U.P. HIGHER EDUCATION SERVICES COMMISSION, PRAYAGRAJ

Syllabus

AGRICULTURAL BOTANY

(Assistant Professor-Higher Education)

(Subject Code-85)

Unit-1: Introductory Microbiology:

History and development of microbiology; diversity, classification and significance of microorganisms (bacteria, archaea, fungi, algae, protozoa, viruses and actinomycetes); Role of microorganisms in agriculture, food, industry, environment and human welfare; Microbial cell organization and ultrastructure; Morphology, nutrition, growth and reproduction of bacteria and fungi; Principles of microbial taxonomy, nomenclature and modern classification; General characteristics, classification and life cycles of major groups of fungi; Introduction to viruses, bacteriophages, viroids and prions; Basic concepts of microbial genetics, evolution and microbial interactions; Plant growth promoting rhizobacteria and role in sustainable agriculture.

Unit-2: Introductory Plant Pathology

History and importance of plant pathology; Nature, classification and characteristics of plant pathogens (fungi, bacteria, phytoplasmas, viruses, viroids, nematodes and parasitic flowering plants); Disease cycle, inoculum, survival, dissemination, infection, colonization and epidemiology; Symptoms, signs and diagnosis; physiology and biochemistry of plant diseases; Pathogenicity, virulence; Host–pathogen interactions: phytoalexins, hypersenstive response, signal transduction during the interaction; Mechanisms of host resistance and plant defense; Principles of plant disease management including cultural, physical, biological, chemical, regulatory and integrated disease management; Fungicides, bactericides, nematicides and biopesticides, their classification, mode of action and resistance management; General characteristics, transmission and management of diseases caused by fungi, bacteria, phytoplasma, viruses and viroids; Important diseases of major agricultural, horticultural and plantation crops, their causal organisms, symptoms and integrated management; Endophytes and their role in biotic and stress management and crop production.

Unit-3: Cytogenetics and Plant Breeding

Cell structure, organization and functions of cell organelles; Cell cycle, mitosis and meiosis; chromosome structure, behavior and karyotype analysis; Cytogenetics including euploidy, aneuploidy, polyploidy, chromosome aberrations, distant hybridization and cytoplasmic inheritance; Principles of heredity, gene interactions, quantitative inheritance, genotype × environment interaction, heritability and genetic advance; Linkage, recombination, chromosome mapping; epigenetics; Scope and objectives of plant breeding; Breeding methods for self-pollinated, cross-pollinated and clonally propagated crops; Selection methods including pedigree, bulk, backcross, recurrent selection and single-seed descent; Hybrid breeding, heterosis, combining ability, male sterility, self-incompatibility and hybrid seed production; Mutation breeding, polyploid breeding, wide hybridization, ideotype breeding, speed breeding and breeding for yield, quality, biotic resistance and abiotic stress tolerance.

Unit-4: Molecular biology and gene expression

Methods of gene isolation, split genes; Mutation and its types; Site-directed recombination in bacteria, fungi and viruses; Molecular genetics including DNA replication, transcription, translation mechanism and its control, gene regulation, recombinant DNA technology, QTL mapping, marker-assisted selection, genomic selection and genome editing; Operon concept, Transcription in prokaryotes and eukaryotes, Transcription factors, Transposable elements. DNA-protein interaction; RNA processing and post-translational modifications; Nucleic acid hybridization, Southern, Northern and Western blotting; Construction and screening of genomics and c-DNA libraries; PCR, rtPCR; Restriction enzymes and uses; Vectors: plasmids, cosmids, bacteriophages, phasmids, BACs, YACs; Gene cloning and its strategies; Chromosome walking; Risk assessment and IPR

Unit-5: Crop Physiology

Plant water relations, water potential, transpiration, stomatal regulation, water-use efficiency and antitranspirants; Mineral nutrition, nutrient uptake, transport and physiological functions of essential macro- and micronutrients; Photosynthesis, photorespiration and respiration, including C_3, C_4 and CAM pathways; Plant growth and development, growth analysis, source–sink relationships and assimilate partitioning; Plant growth regulators, their biosynthesis, mode of action and agricultural applications; Physiology of seed development, dormancy, germination, vigor and longevity; Physiology of flowering, photoperiodism, Phytochrome, vernalization, fertilization, fruit development, ripening, senescence and abscission; Biological nitrogen fixation, plant–microbe interactions and nutrient use efficiency; physiology and biochemistry of herbicides and plant responses to agrochemicals; Stress physiology, crop responses to abiotic stresses, antioxidant defense mechanisms and stress signaling; Physiological basis of crop productivity, physiological breeding, phenotyping and climate-resilient crop improvement.

Unit-6: Growth, Nutrition and Soil Relations

Soil as a medium for plant growth; soil formation, classification and physical, chemical and biological properties; Major soil groups of India and their suitability for crop production; Soil–plant–water relations, soil moisture, water movement, crop water requirement, evapotranspiration, irrigation scheduling and water-use efficiency; Plant nutrition, nutrient uptake, translocation, nutrient use efficiency, deficiency and toxicity symptoms; soil fertility and productivity, nutrient cycling, C:N ratio, organic matter dynamics and nutrient transformations; Nitrogen, phosphorus, potassium, sulfur and micronutrient dynamics, nutrient losses, fixation and restoration of soil fertility; Integrated nutrient management, biofertilizers, organic manures and sustainable nutrient management; Soil microorganisms, rhizosphere interactions, biological nitrogen fixation and mycorrhizae; tillage, conservation agriculture and residue management; Problem soils including saline, sodic (alkali), acidic, calcareous and waterlogged soils and their reclamation; Principles of dry land and rainfed agriculture, moisture conservation, mixed cropping, intercropping, strip cropping and contingency crop planning; Soil health, carbon sequestration, precision nutrient management and climate-smart soil management.

Unit-7: Biochemistry and Biotechnology

Scope and significance of biochemistry and biotechnology in agriculture; Biomolecules including carbohydrates, lipids, proteins, amino acids, nucleic acids, vitamins and secondary metabolites; Acid–base concepts, pH, buffers, bioenergetics and thermodynamics; Enzymes, their classification, kinetics and mode of action; DNA structure, replication, repair, recombination; DNA sequencing; Plant tissue culture and *in vitro* techniques including micropropagation, haploid and doubled haploid production, somatic embryogenesis, embryo rescue, synthetic seeds, cryopreservation, protoplast fusion and somatic hybridization; genetic transformation, transgenic plants, RNA interference and CRISPR/Cas systems; Genomics, transcriptomics, proteomics, metabolomics, bioinformatics, diversity assessment and phylogenetic analysis; Methods of gene transfer to plants; Application of plant genetic engineering for crop improvement: insect-pest resistance, abiotic stress resistance, herbicide resistance. Transgenics; DNA molecular markers: RFLP, AFLP, RAPD, SSR, SNP; Gene mapping and gene tagging. Applications of biotechnology in crop improvement, germplasm conservation, nutrient use efficiency, stress tolerance and climate-resilient agriculture; Biosafety, bioethics, Intellectual property rights and regulatory aspects of agricultural biotechnology; Biofortification.

Unit-8: Environmental Science

Fundamentals of environmental science and ecology; Ecosystem structure and function, energy flow, food chains, food webs, ecological pyramids, ecological succession and biogeochemical cycles; Ecosystem services and conservation of natural resources; Environmental factors influencing crop growth and productivity; Environmental pollution including air, water, soil, heavy metal, radioactive and noise pollution and their impacts on agriculture, livestock and human health; Climate change, greenhouse effect, carbon cycle, carbon sequestration, ozone depletion, acid rain; Conservation agriculture, integrated farming systems and sustainable resource management; Environmental monitoring, environmental impact assessment, environmental auditing and waste management; Disaster management and environmental risk assessment; Environmental legislation, national and international environmental policies and sustainable development goals; Principles of weed science, crop–weed competition, integrated weed management, prevention of invasive weeds and herbicide resistance management; Social dimensions of environmental management, environmental education, gender in agriculture and the application of information and communication technology (ICT), remote sensing, GIS and artificial intelligence in environmental monitoring and resource management.

Unit-9: Economic Botany

Scope and importance of economic botany; origin, domestication, centres of origin and diversity of cultivated plants; Botanical classification, morphology and economic uses of major crop plants; Economic importance, origin, distribution and utilization of cereals, millets, pulses, oilseeds, fibre, sugar and starch crops, fodder and forage crops, fruit and vegetable crops, plantation crops, spices and condiments, beverage crops, medicinal and aromatic plants, timber, forest products, latex, gum, resin, tannin and dye-yielding plants; Underutilized and indigenous crops and their role in nutritional security; Economic importance of weeds and invasive alien plant species; Introductory concepts of horticultural crops, landscaping and the history and principles of gardening.

Unit 10: Plant Genetic Resources and Biodiversity

Concept, scope and importance of plant genetic resources (PGR); Origin, evolution, domestication and diversification of cultivated plants; Centres of origin and diversity, gene pools and crop evolution; Genetic erosion and its causes; Plant exploration, collection, exchange, quarantine, characterization, evaluation, documentation and utilization of germplasm; *In situ* and *ex situ* conservation methods including gene banks, field gene banks, *in vitro* conservation and cryopreservation; Agrobiodiversity, endemism, biodiversity hotspots, ecosystem services and causes of biodiversity loss; Threatened species, Red Data Book and IUCN categories; Bioprospecting and sustainable utilization of biological resources; National and international organizations related to PGR conservation; International agreements including CBD, Nagoya Protocol, Cartagena Protocol and ITPGRFA; Intellectual property rights, Plant Breeders' Rights, Farmers' Rights, Geographical Indications, Access and Benefit Sharing and sui generis systems; Organic and Natural farming; Sustainable agriculture and biodiversity conservation; DNA fingerprinting and bioinformatics tools in conservation and utilization of plant genetic resources.

Unit-11: Seed Science and Technology

Floral biology, reproductive biology, sporogenesis, gametogenesis, pollination, fertilization, embryogenesis, fruit and seed development; Apomixis, polyembryony, parthenocarpy, somatic embryogenesis and synthetic seeds; seed structure and development in monocots and dicots; Seed maturation, desiccation tolerance, seed longevity, orthodox, recalcitrant and intermediate seeds; Physical, physiological and biochemical composition of seeds; Seed dormancy, germination, seed vigor, viability and seed deterioration; Seed production principles, seed multiplication systems, classes of seed (nucleus, breeder, foundation, registered and certified seed), isolation requirements and maintenance of genetic purity; Seed processing, drying, cleaning, grading, treatment, coating, pelleting, packaging and storage; Seed enhancement technologies including priming and invigoration; Seed quality assurance including sampling, moisture determination, physical purity, germination, vigor, viability, seed health and genetic purity testing; Seed certification, field inspection, certification standards and quality control; Seed legislation, seed policies and regulatory framework governing seed production and marketing; Principles of seed production of major agricultural and horticultural crops; Recent advances in seed science including hybrid seed production, molecular techniques for seed quality assessment, seed traceability and digital seed systems.

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