Curriculum of

M.Sc. Botany

DDU Gorakhpur University, Gorakhpur

CHOICE BASED CREDIT SYSTEM (CBCS)

Semester	Code/ Activity	Core Paper	Credit	Semester Credits
Sem. 1	BOT 1.1	Algae and Bryophytes	4	25
	BOT 1.2	Fungi and Plant Viruses	4	
	BOT 1.3	Pteridophyta, Gymnosperms andPaleobotany	4	
	BOT 1.4	Microbiology	4	
	Practical	Based on BOT 1.1 to 1.4	8	
	Seminar	Based on BOT 1.1 to 1.4	1	
Sem. 2	BOT 2.1	Angiosperms I (Taxonomy & Biosystematics)	4	25
	BOT 2.2	Angiosperms II (Morphology,Embryology and Anatomy)	4	
	BOT 2.3	Cytology and Genetics	4	
	BOT 2.4	Soil Science, Phytogeography	4	
	Practical	Based on BOT 2.1 to 2.4	8	
	Seminar	Based on BOT 2.1 to 2.4	1	
Sem. 3	BOT 3.1	Plant Biochemistry	4	25
	BOT 3.2	Plant Physiology	4	
	BOT 3.3	Plant Ecology	4	
	BOT 3.4	**Elective paper (BOT3.4.1 to BOT 3.4.7)***	4	
	Practical I	Based on BOT 3.1 to 3.3	6	
	Practical II	Based on BOT 3.4 (Elective paper / Optional Paper*)	2	
	Seminar	Based on BOT 3.1-3.4	1	
Sem. 4	BOT 4.1	Molecular Genetics, Genetic Engineering & Biotechnology	4	25
	BOT 4.2	Plant Resource Utilization and Conservation	4	
	BOT 4.3	Cytogenetics, Plant Breeding and Biostatistics	4	
	BOT 4.4	**Dissertation** andViva-voce: Based on Elective / Optional Papers*	6	
	Practical	Based on BOT 4.1 to BOT 4.3	6	
	Seminar	Based on BOT 4.1 to BOT 4.3	1	

***Elective / Optional Papers:**

- Plant Pathology (Code: BOT 3.4.1)
- Advance Plant Physiology (Code: BOT 3.4.2)
- Forest Ecology (Code: BOT 3.4.3)
- Advance Plant Taxonomy (Code: BOT 3.4.4)
- Advance Molecular Genetics (Code: BOT 3.4.5)

- Environment Management and Technology (Code: BOT 3.4.6)
- Water Resource Management (Code : BOT 3.4.7)

SEMESTER-I

Paper – 1
(Code: BOT-1.1)
ALGAE AND BRYOPHYTA Total Credit: 04

Unit 1

Criteria for algal classification, comparative survey of important systems of classification of algae up to the rank of class, Study of division Cyanophyta, Chlorophyta and Xanthophyta with reference to the following:

General features, Range of structure and organization of thallus, Reproductive diversity and life cycle patterns, Classification up to the level of order. Evolutionary tendencies in algae; parallelism in evolution.

Unit 2

Study of division Phaeophyta and Rhodophyta with reference to the following :

General features, Range of structure and organization of thallus, Reproductive diversity and life cycle patterns, Classification up to the level of order. General characteristic of the divisions Prochlorophyta, Charophyta, Euglenophyta, Pyrrophyta, Bacillariophyta and Cryptophyta, Distribution of Algae in soil, freshwater and marine environments; Economic Importance of Algae.

Unit 3

Criteria and recent trends in the classification of Bryophytes; Origin and evolution of bryophytes; Ecological -significance and economic importance of Bryophytes.

Diversity in Bryophytes: Habit and Habitat; Developmental morphology and- organization of gametophyte and sporophyte bodies.

Unit 4

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.

Course Outcomes-

CO1. The study will provide the basic concepts of developmental details of Algae. It will utilize for increasing yield in agriculture.

CO2. It can be utilized for development of bio-fertilizers.

CO3. Students will be able to understand the origin and evolutionary aspects of bryophytes and know the ecological-significance and economic importance of Bryophytes.

Paper- 2
(Code: BOT-1.2)
FUNGI AND PLANT VIRUSES

Unit 1

The status of fungi. Principles of important systems of classification up to the rank of classes. A study of the Myxomycetes,Plasmodiophorornycetes, Chytridiomycetes, Omycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes with reference to:
Classification upto the rank of orders; Range of structure and organization of vegetative and reproductive bodies; Ultrastructure; Method of reproduction; Variation in life-cycle; Economic importance;Nutritional and physical requirement for growth and reproduction in fungi.

Unit 2

Heterokaryosis, Parasexuality, Heterothallism, Hormonal control of sexual reproduction.General account of lichens with special reference to: Habitat, Structure and organization of lichens, Method of reproduction. Physiological relationship of mycobiont and phycobiont, Economic importance of lichens;
Mycorrhizae: Types and significance.

Unit 3

Brief history of plant viruses and their origin; Nomenclature and classification of plant virus and their strains; Variation in morphology and ultrastructure of plant viruses.

Unit 4

Mode of infection and replication of plant viruses; Translocation of viruses in the host; Basic control measures and production of virus-free plants; Modern concept of organic viruses, viroids, virusoids, satellite viruses and Prions.

Course Outcomes-

CO.1 Students will be able to develop mycological knowledge and skill to conduct independent research.

CO.2 Pathological identification and work in different mycological industries for economic purposes.

CO.3 Students will be able to learn the nomenclature, classification, identification of various strains of viruses and will be able to apply different control measures for production of virus-free plants.

CO.4 Management of different diseases caused by viruses in plants.

Paper – 3
(Code: BOT-1.3)

PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY

Unit 1

Classification and origin of Pteridophytes; The vegetative sporophyte; Microphylls and megaphylls; Stelar theory; Telometheory; The fertile sporophyte: sporangia; position, ontogeny. Types, structure. Heterospory: Occurrence, causes and significance. The gametophytes: Germination of fern spores, development of fern prothallus; Comparative study of Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

Unit 2

Classification of gynmospermsupto the rank of orders. General account of the following groups with special reference to the genera indicated in brackets: Pteridospermales (*Calymmatotheca,Hoeninghausi*), Glossopteridales, Caytoniales (*Caytonia*), Cycadales, Bennettitales (*Williamsonia* sp.), Pentoxylales, Corditales (*Cordaites* sp.)

Unit 3

General account of the following groups with special reference to the genera indicated in brackets: Ginkgoales (*Ginkgo biloba*), Coniferales: general anatomy, cone organization, life history and distribution), Ephedrales (*Ephedra* sp.) Gnetales (*Gnetum* sp.) and Welwitschiales (*Welwitschia* sp.)

Unit 4

Fossil history of Bryophytes, Pteridophytes and Gymnosperms: Principles of Palaeobotany and geological time scale; Process of fossilization and types of fossils; Methods of study of fossils and carbon dating technique.

Course Outcome-

CO1. To study first vascular land plants, naked seed plants and palaeological evidences.

CO2. Students will be able to learn the diversity and adaptation of pteridophytes and gymnosperms during the long geological time periods.

CO3. The study will provide an insight to evolution and palaeological knowledge. CO4. Students will learn the economic importance of pteridophytes and gymnosperms as this group includes highly medicinal plants.

Paper - 4
(Code: BOT – 1.4)

MICROBIOLOGY

Unit 1

Microbial taxonomy: Basis of bacterial classification: analysis of phenetic, genetic and phylogenetic characteristics; polyphasic approaches to bacterial taxonomy. Salient features of major bacterial groups according to Bergey's Manual of Systematic Bacteriology. Types of culture media, isolation of pure cultures, enrichment culture techniques, maintenance and preservation of bacterial cultures. Control of microorganisms: physical and chemical methods.

Unit 2

Photosynthesis and fermentative metabolism: Bacterial photosynthesis (anoxygenic and oxygenic): antennae complex and reaction centre, chemosynthesis. Bacterial fermentative pathways: lactic acid, propionic acid, mixed and butanol fermentation. Nitrogen metabolism: ammonification, nitrification, denitrification and nitrogen fixation. Nif genes: functions and regulation. Cell Signaling in Bacteria: two component system, quoram sensing, chemotaxis.

Unit 3

Genetic analysis of bacteria: Conjugation: molecular mechanism of gene transfer and regulation. Conjugation mapping, Plasmids: types, function and application. Transformation: molecular mechanism of transformation. Transduction: Generalized and specialized transduction-T4, T7 and lambda phages. Lysogenic phages: genome organization and its regulation. Transposons: Types of bacterial transposons. Detection, regulation and molecular mechanism of transposition in bacteria.

Unit 4

Recognition and entry process of different pathogens like bacteria and viruses into animal and plant host cells. Plant microbe interactions (PMIs). Antibiotics and their mode of action. Biopesticides, basic principles of immunology, vaccines and antibodies. Microbial production of pesticides; degradation of Xenobiotics Bioremediation of heavy metals. Biosensors and their applications

Practical: Based on the above 4 papers.
Seminar: Based on the above 4 papers.

Course outcomes:

CO1. Students will be introduced with the basic principles of classifying prokaryotes, which will enhances the knowledge of classical to modern molecular approach of classification of bacteria commonly used nowadays.

CO2. To understand the nitrogen metabolism and also to effect yield of nitrogen content in legumes

CO3. Commercial production of different acids in Industry with the help of microbes eg. Lactic acid, Ethanol, Propionic acid etc.

SEMESTER 2

Paper- 1
(Code: BOT 2.1)

ANGIOSPERMS (TAXONOMY AND BIOSYSTEMATICS)

Unit 1

Angiosperms: Evolutionary trends in characters; Contribution of Ancient India in taxonomy and classification of Plants.

Brief comparative study of the following systems of classification:

a) Engler and Prantle
b) Hutchinson
c) Takhtajan
d) Bentham and Hooker system of classification

Unit2

Molecular approaches to plant taxonomy: Angiosperm phylogeny groups (APG); DNA barcoding and its practical implications. Application of DNA markers in angiosperm taxonomy.

Botanical nomenclature: International code of nomenclature (ICN); Principles: rules and recommendations; typification, priority, rules of effective and valid publications; retention and choice of names; Conservation of names, Name changes, Synonyms, Basionyms.

Unit 3

Recent trends in taxonomy; Plant identification: Taxonomic keys

Field and Herbarium techniques: Plant Collection and Documentation: Methods of collecting plants; Herbarium Specimens' preparations, Data Information Systems; Role of Botanic Gardens in conservation of biodiversity.

Unit 4

Taxonomic features, systematic phylogeny and economic importance of families**:**

Dicotyledons: Ranunculaceae, Magnoliaceae, Capparidaceae, Caryophyllaceae, Asteraceae,Sterculiaceae, Rosaceae, Rutaceae, Anacardiaceae, Fabaceae, Myrtaceae, Combretaceae, Oleaceae, Asclepiadaceae, Boraginaceae, Scrophluriceae, Bignoniaceae, Pedaliaceae, Acanthaceae, Verbaenaceae, Lamiaceae, Polygonaceae, Piparaceae, Euphorbiaceae, Moraceae

Monocotyledons:Orchidaceae, Amaryllidaceae, Araceae and Arecaceae, Zingiberaceae, Cyperaceae, Poaceae

Practical: Based on the above 4 papers.
Seminar: Based on the above 4 papers.

Course Outcome-

CO1.Students will be able to understand the basics of plant collections, identification and nomenclature.
CO2. Conservation of plants. They will be acquainted with herbarium concepts and able to utilize plant diversity for their basic needs such as foods, fruits and medicine.
CO3. They will be able to know the evolutionary history of plants by molecular systematic concepts.
CO4. To make herbaria of local plants.

Paper – 2
(Code: BOT 2.2)

ANGIOSPERMS II (MORPHOLOGY, EMBRYOLOGY AND ANATOMY)

Unit 1

Morphology of flower; Morphology of carpel and ontogeny of inferior Ovary;Phylogeny of Angiosperms; Criterion for advancement of Angiosperms; Advancement index of Angiosperms

Unit 2

Development of Male and female gametophyte, microsporogenesis andmegasporogenesis; domains of pollen wall; pollen tube growth and guidance, Fertilization: double fertilization, self-incompatibility mechanisms; Development of endosperm, embryo and its culture, polarity during embryogenesis; somatic embryogenesis; apomixis, polyembryony and its induction, Induced Parthenocarpy; in vitro pollen germination.

Unit 3

Primary meristem organization of shoot and root apices; Cell fate determination, lineage decisions, developmental patterning of angiosperms; Differentiation of cells: stomata, trichomes, tracheary elements etc.; Development of organs: organ identity, key regulatory mechanisms in development of size and shape of specific organs such as leaf, stem, shoot etc.

Unit 4

Cambium and its derivative tissues, differentiation of secondary xylem and secondary phloem; Structure of wood in relation to its weight, strength and durability; General structure of plant cell wall, stomata and secretory structures. Cork cambium and its derivatives, function of cork and abscission layers, Anatomy of floral organs.

Course outcome-

CO1. This course provides an opportunity to grasp the knowledge of cell development, regulation and *in vitro* fertilization for the improvement of crop varieties.

CO2. Students will be able to learn interaction of growth regulators in developmental processes.

CO3. To understand the concept of polyembryony and produce seedless fruits and can perform control of fertilization and different experiments of embryology in field.

Paper – 3

(Code: BOT 2.3)

CYTOLOGY AND GENETICS

Unit 1

Techniques of Cell Biology: Light Microscopes, Phase contrast, confocal microscopes, TEM and SEM. Cell membrane: Structure and function solute transport across the membrane: passive transport, primary active and secondary active transport, membrane transport systems: ion channels and its types, aquaporins, P-type, V-type, F-type ATPases, ABC transporters, vesicular transport.

Unit 2

Cytoskeleton: microtubules, microfilaments, and intermediate filaments. Interphase nucleus and nucleolus, Nuclear Pore Complex (NPC). Cell organelles: structure and functions, endomembrane system; Plasmodesmata.

Unit 3

Cell division: cell cycle, mitosis and meiosis; Control of cell division: cyclins, Cdks, cell cycle check points, spindle organization and chromosomal movement, uncontrolled cell division, tumor, cancer, apoptosis and programmed cell death in plants.Cell signaling: cell

surface receptors, G-protein, GPCRs, second messengers, membrane derived messengers, serine/threonine kinases and receptor tyrosine kinases (RTKs).

Unit 4

Concept of gene, allele, multiple allele, pseudoallele, complementation test, extensions of Mendelian principles: gene interaction, genomic imprinting, linkage and crossing over, sex linked and sex influenced characters, linkage maps, genetic recombination in bacteria and fungi, mapping genes by interrupted mating.

Course Outcome-

CO1. Students will be able to learn the techniques related to cytological analysis.
CO2. The knowledge of cell and its organelles will provide an insight into drug development processes.
CO3. To understand the concept of tumor formation and its control.

Paper- 4
(Code: BOT 2.4)

SOIL SCIENCE AND PHYTOGEOGRAPHY

Unit 1

The nature of parent material and development of soil; Major processer of soil formation: Calcification, Podzolization and Laterization; Physical properties:
Particle system, structure of soil; soil moisture constants, soil aeration, pF scale;

Unit 2

Chemical properties: Soil solution and nutrients, soil pH, Cation exchange phenomenon, redox potential, acidity, alkalinity, and salinity of soils; Soil organisms; organic matter, over view of decomposition, Process of humification and mineralization, recycle index, decomposition and release of nutrients.

Unit 3

Phytogeography: Biogeographic divisions; Endemism; Distribution of plant species, migration, routes of dispersal, major terrestrial biomes, theory of island biogeography.

Unit 4

Behavioral Ecology: Habitat selection, group selection, individual selection, Altruism, Hamilton's rule sexual selection (mate choice), mating systems and extra-pair copulation.

Practical: Based on the above 4 papers.

Seminar: Based on the above 4 papers.

Course outcomes:

CO1. Students will learn the different physical and chemical properties of Soil.

CO2. Learn how to increase soil fertility and overview of decomposition and release of nutrients.

CO3. To test soil pH and help in agricultural crops.

SEMESTER 3

Paper- 1
(Code: BOT 3.1)
PLANT BIOCHEMISTRY

Unit 1

Composition, Structure and functions of carbohydrates, lipids and proteins. Stabilizing interactions (vander Waals, electrostatic, hydrogen bonding and hydrophobic interactions etc.) Conformation of proteins Ramchandran plot, secondary structure, domains, motif and folds, peptide bond.

Unit 2

Enzymes: regulatory and active sites, activation energy, isozymes,.Principles of catalysis, kinetics of enzymatic catalysis, Michaelis-Menten equation, its derivation and significance. Coenzymes: Structure and classification of coenzymes, Prosthetic group and cofactors; role of vitamins as coenzymes. Allosteric enzymes, ribozymes, abzymes, Enzyme regulation.

Unit 3

Bioenergetics: Laws of thermodynamics and its application in biological systems, concept of entropy and enthalpy, concept of free energy, energy rich bonds and high energy compounds, energetic coupling. Redox systems and standard redox potential in living systems, substrate level phosphorylation. Nucleic acids: Biosynthesis and degradation of purines and pyrimidines.

Unit 4

Biochemical techniques: Different types of chromatographic techniques, based on ion exchange and affinity, electrophoresis and electrofocussing, centrifugation: ultracentrifugation and density gradient centrifugation, Spectrophotometry, tracer techniques.

Course Outcomes-

CO1. The paper will provide an opportunity to develop an understanding of biomolecules interactions and mechanism of biological catalysts.

CO2. The understanding of biochemical techniques will prepare students to isolate potential biomolecules.

CO3. To understand the role of vitamins and its role in metabolism in plants.

Paper – 2
(Code: BOT 3.2)

PLANT PHYSIOLOGY

Unit 1

Photochemistry and Photosynthesis: Photosynthetic pigments and light harvesting complexes, photo-oxidation of water, mechanism of electron and proton transport, carbon assimilation; regulation of Calvin cycle; photorespiration and its significance, the C_3, C_4 and CAM pathways.

Water potential, transport of water, solutes and translocation: uptake transport and translocation of water, ions, solutes from soil, through xylem and phloem, mechanism of loading and unloading of photo-assimilates.

Unit 2

Respiration: Glycolysis, TCA cycle, electron transport in plant mitochondria and ATP synthesis, Pentose Phosphate pathway, Glyoxylate cycle. Lipid Metabolism: Structure and synthesis of saturated and unsaturated fatty acids; synthesis of fats and lipids; (α, β and ω oxidation).

Unit 3

Plant Growth Regulators: Structure, biosynthesis, storage, break down and transport. Physiological effects and molecular mechanism of action of auxins, gibberellins, cytokinins, ethylene, abscissic acid, brassinosteroids, jasmonates, salicylic acid and strigolactones.

Unit 4

Physiology of Floral Induction: photoperiodism and its significance, CO, FT and Hd1 proteins, vernalization, homeotic genes, quartet (ABCE) model of flowering.

Sensory Photobiology: History, discovery, photochemical biochemical properties and Photophysiology of light induced responses by the photoreceptors: phytochromes, cryptochromes, phototropins and zeitlupe (ZTL). Stomatal physiology.

Course Outcome-

CO1. The students will be able to learn role of growth regulators in plant development.

CO2. Carbon assimilation is a process related to biomass accumulation. Students will learn the factors related to carbon assimilation and processes that regulate it.

CO3. To understand the concept of flowering and understand role of hormones.

PAPER –3
(Code: BOT 3.3)
PLANT ECOLOGY

Unit 1

Concept and Scope of Ecology; Collective, and Emergent properties, Habitat and niche: niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.

Unit 2

Population Ecology: Natality, mortality, survivorship growth rates of population, growth curve; biotic potential, carrying capacity and environmental resistance; competition-coexistence models, concept of meta-population, life history strategies (r and K selection).

Unit 3

Community Ecology: community vs. continuum concept. Bioenergetics of Ecological succession, type of succession Climax theories; Analytical and Synthetic characters of community, biodiversity status, major drivers of biodiversity change, indices of diversity; diversity and stability of ecosystem, edges and ecotones. Species interactions and coevolution.

Unit 4

Ecosystem Ecology: Concept of ecosystem, trophic structure, food chain energy flow, productivity and energy subsidy; global carbon cycle, Ecosystem services, restoration ecology, structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (freshwater, marine and estuarine).

Practical: Based on the above 3 papers.

Seminar: Based on the above 3 papers.

Course outcome:

CO1. Students will learn about different ecosystems, plant communities and other important aspects related to biodiversity.

CO2. Conservation of our forests

CO3. To understand the concept of energy flow in different ecosystems.

Paper – 4

(Code: BOT 3.4)

ELECTIVE / OPTIONAL PAPERS

- Plant Pathology (Code: BOT 3.4.1)
- Advance Plant Physiology (Code: BOT 3.4.2)
- Forest Ecology (Code: BOT 3.4.3)
- Advance Plant Taxonomy (Code: BOT 3.4.4)
- Advance Molecular Genetics (Code: BOT 3.4.5)
- Environmental Management and Technology (Code: BOT 3.4.6)
- Water Resource Management (Code: BOT 3.4.7)

 Practical: Based on OPTIONAL papers.

 Dissertation & Viva-voce: Based on the OPTIONAL papers.

Attendance (%) Marks

<67	0
67–69.9	1
70–74.9	2
75–79.9	3
80–84.9	4
85 above	5

(As per CBCS Criterion)

PLANT PATHOLOGY

(Code: BOT 3.4.1)

Unit 1

The concept of disease in plants. Importance of plant disease. Mechanism of attack by plant pathogens: Microbial enzyme, toxins and growth regulators. Variability in plant pathogens: Types of variation; mechanism of variability. Effect of environmental on development of infectious disease of plants: Epidemiology. Plant disease forecasting.

Unit 2

Transmission of plant diseases caused by viral pathogens. Methods of study of infectious diseases of plants: isolation of pathogens and tests of pathogenicity. 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. Use of resistant varieties.

Unit 3

Study of importance, symptoms, causal organism, disease cycle and control of following diseases of crop plants in Uttar Pradesh caused by fungi:

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

Unit 4

Study of importance, symptoms, causal organism, disease cycle and control of following diseases of crop plants in Uttar Pradesh caused by bacteria, viruses, viroids, Phytoplasma and nematodes: Bacterial diseases: Citrus canker and Tundu disease of wheat. Viral diseases: Mosaics of tobacco, papaya, potato and tungro of rice. Phytoplasmal diseases: Grassy shoot of sugarcane. Nematode diseases: Ear cockle of wheat

Course Outcome-

CO1. Students will get an idea about major plant diseases of cash crops in India.
CO2. The course discusses major aspects of pathogens, epidemic, disease forecasting, and quarantine rules.
CO3. Students will learn details of various aspects of plant disease control and management.

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.
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.

ADVANCE PLANT PHYSIOLOGY

(Code: BOT 3.4.2)

Unit 1
Nitrogen Metabolism: nitrate assimilation, synthesis of essential amino acids, amides and ureides. Biological nitrogen fixation and the various organisms.

Unit 2
Secondary metabolites: structure, and biosynthesis of non-nutrients viz., alkaloids, sterols, terpenoids, phenols, flavonoids and quinines and their biofunctional role.

Unit 3
Seed physiology: Seed development, germination dormancy, growth and its measurement.

Unit 4
Stress Physiology: stress due to, salinity, alkalinity, temperature, radiation and the physiology of adaptation.

PRACTICALS:

Based on above

Course outcome-

CO1.Students will learn in detail aspects of nitrogen metabolism.

CO2. Production of Secondary metabolites, seed and stress physiology.
CO3. Production and conservation of seeds.

FOREST ECOLOGY

(Code: BOT 3.4.3)

Unit1

Human evolutionary dependence on forests: scope and relevance.; forest types of India; Ecological morphology of rain forest flora.

Unit 2

Structure of forest ecosystem: Photosynthetic efficiency; leaf area and growth Nutrient cycling in tropical forest ecosystems.

Unit 3

Reproductive strategy of tropical trees; Natural and artificial regeneration; Factors destructive to forest ecosystems; causes and effects of deforestation; systems; Role of trees in combating air pollution.

Unit 4

Physico-chemical properties of forest soil; ecological significance of soil texture; soil biology and soil fertility; Comparison of forest and grassland. Accumulation and decomposition of forest litter; forest humus; the geochemical, biogeochemical cycling of nutrients

Course Outcome-

CO1. Students will get detail idea of advanced aspect of forest ecology viz. forest types of India, forest ecosystem, reproductive strategies of tropical trees.
CO2. Detailed study of forest and grassland soil.
CO3. Effects of deforestation on community and nation at large.
CO4. 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.

ADVANCE PLANT TAXONOMY

(Code: BOT 3.4.4)

Unit 1

Plant Systematics: Taxonomic History and outline of various system of classification; Principles of classification and concept of Taxa. Botanical Nomenclature and type concepts; Citation of authors; Priority; Type method; Naming a new species; Legitimacy; Synonyms. History of Botanical exploration in India; Herbarium and herbarium methods. Botanical Garden. Botanical Collection. Botanical keys, their uses and construction. Botanical line drawings and photoplates.

Unit 2

Floristics and monographs; Taxonomic literature; Flora of Uttar Pradesh; Ethnobotanical works in India; Role of palynology in plant taxonomy. The plasticity of phenotypes; Internal variability of population; Ecological differentiation and population; Centres of taxonomic work in India

Unit 3

Development of flower: Vegetative to reproductive evocation, floral meristems and floral development; floral homeotic mutations in Arabidopsis. Stem cell developmental potency; cellular plasticity in plants; determination and differentiation, mechanism of cellular determination; morphogenetic gradients, cell fate and cell lineages; positional information, pattern formation (apical-basal and radial); morphogenesis for developmental studies in *Arabidopsis thaliana*

Unit 4

Structure of xylem and phloem elements; leaf and wood anatomy in ecological perspective; leaf structure in C3 and C4 plants; xylem structure and water movement; Structure and function of cuticle and epicuticular waxes; anatomical response to mineral deficiency; response of plants to wounding and invasion by microorganisms.

PRACTICAL

Based on above

Course Outcome-

CO1. Students will be able to learn the basics of plant systematic, developmental and evolutionary studies.
CO2. They will be able to explore the floristic diversity of the country.
CO3. To understand how to make monographs and herbaria of our area.
CO4. To understand ex-situ conservation of plants.

ADVANCE MOLECULAR GENETICS

(Code: BOT 3.4.5)

Unit 1

Genome organization: from nucleotides to chromatin. DNA protein interaction: DNA binding motifs, zinc fingers basic leucine zipper (bZIP), basic helix-loop-helix (bHLH) motif.

Unit 2

Control of gene expression by chemical modification of DNA: types of chemical modifications and nucleosome remodeling. Regulatory RNA: riboswitches, micro RNA, siRNA: RNA interference.

Unit 3

Tools for analyzing gene expression: antisense technology, analysis of DNA protein interactions – EMSA, ChIP, DNase I foot printing, analysis of protein-protein interactions– Pull down assay, yeast two hybrid assay, Coimmunoprecipitation assay, FRET.

Unit 4

Transposable elements: their types and role in genome evolution. Molecular markers and their importance, molecular analysis of genes: Southern blotting, Northern blotting, DNA sequencing. PCR, RT-PCR and DNA microarray technology, In situ hybridization techniques: FISH, GISH, CRISPR Cas 9 technology.

Course Outcome-

CO1. Students will get detail knowledge of genome organization gene expression and its control.

CO2.Various tools for analysis of gene expression and recombinant DNA technology.

CO3. Role of Recombinant technology in Plant Breeding.

PRACTICAL: Based on the above

ENVIRONMENTAL MANAGEMENT AND

TECHNOLOGY

(Code: BOT 3.4.6)

Unit 1

Basics of Environmental Science: Origin of Earth, Biotic-abiotic interaction, Decline in Biodiversity and the consequences. Environmental Phenomenon and Episodes: Ozone layer depletion, Green House Effect, Climatic change, Bhopal gas tragedy and Chernobyl episode. Occupational Health Hazards: Silicosis, Asbestosis, Carcinogens, Mutagens, Teratogens and Toxicity of Heavy Metals.

Unit 2

Non-conventional Energy: Hydrogen, Alcohol, Bio-diesel, Wind and Solar energy 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.

Unit 3

Air Quality Monitoring and Management: Composition of air, Major sources of air pollution, in-door air pollution, Monitoring of SOx, NOx and O3. Solid Waste Management Technologies: Sources of solid waste, Solid waste disposal, Vermicomposting, R3 Principle. Noise Pollution and Abatement: Sources of noise pollution, Noise standards, Biological and behavioural effects of noise pollution. Environmental Biotechnology: Use of Micro-organisms in waste treatment, Biodegradation of petroleum pollutants, Production of microbial enzymes (Cellulases and Proteases)

Unit 4

International Agreements on Environment: Treaties and Protocols of United Nations Conference on Human Environment-UNCHE (Stockholm, 1972), United Nations. Conference on Environment and Development- UNCED (Rio de Janeiro, 1992), World Summit on Sustainable Development- WSSD (Johannesburg, 2002). 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. Environmental Economics: Valuation of natural resources, cost benefit analysis and integrated economic modeling.

PRACTICAL: Based on the above

Course outcome-

CO1.Students will learn about various aspects of basics of environmental science, non-conventional energy sources, air quality monitoring and management.

CO2. International agreements on environment Protection.

CO3. The hazards of pollution and control measures.

WATER RESOURCES MANAGEMENT

(Code: BOT 3.4.7)

Unit 1

Distribution of Water, Water Resources, Diversity of Aquatic Habitats, Lentic and Lotic Ecosystems, Aquifers, Hydrological Cycle, Disposition of Water, Catchment Infiltration, Watershed Management

Unit 2

Quality of Water, Physico-chemical Properties of Freshwater, Water Quality Parameters and Standards, Water Pollution and its Sources, Groundwater Contamination, Threats to Surface Water Resources.

Unit 3

Water and Plants, Aquaculture, Water Stress Adaptations in Plants, Role of Plants in Water Management, Water Borne Diseases, Eutrophication. Water Management Strategies, Management of Ground Water, Rain Water Harvesting, Recharging of Ground Water, Recycling of Waste Water,

Unit 4

The Water (Prevention and Control of Pollution) Act, 1974, Ramsar Convention. Treatment Technologies, Treatment of Drinking Water (Ion-Exchange, Reverse Osmosis and Disinfection of Water), Treatment Technologies for Domestic Waste Water, Biological Treatment of Waste Water.

PRACTICAL: Based on the above

Course outcomes:

CO1. Students will learn details of distribution of water, water resources, quality of water.

CO2. Physico-chemical properties of freshwater, aquaculture and water (prevention and control of pollution) act.

CO3. The role of contaminants of Water resource and its control measures.

SEMESTER 4

Paper – 1

(Code: BOT 4.1)

MOLECULAR GENETICS, GENETIC ENGINEERING AND BIOTECHNOLOGY

Unit 1

Nucleic acids : Structure and form of DNA, Circular DNA in bacteria and chloroplast, packaging of DNA, DNA melting (Tm), DNA annealing $C_o t$ curves, Genome complexity (unique, moderately repetitive, and highly repetitive or satellite DNA) C-value and C-value paradox.

Gene Replication: DNA replication in prokaryotes and eukaryotes (initiation, elongation, termination and regulation), fidelity of replication.

Unit 2

Gene Mutation: Mutagenic agents, mechanisms of mutagenesis, DNA damage and repair mechanism, uses of mutation.

Genetic Code: Codon assignment, code in mitochondria, second genetic code, initiation and termination codons.

Unit 3

Gene Expression: Mechanism of transcription and translation in prokaryotes and eukaryotes (initiation, elongation and termination), transcription activators and repressors. Post transcriptional modifications and RNA transport, translational proof reading, translational inhibitors, post translational modification of proteins.

Regulation of Gene Expression: Concept of operon, *lac* operon in detail, *trp* operon, attenuation, role of chromatin in gene regulation, gene silencing: miRNA and siRNA.

Unit 4

Genetic Engineering: Enzymes (endonucleases, ligases) and, vectors *viz.*, plasmids, phages, cosmids, BAC, YAC and *Agrobacteriumtumefaciens*, gene cloning; Methods of gene transfer.

Tissue and Organ Culture: Micropropagationsomaclonal variation, haploid production, protoplast culture and somatic hybridization.

Application of Biotechnology in agriculture: disease resistance, abiotic stress tolerance and production of useful products.

Course Outcome-

CO1.Students will be able to learn biotechnological concepts of crop improvement, tolerance, and resistance.

CO2. Development of new transgenics.

CO3. Use of Mutation in plant improvement and its yield.

Paper- 2

(Code: BOT 4.2)

PLANT RESOURCE UTILIZATION AND CONSERVATION

Unit 1

Plant biodiversity for Man and their importance; History, Botany, cultivation and processing of: Cereals (Wheat, Rice, Maize), Legumes and Pulses, Forage crops, Fiber plants and their products.

Unit 2

Medicinal plants, Drugs and narcotics, Fumitories and mastigatories, Beverage yielding plants, Important wood and timber yielding plants, Sugar and sugar yielding plants, Tropical and subtropical fruits.

Unit 3

Spices and flavoring materials, Vegetables, Gum and dye yielding plants, Latex yielding plants, teal coffee, rubber and Insecticide yielding plants. Origin of cultivated plants: center of origin, criteria and Vavilov's center of origin. Origin and cultivation of wheat, rice, maize, sugarcane, mustard and potato.

Unit 4

Principles of conservation; In situ conservation: Sanctuaries, national parks, biosphere resaves, wet lands, mangroves and coral reef, *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.

Course outcome

CO1. This course work provides knowledge, utilization and their conservation with practical application.

CO2. It opens the areas of plant based industries like food industry, pharmaceutical industry and their bioprospection for nature and ecological services.

Paper – 3

(Code: BOT 4.3)

CYTOGENETICS, PLANT BREEDING AND BIOSTATISTICS

Unit 1

Structural Changes in Chromosomes: Deletion, duplication, inversion (paracentric and pericentric), and translocation: cytology, genetics and their role in genome evolution. Robertsonian Translocation.

Numerical changes in chromosomes: Aneuploidy and Euploidy-cytology and genetics, their role in crop improvement. Genetic counseling.

Quantitative inheritance, population genetics, Hardly-Weinberg equilibrium, genetic drift, speciation, and adaptive radiation.

Unit 2

Introduction to plant breeding; Domestication; plant introduction and acclimatization, kinds of germplasm, Methods of selection and hybridization; Techniques of selfing and crossing.

Unit 3

Cytoplasmic male sterility; Heterosis and hybrid seed production; Mutant breeding; Polyploidy in plant breeding; Breeding for nutritional quality.

Unit 4

Relevance of biostatistics to biological interpretative, elementary idea of probability, combination and permutations, continues and discontinuous variables; Measures of central tendency: Mean, Median and Mode; Measures of dispersion: Standard deviation, Standard error, Mean deviation. Test of significance: Chi- square test, t- test; Analysis of variance; Correlation and regression.

Practical: Based on the above 3 papers.
Seminar: Based on the above 3 papers.

Course Outcomes-

CO1. The students will be able to apply the concept of the biostatistics in their research work.
CO2. The cytological knowledge of genetics will provide an opportunity to develop new crop varieties.
CO3. Knowledge of plant breeding will help to improve crop varieties by plant introduction, mutation breeding and utilize other techniques of hybridization for crop improvement.

Paper – 4

(Code: BOT 4.4)

DISSERTATION AND VIVA-VOCE

Based on Elective/Optional papers

- Plant Pathology (Code: BOT 3.4.1)
- Advance Plant Physiology (Code: BOT 3.4.2)
- Forest Ecology (Code: BOT 3.4.3)
- Advance Plant Taxonomy (Code: BOT 3.4.4)

- Advance Molecular Genetics (Code: BOT 3.4.5)
- Environmental Management and Technology (Code: BOT 3.4.6)
- Water Resource Management (Code: BOT 3.4.7)