 400)	80 Theory (5 x 10 = 50) Practical (3 x 10 = 30)
Core Courses (Optional)	150 Theory (50) Practical (50) Project Work (50)	12 Theory (4) Practical (4) Project Work (4)
Elective Course	50 Theory (50)	4 Theory (4)
Total	1200	96

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

Courses	**Full Marks**	**Credit**
Semester I		
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	300	24
Semester II		
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	300	24

Courses	**Full Marks**	**Credit**
Semester III		
Theory		
Core Course (General): MBC-31	60	5
Group A – Pteridology		
Group B - Gymnosperm & Palaeobotany		
Core Course (General): MBC-32	60	5
Group A – Taxonomy of Angiosperms		
Group B - Palynology of Angiosperms		
Core Course (Optional): MBC-33	50	4
[List given below]*		
Elective Course (Choice based): MBE-31	50	4
[List given below]**		
Practical		
Core Course (General): MBC-34	40	3
[Based on theory course MBC-31]		
Core Course (General): MBC-35	40	3
[Based on theory course MBC-32]		
Total	300	24
Semester IV		
Theory		
Core Course (General): MBC-41	60	5
Group A – Anatomy		
Group B - Pharmacognosy		
Core Course (General): MBC-42	60	5
Group A – Plant Ecology		
Group B - Environmental Botany		
Practical		
Core Course (General): MBC-43	40	3
[Based on theory course MBC-41]		
Core Course (General): MBC-44	40	3
[Based on theory course MBC-42]		
Core Course (Optional): MBC-45	50	4
[Based on theory course MBC-33]		
Project work* **		
Core Course: MBC-46	50	4
Total	300	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

Semester I
THEORY

Core Course (General): MBC-11; Full Marks: 60; Credit: 5; No. of Lectures: 80

Group A – Microbiology

Basics of Microbiology: History, Microbial growth parameters; Culture media: types, selective, enrichment & differential; Pure culture; Brief idea about cultivable and yet-to-be cultivable microorganisms; 16S rRNA gene sequence based phylogeny **(10 lectures)**

Environmental Microbiology: Normal microflora of air, water & soil; Rhizosphere & soil microorganisms; Winogradsky column, Microbiological analysis of water: TOC, COD and BOD; Indicator organisms; Air- and water-borne human diseases **(8 lectures)**

Metabolic diversity of microorganisms: Basic idea about Phototrophy, Autotrophy, heterotrophy, chemolithotrophy; Biological nitrogen fixation: Nitrogenase, *nif* genes, leghemoglobin and hydrogenase; Root nodule formation: *nod* genes, Nod factors **(8 lectures)**

Microbial genetics: Genetic recombination: transformation, conjugation, transduction and sex-duction, complementation; mapping genes by interrupted mating; Plasmid biology: Types, Replication (theta mode and rolling circle), partition, incompatibility and transfer; Regulation of gene expression: Lac operons **(14 lectures)**

Group B (Virology & Immunology)

Virology: History; Structure; Cultivation of viruses; Bacteriophages: Lytic and Lysogenic cycle; Principles of viral taxonomy; Replication of viral nucleic acids; One step growth curve; early and late proteins; Clear & turbid plaques; Viroids: Structure, RNA world hypothesis; Prions: diseases, structure, & genetic basis; Virus-induced cancer **(12 lectures)**

Immunology: Innate & adaptive immunity; Cells and organs of the immune system; Lymphocytes, MHC, exogenous & endogenous antigens, B-cell activation & antibody production; Self and non-self recognition; Antibodies: Immunoglobulin classes; Structure of Immunoglobulin G; Polyclonal and monoclonal antibodies; Vaccine **(12 lectures)**

Immune diseases: AIDS: Human immunodeficiency virus, structure & genomic organization; Pathogenesis and control; Hypersensitivity; Autoimmune diseases **(6 lectures)**

Antigen-antibody reactions and Immunodiagnostics: Factors involved; Immunoprecipitation: Mancini & Ouchterlony; Immunoelectrophoresis; Agglutination: Latex agglutination test, Viral hemagglutination, Blood group determination; Titer value; RIA; ELISA: Types, substrates &

enzymes used Pregnancy detection test; Western Blotting; Phage display; Immunofluroscence **(10 lectures)**

Core Course (General): MBC-12; Full Marks: 60; Credit: 5; No. of Lectures: 80

Group A – Phycology

Phycology: Thallus organization and modes of development; endosymbiotic theory of origin of chloroplasts ultra-structure of algal cell; metabolic pathway in algal cells; ecology; adaptation of algae in diversified habitats; algal bloom; life cycle pattern and reproductive strategies; phylogeny, evolutionary tendencies in major algal groups; algal biotechnology with special reference to genetic engineering and bioprospecting.

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 with special reference to molecular and chemical data; Origin, evolution and fossil history of bryophytes; comparative study of gametophytic and sporophytic structure and their development in major groups with special reference to Indian forms; ecology-role of bryophytes in plant succession, physiology with special reference to water relation and photoperiodism.

Classification of mosses with Indian examples and distribution; Phylogenetic relationship and evolutionary tendencies exhibited by the group. Economic and ecological importance of bryophyte culture and bryotechnology

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

Core Course (General): MBC-13; Full Marks: 60; Credit: 5; No. of Lectures: 80

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 bight 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 bight of rice.

PRACTICAL

Core Course (General): MBC-14 Full Marks: 40 Credit: 3 No. of Lectures: 96

(Microbiology, Virology & Immunology)

1. Differential Staining (Gram and endospore) to study prokaryotic cell morphology
2. Isolation and study of rhizobia from root nodules
3. Preparation of bacteriological culture medium and Sterilization methods
4. Techniques in bacterial culture: streak-plate, pour-plate and spread-plate
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. Antibiotics sensitivity test using paper disc method
10. Study of bacterial growth by turbidometric method
11. Determination of the influence of temperature, pH, and aeration on microbial growth
12. Plaque assay of bacteriophage
13. Blood group determination using slide agglutination method
14. Kit based antigen-antibody interaction assay

Core Course (General): MBC-15 Full Marks: 40 Credit: 3 No. of Lectures: 96

(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 No. of Lectures: 96

(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; No. of Lectures: 80

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. **(15 lectures)**

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. **(15 lectures)**

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. **(20 Lectures)**

Characteristics and function of genes : Unique and repetitive sequences of DNA, Interrupted gene, Selfish DNA, Pseudoallele **(15 Lectures)**

Cell cycle: Molecular mechanism of cell cycle regulation. **(15 Lectures)**

Group B - Genetics

Extension of Mendelian genetic analysis: Modified Mendelian ratios; Multiple factor and polygenic inheritance, Pentrance and expressvity, Heritability and its measurements **(15 Lectures)**

Regulation of gene expression: Lac and Trp operon in prokaryotes, general regulatory process in eukaryotes, Gene silencing and Genomic imprinting **(15 Lectures)**

Gene mutation & DNA repair: Types and causes and detection, Mutant types-lethal, conditional, biochemical, Loss of function, gain of function insertional mutagenesis; Molecular mechanism of DNA repair. **(15 Lectures)**

Sex determination: Sex determination in plants, Sex linkage, Sex limited and Sex influenced characters, dosage compensation. **(15 Lectures)**

Genetic code: Properties of genetic code with evidences, deciphering of genetic code (code assignment). **(10 Lectures)**

Mobile genetic elements: Transposable genetic elements in prokaryotes and eukaryotes, retro-transposons. Homologous and non-homologous recombination in transposition **(10 Lectures)**

Core Course (General): MBC-22; Full Marks: 60; Credit: 5; No. of Lectures: 80

Group A – Plant Physiology

Water relations of plants: Water potential & its components; Water movement through root, stem and leaf – passages and driving forces. **(15 Lectures)**

Photochemistry & Photosynthesis: Photosynthetic apparatus - organization and pigments, concept of photosystems and light energy harnessing mechanism, photosynthetic electron transport; Carbon assimilation and regulation in C_3 plants, CO_2 concentrating mechanism in C_4 and CAM plants. **(15 Lectures)**

Translocation of assimilates: Source-sink relationship and patterns of movement; Phloem transport – phloem loading and unloading; Mechanism of long distance transport. **(15 Lectures)**

Plant growth regulators: Chemistry, biosynthesis and physiological action of auxins, gibberellins, cytokinins, ethylene and abscisic acid. **(10 Lectures)**

Photoperiodism: Photoperiodic classes; Photoperiodic induction – importance of light and dark period; Mechanism of induction and role of phytochrome. **(10 Lectures)**

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. **(15 Lectures)**

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. **(20 Lectures)**

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. **(20 Lectures)**

Bioenergetics: Concept of Gibbs free energy, calculation of standard free energy change (ΔG^{o}) for hydrolysis; ATP as energy currency; Mechanism of oxidative phosphorylation. **(20 Lectures)**

Biochemistry of nucleic acids: DNA - molecular structure, physical and chemical properties. **(20 Lectures)**

Core Course (General): MBC-23; Full Marks: 60; Credit: 5; No. of Lectures: 80

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. **(15 Lectures)**

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. **(15 Lectures)**

Transcription: Molecular mechanisms of transcription; Regulation of gene expression with special reference to two component gene regulatory system; RNA processing. **(15 Lectures)**

Gene library: Construction of cDNA library and genomic library; Screening of libraries. **(7 Lectures)**

DNA hybridization & sequencing: Generation of radiolabeled probe and blotting techniques; Southern and Northern hybridization; DNA Sequencing methods. **(15 Lectures)**

DNA Replication: Basic mechanism of DNA replication. **(8 Lectures)**

Polymerase chain reaction: Principles & methods **(5 Lectures)**

Group B - Plant Biotechnology

Plant Biotechnology: Basic concept, principles and its scope. **(7 Lectures)**

Plant cell and tissue culture: General introduction and techniques **(10 Lectures)**

Callus and cell suspension culture: Techniques, characteristics and applications. **(10 Lectures)**

Organogenesis and somatic embryogenesis: Techniques and application. Cytodifferentiation **(10 Lectures)**

Shoot tip and shoot meristem culture: Techniques and applications. **(10 Lectures)**

Androgenesis: Techniques and utility.Diploidazation, Gynogenic haploids **(7 Lectures)**

Protoplast culture: Isolation, purification and culture of protoplast. **(10 Lectures)**

***In vitro* conservation of plants:** Aim, methods of in vitro conservation of plant germplasm **(6 Lectures)**

Chloroplast and Mitochondrial DNA transformatiom: Techniques and Biosafety concerns **(10 Lectures)**

PRACTICAL

Core Course (General): MBC-24 Full Marks: 40 Credit: 3 No. of Lectures: 96

(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 No. of Lectures: 96

(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 No. of Lectures: 96

(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; No. of Lectures: 80

Group A – Pteridology

Introduction and concept about primitive and advancecharcters of pteridophytes as proposed Bower **(2 lectures)**

Systematic study of the distribution, structure, reproduction and evolutionary trends of the following groups: Ophioglossales b) Marattiales c) Osmundales d) Filicales (generilsed form of Simplices, Gradatae and Mixtae types) e) Marsileales f) Salviniales **(18 lectures)**

Systematic study, structures, geological and geographical distribution and evolutionary trends of the following groups: Rhyniopsida, b) Zosterophyllopsida, c) Trimerophytopsida and d) early Lycopsids **(6 lectures)**

Stellar concept, types and evolution **(2 lectures)**
Soral evolution in ferns (2 lectures)
Types of spore, germination pattern, gametophyte development and types 2 lectures)
Mating system in ferns, control of sexuality in homosporouspteridophytes by antheridogen activity **(3 lectures)**

Apospory and apogamy: definition, factors for induction and significance **(2 lectures)**

Geological time scale and distribution of major extinct group of pteridophytes **(1 lectures)**

Progymnosperms: Characterisation and its role in gymnosperm evolution.Heterospory and seed habit **(2 lectures)**

Group B - Gymnosperm, Palaeobotany& Palaeopalynology

Introduction: Modern classification and economic importance of gymnosperms **(2 lectures)**

Cycadales- characteristics, fossil records, worldwide distribution pattern of extant cycads, origin and evolution of leaf and megasporangiate cones, phylogeny with special reference to molecular phylogeny **(6 lectures)**

Coniferales- characteristics, distribution pattern of Indian conifers, origin and evolution of seed-cone complex among extinct and extant conifers, phylogeny with special reference to molecular phylogeny **(6 lectures)**

Gnetales- characteristics, distribution pattern, systematic and phylogeny with special reference to molecular phylogeny **(6 lectures)**

Paleobotany: Fossil and fossilization process; Relative and Absolute datings (C^{14}, Argon and Uranium datings), techniques for studying fossil plants (ground thin section, peel technique, transfer technique and microfossil analysis). Pre-Cambrian life forms, Continental drift hypothesis and Plate tectonics, Indian Gondwana system **(10 lectures)**

Palaeopalynology: Basic principle of palynology, sporoderm stratification, physical and chemical properties of sporopollenin, application of palaeopalynology in stratigraphy, palaeoclimate and hydrocarbon exploration **(10 lectures)**

Core Course (General): MBC-32; Full Marks: 60; Credit: 5; No. of Lectures: 80

Group A- Taxonomy of Angiosperms

Principles of Taxonomy: Modern systems of classification including Cornquist, Takhtajan and Thorne. APG classification. (**6 Lectures**)

The International Code of Nomenclature for algae, fungi and Plants (ICN): General principle and important rules relating to the nomenclature types, priority, publication and name changes. (**4 Lectures**)

Taxonomic evidences: From anatomy, cytology, embryology, palynology and phytochemistry in taxonomy; Computer and GIS as taxonomic tool. (**6 Lectures**)

Major evolutionary trends: Evolutionary trends in the Dicotyledons; Interrelationships among the different groups of Dicotyledons and Monocotyledons. (**6 Lectures**)

Taxonomy and phylogeny: Taxonomy and phylogeny of the important groups like Ranales, Rosales, Casuarinales, Campanulatae, Helobiales, Liliales and Orchidales. (**8 Lectures**)

Concept of Phytogeograpgy: Phytogeographical regions, biomes, endemism, biological hotspots and hottest hotspots; plants exploration, invasions and introductions, local plant diversity and its socioeconomic importance, conservation, sustainable utilization of bio-resources. (**10 Lectures**)

Group B- Palynology of Angiosperms

Basics of Palynology: History, basic concept and scope, short and long term pollen storage. (**4 Lectures**)

Pollen morphology: Pollen units, symmetry, polarity, shape classes, sporoderm stratification and ornamentation, morphological characters of pollen and spores and their modern terminology. (**8 Lectures**)

Classification and Evolutionary trends: NPC classification, LO analysis, primitive and advanced types of pollen grains. (**6 Lectures**)

Pollen wall chemistry: Analysis and chemistry of pollen wall, Sporopollenin, Ubisch body, Viscin threads, Pollen kitt, Pollen allelopathy. (**8 Lectures**)

Aeropalynology: Principle and techniques of air sampling (qualitative and quantitative) of pollen and spores, significance of airborne pollen grains and spores in allergic disorders, *in-vitro* and *in-vivo* test for detection of allerginicity of pollen and spore. (**8 Lectures**)

Melissopalynology: Definition and assessment of honey (qualitative and quantitative) in relation to vegetation study and honey adulteration. (**6 Lectures**)

Core Course (Optional): MBC-33; Full Marks: 50; Credit: 4; No. of Lectures: 64

[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, Polyphasic taxonomy: molecular chronometers, 16S

rRNA gene sequencing, DNA-DNA hybridization, and G+C content; The species concept; Bioinformatics & phylogeny: Nucleic acid and protein sequence databases, sequence analysis, sequence alignment, Blast search, and phylogenetic tree **(15 lectures)**

Culture conditions and Growth: Culture media, Selective, differential & enrichment culture; Batch culture and continuous culture; Microbial growth and enumerations; Peptidoglycan synthesis & cell division; Proteins in cell division; Environmental factors influencing growth: temperature, salinity, water activity, pH, & oxygen; Biofilm formation and Quorum sensing. Microorganisms in extreme environments and extra-terrestrial microbiology **(12 lectures)**

Metabolism: Metabolic classes of microorganisms (autotroph, phototroph, chemotroph, heterotroph); Photosynthesis (anoxygenic and oxygenic), Cyclic and non-cyclic photophosphorylation, electron transport chain; Chemosynthesis (sulfur oxidation, iron oxidation, hydrogen oxidation and nitrification); Methanotrophy; Anaerobic Respiration: Denitrification, sulfate reduction, and methanogenesis **(12 lectures)**

Microbial genetics and Molecular biology: Origin of Spontaneous mutation, Fluctuation test; Transposons (Tn5); Regulation of gene expression: allosteric regulation, feed-back inhibition, positive and negative control, catabolite repression, attenuation, retroregulation, antisense RNA control, antitermination; Polymerase chain reaction (end-point PCR, RT-PCR, nested PCR, inverse PCR, degenerate PCR, qPCR) and its applications; Strategies to express foreign proteins in bacteria; DNA sequencing: Sanger and Next generation sequencing; A brief idea about genomics, proteomics and transcriptomics of microbes; Techniques involved in microbial population analysis: T-RFLP, DGGE, FISH, Amplicon sequencing and metagenomics **(15 lectures)**

Virology: Molecular biology of the bacteriophage lambda, M13 and P1; Novel emerging viruses: SARS, Corona virus; Phage therapy **(10 lectures)**

2. Phycology

Phycology

General account of important groups: Glaucophyta, Haptophyta, Chrysophyceae, Xanthophyceae, Eustigmatophyceae, Dinophyta, Euglinophyta & Chlorarachniophyta

Biology of Cyanobacteria: Classification, phylogeny, role in evolution of O_2; photosynthesis, nitrogen metabolism, nif genes, respiration, nature of genome, genetic recombination, genetic mapping, plasmids, gene cloning, cyanophages.

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

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

Algal genetics: Classical and modern concepts; *Chlamydomonas* as a model genetic system, recombination and gene mapping, plastid inheritance; Gene expression in *Acetabularia*.; 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 heterotropic 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.

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.

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, appresorial 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. **(15 Lectures)**

Karyotype concept: Role in the study of phylogeny, evolution and systematic status.
(10 Lectures)

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implication. **(15 Lectures)**

Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor gene, virus induced cancer, metastasis, apoptosis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth **(15 Lectures)**

Developmental Biology: floral meristem and gene controlling floral development in *Arabidopsis* and *Antirrhinum*, Cell fate and Cell lineages. **(10 Lectures)**

Gene mapping and Human Genetics: Linkage maps; molecular maps of the genome: sequencing of human genome, QTL mapping, human genome project, genetic disorders. **(15 Lectures)**

6. Plant Ecology

Introduction: Origin and evolution of life on earth (pre-RNA world, RNA world and DNA world), life and life processes; Biological significance of carbon, hydrogen, nitrogen and oxygen**(6 lectures)**

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. **(10 lectures)**

Community organization and development: Analysis of communities (analytical and synthetic characters), interspecific associations, ecological niche, changes during ecological properties and mechanism of ecological succession **(10 lectures)**

Population ecology: Population Characteristics, Population Growth, Effect of Competition **(**Gause's Competitive Exclusion Principle; Lotka-Volterra model) **(10 lectures)**

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 **(8 lectures)**

Biodiversity: Categories, megadiverse countries, status in India, significance, spatial scales and diversity, causes for loss of biodiversity, measurement and values of biodiversity **(10 lectures)**

Conservation: Principles of conservation, conservation status of plants based on IUCN, types of conservation of biodiversity (in situ and ex-situ conservation), design of biosphere reserve, CBD, CITES and Ramsar convention **(10 lectures)**

7. Pharmacognosy

Pharmacognosy: Definition, history and scope. Brief account of Ayurveda, Siddha and Unani systems of medicine. Alternative medicine and Aromatherapy.

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

Drug adulteration: Concept and its various modes. Detection of drug adulterant.

Drug evaluation: Organoleptic study, macromorphology, micromorphology, anatomy, physical constants,microchemistry and powder study of common herbal drugs (herbs, barks, wood, inflorescence, seeds, subterranean organs and exudates).

Herbal products: *Volatile oils:* Chemistry, extraction, sources and uses with reference to Aromatherapy;

Phenols, Flavonoids and *tannins:* Sources, chemical nature, isolation, biosynthesis (brief outline) and therapeutic uses;

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

*Glycosides:*Sources, properties, classification and therapeutic uses;

Steroids: Chemical characteristic, classification, extraction, biosynthesis 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.

Nutraceuticals and *functional foods*: Concept and applications.

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 importance in drug discovery. Bioprospecting, IPR and Conservation of Medicinal Plant Resources.

8. Plant Biosystematics

Biosystematics and modern approaches of plant taxonomy: Modern systems of classification and recent development; Phenetic and cladistic approach; Molecular systematics; Population concept, biosystematic categories and Numerical taxonomy; Importance of nuclic acids and proteins in taxonomic delimitations; Application of chemotaxonomy and phytogeography; Computer aided taxonomic studies on Indian flora and its component. (**18 Lectures**)

Herbarium techniques: Field and herbarium techniques; Herbaria and Botanical Gardens of the world. (**10 Lectures**)

Important orders of Angiosperms: Study of important orders / groups of angiosperms with reference to their interrelationship, evolutionary trends and present concept in light of modern researches. (**14 Lectures**)

Indian flora: Indian flora with reference to endemism and foreign elements; Taxonomic literatures and floras. (**10 Lectures**)

Biodiversity: Biodiversity and conservation of natural resources (*Ex-situ* and *In-situ*). (**12 Lectures**)

9. Pteridology

Origin of arborescent Lycopods. (**2 Lectures**)

Origin and evolutionary trends in the Sphenopsids (**2 Lectures**)

A brief account of the Paleozoic and Mesozoic Lycopods, Sphenopsids and Filicopsids found in India. (**8 Lectures**)

Distribution of pteridophytes in diversified ecological conditions - A brief mention of climates and flora of the past geological era. (**2 Lectures**)

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). (**16 Lectures**)

Present status of distribution of pteridophytes in India. Endangered pteridophytes and their conservation. (**4 Lectures**)

A brief account on the pteridophyte phylogeny group. A community-derived classification for extant lycophytes and ferns.Different systems of classification of major groups of Filicopsida. (**6 Lectures**)

Recent taxonomic circumscriptions of *Lycopodium, Selaginella, Equisetum* and Gleicheniaceae, Polypodiaceae. (**12 Lectures**)

Study of morphology, anatomy and ontogeny of petiole, rachis, stomata, sporewall in various extant groups. (**12 Lectures**)

Elective Course (Choice based): MBE-31; Full Marks: 50; Credit: 4; No. of Lectures: 64

[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 of antibiotics: antibacterial (Penicillins, Chloramphenicol, Streptomycin, Rifampicin, Tetracycline, Erythromycin, Nalidixic acid) & antifungal (Amphotericin B, Nystatin); Antibiotic resistance in bacteria; Antiviral drugs **(16 lectures)**

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), animal products (sausages, sauces), plant products (soy sauce, idli), breads; Probiotics, prebiotics and synbiotics **(10 lectures)**

Industrial Microbiology: Primary and secondary microbial metabolites, properties of an industrial microorganism; Applications of microbial enzymes in industries; Fermentation technology, Fermentor, Fermentation scale up; industrial production of alcohol, organic acids, amino acids, antibiotics (penicillin), enzymes (protease, amylase); Microbial strain improvement strategies: mutation, protoplast fusion, genome shuffling, targeted mutation **(12 lectures)**

Novel Application of microorganisms: Search for novel bioactive compounds; Biofuel production: first and second generation, pretreatment and saccharification; Microbial production of hydrogen gas and bioelectricity; Bioprospecting of microorganisms from extreme environments; Bioinsecticides (*Bacillus thuringiensis*); biopolymers (bacterial plastics); Nanobiotechnology: role of bacteria and viruses **(8 lectures)**

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 and biopesticides; Vermitechnology; Biogas production **(10 lectures)**

Microorganisms in health and disease: Normal microbial flora of different body parts; Gut microbiota and its implication in health and disease control; Virulence factors & toxins; Basic idea about some microbial diseases: TB, and AIDS **(8 lectures)**

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 and its commercial potential (Phycocyanin, Phycoerythrin, allophycocyanin, Astraxanthin, *beta-carotene,* UV-Pigments); *Spirulina*, *Botryococcus*, *Dunaliella, Haematococcus* and *Porphyra*.

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: cellulose and lignin materials
Fungi as source : 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; vecors; 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. **(12 Lectures)**

Micropropagation: technique in horticulture and crop improvement, advantage and disadvantage of micropropagation. **(12 Lectures)**

Protoplast fusion and somatic hybridization: methods of protoplast fusion; selection of heterokaryons; contribution of somatic hybridization in crop biotechnology. **(10 Lectures)**

Somaclonal variation: Source of somaclonal variation; selection of somaclones; application of somaclonal variation in crop improvement. **(10 Lectures)**

Production of virus free plants through in vitro techniques: methods of disease indexing. **(10 Lectures)**

Secondary metabolites: *In vitro* approaches for improved synthesis of secondary metabolites, biotransformation and its application in biotechnology. **(10 Lectures)**

Brief introduction of Bioinformatics: Databases and analysis services **(8 Lectures)**

Intellectual Property Right: Introduction, Patenting, advantages and case studies. **(8 Lectures)**

6. Environmental Botany

Introduction: Categorization of pollutants; point and non-point source, bio-degradable and non-degradable pollutants **(4 lectures).**

Gene ecology: Interaction of gene and environment with reference to heat stress and salt stress, expression and silencing of genes with reference to epigenetic hypothesis**(8 lectures)**

Air pollution: Sources, types and effects on plants and animals, control measure, biomonitoring of air pollution, classical and photochemical smog, acid rain, environmental biopollution **(10 lectures)**

Water pollution: Measurement of water quality, sources and adverse effects on plants and animals, biomonitoring of water pollution, oil spills, prevention and control, Household purification of water (small scale), waste water characteristics and its treatment (large scale) **(10 lectures)**

Pesticides and Metal pollution: Types, environmental hazards, biodegradation, Heavy metal

pollution, xenobiotics, bioaccumulation and biomagnifications **(8 lectures)**

Noise pollution: Concept, measurement of the intensity of sound, sources and health hazards, control measure **(4 lectures)**

General Discussion: Basic concept of Bioremediation, Bioindicators, Biosensors**,** Carrying capacity and Sustainable Development, Environmental Impact Assessment **(10 lectures)**

Global environmental problems: Greenhouse effect and global warming, ozone depletion, Ozone hole- modern outlook, Environmental conventions and Earth Summits, Environmental Acts and Laws, and Environmental movements in India **(10 lectures)**

7. Plant Anatomy

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

Epidermis: General features, epidermal cells with special structures or contents, 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 and cell wall genes.

Systematic Plant Anatomy: Concept and application of various anatomical features in plant systematics.

Ecological Plant Anatomy: Ecological leaf anatomy, ecological wood anatomy, pollution anatomy (effects of air pollutants, ozone injury and 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: Pollen analysis- its principles and application; Role of pollen grains in the evolution of angiosperms; Pollen physiology and chemistry; Structure and chemical nature of pollen wall and ubisch body. (**14 Lectures**)

Melissopalynology: Physical and chemical characteristics of honey, honey as environmental monitors. (**8 Lectures**)

Pollination biology: Basic concept, pollen dispersal and pollen adaptation, pollen-pistil interaction and molecular aspect of self incompatibility; Pollen biotechnology and crop improvement. (**16 Lectures**)

Aerobiology: Application of aerobiology, airborne biological materials, impact of aerobiological research; Formulation of pollen/ spore calendar; Aerobiology in India and abroad, impact of airborne materials on living systems (human health and plant diseases). (**16 Lectures**)

Aerobiology and pollution control: Meteorology in relation to dispersal and deposition of airborne bioparticles; Aerobiology and biodeterioration. (**10 Lectures**)

9. Applied Pteridology

Experimental approach in understanding ecology of pteridophytes – with special reference to introduction of new species. (**8 Lectures**)

Mycorrhizae, symbiotic association of *Azolla* with *Anabaena azollae*- an approach to biofertiliser. (**4 Lectures**)

Myrmecophily in the genus *Lecanopteris*- habitat for insects. (**2 Lectures**)

Biochemistry of toxin, biolology and control of Braken fern. (**6 Lectures**)

Cytogenetics of fern: Chromosome numbers, morphology; polyploidy and cytogenetic analysis of species complexes (**4 Lectures**)

Laboratory induced apospory, apogamy and apomixes; hybridization- An approach for rapid multiplication of economically important pteridophytes; Gibberellic acid and Ethylene Control male sex determination (**8 Lectures**)

Nature of fern breeding systems, homozygosity Vs heterozygosis, genetic load-for conservation of economically important pteridophytes. (**8 Lectures**)

Environmantal biotechnology: ecotoxicology and bioremediation in fern; mitochondrial activity of fern spores for the evaluation of acute toxicity in higher plant development; chronic phyto toxicity in gametophytes; arsenic hyperaccumulator ferns; aerobiology of pteridophyte spores. (**6 Lectures**)

Therapeutical and medicinal applications of pteridophytes: studies on folk medicinal fern; ecdysteroids in ferns-distribution, diversity, biosynthesis and functions; traditional and pharmaceutical development and chemical identification of active principals; functional activities of ferns for human health; toxicological and medicinal aspects of the ferns (**6 Lectures**)

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 (**4 Lectures**)

Culture of fern gametophytes, Photomorphogenesis in Fern gametophytes (**4 Lectures**)

Phytochemical analysis (quantitative and qualitative analysis) - total chlorophyll, carbohydrate, protein; screening tests for alkaloid, flavonoid, glycoside, tannin, steroid, saponins, anthroquinone etc. (**4 Lectures**)

PRACTICAL

Core Course (General): MBC-34; Full Marks: 40; Credit: 3; No. of Lectures: 96

(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; No. of Lectures: 96

(Taxonomy & Palynology of Angiosperms)

1. Description and identification of different plant taxa using keys
2. Pollen morphological studies of different plant taxa
3. Preparation of safranine jelly
4. Acetolysis/ Alkali maceration of pollen grains
5. Study of pollen in honey samples
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; No. of Lectures: 80

Group A – Anatomy

Plant Anatomy: Introduction and its practical application.

Differentiation: Alternate pathway of development; controlling factors (totipotency, polarity, pattern formation, genetic and environmental) in differentiation.

Cell wall: Chemistry, ultrastructure, biosynthesis and phylogeny.

Secretory tissues: Characteristics and types. External and Internal secretory tissues: Characters and types. Laticifers: Types,structure,development and economic importance of latex.

Xylem: Ontogeny, ultrastructure and phylogeny; Xylogenesis.

Phloem: Ontogeny, structure, p-protein, transcellular strands, ultrastucture and phylogeny.

Nodal anatomy: Structure, types and phylogenetic trends.

Bark: Types, structure, development and economic importance.

Transfer cells: Distribution, function and phylogeny.

Group B - Pharmacognosy

Pharmacognosy: Introduction and scope of pharmacognosy.

Crude durgs: Concept and different systems of crude drug classification. Collection, drying, processing and storage practices of crude durgs. Importance of crude drugs in traditional systems of medicine.

Pharmacognostic characters: Organoleptic, macromorphological, micromorphological, anatomical, physical constants and chemical characters of the crude durgs: *Digitalis*, , *Rauvolfia*, Ashoka, *Adhatoda*, *Glycyrrhiza*, Asafoetida, Ginger, Black catechu and Clove.

Secondary plant metabolites: Introduction and its pharmaceutical uses. Physico-chemical properties of major phytochemical groups (alkaloids, glycosides, terpenoids, steroids and phenoilcs). Brief outline of the biosynthetic pathways of Mavalonic acid, Malonic acid and Shikimic acid. Biotechnological approaches for production of plant secondary metabolites (in brief).

Nutraceuticals: Concept and applications.

Core Course (General): MBC-42; Full Marks: 60; Credit: 5; No. of Lectures: 80

Group A – Plant Ecology

Biomes: Life zones, major biomes and soil types of the world; Parameters delimiting individual biomes **(4 lectures)**

Population concepts: Population growth, carrying capacity, population regulation, r and k selection, population interactions **(8 lectures)**

Community Ecology: Concept of community and continuum; Mechanism of ecological

succession (facilitation, tolerance and inhibition models); Changes in ecosystem properties during succession **(6 lectures)**

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) **(6 lectures)**

Ecosystem stability: Concept (resistance and resilience), ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion **(4 lectures)**

Plant Biodiversity : Concepts and types, status in India, Megadiverse countries; measurement, causes of loss, values and importance **(6 lectures)**

Conservation: Principles, types (ex situ and in situ conservation), in vitro germplasm conservation and strategies, CBD, CITES, Ramsar convention **(6 lectures)**

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Group B - Environmental Botany

Introduction: Pre-biotic environment, origin and evolution of life - RNA world hypothesis, diversification of protein world. Basic concept of hydrosphere, lithosphere and atmosphere. Interrelationship between the living world and the environment **(6 lectures)**

Genes and environment: Interaction of genes and environment with reference to heat stress and salt stress. Concept of epigenetics **(4 lectures)**

Adaptation: Eco-physiological adaptations in cyanobacteria, aquatic plants, C_4 and CAM plants for efficient mechanism of CO_2 concentration **(6 lectures)**

Impact of human activities: Greenhouse effect and global warming, ozone depletion, acid rain, deforestation **(6 lectures)**

Air Pollution: Types, sources, adverse effects on plants and humans**,** prevention and control. Black and photochemical smog **(6 lectures)**

Water pollution : Measurement of water quality, types, sources, adverse effects on plants and humans**,** prevention and control. Biomagnification and bioconcentration. Heavy metal pollution. Purification of water, Waste water treatment **(6 lectures)**

Noise pollution: Basic concept **(2 lectures)**

General Discussion: Bioremediation, Bioindicators, Sustainable Development, Earth Summits, Environmental Acts and Laws in India **(4 lectures)**

PRACTICAL

Core Course (General): MBC-43; Full Marks: 40; Credit: 3; No. of Lectures: 96

(Anatomy & 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.
10. Methods of plant tissue culture (Demonstration).

Core Course (General): MBC-44; Full Marks: 40; Credit: 3; No. of Lectures: 96

(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 CO_2, chlorinity and salinity of different water samples).

Core Course (General): MBC-45; Full Marks: 50; Credit: 4; No. of Lectures: 128
[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) Assay for microbial extracellular enzyme: Protease, Amylase, Lipase, Cellulase
iii) Study of physiological and biochemical activities of bacteria: nitrate reduction; VP reaction; indole production; gelatin liquefaction; citrate utilization; fermentation 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 well diffusion methods
vii) Bacteriological examination of natural samples
viii) Enrichment and isolation of endospore-forming, and diazotrophic bacteria
ix) Induction of mutation, and selection of mutants using replica plating technique
x) Isolation of antibiotic-resistant mutants
xi) Isolation and enumeration of coliphage from sewage
xii) Paper chromatography for separation of amino acids
xiii) Isolation of bacterial chromosomal / plasmid DNA and study of DNA profile
xiv) Agarose gel electrophoresis of DNA
xv) Isolation of metagenomic DNA from environmental sample
xvi) Confirmation of nucleic acid by UV absorption
xvii) Demonstration of PCR and transformation
xviii) Demonstration of artificial bacterial transformation by $CaCl_2$ method
xix) Demonstration and working principle of sophisticated instruments: Spectrophotometer, Fluorescence spectrophotometer, Fluorescence microscope, Gel doc, Sanger sequencer

xx) 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) Detrmination 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-carmine and feulgen stains
(ii) Pre-traetment, fixation, staining and chromosome analysis of *Lens culinaris*, *Allium cepa* and *Aloe vera/ Vicia faba* for karyotype study and karyogram preparation
(iii) Study of chiasma frequency and terminalization coefficient from meiotic cell division of *Allium cepa*
(iv) Study of nucleolus by Hematoxylin stain method of *Allium cepa*.
(iv) Effect of chemicals on mitotic cell division as well as on chromosomes of *Allium cepa*; and study of chromosome abnormalities induced by chemicals
(vi) Preparation of standard curve of DNA 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 *Drimiopsis Kirkii*.
(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 CO_2, 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) Microchemical tests of different extracts of crude drugs
xii) Histochemical study of medicinal plants
xiii) Determination of ash value, water soluble ash, acid insoluble ash, etc. of selected medicinal plants
xiv) Extraction, isolation and quantification of selected phytochemicals groups
xv) In vitro biological activity studies (antioxidant, anti-inflammatory and antidiabetic) of selected crude drug extracts
xvi) Preliminary antimicrobial screening of medicinal plant
xvii) *In vitro* culture of medicinal plant

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) Prepration of glycerine jelly
iv) Study of different pollen morphotypes: Acetolysis/ Alkali maceration and temporary preparation
v) Honey analysis
vi) Pollen physiology and chemistry (*In-vitro* pollen germination, TTC test)
vii) Study of air borne pollen/spore
viii) Preparation of herbarium sheets
ix) Preparation of list of Indian species of some taxa using Idex Kewensis
x) Reproductive Biology: pollen-pistil interaction (*In-vivo* pollen germination, stigma receptivity test)
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, Thelypteripteridaceae, Pteridaceae, Davallaceae, Hymenophylaceae, 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)
vii) Laboratory induction of apospory and apogamy
viii) Studies on pteridophyte spore viability
ix) Pharmacognostic study of ferns

PROJECT WORK/REVIEW WORK

Core Course: MBC-46; Full Marks: 50; Credit: 4; No. of Lectures: 128

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.