RESEARCH METHODOLOGY

Culture media for microbes; Methods of sterilization in Plant Pathology; Isolation of nematodes, fungi and bacteria from soil and infected plant material; Micrometry; Histopathological techniques; Preparation of fungus and nematode inocula and their inoculation; Maintenance of fungus and nematode culture; Symptomatology of diseases caused by nematodes, fungi and bacteria; Koch’s postulates.

Preparation of molar, molal and percent solutions; Calculation of normality of stock acid; Quantitative test for estimation of carbohydrates, proteins, fats, nitrogen, phosphorus and chlorophyll; DNA isolation; Hydroponics; Hoagland solution; Autoradiography; Spectrophotometer; Atomic absorption spectrophotometer; Ash analysis; Electrophoresis; Chromatography; pH meter; Plant growth chamber; Laboratory safety rules

Mutation, Cytogenetics and Plant Breeding Methods- introductory remarks; Nuclear and extra-nuclear mutations; Phenotypic classification of mutations; Use of chemical mutagens; and radiations for mutation breeding; Preparation of semi-permanent and permanent slides pertaining to cytology, Pollination methods, Breeding methods, Techniques of slide preparation for cytological studies.

Description of exposure chamber; Micro-gas chamber; SO$_2$ generator; O$_3$ generator; High volume air sampler, Handy air sampler; Preparation of simulated acid rain; Production of SO$_2$ gas; Estimation of dust fall rate; Estimation of dissolved O$_2$, hardness, chloride and calcium content in H$_2$O samples.

MS medium; Protoplast isolation; Somatic hybridization; Synthetic seed technology; Genetic transformation methods; Techniques of haploid and di-haploid production; Micropropagation; Secondary metabolite production; Bioreactor technology.

Measurement of growth parameters; Preparation of stains, fixatives, stock solutions; Population dynamics; Scientific equipments –Light and Electron microscope – TEM and SEM; Electric and electronic balances; Microtome; BOD incubator; Laminar flow; Furnace and Microwave ovens; PCR technique; Blotting technique; Autoclave; Centrifuge; Colorimeter; Incubator; De-ionizer; Distillation apparatus; Plagiarism: Etymology and concept, legal aspects, in academia and journalism, self plagiarism, code of ethics.
PLANT PATHOLOGY

General account of nematodes, fungi, bacteria, phytoplasma, viruses and viroids.

Roles of enzymes, growth regulators and toxins in pathogenesis. Effect of infection on physiology of plants (photosynthesis, translocation, respiration, membrane permeability, transcription and translation).

Disease resistance mechanism in plants, preformed substances and structures, induced structures and biochemical defense.

Outline classification of plant parasitic nematodes. General characteristic features of *Aphelenchoides*, *Criconemoides*, *Tylenchorhynchus*, *Anguina*, *Hoplolaimus*, *Helicotylenchus*, *Rotylenchulus*, *Tylenchulus*, *Meloidogyne*, *Heterodera* and *Xiphinema*.


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.

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.

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.

Bio-control of fungal and nematode diseases. Chemical measures of diseases management, fungicides and nematicides.
ADVANCED PLANT PHYSIOLOGY

**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).

**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.

**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.

**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.

**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.

**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.

**Regulatory metabolism of nitrogen and sulfate:** Enzymology of nitrogen fixation (nitrate reductase activity and nitrite reductase activity), reduction of sulfate, significance of ATP-sulfurylase.

**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.
ENVIRONMENTAL BOTANY

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


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

Forest and Forest Management: Present status of forest wealth of the world, ecological significance of forest, Deforestation, major causes of deforestation, consequences of deforestation. Forest management and conservation. Present Programmes for the development of forestry and wildlife.

Particulate Matters: Sources and effect of particulate matters (flyash, brick kilm dust and cement dust) Suspended particulate matters (SPM).

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).

Pollution and Animate pathogens: Concept of pathogen and disease in plants, biotic and abiotic pathogens, biotic and abiotic diseases and their symptoms in plants. Concept and different types of interactions (synergistic, antagonistic, additive and neutral), impact of pollutants on phylloplane, rhizoplane and rhizosphere microbes.

Allelopathy / Weed Science: 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). Allelochemicals – significance uses, understanding the mechanism of crop/weed interference in agroecosystem.

Pollution control: Mechanical devices to control gaseous and particulate matters with reference to bag filters, carbon absorber electrostatic precipitators, cyclone collectors and spray collectors. Legislative measures and international agencies, environmental impact assessment (EIA) Phytoremediation.

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.

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.

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.

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.

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.

Karyotype: evolution, molecular basis of chromosome pairing, molecular organization of centromere and telomere; ribosomal RNA (rRNA) genes, banding pattern.

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.

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.
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.

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.

Plant growth regulators and adjuvants: Role in in vitro morphogenesis, of – auxin, gibberellins, ethylene, abscisic acid, salicylic acid, ethylene, abscisic acid, jasminic acid, brassinosteroids, asparagin, glutamine, CCM, malic acid, yeast extract, casein hydrolysate.


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.

Genetic Engineering of Plants: Objectives, strategies and approaches; transformation methods: Agrobacterium mediated, biolistic approach, microinjection, electroporation and liposome mediated, selection of transforments 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.

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.

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.