

M.Sc. I Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

I – C1 | Diversity of Microbes (Viruses, Bacteria, Fungi, Nematodes)

UNIT – I

- Classification of plant viruses, characteristics and ultrastructure of viruses; Isolation, purification and characterization of viruses
- Chemical nature, replication, transmission of viruses, economic importance, symptomatology of plant viruses

UNIT – II

- **Phytoplasma:** General characteristics and role in causing plant diseases
- **Archaeobacteria and Eubacteria:** General account, ultrastructure, nutrition and reproduction, biology and economic importance, Cyanobacteria-salient features and biological importance, plasmids and their characteristics.

UNIT – III

- **General characters of fungi:** Structure of cell, unicellular and multicellular organization, cell wall composition, nutrition (saprobic biotrophic, symbiotic), reproduction (vegetative, asexual, sexual); General account of Mastigomycotina (*Synchytrium*), Zygomycotina (*Pilobolus*), Ascomycotina (*Claviceps*), Basidiomycotina (*Puccinia*), Deuteromycotina (*Fusarium*)
- Heterothallism, Heterokaryosis and para-sexuality; a concise account of fungi in industry, medicine and food; fungal diseases in plants and humans, mycorrhizae as biocontrol agents

UNIT – IV

General characters of plant parasitic nematodes: Distribution, morphology, life history, feeding habit, symptoms of plant nematode infection, root-knot disease of brinjal, diagnostic features of Tylenchoidea, Heteroderoidea, Criconematoidea, Aphelenchoidea, Dorylaimoidea and Trichoderoidea.

LABORATORY: Exercises corresponding to the theory courses

M.Sc. I Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 02

I – C2 PLANT PATHOLOGY

UNIT – I

Concept of plant disease. Identification of plant diseases- Koch's postulates, Types of plant diseases, Symptoms caused by fungi and bacteria. Economic importance of nematodes in relation to agriculture.

UNIT – II

Plant diseases: causal organism, symptoms and management of following diseases-Stripe disease of barley, White rust of crucifer, Ear- cockle disease of wheat, Citrus canker, Yellow vein mosaic of okra.

UNIT – III

General principles of plant disease management: Avoidance of pathogen, Exclusion of inoculum, Eradication of pathogen, Protective measures of crop plants, Therapeutic measures.

UNIT – IV

Isolation of fungi from leaf, root, stem and seeds. Maintenance of fungal culture. Isolation of nematodes from soil by Cobb's decanting and sieving method followed by Baermann's funnel technique. Isolation of nematodes from the roots. Culture media preparation (Czapek-Dox Agar, Nutrient Agar media and PDA).

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. I Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

I – C3 ALGAE AND BRYOPHYTES

UNIT – I

Algae: Distribution, structure, classification and its basis (Graham and Wilcox), reproduction and life cycles of Cyanobacteria, Glaucophyta, Euglenophyta, Cryptophyta, Haptophyta, Dinophyta, Ochrophyta, Rhodophyta and Chlorophyta

UNIT – II

Technological applications of algae: Algae as research tools, biomonitor, a gelling agents, antiviral and anticancerous compounds; algae in production of food additives and hydrocarbons and space research; human uses of sea weeds

UNIT – III

Bryophyta: Distribution, structure, outline classification (Proskauer, 1957); Reproduction and life history of Hepaticopsida (Marchantiales), Anthocerotopsida (Anthocerotales) and Bryopsida (Funariales); simple land plant nature

UNIT – IV

Economic importance of bryophytes: Uses of peat, medicinal uses, source of food, soil conservation, bog succession and rock builders; ecological importance of bryophytes as air and water pollution, bioindicators

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. I Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

I – C4 PTERIDOPHYTES AND GYMNASPERMS

UNIT – I

General characteristic features and classification (Smith, 1955 and Bierhorst, 1971) of Pteridophytes. Morphology, anatomy and reproduction of Psilophyta (*Psilotum*), Lycophyta (*Selaginella*), Sphenophyta (*Equisetum*), Pteropsida (*Marsilea*). Telomic theory, Classification and evolution of steles. Heterospory and origin of seed habit.

UNIT – II

General account of fossil vascular cryptogams: *Rhynia Horneophyton* and *Asteroxylon*, *Calamites* and *Lepidodendron*. Origin of vascular cryptogams, Evolution of sorus in ferns, Economic importance of Pteridophytes.

UNIT – III

- General diagnostic features of gymnosperms with special reference to drop mechanism, vessel-less and fruitless seed plants. General account of anatomical variations in gymnospermic leaves (*Abies*, *Cedrus*, *Picea*, *Cycas* and *Taxus*)
- General characters, global geographical distribution and external features of modern living members of Cycadales, Coniferales and Ginkogales

UNIT – IV

- Outline classification of gymnosperms as proposed by Sporne (1965) and Sandra Holms (1986); Distribution of living gymnosperms in India; Economic importance of gymnosperms
- General account of fossils of Medullosaceae (*Medullosa*), Glossopteridaceae (*Glassopteris*) and Cycadeoideaceae (*Cycodeoidea*)

LABORATORY: Exercises corresponding to the theory courses

M.Sc. I Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

I – C5 TAXONOMY OF ANGIOSPERMS

UNIT – I

- **The species concept:** Taxonomic hierarchy, species, genus, family and other categories; taxonomic keys; salient features of the Recent International Code of Botanical Nomenclature
- **Taxonomic tools:** Field and herbarium techniques, floras, serological techniques.

UNIT – II

Systems of angiosperm classification: History, basis, outline and relative merits and demerits of (i) Benthum and Hooker, (ii) Takhtajan, (iii) Bassey, (iv) Hutchinson and (v) Cronquist

UNIT – III

- **Flowering plant families of local importance:** Annonaceae, Portulacaceae, Fumariaceae, Papaveraceae, Malvaceae, Zygophyllaceae, Moringaceae, Lythraceae, Oleaceae, Convolvulaceae, Solanaceae, Asclepiadaceae, Apocynaceae, Scrophulariaceae, Bignoniaceae, Polygonaceae, Casuarinaceae, Commelinaceae, Arecaceae, Cyperaceae and Poaceae
- **Concepts of phytogeography:** Phytogeographic zones of world and India; Endemism (definition, types and endemism in Indian flora); Disjunction and vicariance biogeography. Parallelism and convergence

UNIT – IV

Origin of Intrapopulation variations and speciation: Dynamic nature of populations in relation to environment. Evolution (cladogenesis, anagenesis), Natural selection (stabilizing, directional and disruptive). Ecotypes and ecads. Hardy-Weinberg Equilibrium. Isolating mechanisms. Models of speciation. Some examples of known speciation events in plants

LABORATORY: Exercises corresponding to the theory courses

M.Sc. II Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 02

II – C9 | PLANT RESOURCE UTILIZATION AND CONSERVATION

UNIT – I

- World centres of primary diversity of domesticated plants, plant introductions
- Origin, evolution, botany, cultivation and uses of (i) Cereal Crops – wheat (*Triticum* spp.) (ii) Fibre Crop – Cotton (*Gossypium* spp.).
- Medicinal and aromatic plants – Opium poppy (*Papaver somniferum*), Rauwolfia (*Rauwolfia serpentina*).

UNIT – II

- Vegetable oil yielding crops : Distribution, botany, cultivation and uses of soybean (*Glycine max*).
- Fire and timber wood : Diagnostic features of wood and uses of Babul (*Acacia nilotica*), Sissoo (*Dalbergia sissoo*), Teak (*Tectona grandis*), Sal (*Shorea robusta*).

UNIT – III

Strategies for plant conservation (*ex situ* conservation) - general account of the activities of Botanical Survey of India (BSI), Indian Council of Agricultural Research (ICAR).

UNIT – IV

- Plant biodiversity and its status in India
- Green revolution - benefits
- Seed banks & cryobanks

LABORATORY: Exercises corresponding to the theory courses

M.Sc. II Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

II – C10 REPRODUCTION IN FLOWERING PLANTS

UNIT – I

- **Male gametophyte** - Microsporogenesis, tapetum and its roles, pollen development, pollen embryos
- **Female gametophyte** - Ovule development, megasporogenesis, organization of the embryo sac, types of embryo sacs.

UNIT – II

Pollination - pollination mechanisms and vectors, pollen germination and pollen tube growth, structure of the pistil; pollen-stigma interactions, pollen allergy

UNIT – III

Double fertilization, *in vitro* fertilization – Intra-ovarian pollination and fertilization, factors affecting *in vitro* fertilization and applications; Embryogeny in dicotyledons and monocotyledons, Apomixis, Floral biology

UNIT – IV

- Endosperm development, Polyembryony – origin, classification, causes and practical value of polyembryony
- Latent life (dormancy) - types of dormancy and importance, overcoming seed dormancy
- Reproduction - vegetative options and sexual reproduction

LABORATORY: Exercises corresponding to the theory courses

M.Sc. II Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

II – C11 | PLANT DEVELOPMENT

UNIT – I

Cell wall - nature, formation, growth of cell wall, microscopic and submicroscopic structure and functions

UNIT – II

- Shoot development - organization of the shoot apical meristem (SAM) and vascular tissue differentiation, plastochron, origin of leaves and branches
- Root development - organization of the root apical meristem (RAM), cell fates and lineages, vascular tissue differentiation, origin of lateral roots and root hairs in dicots and monocots

UNIT – III

Vascular cambium – origin, structure and function; formation of secondary body, formation of secondary phloem and xylem in relation to environmental factors

UNIT – IV

- Secretary ducts and laticifers – resin ducts of primary body and secondary body, gum ducts, kinoveins.
- Leaf growth and differentiation, phyllotaxy, structure and differentiation of epidermis (with special reference to stomata and trichomes), mesophyll

LABORATORY: Exercises corresponding to the theory courses

M.Sc. II Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

II – C12 CELL AND MOLECULAR BIOLOGY

UNIT – I

Nucleus: structure, nuclear pores, nucleosome organization, DNA structure (A, B and Z forms), plant promoters and transcription factors, RNA splicing, m-RNA transport, rRNA biosynthesis, nucleolus, gene expression at RNA and protein level.

UNIT – II

Ribosomes: Structure, site of protein synthesis, mechanism of translation, initiation, elongation and termination, structure and role of transfer RNA (t-RNA), protein sequencing methods, detection of post translational modification of proteins.

UNIT – III

Cell cycle and apoptosis: Control mechanism, role of cyclins and cyclin depended kinases, cytokinesis and cell plate formation, mechanism of programmed cell death.

UNIT – IV

Techniques in cell biology: Immunotechniques- SDS-PAGE and protein analysis; single and double (Ouchterlony) immunodiffusion; quantitative, qualitative, cross-over and two-dimension immunoelectrophoresis; radioimmunoassay (RIA); ELISA; dot immunobinding assay; isoelectricfocusing gels; in situ hybridization- FISH and GISH; confocal microscopy.

LABORATORY: Exercises corresponding to the theory courses

M.Sc. II Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

II – C13 PLANT PHYSIOLOGY AND METABOLISM

- Unit-I:** (a) **Plant water relations and mineral nutrition:** Absorption, translocation and loss of water, regulation of opening and closing of stomata; criteria of essentiality of mineral nutrients, role of essential elements, mechanism of ion transport, deficiency diseases.
- (b) **Enzymology:** Properties of enzymes, nomenclature and classification, mechanism of enzyme action, regulatory and active sites, K_M and its significance, enzyme inhibition, isozymes.
- Unit-II:** (a) **Photosynthesis:** Light harvesting complexes of higher plants, light reactions of photosynthesis, photosynthetic carbon reduction pathway; Hatch-Slack pathway; mechanism of stomatal opening, Crassulacean acid metabolism.
- (b) **Respiration:** Glycolysis, TCA cycle, mitochondrial electron transport and oxidative phosphorylation, fermentation, respiratory quotient, photorespiration
- Unit-III:** (a) **Nitrogen metabolism:** Biological nitrogen fixation, nitrate assimilation, ammonia assimilation, amino acid biosynthesis
- (b) **Lipid metabolism:** General account of storage (triacyl glycerol and waxes) and structural (glycerophospholipids and sterols) lipids, fatty acids and triacylglycerols-their structure, synthesis and degradation-alpha and beta oxidation and glyoxalate cycle.
- Unit-IV:** (a) **Growth regulators:** Biosynthesis, mechanism of action (including hormone receptors and signal transduction) and physiological roles of phytohormones (auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids).
- (b) **Sensory photobiology:** Photochemical and biochemical properties of phytochromes, cryptochromes and phototropins, vernalization, photoperiodism and biological clock.

LABORATORY: Exercises corresponding to the theory courses

M.Sc. III Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

III – C17 GENETICS AND CYTOGENETICS

UNIT – I

Genetic mapping: Restriction mapping, mapping with molecular marker, linkage map, tetrad-analysis, somatic cell genetics – an alternative approach to gene mapping.

UNIT – II

Plasmids: Classification, replication and transfer in plasmids; transposable genetic elements; transposable elements in bacteria insertion sequences or IS elements; transposable elements in eukaryotes- yeast Ty elements, Ac-Ds elements in maize, Spm- dSpm elements in maize; mutations induced by transposons.

UNIT – III

Mutations: Spontaneous and induced mutation, physical and chemical mutagens; molecular basis of gene mutation; oligonucleotide site directed mutagenesis. DNA damage and repair mechanism, inherited human diseases and defects in DNA repair.

UNIT – IV

Alien gene transfer through chromosome manipulations: Transfer of whole genome (examples from Triticum, Arachis and Brassica); transfer of individual chromosomes and chromosome segments; genetic basis of inbreeding and heterosis; exploitation of hybrid vigour

LABORATORY: Exercises corresponding to the theory courses

M.Sc. III Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

III – C18 | PLANT BIOTECHNOLOGY

UNIT – I

Tissue culture: Concept of cell culture, development of tissue culture, shoot, root tip and embryo culture; problems in plant tissue culture- contamination, phenolics and recalcitrants; factors responsible for *in vitro* & *ex-vitro* hardening; role of growth regulators, Somaclonal variations

UNIT – II

Tools and procedures of tissue culture: Techniques of sterilization of media and explants, Types of culture media (MS, B5, WPM); Preparation of stock solution; Micropropagation - direct and indirect organogenesis, Somatic embryogenesis, Suspension culture, Synthetic seeds and its application, Haploid plant production and its application

UNIT – III

Protoplast isolation and somatic hybridization: Protoplast isolation, Purification, Viability testing, Protoplast culture and regeneration of plants, Protoplast fusion - spontaneous and induced fusion; mechanism of fusion; Identification and selection of hybrid cells; Chromosome status of somatic hybrids; Cybridization; Application of somatic hybrids and cybrids

UNIT – IV

Genetic engineering – Gene cloning strategies, Restriction endonuclease, DNA ligase, cloning vectors based on *E. coli* plasmids, bacteriophage, and M13 bacteriophage, Cosmids, BAC, YAC, DNA ligase, DNA modifying enzymes, Linkers and adaptors, Transformation of bacteria and analysis of recombinant, Generation of genomic DNA library and cDNA library, *Agrobacterium tumefaciens*-mediated transformation

LABORATORY: Exercises corresponding to the theory courses

M.Sc. III Semester

Max. Marks : 100
Sessional : 30
End-Sem Exam. : 70

Credits: 02

III – C19 Environmental Sciences

- Unit – I:** **Environment and Pollution:** Introduction to environment: Brief idea of hydrosphere, lithosphere, biosphere and atmosphere (troposphere, stratosphere, mesosphere, ionosphere and exosphere). Introduction to pollution: Brief idea of air pollutants (Primary and Secondary air pollutants).
- Unit – II:** **Environmental Changes:** Global warming, greenhouse gases, consequences of global warming (sea level rise, human health, effect on agriculture and temperature rise). Ozone depletion (Ozone hole), Chlorofluro carbon cycle, consequences of ozone depletion.
- Unit – III:** **Natural Resources:** Different types of natural resources: Forest resources, Wildlife resources, Water resources. Food and agriculture resources: Shifting and Sedentary cultivations: Energy resources: Petro plants.
- Unit – IV:** **Environmental Management:** Control of air pollution, water pollution, soil pollution and noise pollution. Enforcement of legal provision in India, wildlife management: conservation of habitats, species preservation, introduction of exotic species.

M.Sc. III Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

III – C20 ECOLOGY

UNIT – I

- **Climate, soil and vegetation patterns of the world:** Life zones and major vegetation and soil types of the world.
- **Vegetation organization:** Concepts of community and continuum, analysis of communities (analytical and synthetic characters), indices of diversity (Simpson's index and Shannon's index), interspecific association, ordination, concept of ecological niche and habitat
- Introduction to vegetation sampling methods - quadrat method, line transect and plot less method

UNIT – II

Ecosystem organization: Structure and functions, primary production (methods of measurement, global pattern, controlling factors); energy dynamics (trophic organization, energy flow pathways, ecological efficiencies)

UNIT – III

Biological diversity: Concept and levels, role of biodiversity in ecosystem functions and stability, island biogeography, extinction, IUCN categories of threat, distribution and global patterns of terrestrial biodiversity, hot spots, inventory

UNIT – IV

- **Ecosystem stability:** Concept (resistance and resilience), ecological perturbation (natural and anthropogenic) and their impact on plants and ecosystem, ecology of plant invasion.
- **Ecological management:** Concept, sustainable development, sustainability indicators and ecosystem restoration.

LABORATORY: Exercises corresponding to the theory courses

M.Sc. III Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

III – C21 GENERAL BOTANY (CBC)

- Unit I:** Introduction to fungi, diseases caused by fungi and virus (Powdery mildew of cururbits, white rust of crucifers, wilt of pigeon pea, leafcurl of papaya), Type study of bacteria, viruses and nematodes (*Bacillus*, Tobacco mosaic virus and *Meloidogyne* spp.).
- Unit II:** Elementary idea of mineral nutritions and their roles. Deficiency symptoms, significance of photosynthesis and respiration.
- Unit III:** (a) Environment, brief idea of air, water and sound pollutions, particulate matter. Gene diversity, species diversity, community diversity, National parks and sanctuaries.
- (b) Identification, classification and nomenclature of plants. Bentham and Hooker's system of classification, herbarium techniques.
- Unit IV:** (a) Concept of tissue culture, types of cultures, hybrids, cybrids, gene transfer methods.
- (b) Laws of Mendel, chromosomes, DNA structure, Mitosis and Meiosis and their significance, vegetative and sexual reproductions.

M.Sc. IV Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

IV- C27 PLANT PATHOLOGY – I (Elective Paper I)

- Unit I** General characteristics of plant viruses: Morphology, composition and structure of viral protein & nucleic acid. Transmission of plant viruses. Symptoms caused by plant viruses. General characteristics and classification of plant pathogenic bacteria. Symptoms caused by bacteria.
- Unit II** (a) Roles of enzymes, growth regulators and toxins in pathogenesis.
- (b) Effect of infection on physiology of plants (photosynthesis, translocation, respiration, membrane permeability, transcription and translation).
- Unit III** (a) Disease resistance mechanism in plants, preformed substances and structures, induced structures and biochemical defense.
- (b) Genetics of pathogen and physiological specialization with special reference to *Puccinia graminis tritici*. Gene for gene concept, breeding for resistant varieties.
- Unit IV** (a) Morphology and anatomy of nematodes: Body wall and digestive system, excretory, nervous and reproductive systems. Life history of root-knot nematode.
- (b) Outline classification of plant parasitic nematodes. General characteristic features of *Aphelenchoides*, *Criconemoides*, *Tylenchorhynchus*, *Anguina*, *Hoplolaimus*, *Helicotylenchus*, *Rotylenchulus*, *Tylenchulus*, *Meloidogyne*, *Heterodera* and *Xiphinema*.

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. IV Semester

Max. Marks : 100
Sessional : 30
End-Sem Exam. : 70

Credits: 04

IV- C28 PLANT PATHOLOGY - II (Elective Paper II)

- Unit I**
- (a) Concept of plant disease, Host parasites relationship in nematode infection. Effect of abiotic factors in nematode multiplication.
 - (b) Interaction of Plant parasitic nematodes with fungi, bacteria and viruses. Nematode-Nematode interactions.
- Unit II**
- Fungal plant diseases: Causal organism, symptoms and management of stem gall of coriander, powdery mildew of cucurbits, apple scab, ergot of rye, loose smut of wheat, brown rust of wheat and its recurrence in India, red-rot of sugarcane and Tikka disease of groundnut.
- Unit III**
- Bacterial blight of rice, potato scab, Citrus-canker, tundu disease of wheat, Brinjal mosaic, potato leaf roll, cauliflower mosaic, potato spindle tuber viroid, diseases caused by *Rotylenchulus* on pulses, *Meloidogyne* on vegetables and *Globodera* on potato.
- Unit IV**
- (a) Broad principles of plant disease management: Disease forecasting, Integrated pest management (IPM), Regulatory and physical measures of disease management, Management of diseases by cultural practices, cropping sequences, organic amendments.
 - (b) Bio-control of fungal and nematode diseases. Chemical measures of diseases management, fungicides and nematicides.

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. IV Semester

Max. Marks : 100
Sessional : 30
End-Sem Exam. : 70

Credits: 04

IV– C27 ADVANCED PLANT PHYSIOLOGY - I (Elective Paper I)

- Unit I** **Mineral nutrients:** Evolution and scope of plant nutrition; classification of mineral nutrients according to biochemical functions, deficiencies and plant disorders, essential elements (P, K, Cu and Mo) and their roles and an idea of mineral metabolism (P and K).
- Unit II** **Ion uptake by individual cells and roots:** Short distance transport; pathways of solutes from external solution into root cells, composition of biological membranes; solute transport across membranes and factors affecting ion uptake.
- Unit III** **Signal transduction:** Overview, receptors and G-proteins; phospholipid signalling; role of cyclic nucleotides; calcium-calmodulin cascade; diversity in protein kinases and phosphatases; and sucrose sensing mechanism.
- Unit IV** **Growth regulators:** Biosynthesis and physiological roles of salicylic acid, polyamines and jasmonates; role of plant growth regulators in water balance, photosynthate partitioning and potato tuberization; and use of natural and synthetic growth regulators in fruit set, chemical ripening, malting and latex flow.

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. IV Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70
Credits	: 04

IV-C28 ADVANCED PLANT PHYSIOLOGY - II (Elective Paper II)

- Unit I** **Secondary metabolites:** Introduction, occurrence, biosynthesis and significance of alkaloids (Amino acid and purine derivatives), phenols (simple phenols, phenol carboxylic acid, phenyl propanes, flavon derivatives), terpenoids (Hemi terpenes, mono terpenes, sesqui terpenes) and cutin, suberin and waxes.
- Unit II** **Regulatory metabolism of photosynthesis and respiration:** Structure of photosynthesis antennae pigments, its role in light harvesting and protection against active oxygen species, regulation of Rubisco, chloroplast dimorphism and variation in C4 photosynthesis pathway, regulation of glycolysis and pentose phosphate pathway, Citric acid cycle in biosynthesis of carbohydrates.
- Unit III** **Regulatory metabolism of nitrogen and sulfate:** Enzymology of nitrogen fixation (nitrate reductase activity and nitrite reductase activity), reduction of sulfate, significance of ATP-sulfurylase.
- Unit IV** **Stress physiology:** Introduction, water stress and related issues, chilling injury, high temperature, salt and heavy metal stress, heat shock proteins, effect of UV radiation on plants, basic concept of biotic (insects and pathogens) stress, systemic acquired resistance (SAR) in response to pathogens.

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. IV Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

IV- C27 ENVIRONMENTAL BOTANY – I (Elective Paper I)

Unit I Air Pollution:

- (a) Source and effects of primary air pollutants: Sulphur dioxide (SO₂), Nitrogen oxides (NO₂, NO) and Fluorides.
- (b) Sources, formation and effects of secondary air pollutants: Acid rain, Ozone (O₃) and Peroxyacetylenitrate (PAN).

Unit II Soil Pollution:

- (a) Kinds and sources of soil pollutants (Biodegradable, slow degradable and non-degradable pollutants). Pesticides; kinds of pesticides, ill effects of pesticides.
- (b) Heavy metal pollution, sources of heavy metals. Behaviour of heavy metals in soil. Impact of heavy metals on agriculture. Solid waste management.

Unit III Water Pollution:

- (a) Sources of water pollution, Mercury pollution, Lead pollution, fluoride pollution, Ganga Action Plan, Water standard and water quality management in India.
- (b) Role of waste water in agriculture, eutrophication, oil slick and bio-magnification.

Unit IV Forest and Forest Management:

- (a) Present status of forest wealth of the world, ecological significance of forest, Deforestation, major causes of deforestation, consequences of deforestation.
- (b) Forest management and conservation. Present Programmes for the development of forestry and wildlife.

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. IV Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

IV– C28 ENVIRONMENTAL BOTANY – II (Elective Paper II)

- Unit I**
- (a) **Particulate Matters:** Sources and effect of particulate matters (flyash, brick kiln dust and cement dust) Suspended particulate matters (SPM).
 - (b) **Stress and Plant Life:** Dynamic concept of stress, Mechanism of tissue temperature tolerance (mechanisms that regulate enzyme and membrane functions). Salt stress: effects of high salt concentration on plants, Regulation of salt content (salt elimination, salt exclusion and salt succulence).
- Unit II** **Pollution and Animate pathogens:**
- (a) Concept of pathogen and disease in plants, biotic and abiotic pathogens, biotic and abiotic diseases and their symptoms in plants.
 - (b) Concept and different types of interactions (synergistic, antagonistic, additive and neutral), impact of pollutants on phylloplane, rhizoplane and rhizosphere microbes.
- Unit III** **Allelopathy / Weed Science:**
- (a) Historical back ground of allelopathy, weed characteristics adaptive strategies and role in agroecosystems, weed control techniques, potential of allelopathy for weed management (aquatic, terrestrial and parasitic).
 - (b) Allelochemicals – significance uses, understanding the mechanism of crop/weed interference in agroecosystem.
- Unit IV** **Pollution control:**
- (a) Mechanical devices to control gaseous and particulate matters with reference to bag filters, carbon absorber electrostatic precipitators, cyclone collectors and spray collectors.
 - (b) Legislative measures and international agencies, environmental impact assessment (EIA) Phytoremediation.

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. IV Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

IV- C27 CYTOGENETICS AND PLANT BREEDING - I (Elective Paper I)

- Unit I** **Numerical changes in chromosomes:** Aneuploidy: monosomy, nullisomy, trisomy, tetrasomy. Monoploidy and Haploidy, origin, production, morphology, cytology, uses of haploids.
- Unit II** **Polyploidy:** Autopolyploids, origin and production of autopolyploids, induced autopolyploids, effects of chromosome doubling, uses of induced polyploids, allopolyploids, synthesized allopolyploids, evolution of major crop plants, segmental allopolyploids.
- Unit III** **Structural changes in chromosomes:** Deficiencies; duplications, translocations; cytology of translocation heterozygote, balanced lethals and gametic complexes, inversions and its types, cytology of inversions, genetic consequences of inversion, DNA damage and repair.
- Unit IV** (a) **Molecular cytogenetics:** Nuclear DNA contents, C-value paradox, cot curve and its significance. Restriction mapping: concept and techniques, multigene families and their evolution, physical mapping of genes on chromosomes.
- (b) **Analysis of variance:** Simple measures of variability-range, mean, standard deviation, standard error and coefficient of variation (CV). Analysis and components of variance, phenotypic coefficient of variance (CVp), genotypic coefficient of variance (CVg) heritability (h^2) and genetic advance (GS), correlation coefficient (r) analysis, t-test.

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. IV Semester

Max. Marks	: 100
Sessional	: 30
End-Sem Exam.	: 70

Credits: 04

IV- C28 CYTOGENETICS AND PLANT BREEDING - II (Elective Paper II)

- Unit I** **Gene structure and Expression:** Genetic fine structure, Cis-trans test, fine structure analysis of eukaryotes, introns and their significance, regulation of gene expression in prokaryotes and eukaryotes.
- Unit II** **Karyotype:** evolution, molecular basis of chromosome pairing, molecular organization of centromere and telomere; ribosomal RNA (rRNA) genes, banding pattern.
- Unit III** **Mechanism of sex determination:** Chromosomal basis of sex determination, balance concept in *Drosophila*, quantitative balance theory, single genic mechanism, environment and hormonal control of sex, sex determination in plants. Sex reversal.
- Unit IV** **Sex linked traits:** Sex linkage in *Drosophila*, Sex linked lethals in *Drosophila*, Sex linkage in human being, colour blindness, haemophilia, sex linkage in poultry. Sex Influenced traits in sheep and human beings. Sex-limited traits in poultry, man and cattle, multiple alleles.

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. IV Semester

Max. Marks : 100
Sessional : 30
End-Sem Exam. : 70

Credits: 04

IV- C27 PLANT BIOTECHNOLOGY- I (Elective Paper I)

- Unit I** **Plant Biotechnology in India and its scope:** Plant Tissue Culture: Concept of cell differentiation and totipotency, Pathways for *in vitro* culture of reproductive organs, androgenic haploids- anther and microspore culture, gynogenic haploids, chromosome elimination technique for haploid production, significance and use of haploid in crop improvement.
- Unit II** **Preserving plant diversity through cryopreservation and germplasm storage:** Increasing genetic diversity through somaclonal variation, factors influencing SCV, isolation and molecular basis of SCV, achievements, advantage and limitations. Slow growth and excised root culture methods of germplasm preservation and cryopreservation.
- Unit III** **Plant growth regulators and adjuvents:** Role in *in vitro morphogenesis*, of – *auxin*, gibberellins, ethylene, abscisic acid, salicylic acid, ethylene, abscisic acid, jasmonic acid, brassinosteroids, asparagin, glutamine, CCM, malic acid, yeast extract, casein hydrolysate.
- Unit IV** **In vitro mutagenesis:** Site directed mutagenesis (unidirectional deletion, gap sealing mutagenesis, linker scanning mutagenesis). Advantages of site directed mutagenesis. Olegonucleotide directed mutagenesis (Chemical mutagenesis, PCR mediated *in vitro* mutagenesis). Insertional mutagenesis, transposon mediated insertion mutagenesis, T-DNA mediated insertion mutagenesis.

LABORATORY: Exercises corresponding to the theory courses.

M.Sc. IV Semester

Max. Marks : 100
Sessional : 30
End-Sem Exam. : 70

Credits: 04

IV– C28 PLANT BIOTECHNOLOGY- II (Elective Paper II)

- Unit I** **Molecular markers and crop improvement:** Morphological, biochemical and molecular markers, non-PCR based marker (RFLP, Procedure, construction of RFLP and uses), PCR based markers (RAPD, DAF, AP-PCR, AFLP, SSR). molecular maps, structural and functional genomics in relation to crop improvement, DNA fingerprinting, marker assisted selection.
- Unit II** **Genetic Engineering of Plants:** Objectives, strategies and approaches; transformation methods: *Agrobacterium* mediated, biolistic approach, microinjection, electroporation and liposome mediated, selection of transformants and their molecular characterization.
- Application:** Production of herbicide resistant plants; engineering Plants for abiotic stress, senescence- tolerance and male sterility, environmental, social and legal implications. Production of genetically modified (GM) plants.
- Unit III** **Biotechnology of Medicinal and Aromatic Plants:** Importance of medicinal plants as a source of secondary metabolites, biopesticides and growth regulators etc. Maximization of secondary metabolites production by adding elicitors, through biotransformation and genetic transformation using hairy root cultures (*Agrobacterium rhizogenes*); development of high producing clone; industrial production of shikonin prospects for discovering new and bioreactive compounds from plants.
- Unit IV** **Genetic Manipulation and Its Application:** Recombinant DNA technology, basics involved in r-DNA technology, application of restriction endonucleases, DNA ligases and other enzymes used in cloning, principles and process of polymerase chain reaction, transgenic biology, biopiracy and Intellectual property rights.

LABORATORY: Exercises corresponding to the theory courses.