

Department of Botany

Program Outcome of M. Sc. Botany

1. They can pursue PhD with various fellowship like DBT, ICAR, CSIR, ICMR and other Government fundings like JFR or SRF. They can also pursue Ph. D. in foreign university.
3. They can join various research projects in government research Labs like CSIR, NBRI, CMAP etc.
4. They can apply for various government jobs through UPSC, SSC, Railway recruitment, etc
5. Can do their independent research to find out solution to various problems related to plant and environment.

Program Specific Outcome

1. PG holders in Botany have opportunities in public sector like Botanical Survey of India (BSI), National Institute of Oceanography (NIO), Indian Agricultural Research Institute (IARI) etc.
2. They can pursue their career as environmental consultant in various environmental constituencies.
3. They can also work as nursery manager, park ranger, herbarium keeper etc.
4. They can start their own Plant Tissue Culture Lab.
5. They can start their own Seed Industry and Seed Bank
6. They can do production of biofertilizers.
7. They can pursue Ph. D. in Botany, Plant Biotechnology, Molecular biology, Phycology and Mycology, Plant taxonomy, Ecology Plant breeding, Environmental Sciences and almost all branch of science.

Course Outcomes

Students know about different types of lower and higher plants their evolution in from algae to angiosperms and also their economic and ecological importance. Cell biology gives detailed knowledge about cell organelles and their functions. Molecular biology gives knowledge about chemical properties of nucleic acid and their role in living systems. Genetics provides knowledge about laws of inheritance, various genetic interactions, chromosomal aberrations and multiple alleles. Student can describe morphological and reproductive characters of plant and also identified

different plant families and classification. They know economic importance of various plant products and artificial methods of plant propagation. Use modern Botanical techniques and decent equipment. To inculcates the scientific temperament in the students and outside the scientific community.

M. Sc. I year Ist Semester Botany

Paper-I: ALGAE AND BRYOPHYTES

Outcomes

1. Students know about criteria for algal classification, comparative survey of important systems of classification of algae up to the rank of class.
2. learn about the divisions Cyanophyta, Chlorophyta, Xanthophyta, Phaeophyta and Rhodophyta and their general features, range of structure and organization of thallus, reproductive diversity and life cycle patterns, classification up to the level of order.
3. Understand the general characteristic of the divisions Prochlorophyta, Charophyta, Euglenophyta, Pyrrophyta, Bacillariophyta and Cryptophyta.
4. He understands the evolutionary tendencies in algae; parallelism in evolution and distribution of algae in soil, freshwater and marine environments.
5. The student learnt about economic importance of algae.
6. Students learn about the criteria and recent trends in the classification of Bryophytes and origin and evolution of bryophytes.
7. He understands the diversity in bryophytes: habit and habitat; Developmental morphology and organization of gametophyte and sporophyte bodies.
8. He also understands about the comparative study of morphology, anatomy, life history, classification and phylogeny of the following groups (with special reference to Indian forms.): Takakiales, Calobryales, Monocleales, Sphaerocarpales, Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Andreaeales and Bryales.
9. Understand the fossil history of bryophytes.
10. He learns about the ecological significance and economic importance of Bryophytes.

Paper- II: FUNGI AND PLANT VIRUS

Outcomes

1. The students learn about the status of fungi. Principles of important systems of classification up to the rank of classes.
2. He understands the classification, Range of structure and organization of vegetative and reproductive bodies, ultrastructure, method of reproduction, life-cycle variation, and economic importance of Myxomycetes, Plasmodiophoromycetes, Chytridiomycetes, Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes.
3. Students understands the nutritional and physical requirement for growth and reproduction.
4. Learn about the heterokaryosis, parasexuality, heterothallism, hormonal control of sexual reproduction.
5. The student also learns about fungal associations: habitat, structure and organization of lichens, method of reproduction, physiological relationship of mycobiont and phycobiont, economic importance of lichens.
6. Learn about the types of mycorrhizal associations.
7. In addition to fungi students also learn about the brief history of plant virus and their origin.
8. He understands about nomenclature and classification of plant virus and their strains, variation in morphology and ultrastructure of plant viruses.
9. He also learns about the mode of infection and replication of plant viruses.
translocation of viruses in the host.
10. Understand the basic control measures and production of virus-free plants.
11. He learns modern concept of organic viruses, viroid virusoid, satellite viruses and Prions

Paper- III: PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY

Outcomes

1. On completion of this course student learn about the classification and origin of Pteridophytes.
2. He understands the vegetative sporophyte; microphyll and megaphylls; Stelar theory; Telome theory of the earliest vascular plants.
Student understand about the fertile sporophyte: sporangia: position, ontogeny types, structure.
Heterospory: Occurrence, causes and significance.
3. He learns about the structure of fern gametophytes: germination of fern spore and development of fern prothallus.

4. He is able to study comparatively about the Psilopsida, Lycopsida, Sphenopsida and Pteropsida with reference to *Osmunda*, *Ophioglossum*, *Lygodium*, *Gleichenia*, *Cyathea*, *Pteris*, *Dryopteris*, *Adiantum* and *Polypodium*.

5. Student also learn the classification of gymnosperms.

6. He understands the general account of the Pteridospermales (*Calymmatotheca*, *Hoeninghausi*), Glospteridales, 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.)

7. He is able to understand about the principles of Paleobotany and geological time scale. Process of fossilization and types of fossils and methods of study of fossils and carbon dating technique.

Paper- IV: MICROBIOLOGY

Outcomes

1. The student understands the detail study of bacteria with reference to their ultra-structure, reproduction and classification (Ref. Bergy's manual of systematic bacteriology).

2. He is familiar with the soil Microbiology- Decomposition of organic matter and biogeocycles of elements; Bio-fertilizers.

3. Student understands the basic concepts of food microbiology.

4. Student learns the water microbiology, potable water and sewage disposal and industrial base of microbes, production of ethanol, antibiotics, etc.

5. Student also able to understand the basic principles of immunology, vaccines and immunoglobulins.

M. Sc. I year IInd Semester Botany

Paper- I: ANGIOSPERMS, TAXONOMY AND BIOSYSTEMATICS

Outcomes

1. After the completion of this course the student can understand the contribution of ancient India in taxonomy and classification of Plants.

2. Student learns about the brief comparative study of Engler and Prantle, Hutchinson and Takhtajan

systems of classification:

3. Student also learns about the basics of the Bentham and Hooker's System of Classification, recent trends in taxonomy, International Code of Botanical Nomenclature (ICBN), rules of Botanical Nomenclature.

4. Student learns about the field and herbarium techniques and biosystematics: Role of the following disciplines in Taxonomy: Anatomy, Embryology, Cytology, Phytochemistry, Palynology Numerical analysis etc.

5. Student understands about the general knowledge and distinguishing features of the following families: 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.

6. Student also learn about the monocotyledon families Hydrocharitaceae, Orchidaceae, Musaceae, Amaryllidaceae, Arecaceae, Araceae, Commelinaceae, Zingiberaceae, Alismaceae, Cyperaceae, Poaceae.

Paper- II: MORPHOLOGY, EMBRYOLOGY AND ANATOMY

Outcomes

1. After completion of this course the students are able to understand about the phylogeny of angiosperms. Morphology of flower with special reference to the morphology of carpel and inferior Ovary.

2. Students learn the history and present status of embryology, male and female gametophyte, fertilization and its control, endosperm, embryo and its culture and apomixis.

3. Students learn about the polyembryony and its induction, induced parthenocarpy.

4. Understand the primary meristem organization of shoot and root apices of angiosperms.

5. Student is able to get the structure of cambium and its derivative tissues, differentiation of secondary xylem and secondary phloem.

6. Students understand the structure of wood in relation to its weight, strength and durability.

7. Learns the cork cambium and its derivatives, function of cork and abscission layers and anatomy of floral organs.
8. The student gets the idea about the general structure of plants; cell wall, stomata and secretory structures.

Paper: III- GENETICS AND CYTOGENETICS

Outcomes

1. On the completion of this course the student learns about the genes in evolution of species and gene environmental interaction.
2. Student learns the population genetics, genetic counseling. karyotype: Analysis and evolution (Banding techniques, in-situ Hybridization, FISH, GISH, autoradiography), genome analysis etc.
3. In addition to this he also learns about chromosomal aberrations like structural changes as Inversion: Cytology and genetic inversions, Role in evolution, uses and chromosomal translocations: Orientation of multiples, uses of interchanges, Robertsoman Translocations, BA translocations, multiples translocations, Renners complex and Pseudoisochromosomes.
4. Students also learns about the numerical changes in chromosomes: Haploidy-production of haploids, importance in crop improvement, triploids and tetraploids, cytology and genetics, aneuploids-monosomics and trisomics.
5. Student understands about the classical method of genetic engineering in chromosome engineering and crop improvement.
6. Students learns about the inbreeding depression and heterosis.

Paper- IV: SOIL SCIENCE AND PHYTOGEOGRAPHY

Outcomes

1. This course helps the students in learning about the nature of parent material and development of soil.
2. Students understands the major processer of soil formation: Calcification, Podzolization and Laterization
3. Student learns about the physical properties: Particle system, structure of soil; soil moisture constants, soil aeration, pF scale.
4. Student also learns about the chemical properties: Soil solution and nutrients, soil pH, Cation exchange phenomenon, redox potential, acidity alkalinity, and salinity of soils.

5. Understand the decomposition and release of nutrients: Soil organism; organic matter, over view of decomposition,
6. Student gets the brief idea of the process of humification and mineralization, Recycle index; Biogeochemical cycle of N, S and P.
7. Student learn about the plant geography: Distribution patterns, Basics, Endemics, Age Area hypothesis and vegetation and floristic regions of India.

M. Sc. II year IIIrd Semester Botany

PAPER- I: PLANT BIOCHEMISTRY

Outcomes

1. On the completion of this course students understand the enzymes: their 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. Student learns about co-enzymes: Structure and classification of Co-enzymes, Prosthetic group and co- factors; Mechanism of action of ATP, NADH and Co-A.
3. Understand carbohydrates: Inter conversion of carbohydrates.
4. Learns about 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. Students also understands about nucleic acids: Biosynthetic and degradation of purines and pyrimidines, denaturation, renaturation and degradation of nucleic acids.
6. The students also aware about the biochemical techniques: Different types of chromatographic techniques, based on ion exchange and affinity.
7. The students learn about some basic biochemical techniques like centrifugation, ultracentrifugation and Density gradient centrifugation, Spectrophotometry and Tracer techniques.

PAPER: II- PLANT PHYSIOLOGY

Outcomes

1. This course enhances the knowledge about the 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. Students learn about the respiration: Glycolysis, the TCA cycle, electron transport and ATP synthesis, Pentose- Phosphate, Glyoxylate cycle.
3. Understand the lipid Metabolism: Structure and synthesis of saturated and unsaturated fatty acids; synthesis of fats and lipids; (α , β , ω -oxidation).
4. Understand and learns about plant Growth Regulators: Structure, metabolism and physiology effect of auxins, gibberellins, cytokinins, ethylene and abscisic acid.
5. Student also understands the physiology of Floral Induction: Photoperiodism and its significance, role of Vernalization.
6. Students learns about sensory Photobiology: History and discovery of phytochromes and cryptochromes and their photochemical and biochemical properties, Photophysiology of light induced responses.

PAPER: III- ECOLOGY

Outcomes

This course is very important for the understanding the introduction to ecology: Brief history and modern concept and scope; Organization hierarchy and emergent property principle; Ecological interfacing; Ecological model. It increases the knowledge about the earth and their environment which is the cross-cutting issue in the world

Students learnt about the 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.

Understand about the community Ecology: Concept of community; community development, mechanism of succession; climax theories and continuum concept; Phytosociological methods, analytical and synthetic characters; Indices of diversity.

Students learn ecosystem Ecology: Concept of ecosystem; trophic structure, food chains and energy flow; overview of production and decomposition; biogeochemical cycles of sulfur and phosphorus; Global pattern of carbon cycle; Energy subsidy, energy-based classification of ecosystems.

Students also learn about the 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.

Students also learn the ecological Applications: Global environment concerns; restoration ecology and ecosystem conservation; Idea of input management and ecological economics.

Paper VI Specialization (Optional Papers)

A: PLANT PATHOLOGY

Outcomes

1. This specialization subject is based on the study of plant pathogens and the concept of disease in plants. Importance of plant disease. Student gain the knowledge and become a plant pathologist after completing this course.
2. Student learns about the mechanism of attack by plant pathogens: Microbial enzyme, toxins and growth regulators.
3. Student understands the variability in plant pathogens: Types of variation; mechanism of variability and effect of environmental on development of infectious disease of plants: Epidemiology. Plant disease forecasting. Transmission of plant diseases caused by viral pathogens.
4. Students learn about the methods of study of infectious diseases of plants: isolation of pathogens and tests of pathogenicity.
5. Student increase the knowledge of about the Principles and methods of plant disease control, Control through regulatory methods: Plant quarantine, cultural and biological methods of control,

control through physical means, chemical method for plant disease control: Fungicides, chemotherapy and use of resistant varieties.

6. Students learn and also perform the dissertation about the study of importance, symptoms, causal organism, disease cycle and control of following diseases of crop plants in Uttar Pradesh specially in Balrampur caused by fungi, bacteria, viruses, viroid, Phytoplasma and nematodes.

7. Students also increase the knowledge about the various fungal diseases: Rots diseases with special reference to fruit and stem end rot of papaya, Damping off of seedlings of crop plants, Downy mildews of cucurbits, Rust of wheat and Barley, Powdery mildew of pea, Smuts and Bunts: covered smut of Barley; loose smut of wheat and Bunt of Rice, Wilt of sugarcane Leaf spots: leaf spot of turmeric; Leaf blight of wheat. Blast disease of rice and mango anthracnose, Galls and other abnormalities: stem gall of coriander, leaf curl of Peach

8. Students learn also some important bacterial diseases: Citrus canker and Tungro disease of wheat

9. Some viral diseases: Mosaics of tobacco, papaya, potato and tungro of rice c. Phytoplasmal diseases: Grassy shoot of sugarcane

10. Students also learn about the nematode diseases: Ear cockle of wheat

B: ADVANCE PLANT PHYSIOLOGY

Outcomes

1. In this specialization course students learn about the nitrogen Metabolism: nitrate assimilation, synthesis of essential amino acids, amides and ureides. Biological nitrogen fixation and the various organisms.

2. Student understands about the secondary metabolites: structure, and biosynthesis of non-nutrients viz., alkaloids, sterols, terpenoids, phenols, flavinoids and quinines and their biofunctional role.

3. Student learns about seed physiology: Seed development, germination dormancy, growth and its measurement.

4. Student learns about the stress Physiology: stress due to, salinity, alkalinity, temperature, radiation and the physiology of adaptation.

PAPER- IV C: WATER RESOURCE AND MANAGEMENT

Outcomes

1. This specialization is important and a cross cutting issue in the country and student learns about the distribution of water: water resources, Diversity of aquatic habitats, Lentic and Lotic ecosystems Aquifers, Hydrological Cycles and Disposition of water.
2. Students learns about the quality of water, physicochemical properties of freshwater, Water quality parameters and standards, Water pollution and its sources, Ground water, Threats of surface water resources.
3. Students understands the interaction and relation of waters and plants, through learning about water aquaculture, water stress adaptation in plants, role of plants in water management, water borne diseases, Eutrophication.
4. Students learns the water management strategies, management of ground water, Rain Water harvesting, Recharging of ground water-recycling of waste water, catchment infiltration, Watershed management, The water (prevention and control of pollution) Act. 1974 Ramsar convention.
5. Students understands the treatment technologies like treatment of drinking water (ion exchange reverse osmosis and disinfection of water) Treatment technologies for domestic waste water, Biological treatment of waste water.

M. Sc. II year IVth Semester Botany

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

Outcomes

1. After the completion of this course the students learns about the 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. Student understands about the Gene Replication: DNA replication in prokaryotes and eukaryotes (initiation, elongation and termination).
3. Students learn the gene Mutation: Mutagenic agents, mechanisms of mutagenesis, DNA damage and repair mechanism, uses of mutation, Gene Recombination: Mechanism of recombination in viruses, bacteria and fungi.
4. Students learn about the genetic Code: Codon assignment, code in mitochondria, second genetic code, initiation and termination codons.
5. Student Understands the Gene Expression: Mechanism of transcription and translation in eukaryotes (initiation, elongation and termination).
6. Students are aware about the regulation of Gene Expression: Concept of operon, Tryptophan and Arabinose operons, eukaryotic operon (Britten and Davidson model).
Student becomes expert in Genetic Engineering: Enzymes (Endonucleases, Ligase) and vector viz., plasmids phages, cosmid and Agrobacterium spp., recombinant DNA technology (gene cloning), gene isolation and sequencing, PCR.
7. Students also learn about plant tissue and Organ Culture: Micropropagation somaclonal variation, haploid production, protoplast culture and somatic hybridization.

PAPER- II: PLANT RESOURCE UTILIZATION AND CONSERVATION

Outcomes

1. On the completion of the course students learn about the 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: Cereals: Wheat, Rice, Maize, Legumes and Pulses. Forage crops, Fiber plants and their products, Medicinal plants, Beverage yielding plants, Important wood and timber yielding plants, Sugar and sugar yielding plants, Tropical and subtropical fruits, Spices and flavoring materials, Vegetables, Drugs and narcotics, Gum and dye yielding plants, Latex yielding plants, Fumitories and mastigatories, Insecticide yielding plants, Origin of cultivated plants: Center of origin, criteria and Vavilov's center of origin, Botanical, origin and cultivation of wheat, rice, maize, sugarcane, mustard and potato.

3. Students learn about the history, Botany, cultivation and processing of tea/ coffee, tobacco and rubber.
4. Students learn the principles of conservation and *in situ* conservation: Sanctuaries, national parks, biosphere reserves, wet lands, mangroves and coral reef.
5. *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.

PAPER- III: BIOSTATISTICS, CYTOLOGY AND PLANT BREEDING

Outcomes

1. Students aware of the relevance of biostatistics to biological interpretative, elementary idea of probability, combination and permutations, continuous and discontinuous variables.
2. Student is well known about the measures of central tendency: Mean, Median and Mode, Measures of dispersion: Standard deviation, Standard error, Mean deviation, Test of significance: Chi-square test and t- test
3. Students learn about the Analysis of variance, Correlation and regression.
Student also gain knowledge about the Cell membrane: Structure and Function, Cytoskeleton: Microtubules, Microfilaments, basal bodies and cilia.
4. Students learn about Interphase nucleus and nucleolus, Chromosome structure, types, Chromatin fibers, nucleolus, solenoid model, heterochromatin and euchromatin, Centromere and telomere structure, Cell division: Cell cycle, mitosis and meiosis; Control of cell division, spindle
5. Students learn about the organization and chromosomal movement, Synapsis and Synaptonemal complex, crossing over, mechanism and cytological proof.
6. Students understand the introduction to plant breeding, domestication, plant introduction and acclimatization.

7. Student knows the method of selection and hybridization, techniques of selfing and crossing. cytoplasmic male sterility, heterosis and hybrid seed production.
8. Student knows about the mutant breeding, Polyploidy in plant breeding, Breeding for nutritional quality.

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

The dissertation in specialization subject (Plant Pathology, Advanced Plant Physiology, Water resource and Management) provide a training for the research that can help in getting scientific project to carry out further research in these areas.