

## Syllabus for MRFT

### **BOTANY/LIFE SCIENCE( BOTANY)**

#### **Unit-1. Microbiology and Plant Pathology:-**

Structure and reproduction/multiplication of viruses, viroids, bacteria, fungi and mycoplasma; Application of microbiology in agriculture, industry, medicine and in control of soil and water pollution; Prion and Prion hypothesis.

Important crop diseases caused by viruses, bacteria, mycoplasma, fungi and nematodes; Modes of infection and dissemination; Molecular basis of infection and disease resistance/defence; Physiology of parasitism and control measures. Fungal toxins. Modelling and disease forecasting; Plant quarantine.

#### **Unit-2. Cryptogams:-**

Algae, Fungi, Lichens, Bryophytes, Pteridophytes -Structure and reproduction from evolutionary viewpoint; Distribution of Cryptogams in India and their ecological and economic importance.

#### **Unit-3. Phanerogams:**

Gymnosperms: Concept of Progymnosperms, Classification and distribution of gymnosperms. Classification and distribution of gymnosperms. Salient features of Cycadales, Ginkgoales Coniferales and Gnetales, their structure and reproduction. General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Type of fossils and their study techniques.

Angiosperms: Systematic, anatomy, embryology, palynology and phylogeny.

Taxonomic hierarchy; International Code of Botanical Nomenclature; Numerical taxonomy and chemotaxonomy; Evidence from anatomy, embryology and palynology.

Origin and evolution of angiosperms; Comparative account of various systems of classification of angiosperms; Study of angiospermic families- Mangnoliaceae, Ranunculaceae, Brassicaceae, Rosaceae, Fabaceae, Euphorbiaceae, Malvaceae, Dipterocarpaceae, Apiaceae, Asclepiadaceae, Verbenaceae, Solanaceae, Rubiaceae, Cucurbitaceae, Asteraceae, Poaceae, Arecaceae, Liliaceae, Musaceae and Orchidaceae.

Stomata and their types: Glandular and Non-glandular trichomes; Unusual secondary growth; Anatomy of C<sub>3</sub> and C<sub>4</sub> plants; Xylem and phloem differentiation; Wood anatomy.

Development of male and female gametophytes, pollination, fertilization; Endosperm—its development and function. Patterns of embryo development; Polyembryony, apomixes; Applications of palynology; Experimental embryology including pollen storage and test-tube fertilization.

#### **Unit-4. Plant Resource Development:-**

Domestication and introduction of plants; Origin of cultivated plants, Vavilov's centres of origin. Plants as sources for food, fodder, fibres, spices, beverages, edible oils, drugs, narcotics, insecticides, timber, gums, resins and dyes; latex cellulose, starch and its products; Perfumery; Importance of Ethnobotany in Indian context; energy plantations; Botanical gardens and Herbaria.

#### **Unit-5. Morphogenesis:-**

Totipotency, polarity, symmetry and differentiation; cell, tissue, organ and protoplast culture. Somatic hybrids and cybrids; Micropropagation; Somaclonal variation and its application; pollen haploids, embryo rescue methods and their applications.

#### **Unit-6. Cell Biology:**

Techniques of cell biology, Prokaryotic and eukaryotic cells- structural and ultra-structural details; Structure and function of extra cellular matrix (cell wall) and membranes-cell adhesion, membrane transport and vesicular transport; Structure and function of cell organelles (chloroplasts, mitochondria, ER, dictyosomes, ribosomes, endosomes, lysosomes, peroxisomes; cytoskeleton and microtubules; Nucleus, nucleolus, nuclear pore complex; Chromatin and nucleosome; Cell signalling and cell receptors; Signal transduction Mitosis and meiosis; molecular basis of cell cycle. Numerical and structural variations in chromosomes and significance; Chromatin organization and packaging of genome;

Polytene chromosomes, B-chromosomes-structure, behaviour and significance.

#### **Unit-7. Genetics, Molecular Biology and Evolution:**

Development of genetics, and gene versus allele concepts (Pseudoalleles); quantitative genetics and multiple factors; Incomplete dominance, polygenic inheritance, multiple alleles; Linkage and crossing over of gene mapping including molecular maps(idea of mapping,function); Sex chromosomes and sex-linked inheritance; sex determination and molecular basis of sex differentiation; Mutations (biochemical and molecular basis); Cytoplasmic inheritance and cytoplasmic genes (including genetics of male sterility).

Structure and synthesis of nucleic acids and proteins; Genetic code and regulation of gene expression; Gene silencing; Multigene families; Organic evolution-evidences, mechanism and theories. Role of RNA in origin and evolution

## **Unit 8. Biotechnology and Genetic Engineering of plants:-**

*Plant cell, tissue & organ culture:* Totipotency, Fundamental aspects of morphogenesis: organogenesis and somatic embryogenesis, Clonal propagation, Artificial seeds. Androgenesis and production of haploids, Callus and cell suspension culture, Production of somaclonal variants, production of secondary metabolites in cultures, Cryopreservation.

*Somatic hybridization and cybridization:* Factors affecting protoplast isolation, culture and plant regeneration, Protoplast fusion-chemical fusion & electrofusion mechanism & techniques, Selection of heterokaryotic fusion products, biochemical selection and physical selection (micromanipulation, flow cytometric characterization and cell sorting), Analysis of hybrids, Somatic hybrids and cybrids for crop improvement.

*Recombinant DNA technology:* Gene cloning-principles, Cloning vectors-plasmids, phages, cosmids & phagemids; Artificial chromosomes, Polymerase Chain Reaction-principles, types and applications, RT-PCR; Genomic and cDNA libraries; Construction of recombinant DNA molecules and their mobilization into bacteria; Analysis of recombinant clones, DNA sequencing.

*Genetic Engineering of plants:* Methods for gene transfer to plants, *Agrobacterium* mediated and direct gene delivery, Gene tagging, detection of foreign gene and gene products; Southern blotting, Northern blotting and Western blotting; Chloroplast transformation, Gene targeting, Transgenic plants for crop improvement, possible ecological risks and ethical concerns.

## **Unit-9. Instrumentations:-**

UV/Visible Spectrophotometry, Atomic Absorption Spectrophotometry, fluorescence spectroscopy, NMR & ESR Spectroscopy, Mass Spectrometry, Electrophoresis, ELISA, Electron Microscopy–Scanning and transmission, Image processing, Chromatography. Centrifugation techniques, pH Electrode. Northern, Southern and Western Hybridization.

## **Unit-10. Plant Breeding and Biostatistics:-**

Methods of plant breeding-introduction, selection and hybridization (pedigree, backcross, mass selection, bulk method); Mutation, Polyploidy, male sterility and heterosis breeding. Use of apomixes in plant breeding; DNA sequencing; Genetic engineering –methods of transfer of genes; Transgenic crops and biosafety aspects; Development and use of molecular markers in plant breeding;

Sampling methods, Sampling distribution, parametric and non-parametric statistics, measures of central tendency and dispersion, mean, mode & median, Mean deviations coefficient of variance (CV). Standard deviations, Standard error of mean, probability distribution (normal, binomial and poisson), confidence intervals, regression and correlation, tests of significance (t-test, and  $\chi^2$  test), analysis of

variance.

### **Unit-11. Physiology and Biochemistry:**

Water relations, mineral nutrition and ion transport, mineral deficiencies.

Photosynthesis-photochemical reactions, photophosphorylation and carbon fixation pathways; C<sub>3</sub>, C<sub>4</sub> AND CAM pathways; mechanism of phloem transport, Respiration (anaerobic and aerobic, including fermentation) – electron transport chain and oxidative phosphorylation; Photorespiration; Chemiosmotic theory and ATP synthesis; Lipid metabolism; Nitrogen Fixation and nitrogen metabolism. Enzymes, coenzymes; Energy transfer and energy conservation.

Importance of secondary metabolites. Pigments as photoreceptors (plastidial pigments and photochrome). Plant movements; Photoperiodism and flowering. Vernalization, senescence; Growth substance—their chemical nature, role and applications in agriculture; growth indices, growth movements. Stress physiology (heat, water, salinity, metal); Fruit and seed physiology. Dormancy, storage and germinations of seed. Fruit ripening, its molecular basis and manipulation.

### **Unit-12. Ecology and Plant Geography:-**

Concept of ecosystem; Ecological factors. Concepts and dynamics of community; Plant succession. Concepts of biosphere; Ecosystem; Conservation; Pollution and its control (including phytoremediation); Plant indicators; Environment (Protection) Act.

Forest types of India- Ecological and economic importance of forests, afforestation, deforestation and social forestry; Endangered plants, endemism IUCN categories, Red Data Books; Bio-diversity and its conservation; Protected Area Network; Convention of Biological Diversity, Farmers' Rights; and intellectual Property Rights; Concepts of Sustainable Development; Biogeochemical cycles. Global warming and climatic change; Invasive species; Environmental Impact Assessment; Phytogeographical regions of India.

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