

Department of Botany

BOTANY M.Sc. SYLLABUS

FIRST SEMESTER

SEMESTER-I

Paper-I: ALGAE AND BRYOPHYTES

A. ALGAE:

1. Criteria for algal classification, comparative survey of important systems of classification of algae up to the rank of class.
2. A study of division Cyanophyta, Chlorophyta, Xanthophyta, Phaeophyta and Rhodophyta with reference to the following.
 - a. General features.
 - b. Range of structure and organization of thallus.
 - c. Reproductive diversity and life cycle patterns.
 - d. Classification up to the level of order.
3. General characteristic of the divisions Prochlorophyta, Charophyta, Euglenophyta, Pyrrophyta, Bacillariophyta and Cryptophyta.
4. Evolutionary tendencies in algae; parallelism in evolution.
5. Distribution of Algae in soil, freshwater and marine environments.
6. Economic Importance of Algae.

Practical:

1. Study of important genera from the above groups.
2. Local collection of different algae forms and their study.

B. BRYOPHYTES:

1. Criteria and recent trends in the classification of Bryophytes.
2. Origin and evolution of bryophytes.
3. Diversity in Bryophytes: Habit and Habitat; Developmental morphology and organization of gametophyte and sporophyte bodies.
4. A comparative study of morphology, anatomy, life history, classification and phylogeny of the following groups (with special reference to Indian forms.): Takakiales, Calobryales, Monocleales, Sphaerocarpaceae, Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Andreaeales and Bryales.
5. Fossil history of Bryophytes.
6. Ecological significance and economic importance of Bryophytes.

Practical:

Study and identification of the following genera with suitable preparations:

Riccia, Targionia, Cyathodium, Plagiochasma, Dumartiera, Asterella (Fimbriaria), Conocephalum, Lunularia, Marchantia, Riccardia (Anura), Pellia, Porella, Anthoceros, Notothylas, Spahagnum, Pogonatum and Funaria.

SEMESTER-I

Paper- II: FUNGI AND PLANT VIRUS

A: FUNGI

1. The status of fungi. Principles of important systems of classification up to the rank of classes.
2. A study of the classes Myxomycetes, Plasmodiophoromycetes, Chytridiomycetes, Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes with reference to:-
 - a. Classification upto the rank of orders.
 - b. Range of structure and organization of vegetative and reproductive bodies.
 - c. Ultra structure.
 - d. Method of reproduction.
 - e. Variation in life-cycle.
 - f. Economic importance.
3. Nutritional and physical requirement for growth and reproduction.
4. Heterokaryosis, Parasexuality, Heterothallism, Hormonal control of sexual reproduction.
5. **Fungal associations:**

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- i. Lichens: general account of lichens with special reference to:-
 - a) Habitat, Structure and organization of lichens.
 - b) Method of reproduction.
 - c) Physiological relationship of mycobiont and phycobiont.
 - d) Economic importance of lichens.
- ii. Mycorrhizae:
 - a) Types of mycorrhizae.

B: PLANT VIRUS

1. Brief history of plant virus and their origin.
2. Nomenclature and classification of plant virus and their strains.
3. Variation in morphology and ultra structure of plant viruses.
4. Mode of infection and replication of plant viruses.
5. Translocation of viruses in the hort.
6. Basic control measures and production of virus-free plants.
7. Modern concept of organic viruses, viroids virusoides, satellite viruses and Prions

Practical :

1. Collection of virus diseased plant samples and their study.
2. Study of particle morphology of different plant virus (by photograph only)

SEMESTER-I

Paper- III: PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY

A: PTERIDOPHYTES

1. Classification and origin of Pteridophytes.
2. The vegetative sporophyte; Microphyll and megaphylls; Stelar theory; Telome theory.
3. The fertile sporophyte: sporangia: position, ontogeny types, structure.
4. Heterospory: Occurrence, causes and significance.
5. The gametophytes: Germination of fern spore, Development of fern prothallus.
6. Comparative study of Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

Practicals: Monographic study of the sporophyte body of the following:

Osmunda, Ophioglossum, Lygodium, Gleichenia, Cyathea, Pteris, Dryopteris, Adiantum and Polypodium.

B: GYMNOSPERMS

1. Classification of gymnosperms upto the rank of orders.
2. A general account of the following groups with special reference to the genera indicated in brackets.
Pteridospermales (*Calymmatotheca*, *Hoeninghausi*), Glosopteridales, Caytoniales (*Caytonia*), Cycadales, Bennettitales (*Williamsonia* sp.), Pentoxylales, Corditales (*Cordaites* sp.), Ginkgoales (*Ginkgo biloba*) Coniferales (general anatomy, cone organization, life history and distribution), Ephedrales (*Ephedra* sp.) Gnetales (*Gnetum* sp.) and Welwitschiales (*Welwitschia* sp.)

C: PALEOBOTANY

1. Principles of Paleobotany and geological time scale.
2. Process of fossilization and types of fossils.
3. Methods of study of fossils and carbon dating technique.

Practical: A comparative study of vegetative and reproductive parts of the representatives from the above groups.

SEMESTER-I

Paper- IV: MICROBIOLOGY

1. Details study of bacteria with reference to their ultra structure, reproduction and classification (Ref. Bergy's manual of systematic bacteriology).
2. Soil Microbiology- Decomposition of organic matter and geo bicycles of elements; Bio-fertilizers.
3. Basic concepts of food microbiology.
4. Water microbiology, potable water and sewage disposal.
5. Industrial base of microbes, production of ethanol, antibiotics, etc.
6. Basic principles of immunology, vaccines and immunoglobulins.

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SECOND SEMESTER

SEMESTER-II

Paper- I: ANGIOSPERMS, TAXONOMY AND BIOSYSTEMATICS

1. Contribution of ancient India in taxonomy and classification of Plants.
2. Brief comparative study of the following systems of classification:
 - a) Engler and Prantle
 - b) Hutchinson
 - c) Takhtajan.
3. Basics of the Bentham and Hooker's System of Classification.
4. Recent trends in taxonomy
5. International Code of Botanical Nomenclature (ICBN)
6. Rules of Botanical Nomenclature.
7. Field and Herbarium techniques.
8. Biosystematics: Role of the following disciplines in Taxonomy:
 - a) Anatomy
 - b) Embryology
 - c) Cytology
 - d) Phytochemistry
 - e) Palynology
 - f) Numerical analysis.
9. General knowledge and distinguishing features of the following families:
 - a) Dicotyledons: Magnoliaceae, Nymphaeaceae, Annonaceae, Caryophyllaceae, Tamariaceae, Tiliaceae, Sterculiaceae, Linaceae, Rutaceae, Meliaceae, Vitaceae, Sapindaceae, Anacardiaceae, Fabaceae, Caesalpinaceae, Mimosaceae, Rosaceae, Myrtaceae, Lythraceae, Combretaceae, Onagraceae, Passifloraceae, Sapotaceae, Oleaceae, Apocynaceae, Asclepidaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Pedaliaceae, Acanthaceae, Verbenaceae, Lamiaceae, Polygonaceae, Euphorbiaceae, Moraceae.
 - b) Monocotyledons: Hydrocharitaceae, Orchidaceae, Musaceae, Amaryllidaceae, Arecaceae, Araceae, Commelinaceae, Zingiberaceae, Alismaceae, Cyperaceae, Poaceae.

Practical:

1. Description of local plants in semi- technical language.
 2. Identification of taxa upto the level of family.
 3. Identification of taxa upto the level of genus and species with the help of flora.
- N.B.:** Students are required to collect and submit at least 100 plants properly pressed and mounted on herbarium sheets.

SEMESTER-II

Paper- II: MORPHOLOGY, EMBRYOLOGY AND ANATOMY

A. MORPHOLOGY:

1. Phylogeny of Angiosperms.
2. Morphology of flower with special reference to the morphology of carpel and inferior Ovary.

B. EMBRYOLOGY:

1. History and present status of embryology.
2. Male and female gametophyte.
3. Fertilization and its control.
4. Endosperm.
5. Embryo and its culture.
6. Apomixis.
7. Polyembryony and its induction.
8. Induced Parthenocarpy.

C. ANATOMY:

1. Primary meristem organization of shoot and root apices of angiosperms.
2. The cambium and its derivative tissues, differentiation of secondary xylem and secondary phloem.
3. Structure of wood in relation to its weight, strength and durability.
4. Cork cambium and its derivatives, function of cork and abscission layers.
5. Anatomy of floral organs.
6. General structure of plants; cell wall, stomata and secretory structures.

SEMESTER-II

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Paper: III- GENETICS AND CYTOGENETICS:

1. Genes in evolution of species.
2. Gene environmental interaction.
3. Population Genetics, Genetic counseling.
4. Karyotype: Analysis and evolution (Banding techniques, in-situ Hybridization, FISH, GISH, autoradiography), Genome analysis.
5. Inversion: Cytology and genetic inversions, Role in evolution, uses.
6. Chromosomal translocations: Orientation of multiples, uses of interchanges, Robertsoman Translocations, BA translocations, multiples translocations, Renners complex, Pseudoisochromosomes.
7. Numerical changes: Haploidy-production of haploids, importance in crop improvement, triploids and tetraploids, cytology and genetics, aneuploids-monosomics and trisomics.
8. Chromosome engineering and crop improvement.
9. Inbreeding depression and Heterosis.

Practical:

1. Preparation of Karyotypes.
2. Study of the effect of chemicals on mitosis.
3. Study of meiosis: Chiasmata frequency in Phlox, Pea and Wheat.
4. Study of the effect of radiation/Chemicals on meiosis.

SEMESTER-II

Paper- IV: SOIL SCIENCE AND PHYTOGEOGRAPHY

A: SOIL SCIENCE

1. The nature of parent material and development of soil.
2. Major processer of soil formation: Calcification, Podzolization and Laterization
3. Physical properties: Particle system, structure of soil; soil moisture constants, soil aeration, pF scale.
4. Chemical properties: Soil solution and nutrients, soil pH, Cation exchange phenomenon, redox potential, acidity alkalinity, and salinity of soils.
5. Decomposition and Release of Nutrients: Soil organism; organic matter, over view of decomposition, Process of humification and mineralization, Recycle index; Biogeochemical cycle of N, S and P.

B: PHYTOGEOGRAPHY

1. Plant geography: Distribution patterns, Basics, Endemics, Age Area hypothesis.
2. Vegetation and floristic regions of India.

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THIRD SEMESTER

PAPER- I: PLANT BIOCHEMISTRY:

1. **Enzymes:** General aspects, regulatory and active sites, Energy of activation, isozymes, allosteric enzymes, riboenzymes. Abzymes, kinetics of enzymatic catalysis, Michaelis-Menten equation, its derivation and significance.
2. **Co-enzymes:** Structure and classification of Co-enzymes, Prosthetic group and co-factors; Mechanism of action of ATP, NADH and Co-A.
3. **Carbohydrates:** Inter conversion of carbohydrates.
4. **Bioenergetics:** Laws of thermodynamics and its application in biological systems, concept of entropy and enthalpy, concept of free energy, energy rich bonds and energy rich compounds, energetic coupling. Redox systems and standard redox potential in living systems.
5. **Nucleic acids:** Biosynthetic and degradation of purines and pyrimidines, denaturation, renaturation and degradation of nucleic acids.
6. **Biochemical techniques:**
 1. Different types of chromatographic techniques, based on ion exchange and affinity.
 2. Centrifugation, ultracentrifugation and Density gradient centrifugation.
 3. Spectrophotometry.
 4. Tracer techniques.

Practical:

1. To separate the major plant pigments by paper chromatography and to calculate the Rf values.
2. To separate the major plant pigments by thin-layer chromatography and to calculate the Rf values of the pigments.
3. To the separate the amino acids from the given mixture by one-dimensional paper chromatography.
4. To extract free amino acid from seedlings of mung bean/ black gram and to separate soluble amino acid by one-D paper chromatography and to calculate the Rf values.

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5. To extract free amino acid from germinating seedlings of mung bean/ black gram and to separate soluble amino acids by two- dimensional (Paper TLC) chromatography.
6. To determine the R_f values of some given reducing sugars using TLC/Paper chromatography.
7. To extract reducing sugar from plant material (onion bulb) and to separate it by one-d (paper/TLC) chromatography.
8. To measure amylase activity in germination barley seedlings and to study the effect of: (I) substrate concentration. (II) Enzyme concentration (III) pH (IV) Temperature on enzyme activity.
9. To measure the activity of enzyme catalase and to study the effect of: (I) Substrate concentration (II) Enzyme concentration (III) pH ,(IV) Temperature on enzyme activity.

SEMESTER-III

PAPER: II- PLANT PHYSIOLOGY:

1. **Photochemistry and Photosynthesis:** Photosynthetic pigments and light harvesting complexes, photo oxidation of water, mechanism of electron and proton transport, carbon assimilation, the carbon cycle, photorespiration and its significance, the C₄ cycle, the pathway.
2. **Respiration:** Glycolysis, the TCA cycle, electron transport and ATP synthesis, Pentose- Phosphate, Glyoxylate cycle.
3. **Lipid Metabolism:** Structure and synthesis of saturated and unsaturated fatty acids; synthesis of fats and lipids; (α , β , ω -oxidation).
4. **Plant Growth Regulators:** Structure, metabolism and physiology effect of auxins, gibberellins, cytokinins, ethylene and abscisic acid.
5. **Physiology of Floral Induction:** Photoperiodism and its significance, role of Vernalization.
6. **Sensory Photobiology:** History and discovery of phytochromes and cryptochromes and their photochemical and biochemical properties, Photophysiology of light induced responses.

Practical : The following experiments are prescribed:

1. To determine the osmotic pressure of vascular sap of *Rhoeo-discolor/ Tradescantia* leaves by plasmolytic method.
2. To determine the Diffusion Pressure Deficit (water potential) of potato tuber by weighing method/Density method.
3. To extract plant proteins from germinating seeds of mung bean/ black gram and to determine their isoelectric point.
4. To measure the rate of photosynthesis in leaves by the stream method.
5. To study the effect of light quality on rate of photosynthesis in leaves of land plants.
6. To extract the major plant pigments from a green leaf by differential solubility method.
7. To estimate the percentage of total reducing sugar in a plant tissue by titration method using Fehling's or Benedict's reagent.
8. To measure the rate of respiration in germinating seedling by air-steam method.

SEMESTER-III

PAPER: III- ECOLOGY:

1. **Introduction:** Brief history and modern concept and scope; Organization hierarchy and emergent property principle; Ecological interfacing; Ecological model.
2. **Population Ecology:** habitat and niche, niche specialization and separation; natality, mortality and survivorship; growth rate and growth curves; biotic potential, carrying, capacity and environmental resistance; population interaction, competition and coexistence; Ecads and ecotypes.
3. **Community Ecology:** Concept of community; community development, mechanism of succession; climax theories and continuum concept; Phytosociological methods, analytical and synthetic characters; Indices of diversity.
4. **Ecosystem Ecology:** Concept of ecosystem; trophic structure, food chains and energy flow; overview of production and decomposition ; biogeochemical cycles of sulfur and phosphorous; Global pattern of carbon cycle; Energy subsidy, energy based classification of ecosystems.
5. **Evolutionary Ecology:** bioenergetics of succession; P/R ratio; and r- & K- selection; speciation, co-evolution and group selection; diversity and stability of ecosystem, control mechanisms, homeostasis and homeorhesis.
6. **Ecological Applications:** Global environment concerns; restoration ecology and ecosystem conservation; Idea of input management and ecological economics.

Practical:

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1. Preparation of ecological herbarium and chart.
2. Determination of requisite size of quadrat for adequate sampling of given vegetation by species area curve method and testing of Frequency Law.
3. Estimation of frequency, density and abundance by square- quadrat method.
4. Estimation of vegetal cover and relative vegetal cover by line transect method.
5. Estimation of vegetal cover and relative vegetal cover by point frame method.
6. Estimation of total density and absolute density by point -centered quarter method.
7. Determination of similarity index (community coefficient) between two given communities.
8. Estimation of indices of species diversity and dominance of given community.
9. Study of biological spectrum of local vegetation and its comparison with Raunkiaer's Normal Biological Spectrum.
10. Characterization of plastic/ ecotypic differences among population of a single species occupying contrasting habitats.

OPTIONAL PAPERS

Semester-III

PAPER- IVA: PLANT PATHOLOGY

SECTION A: Plant Pathology (General Principles)

1. The concept of disease in plants. Importance of plant disease.
2. Mechanism of attack by plant pathogens: Microbial enzyme, toxins and growth regulators.
3. Variability in plant pathogens: Types of variation; mechanism of variability.
4. Effect of environmental on development of infectious disease of plants: Epidemiology. Plant disease forecasting.
5. Transmission of plant diseases caused by viral pathogens..
6. Methods of study of infectious diseases of plants: isolation of pathogens and tests of pathogenicity.
7. Principles and methods of plant disease control.
 - i. Control through regulatory methods: Plant quarantine.
 - ii. Cultural and biological methods of control.
 - iii. Control through physical means.
 - iv. Chemical method for plant disease control: Fungicides, chemotherapy.
 - v. Use of resistant varieties.

SECTION B: Plant Pathology (Diseases)

Study of importance, symptoms, causal organism, disease cycle and control of following diseases of crop plants in Uttar Pradesh caused by fungi, bacteria, viruses, viroids, Phytoplasma and nematodes.

- a. Fungal diseases:
 - i. Rots diseases with special reference to fruit and stem end rot of papaya.
 - ii. Damping off of seedlings of crop plants.
 - iii. Downy mildews of cucurbits.
 - iv. Rust of wheat and Barley.
 - v. Powdery mildew of pea.
 - vi. Smuts and Bunts: covered smut of Barley; loose smut of wheat and Bunt of rice.
 - vii. Wilt of sugarcane
 - viii. Leaf spots: leaf spot of turmeric; Leaf blight of wheat. Blast disease of rice and mango anthracnose.
 - ix. Galls and other abnormalities: stem gall of coriander, , leaf curl of Peach
- b. Bacterial diseases: Citrus canker and Tundu disease of wheat
- c. Viral diseases: Mosaics of tobacco, papaya, potato and tungro of rice
- c. Phytoplasmal diseases: Grassy shoot of sugarcane
- d. Nematode diseases: Ear cockle of wheat

Practicals:

- i. A study of symptomatology, histopathology and identification of pathogen of various fungal diseases mentioned in syllabus.
- ii. A study of symptomatology in bacteria, viral and phytoplasmal diseases.
- iii. Preparation of culture media and sterilization.
- iv. Isolation of fungi and bacteria from diseased plants.
- v. Inoculation experiments with bacterial and fungal plant pathogens.

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- vi. Measurement of fungal spores.
- vii. Transmission (mechanical and insect) experiments with plants virus.
- viii. Use of fungicides and plant protection appliances.
- ix. Field collection of 50 diseased plant specimens.

Semester-III

PAPER- IV B: ADVANCE PLANT PHYSIOLOGY

1. **Nitrogen Metabolism:** nitrate assimilation, synthesis of essential amino acids, amides and ureides. Biological nitrogen fixation and the various organisms..
2. **Secondary metabolites:** structure, and biosynthesis of non nutrients viz., alkaloids, sterols, terpenoids, phenols, flavinoids and quinines and their biofunctional role.
3. **Seed physiology:** Seed development, germination dormancy, growth and its measurement.
4. **Stress Physiology:** stress due to, salinity, alkalinity, temperature, radiation and the physiology of adaptation.

Semester-III

PAPER- IV C: FOREST ECOLOGY

1. Human evolutionary dependence on forests: scope and relevance.; forest types of India; Ecological morphology of rain forest flora.
2. Structure of forest ecosystem: Photosynthetic efficiency; leaf area and growth;; Nutrient cycling in tropical forest ecosystems.
3. Reproductive strategy of tropical trees; Natural and artificial regeneration;
4. Factors destructive to forest ecosystems; causes and effects of deforestation; systems; Role of trees in combating air pollution.
5. Physico- chemical properties of forest soil; ecological significance of soil texture; soil biology and soil fertility; Comparison of forest and grassland.
6. Accumulation and decomposition of forest litter; forest humus; the geochemical, biogeochemical cycling of nutrients

PRACTICAL:

1. Ecological herbarium collection of plant throughout the study period with notes on the habitat and phenology of plant. Preparation of chart.
2. Determination of frequency, density, relative frequency and relative density of component species of a forest vegetation.
3. Determination of importance value index of tree species if the forest vegetation by point centered quarter method.
4. Gradient analysis of forest vegetation by belt transects method.
5. Study of life forms and biological spectrum of the forest community.
6. Preparation of profile diagram and study of stratification.
7. Determination of leaf area index of the given species.
8. Identification of shade tolerant and shade- intolerant species and a comparison of their adaptive features.
9. Estimation of reproductive effort of a ground layer species.
10. Determination of pH, organic matter and nitrate content of the soil.
11. Determination of total soluble salts of soil samples.
12. Measurement of soil respiration.
13. Estimation of nitrate nitrogen of given samples.
14. Estimation of total nitrogen to given samples.
15. Study of soil profile under forest cover.
16. Measurement of temperature and light intensity along vertical and horizontal gradient within the forest community.

Semester-III

PAPER- IV D: ADVANCE PLANT TAXONOMY

1. History and outline of various system of classification.
2. Principals of classification and concept of Taxa.
3. Botanical Nomenclature and type concepts.
4. History of Botanical exploration in India.
5. Herbarium and herbarium methods.
6. Botanical Garden.
7. Botanical Collection.

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8. Botanical keys, their uses and construction.
9. Floristics and monographs.
10. Taxonomic literature.
11. Centres of taxonomic work in India.
12. Flora of Eastern U.P.
13. Evolution theory and experimental study of variation.
14. The plasticity of phenotypes.
15. Internal variability of population.
16. Ecological differentiation and population.
17. Geographical variation and reproductive isolation.
18. Chemotaxonomy.
19. Numerical taxonomy.
20. Anatomy in taxonomy.
21. Palynology in taxonomy.
22. Cytotaxonomy.
23. Embryology in taxonomy.
24. Physiology in taxonomy.



Practical

1. Botanical collection technique (exploration of assigned area).
2. Herbarium method (preparation of 150 herbarium specimens).
3. Identification and construction of keys.
4. Determination of relationship of some given plants on the basis of essential oils, pigments and amino acids.
5. Determination of relationship on the basis of anatomical characters (trichome, stomata, internal deposition and floral anatomy).
6. Determination of relationship on the basis of pollen morphology.
7. Determination of relationship on the basis some embryological characters.
8. Determination of relationship on the basis of cytological characters.

Semester-III

PAPER- IVE: ADVANCED MOLECULAR GENETICS

1. History concept and scope of molecular genetics.
2. Evidence for the mechanism of DNA Replication; RNA genome replication.
3. Regulation of transcription (Enhancers and silencers), Transcription factors; transcriptional and post transcriptional control; HeLa cells.
4. Genomes: split genes, overlapping genes, Pseudogenes, selfish genes, cryptic genes, Repetitive DNA, Promiscuous DNA, Core DNA, Linker DNA, C-DNA Zyg- DNA; Transposons and Retrotransposons
5. Molecular analysis of genes: (Southern Blot and northern Blot), molecular Probes, molecular markers and molecular genetic maps.
6. PCR walking, electronic PCR (e- PCR), DNA sequencing using PCR (LMPCR).
7. Types of DNA chips and their production, microarrays and their application on DNA chips.
8. Viruses and Cancer (Tumor virus molecular genetics, Viral Oncogenes).
9. Application of gene cloning in production of pharmaceutical protein, vaccines and genetically engineered crops.

Semester-III

PAPER- IV F: ENVIRONMENTAL MANAGEMENT AND TECHNOLOGY

1. Basics of Environmental Science: Origin of Earth, Biotic-abiotic interaction, Decline in Biodiversity and the consequences.
2. Environmental Phenomenon and Episodes: Ozone layer depletion, Green House Effect, Climatic change, Bhopal gas tragedy and Chernobyl episode.
3. Occupational Health Hazards: Silicosis, Asbestosis, Carcinogens, Mutagens, Teratogens and Toxicity of Heavy Metals.
4. Non-conventional Energy: Hydrogen, Alcohol, Bio-diesel, Wind and Solar energy.
5. International Agreements on Environment: Treaties and Protocols of United Nations Conference on Human Environment-UNCHE (Stockholm, 1972), United Nations Conference on Environment and

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Development- UNCED (Rio de Janeiro, 1992), World Summit on Sustainable Development- WSSD (Johannesburg, 2002).

6. Computer Application in Environmental Management: Basic concepts of Windows, software, search engine, use of software in Environmental Studies.
7. Water Management Technologies: Hydrological cycle, Water quality standards, Major sources of water pollution, basics of ground and surface water, Analysis of selected physico-chemical properties of water (DO, BOD, COD, Nitrate, Phosphate, Chloride, pH, Acidity, Alkalinity, Turbidity, Electrical Conductivity, Temperature), Eutrophication and Aquaculture.
8. Air Quality Monitoring and Management: Composition of air, Major sources of air pollution, in-door air pollution, Monitoring of SO_x, NO_x and O₃.
9. Solid Waste Management Technologies: Sources of solid waste, Solid waste disposal, Vermicomposting, R³ Principle.
10. Noise Pollution and Abatement: Sources of noise pollution, Noise standards, Biological and behavioural effects of noise pollution.
11. Environmental Legislation: Powers and functions of Central and State Pollution Control Boards, Wildlife Protection Act 1972, The Water (Prevention and control of pollution) Act 1974, Prevention and Control of Air Pollution Act 1981.
12. Environmental Biotechnology: Use of Micro-organisms in waste treatment, Biodegradation of petroleum pollutants, Production of microbial enzymes (Cellulases and Proteases)
13. Environmental Economics: Valuation of natural resources, cost benefit analysis and integrated economic modeling.

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FOURTH SEMESTER

SEMESTER-IV

PAPER-I: MOLECULAR, GENETICS, GENETIC ENGINEERING AND BIOTECHNOLOGY:

1. **Nucleic acids:** Structure and form of DNA, Circular DNA in bacteria and chloroplast, packaging of DNA, DNA melting (T_m), DNA annealing, cot curves, repetitive, unique and satellite DNA, C- value paradox.
2. **Gene Replication:** DNA replication in prokaryotes and eukaryotes (initiation, elongation and termination).
3. **Gene Mutation:** Mutagenic agents, mechanisms of mutagenesis, DNA damage and repair mechanism, uses of mutation.
4. **Gene Recombination:** Mechanism of recombination in viruses, bacteria and fungi.
5. **Genetic Code:** Codon assignment, code in mitochondria, second genetic code, initiation and termination codons.
6. **Gene Expression:** Mechanism of transcription and translation in eukaryotes (initiation, elongation and termination).
7. **Regulation of Gene Expression:** Concept of operon, Tryptophan and Arabinose operons, eukaryotic operon (Britten and Davidson model).
8. **Genetic Engineering:** Enzymes (Endonucleases, Ligases) and vector viz., plasmids phages, cosmids and *Agrobacterium* spp., recombinant DNA technology (gene cloning), gene isolation and sequencing, PCR.
9. **Tissue and Organ Culture:** Micropropagation somaclonal variation, haploid production, protoplast culture and somatic hybridization.
10. **Application of biotechnology in agriculture.**

Practical

1. Isolation of plasmid DNA.
2. Preparation of genomic DNA from bacteria.
3. Preparation of agarose gel.
4. DNA detection of gel electrophoresis.
5. Preparation of standard curve for RNA.
6. Colorimetric estimation of RNA content in given RNA solution.
7. Preparation of standard curve for DNA.
8. Nitrous acid mutagenesis in *Aspergillus nidulans*.
9. Isolation of milk protein.
10. Isolation of protoplasts from plant tissue and demonstration of somatic fusion.
11. Preparation of spawn and substrate for mushroom cultivation.

SEMESTER-IV

PAPER- II: PLANT RESOURCE UTILIZATION AND CONSERVATION

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A. PLANT RESOURCE UTILIZATION:

1. Plant biodiversity for Man and their importance.
2. Botanical names, families, morphology of the past used, mode of extraction, nature and economic importance with reference to the following:
 - a. Cereals: Wheat, Rice, Maize.
 - b. Legumes and Pulses.
 - c. Forage crops.
 - d. Fiber plants and their products.
 - e. Medicinal plants.
 - f. Beverage yielding plants.
 - g. Important wood and timber yielding plants.
 - h. Sugar and sugar yielding plants.
 - i. Tropical and subtropical fruits.
 - j. Spices and flavoring materials.
 - k. Vegetables.
 - l. Drugs and narcotics.
 - m. Gum and dye yielding plants.
 - n. Latex yielding plants.
 - o. Fumitories and mastigatories.
 - p. Insecticide yielding plants.
3. Origin of cultivated plants: Center of origin, criteria and Vavilov's center of origin.
4. Botanical, origin and cultivation of wheat, rice, maize, sugarcane, mustard and potato.
5. History, Botany, cultivation and processing of tea/ coffee, tobacco and rubber.



B. CONSERVATION:

1. Principles of conservation.
2. *In situ* conservation: Sanctuaries, national parks, biosphere reserves, wet lands, mangroves and coral reef.
3. *Ex-situ* conservation: principles and practices, National seed corporation (NSC), Botanic gardens, role and impact of NSC, botanical survey of India (BSI), NBPGR (National Bureau of plant Genetics Resource), ICAR (Indian Council of Agriculture Research), Council of Scientific and Industrial Research (CSIR), Department of Science and Technology (DST) and Department of Biotechnology (DBT) and Germplasm conservation.

Practical: Based on the Above.

SEMESTER-IV

PAPER- III: BIOSTATISTICS, CYTOLOGY AND PLANT BREEDING

A. BIOSTATISTICS:

1. Relevance of biostatistics to biological interpretative, elementary idea of probability, combination and permutations, continuous and discontinuous variables.
2. Measures of central tendency: Mean, Median and Mode.
3. Measures of dispersion: Standard deviation, Standard error, Mean deviation.
4. Test of significance:
 - a. Chi-square test
 - b. t-test
5. Analysis of variance
6. Correlation and regression

B. CYTOLOGY:

1. Cell membrane: Structure and Function.
2. Cytoskeleton: Microtubules, Microfilaments, basal bodies and cilia.
3. Interphase nucleus and nucleolus.
4. Chromosome structure, types.
5. Chromatin fibers, nucleolus, solenoid model, heterochromatin and euchromatin.
6. Centromere and telomere structure.
7. Cell division: Cell cycle, mitosis and meiosis; Control of cell division, spindle organization and chromosomal movement, Synapsis and Synaptonemal complex, crossing over, mechanism and cytological proof.

C. PLANT BREEDING:

1. Introduction to plant breeding.
2. Domestication, plant introduction and acclimatization.

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3. Method of selection and hybridization.
4. Techniques of selfing and crossing.
5. Cytoplasmic male sterility.
6. Heterosis and hybrid seed production.
7. Mutant breeding.
8. Polyploidy in plant breeding.
9. Breeding for nutritional quality.

SEMESTER IV

PAPER IV: DISSERTATION BASED ON OPTIONAL PAPERS
(SEMESTER III- PAPER IV)

