

## Syllabus of Agriculture

### AGROMETEOROLOGY

Elements of Weather-rainfall, temperature, precipitation, humidity, wind velocity, Sunshine weather forecasting, climate change in relation to crop production.

### AGRONOMY

Agronomy as a science and its scope, plant growth and development, environmental effects on crop growth, ideal plant type, tillage seed quality, sowing, crop density and spatial arrangement, crop nutrition, organic manures and fertilizers, irrigation and drainage, weed management, distribution of crops, cropping system, selection of crops and varieties for multiple cropping, crop yield contributing character; Organic farming concept, practices and scope in India; Crop production in dry lands, salt affected, acidic, flood affected, waterlogged and eroded areas.

### CROP PHYSIOLOGY

Plant cell-an introduction, laws of thermodynamics, diffusion and osmosis, the concept of water potential, cell water relations, absorption of water, transpiration, stomatal physiology, ascent of sap, ion uptake and metabolic utilization of mineral ions, deficiencies of mineral ions in plants, photosynthesis, respiration, fat metabolism, physiology of growth and development, growth regulators, physiological parameter influencing the productivity of major cereal, pulse and oilseed crops.

### ELEMENTARY BIOCHEMISTRY, GENETICS AND PLANT BREEDING

Cell, Biomolecules, water, pH and buffer; cellular constituents: Structure and function- amino acids and protein, carbohydrates, lipids and biomembrances and nucleic acids; Enzymes- function, properties and mechanism, metabolism of cellular constituents: Central Metabolic Pathways: Derivative path ways- glycolysis, hexose mono phosphate pathways, degradation of starch, sucrose, other sugars, fatty acids and acylglycerols, proteins and amino acids; Biosynthetic path ways, photosynthesis, formation of sucrose and starch, Kreb's cycle and electron transport chain; Nitrogen and sulphur cycles; Nitrogen fixation, assimilation of ammonia; synthesis of DNA, RNA and proteins; Secondary metabolites-structure, function and metabolism. Pre-mendelian and post-mendelian concepts of heredity, mendelian principles of heredity, probability and chi-square, Cell and animal cell, chromosome structure. Cell division mitosis, meiosis, variation in chromosomes polytene chromosome, Lampbrush chromosomes.

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Dominance relationship, gene interaction. Multiple alleles, pleiotropism and pseudoalles. Sex determination, sex linkage, sex limited and sex influenced traits. Linkage, crossing over mechanism, chromosomes mapping, structural change in chromosomes: Deletion and Duplication, Translocation and inversion, "Numerical change in chromosomes, chemical basis of heredity" Gene concept, mode of replication of genetic material, transcript and translation genetic material. Gene regulation and operon concept. Mutation- Chemical and physical mutagens, mode of action of mutagens. Extra nuclear inheritance. Polygene and quantitative inheritance. Plant tissue culture, principal and application.

## MICROBIOLOGY

Microbial cell structure, Micro-organisms- Algae, Bacteria, Fungi, Actinomycetes, Protozoa and Viruses. Role of micro-organisms in respiration, fermentation organic matter decomposition

## ENTOMOLOGY

Introduction and scope of Entomology, brief history of entomology in India, Insects as Arthropods and its relationship with phylum Annelida and other classes of Arthropoda, origin of insects, major points related to dominance of insects in Animal Kingdom. External morphology and anatomy of grasshopper; body segmentation, integument, thorax and abdomen, antennae, legs and wings and their modifications, generalized mouth parts and their modification, Alimentary, Circulatory, Excretory, Respiratory, Reproductive and nervous system, major sensory organs like simple and compound eyes, chemoreceptors, endocrine glands; basic embryology and post embryonic development basic groups of present day insects with special emphasis to order and families of agricultural importance

## PLANT PATHOLOGY

Importance of plant disease, scope and objectives of plant pathology. Concept of plant diseases inanimate cause and plant virus. Classification of plant disease. Definition and terms, parasites, pathogens, biotrophs and hemibiotrophs, necrotrophs, pathogenicity, pathogenesis, virulence, infection, primary infection, inoculum, invasion and colonisation, inoculum potential, symptoms, incubation period, disease cycle, disease syndrome, single cycle disease, multiple cycle disease, alternate host, collateral host, predisposition, biotype, symbiosis, mutualism, antagonism. Pathogenesis & parasitism, Koch's postulate. Effect of pathogenesis on the plants, morphological changes, physiological changes. Development of epidemics. Principles

and methods of plant disease management. Basic concepts; avoidance, eradication, protection, disease resistance and therapy. General Morphology, characteristics of fungi and somatic structure, reproduction of various structure. Basic and different methods of classification of fungi, taxonomy and nomenclature. General morphological and cultural characters of prokaryotes (Bacteria, basic methods of classification, taxonomy and nomenclature. Nutrition and effects of physiochemical factors on growth. Reproduction and life cycle. Genetics and variability, importance and general characters of mycoplasma, spiroplasma & Fastidious bacteria, reproduction, nomenclature and classification. Physical architecture and chemical composition of virus & virioids. Nomenclature and criteria of identification, multiplication, transmission and infective nature. General morphological characters, life cycle, reproduction of nematodes behaviour in soil and nematodes as vectors for other plant pathogens. Classification and general identifying characters of phanerogames plant parasites, reproduction and life cycle.

### LIVESTOCK PRODUCTION SCOPE AND IMPORTANCE

(a) Importance of live stock in agriculture and industry, White revolution in India. (b) Important breeds Indian and exotic, distribution of cows, buffaloes and poultry in India. Care and management: (a) Systems of cattle and poultry housing (b) Principles of feeding, feeding practices. (c) Balanced ration-definition and ingredients. (d) Management of calves, bullocks, pregnant and milch animals as well as chicks crockrels and layers, poultry. (e) Signs of sick animals, symptoms of common diseases in cattle and poultry, Rinderpest, black quarter, foot and mouth, mastitis and haemorrhagic septicaemia coccidiosis, Fowl pox and Ranikhet disease, their prevention and control. Artificial Insemination: Reproductive organs, collection, dilution and preservation of semen and artificial insemination, role of artificial insemination in cattle improvement. Livestock Products: Processing and marketing of milk and Milk products.

### CROP PRODUCTION

(a) Targets and achievements in food grain production in India since independence and its future projections, sustainable crop production, commercialization of agriculture and its scope in India. (b) Classification of field crops based on their utility-cereals, pulses, oils seeds, fibre, sugar and forage crops.



## SOIL, SOIL FERTILITY AND WATER MANAGEMENT

Soil as a natural body and medium for plant growth; soil component and soil plant relationship; soil farming rocks and minerals; weathering and process of soil formation; physical properties of soils-texture, structure, density and porosity, soil colour consistence and plasticity, soil reaction pH and its measurement, soil acidity and alkalinity, buffering, effect of pH on nutrient availability, soil colloids-inorganic and organic; silicate clays: constitution and properties; humic substances nature and properties; ion exchange, cation exchange capacity, base saturation; soil organic matter: composition, properties and influence on soil properties, transformation of organic and inorganic wastes in soil- Urban and Industrial wastes. Soil water retention, dynamics and availability; soil air composition and dynamic; source, amount and flow of heat in soils; soil temperature and plant growth; soil survey and classification, soil of India; soil pollution behavior of pesticides and inorganic contaminants, prevention and mitigation of soil pollution, methods of irrigation and drainage.

## WEED CONTROL

Introduction: definition, costs to society from weeds, classification of weed, Ecology of weeds: Reproduction (Seed production, seed dissemination, seed germination, vegetative reproduction), geographical distribution, factor influencing weed distribution, weed succession on uncultivated sites, competition between crops and weeds. Concepts of prevention, eradication and control of weeds. Weed control methods: Physical, cultural, biological, chemical and integrated weed management, Introduction to herbicides: basic concepts, polar vs. Non polar, Esters, Salts, acids etc, surfactant Chemistry. Factors affecting foliage active herbicides: reaching the target plants, spray retention, absorption into leaf, translocation, and factors influencing soil applied herbicides: microbiological effect, soil absorption, photo decomposition and volatilization, spray of herbicides.

## HORTICULTURE

Definition and its branches; importance and scope; horticultural and botanical classification; climate, soil and distribution of fruit crops; propagation and nursery raising; principles of orchard establishment and management; flower bud differentiation and propagation; causes of unfruitfulness; pollinizers and pollinators; environmental and soil factors affecting vegetable production, kitchen gardening; types of gardens and their parts; care and maintenance of ornamental plants; lawn making; knowledge of landscaping of rural and urban area; exposure to important medicinal &

aromatic plants, spices and condiments, use of plant bioregulator in Horticulture, post Harvest Technology-Principles and Practices.

## FUNDAMENTALS OF EXTENSION EDUCATION

Meaning, concept and process of extension education. Objective, principles and philosophy of extension. Education - formal and non-formal. Components of behaviour-knowledge, attitude, skill and motivation. Principles and steps in teaching-learning process, learning situation. Implication of teaching. Concept, need and steps in programme planning. Principle of programme planning, Programme planning process.

## AGRICULTURAL ECONOMICS

Nature and tools of Economic analysis, micro & macro economics, consumer behavior, demand and supply, production, costs, firm, price determination, markets, welfare economics, consumption, saving & investment, business cycle, inflation, income and interest, agriculture in economic development, agricultural policies, role of infrastructure and technological change, land reforms, agricultural finance, rural credit, financial and economic appraisal measures, fundamental accounting and book keeping, financial statements, agricultural marketing, market functions, marketing institutions, trade, role of economics in natural resource accounting, allocation of renewable and non-renewable resources, farm records, farm planning and budgeting, production functions, decision making under risk and uncertainties, farm efficiency measures, resource use efficiency, returns to scale, diversification and insurance.

## AGRICULTURAL ENGINEERING

Farm structures, farm house, dairy and poultry housing, farm site, food grain storage, elementary knowledge on engines/motors, common troubles and remedies, tractors and common farm equipments.

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## BOTANY

### BIODIVERSITY

Microbes, Algae, Fungi and introduction to Archegoniate, Bryophytes, pteridophytes, Gymnosperms

### PLANT ECOLOGY AND TAXONOMY

Introduction, Ecological factors, Plant communities, Ecosystem, Phyto geography, Introduction to plant taxonomy, Identification, Taxonomic evidences from palynology, cytology, phytochemistry and molecular data, Taxonomic hierarchy, Botanical nomenclature, Classification, Biometrics, numerical taxonomy and cladistics

### PLANT ANATOMY AND EMBRYOLOGY

Meristematic and permanent tissues, Organs, Secondary Growth, Adaptive and protective systems, Structural organization of flower, Pollination and fertilization, Embryo and endosperm, Apomixis and polyembryony

### PLANT PHYSIOLOGY AND METABOLISM

Plant-water relations, Mineral nutrition, Translocation in phloem, Photosynthesis, Respiration, Enzymes, Nitrogen metabolism, Plant growth regulators, Plant response to light and temperature

### CELL AND MOLECULAR BIOLOGY

Techniques in Biology (Principles of microscopy, Light Microscopy etc.), Cell as a unit of Life, Cell Organelles (Mitochondria, Chloroplast, ER, Golgi body & Lysosomes, Peroxisomes and Glyoxisomes, Nucleus), Cell Membrane and Cell Wall, Cell Cycle, Genetic Material (DNA, DNA replication (Prokaryotes and Eukaryotes), Transcription (Prokaryotes and Eukaryotes), Regulation of gene expression

### ECONOMIC BOTANY AND BIOTECHNOLOGY

Origin of Cultivated Plants, Cereals, Legumes, Spices, Beverages, Oils and Fats, Fibre Yielding Plants, Introduction to Biotechnology, Plant tissue culture, Recombinant DNA Techniques

### GENETICS AND PLANT BREEDING

Heredity (Brief life history of Mendel, terminologies, laws of inheritance etc.), Sex-determination and Sex-Linked Inheritance Linkage and Crossing over, Mutations and Chromosomal Aberrations, Plant Breeding, Methods of crop improvement, Quantitative inheritance, Inbreeding depression and heterosis, Crop improvement and breeding

### ANALYTICAL TECHNIQUES IN PLANT SCIENCES

Imaging and related techniques (principles of microscopy, light microscopy, fluorescence microscopy etc.), Cell fractionation, Radioisotopes,

Spectrophotometry, Chromatography, Characterization of proteins and nucleic acids, Biostatistics

#### **BIOINFORMATICS**

Introduction to Bioinformatics, Databases in Bioinformatics, Biological Sequence Databases, Sequence Alignments, Molecular Phylogeny, Applications of Bioinformatics

#### **RESEARCH METHODOLOGY**

Basic concepts of research, General laboratory practices, Data collection and documentation of observations, Overview of biological problems, methods to study plant cell/tissue structure, plant microtechniques, the art of scientific writing and its presentation

## SYLLABUS FOR BIOTECHNOLOGY

**Biodiversity and Taxonomy:** Principles of taxonomy and classification of plant kingdom; structural, biochemical and molecular systematic; biodiversity and plant genetic resources; germplasm exploration, collection, regeneration and evaluation; principles and methods of germplasm conservation; conservation of plant biodiversity; tools to assess molecular diversity, germplasm exchange and plant quarantine; ecology and biodiversity.

**Cell structure and Function:** Basics of Cell Biology in prokaryotes and eukaryotes; cell wall and cell membranes; structural organization and functions of cell organelles; intracellular transport; biosynthesis and degradation of cellular components; cell division and cell cycle; intracellular and extra-cellular control of cell division; programmed cell death.

**Biomolecules and Metabolism:** Classification, structure and function of carbohydrates, lipids, proteins, nucleic acids, hormones and vitamins; metabolism of carbohydrates (glycolysis, citric acid cycle, glycogenesis, glycogenolysis, pentose-phosphate pathway); metabolism of lipids (oxidation of saturated and unsaturated fatty acids, oxidation of odd chain fatty acids, energy yield, ketone bodies); metabolism of amino acids (biosynthesis and breakdown of amino acids) and metabolism of nucleic acids (biosynthesis and degradation of purine & pyrimidine); photosynthesis (oxidative phosphorylation and photophosphorylation); respiration (photorespiration).

**Genetics and molecular Biology:** Mendelism & chromosome theory, basic principles of inheritance; linkage & crossing over; allelic variation & gene function, co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting; linkage disequilibrium; sex-linked inheritance; quantitative genetics and polygenic inheritance; population genetics and hardy-weinberg equilibrium; extra chromosomal inheritance; gene concept; mutations; transposable genetic elements; structural and numerical alterations of chromosomes; basics of cyto-genetics, karyotyping, chromosome banding and mapping; formulation and testing of genetic hypothesis; DNA as the genetic material; DNA and the molecular structure of chromosomes; Organization and structure of prokaryotic and eukaryotic of genomes; DNA replication in prokaryotes and eukaryotes; transcription and RNA processing in prokaryotes and eukaryotes; translation and the genetic code; regulation of gene expression in prokaryotes and eukaryotes; mutation, DNA repair, and recombination.

**Microbiology:** History and development of microbiology; classification of microbes; concepts and methods of sterilization; microscopy and staining; microbial culture techniques; concepts of microbial species and strains; growth curves, various forms of microbes; pathogenic microorganisms (bacteria, fungal, viral and protozoan); microbes in extreme environment (photosynthetic bacteria; Cyanobacteria; thermophilic, methanogenic and halophilic archaea); basic concepts of virology.

**Tissue culture:** Basic principles of plant tissue culture, totipotency, establishment of aseptic culture, callusing, regeneration and organogenesis, hardening; micro-propagation; somaclonal variations; endosperm and anther culture; embryo culture; somatic hybrids; synthesis of artificial seed; single cell and protoplast culture and



regeneration; cryopreservation and conservation of plant genetic resources; production of secondary metabolites, hairy roots and bioreactor technology.

**Recombinant DNA Technology:** Basic principles of cloning, tools for cutting and joining DNA molecules, types of vectors and their properties, bacterial transformation and selection strategies; gene transfer to plants; transgenic technology; Intellectual Property Rights (IPR).

**Molecular tools and techniques:** Nucleic acids and protein isolation; molecular markers and their applications; polymerase chain reaction (PCR), RT-PCR; techniques for separation of nucleic acids and proteins; nucleic acid blotting; restriction digestion and ligation; restriction mapping; genetic mapping; preparation of genomic and cDNA libraries; molecular cloning; transformation and screening strategies; techniques for differential gene expression; transcriptomics; proteomics; metabolomics; synthesis and sequencing of oligo-nucleotides; genome sequencing; analysis and management of sequence data; bioinformatics; techniques for targeted mutagenesis; genome editing; techniques for gene transfer in plants.

**General Instrumentation:** Principles and applications of chromatography, agarose gel electrophoresis, PAGE, SDS PAGE, centrifugation, microscopy, X-ray crystallography, spectroscopy, spectrophotometer, autoradiography, preparation of microbial and tissue culture media, sterilization.

## Syllabus for Marine Biology

**Principles of Oceanography:** Geologic history of the oceans - Early history of Oceanography and World exploration - Modern Technology in Oceanography - Seas - Oceans - Ocean floor - Continental shelf - Continental slope - Abyssal basin - Introduction to hydrographic surveying. Marine instrumentation - Structure and motion of the ocean and its environs - properties, populations and energy budget - Oceanic currents. Ocean resources and exploration - Bioresources of the sea - Food production from the sea - Energy production from the sea - Mineral resources of the sea.

**Biology Oceanography:** Life process in the marine environment - Ocean's Food web - Classification of planktons, methods of collection, interrelations. Adaptations of planktons. Organic production, methods of estimation and factors affecting primary production., red tide phenomenon.

Sea weeds - occurrence and distribution in India, economic importance. Sea grasses - morphological and anatomical adaptations, ecological role. Mangroves and salt marshes - distribution - adaptations, ecological role, uses, need for conservation. Marine biodiversity - biodiversity assessment techniques - Marine resources, Fisheries - Pelagic - Benthic and non biological - Threats to marine biodiversity, overexploitation, physical alteration, alien species.

**Marine Flora, Ecology and Zoogeography:** Classification of marine flora - Factors affecting marine life. Marine flora - Bacteria, Fungi, Diatoms, Flowering Plants - Blue green and Red algae. Ecology and Geographic distribution of marine flora - Mangrove associations: Distribution of mangrove plants - Nutrient cycling, ecological significance of mangroves. Marine Environment: zonation, stratification, geographic distributions - ecological factors - light, temperature, salinity, pressure - Classification of marine environment - pelagic environment, planktonic and nektonic adaptations, benthic environment - intertidal, interstitial and adaptation - Coastal environments - coral reefs, estuaries, mangroves, sea grass beds, forests, polar seas and hydrothermal vent - Marine zoogeography. Marine ecosystem structure and function, food chain, food-web, ecological pyramid, energy flow - Systems ecology and modeling. Population ecology - group attributes, population growth, population density variation, carrying capacity, dispersal, prey-predator relationship, density dependent and independent factors. Community ecology - structure and composition, diversity and stability, concept of niche, succession, community wise adaptation - fouling and boring community, animal association in the sea.

**Applied Marine Botany:** Marine Algal Physiology- Marine algae as food, fodder, fertiliser and source of medicine and industrial raw material. Cultivation of Unicellular organisms, sea weeds. Marine Products: Agar-agar, Carragenin, Kiesulguhr, Algin, Laminarin, Phycocolloids.

**Marine Biotechnology:** Marine natural products - Marine organisms: - Pharmaceuticals. Marine Microbiology - Microbial biofilms; Marine polysaccharaides - Molecular pathogenicity; Biochemistry, gene regulation and molecular biology of marine hyperthermophils. Biofouling and Control technology - Genetic engineering and ploidy

manipulation to enhance growth - reproduction and development of disease resistance in aquacultural species.

**Marine Paleobiology:** Principles of fundamental Stratigraphy - Standard Geological time scale - Order of Superposition - Principles of stratigraphic correlation - Various zones of marine realm and their characteristic fauna and flora - Marine habit and habitat. Marine fossils

**Marine Geology:** Structure of the Earth - Origin and structure of Oceans, Plate tectonics, transform faults, ocean trenches, mid-ocean ridges, geothermal vents - Continental shelf, Slope and Rise.

Deep ocean basins, Coastlines and Coastal system beaches - rocky and sandy beaches, bays, inlets, and fjords; physical processes and Classification of coasts - formation of beaches - loss of headlands - formation of barrier islands and lagoons - coastal development. Characteristics of coastal waters - Estuaries - Temperate and tropical wetlands and Lagoons - Marginal seas of the world.

#### **Physical Oceanography**

Characteristics of Ocean Water - major wind systems - Air-Sea Interaction - ocean-atmosphere coupling - marine weather and climate - El Nino/La Nina - global change - storms and hurricanes - methods and measurements - contributors - Ocean currents including wind driven systems - eddies - rings - geostrophic currents - upwelling and down welling processes - tidal waves (Tsunami). Waves and their properties - impact on beaches - marine structures to mitigate wave effects - surfing.

Physical properties of seawater - vertical and horizontal distributions of salinity and temperature - Identification and significance of water masses.

**Chemical Oceanography:** Chemical properties of water and seawater - Chemical processes in oceans - pH and buffering capacity of seawater. Basic properties and processes in estuarine chemistry.

**Marine Mineral Resources:** Marginal marine, Subsurface, Beach placer, Deep sea deposits - Ocean boundaries and Petroleum resources - Petroleum prospects beneath oceans - Relation of boundary to petroleum - Contribution of sea for world's petroleum production - Future prospects of petroleum resources of sea - Contribution of marine petroleum resources in Indian petroleum production.

**Marine Pollution:** Kinds and quantities of ocean pollution. Oil spills, plastics, trace metals, sewage and nutrients, Factors influencing the toxicity of trace metals to marine organisms. Effects on marine organisms. Time scale of global changes in the ecosystem and climate - impact of circulation in atmosphere and ocean on climate, rainfall and agriculture.