# Agronomy | PhD Entrance Syllabus

Crop growth analysis in relation to environment; Agro-ecological zones of India.
Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.
Effect of lodging in cereals; physiology of grain yield in cereals; Optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.
Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.
Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture.
Soil fertility and productivity - factors affecting; Features of good soil management
Problems of supply and availability of nutrients; Relation between nutrient supply and crop growth; Organic farming - basic concepts and definitions.
Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients
Preparation and use of farmyard manure, compost, green manures, vermicompost, bio-fertilizers. Organic concentrates their composition, availability and crop responses; Recycling of organic wastes and residue management.
Commercial fertilizers; composition, relative fertilizer value and cost; Crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades
Agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interactions
Time and methods of manures and fertilizers application; Foliar application and its concept;
Relative performance of organic and inorganic manures; integrated nutrient management; use of vermicompost and residue wastes in crops. Economics of fertilizer use.
Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices.
Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.
Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio-herbicides, myco-herbicides and allele-chemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation.
Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control.
Integrated weed management; cost : benefit analysis of weed management
Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition.

Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; micro irrigation system; fertigation; management of water in controlled environments and polyhouses.

Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency.

Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.

Agro meteorology - aim, scope and development in relation to crop environment; composition of atmosphere, distribution of atmospheric pressure and wind.

Characteristics of solar radiation; energy balance of atmosphere system; radiation distribution in plant canopies, radiation utilization by field crops; photosynthesis and efficiency of radiation utilization by field crops; energy budget of plant canopies; environmental temperature: soil, air and canopy temperature.

Temperature profile in air, soil, crop canopies; soil and air temperature effects on plant processes; environmental moisture and evaporation: measures of atmospheric temperature and relative humidity vapor pressure and their relationships; evapo-transpiration and meteorological factors determining evapotranspiration.

Modification of plant environment: artificial rain making, heat transfer, controlling heat load, heat trapping and shading; protection from cold, sensible and latent heat flux, controlling soil moisture; monsoon and their origin, characteristics of monsoon; onset, progress and withdrawal of monsoon; weather hazards, drought monitoring and planning for mitigation.

Weather forecasting in India – short, medium and long range; aerospace science and weather forecasting; benefits of weather services to agriculture, remote sensing; application in agriculture and its present status in India; atmospheric pollution and its effect on climate and crop production; climate change and its impact on agriculture

# Entomology | PhD Entrance Syllabus

Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colourations and special integumentary structures in insects, body tagmata, sclerites and segmentation.
Head-Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites.
Thorax-Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modification, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications.
Abdomen-Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-photo-and chemoreceptors).
Scope and importance of insect anatomy and physiology.
Structure, modification and physiology of different systems-digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands
Thermodynamics; physiology of integument, moulting; growth, metamorplosis and diapause.
Insect nutrition-role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.
Brief evolutionary history of insects-Introduction to phylogeny of insects and Major Classification of Superclass Hexapoda-Classes-Ellipura (Collembola, Protura), Diplura and Insecta-Orders contained.
Distinguishing charactrs, general biology, habits and habitats of insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass: Apterygota-Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera-Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera,Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid. Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.
Distinguishing chracters, general biology, habits and habitats of insect orders and economically important familie contained in them. Division Neoptera-Subdivision Endopterygota, Section Neuropteroid-Coleopteroid orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera and Section Hymenopteroid Orders: Hymenoptera.
History and Definition. Basic Concepts. Organization of the biological world. Plato's natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalized action on insects. Implications for abundance and distribution of organisms including insects-Law of the Minimum, Law of Tolerance and biocoenosis, systems approach to ecology.
Basic concepts of abundance-Model vs Real world.Population growth basic models-Exponential vs Logistic models. Discrete vs Continuous growth models.Concepts of carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics-Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics-Factors affecting abundance-Environmental factors, dispersaland migration, seasonality in insects. Classification and mechanisms of achieving different seasonality-Diapause (Quiescence)-aestivation, hibernation.
Biotic factors-Food as limiting factors for distribution and abundance, Nutritional Ecoliogy. Food chain-web and ecological succession. Interspecific interactions-Basic factors governing
The interspecific interactions-The argument of cost-benefit ratios. Competition-Lotka-Volterra model, concept of nicheecological homologues, competitive exclusion. Prey-predator interactions-

Basic model-Lotka-Volterra Model, Volterra's principle. Functional and numerical response. Defense mechanisms againstpredators/ parasitoids. Evolution of mimicry colouration, concept of predator satiation; evolution of life history strategies.

Community ecology-Concept of guild, Organization of communities-Hutchinson Ratio, May's *d/w*, Relation between the two and their association with Dyar's law and Przibram,s law. Relative distribution of organisms, Concept of diversity-the Wallacian view. Assesment of diversity, Diversity-stability debate, relevance to pest management. Pest management as applied ecology.

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds etc.

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticide-synergism, potentiatism and antagonism: factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.

Insecticide metabolism; pest resistance to insecticides, mechanisms and types of resistance; insecticide resistance management and pest resistance.

Insecticide residues, their significance and environmental implications.Insecticide Act, registraction and quality control of insecticides; safe use of insectides; diagnosis and treatment of insecticide poisoning.History and origin, definition and evolution of various related terminologies. Concept and philosophy, ecological principles, economic threshold concept and economic consideration.

Tools of pest management and their integration-legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods; factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; cost-benefit ratio and partial budgeting; case studies of successful IPM programmes.

**Syllabus for Ph.D Entrance (Environmental Sciences):-**

Ecology-definition, history and scope. Basic elements of ecology-substrate, water, oxygen, carbon dioxide, light, temperature and nutrients. Ecosystem and ecological balance, inter and intra-species relationship, food chain, food webs and ecological pyramids. Major ecosystems of world-arctic, tundra, northern coniferous forests, temperate forests, grassland deserts, tropical rain forests, fresh water and marine ecosystems. Nutrient cycling at ecosystem level-Biogeochemical cycles and their importance in biosphere. Ecology of population community, succession and fluctuation dynamics of ecosystem. Environment-definition and concepts. Components of environment-atmosphere, hydrosphere, biosphere, pedosphere and their interaction. Climate change: Impacts on agriculture and agro climatic regions in India with special reference to J&K; Animal-plant-soil-water-air interaction. Environmental pollution; Green house effect. Environmental pollution definition and sources. Types of pollution - air, water and soil pollution their effects on biosphere: common pollutants of air. Sources of diffusion of fuel, sulfur dioxide, nitrous oxide, carbon monoxide, carbon dioxide, methane, dust, noise, heavy metals etc. Water pollution sources and types, eutrophication, pesticides, fertilizers, herbicides and heavy metals in surface and ground waters; treatment of waste waters. Soil pollution - Sources and types: Impact on crop productivity, soil fertility and micro flora and fauna. Solid wastes and their disposal – physical, chemical and biological, waste treatments. Hazards of pollution on human, animal and plants; Inter-relationship of crop, human and animal waste production with air, water and soil The Microbial world, ecological successions: Terrestrial, aquatic and extreme environments of microorganism, micro-habitats, metabolic activities and energy flow. Microbial interactions-nature and types of interactions, metabolic associations, antibiosis, symbiosis, pathogenesis, predation. Microbiology of rhizosphere and phyllosphere. Microbial activities of ecological significance-role in ecosystem development, cycling of bio-elements, detritus food chain, bio-fertilizers, biofuel, biological control. Microbial degradation of agricultural chemicals, synthetic polymers, fossil fuel and other recalcitrant chemicals, microbial corrosion and biofilms The natural environment and man: physical environments. The concept of change Tectonics, Mass movements, Erosion, Deposition, changes in sea level, Mass wasting and the Environments. Rock weathering, soil formation, causes of mass movements. Hydrology and environments: Hydrological cycle. Different environments: Coastal, Dry Tropical rain forests and cold environment. Geochemistry and environment: Composition of earth materials as a source of contamination, Environmental problems of the energy, industry. Coal, fuel, hydroelectric and nuclear. Remote sensing and aerial photography in environmental investigation. Land use planning and geology: soil and land classification, Land-use data in agriculture, forestry, engineering and urban community planning Introduction, basic concepts, background and importance of environmental chemistry. Chemical significance of water, chemical structure of water molecule, chemical properties of water. Acid base theory, concept of pH, oxidation-reduction reaction. Theory of solutions, general properties of solutions. Photochemical reactions in the atmosphere, photolytic and radiolysis transformations, Chlorofluorocarbons and ozone depleting substances, chemical toxicology in the environment, Peroxy Actyl Nitrate (PAN), classification and nature of environment pollutants. Natural cycles and environment-hydrological, oxygen nitrogen, carbon, phosphorus and sulfur. Agro-environmental chemistry: fertilizers, pesticides and their hazardous effects on agricultural production and environment Environmental monitoring: Introduction concepts and Importance. Monitoring systems - physical, chemical and biological, monitoring tools – surveys spatial data base, experimental models, remote sensing, Environmental pollution-Different types viz; atmospheric, hydrospheric and lithosphere. Role of different gases, particulates, heavy metals and pesticides in environmental pollution. Sampling and analysis techniques of monitoring pollution. Population and habitat management-different models of population growth involving various impacts. Introduction - Origin and classification of toxic chemicals in environment. Toxicants- agricultural and industrial toxicants. Radiation-types of hazards. Eco-toxicology of heavy metals. Health hazards of automobile exhausts. Biochemical mechanisms and hazards of organic toxicants with special reference to polychlorinated biphenyl. Energy - Introduction, classification and conservation. Natural energy resources - renewable source viz; solar, wind and tidal energy, geothermal energy, hydropower energy, biomass energy.

Non-renewable sources viz, nuclear and fossil fuel energy. Energy problems and prospects. Energy utilization - efficiencies and strategies. Impact of energy on different ecosystems. Recycling - hydrological, forest, mineral. Agroindustrial wastes for fuel and manure. Biogas from animal and agriculture wastes Wastes: Sources and types; solid, liquid and gaseous wastes; physical chemical and biological properties of wastes: Disposal of waste; problems associated with waste disposal; Impact on air, water and soil. Waste processing; physical, chemical and biological methods; landfilling operations and its impact on water and agriculture. Hazardous wastes: Xenobiotic, radioactive, recalcitrant and hospital wastes and their disposal. Recyling of agricultural and industrial wastes; single cell protein, biogas, biofuel, compost, bio-energy. Waste management laws. Environmental Impact Assessment; definition, scope, objectives, methods and applications in agriculture, industrial, human settlements and developmental activities. Types of environmental Impacts. Concepts of consequence, environmental protection, conservation and management. Environmental impact assessment of physical, chemical biological and demographic factors. Economic impact assessment; Laws, policies and implementation; case studies Agricultural Ecosystems. Irrigated agriculture. Dry land farming natural/organic farming. Cold arid farming. Agri-silvi-pastoral practices. Floating gardens. Wetland agriculture. Aquaculture/aquatic weeds and terrace farming. Irrigation modes: Methods, frequency and water quality involving various biochemical changes. Synthetic fertilizers; Impact on environment, alternative and eco-friendly sources of fertilizers. Pesticides: residues, effect on non-target organisms, ill-effects on human health, eco-friendly alternatives to pesticides. Crop productivity and climate Introduction and Importance; Complexity and levels. Biogeography and major biomes, systematics, ecological role of biodiversity. Origin of diversity, Centres of origin and diversity, speciation, taxonomical Classification of PGRs, endangered species-description, threat to economically important species. National and international mechanisims for PGR management access and benefit sharing. Convention on Biological Diversity (CBD) issues and consequences. Principal-strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGRs. Principals of in-vitro and cryo - preservation; germplasm conservation in-situ, ex-situ and on farm. Short, medium and long term strategies for conservation of orthodox and non-orthodox genetic resources and other materials; vegetatively propagated crops. Registration of plants genetic resources, PGR database management Introduction to Biotechnology, Gene identification: restriction endnucleases, plasmids, phage vectors. Techniques of gene transfer. Role of Biotechnology in environmental protection. Biosensors for the detection of Pollutants. Industrial pollution: Control through natural and genetically engineered microorganisms in distillery effluents, food industries, paper pulp industry, heavy metal wastes, spilled oil, synthetic pesticides. Use of biodegradable and eco-friendly products. Biotechnology in agricultural crops. Forest rehabilitation and wetland development. Treatment of water through biotechnological methods. Legislations on genetically engineered organisms Definition, units and scope of environmental engineering. Meteorological phenomenon and its influences of air quality. Engineered systems for water purification. Air pollution control, gravitation settling chambers, centrifuge collectors, wet collectors, scrubbers, solid. Waste management and energy recovery. Water purification, process of water treatment, theory, application and design. Waste water treatment, hydraulic designs of waste water drains, sewers, pipes, primary sedimentation. Activated sludges, ponds, lagoons. Secondary classification and the design involved. Landfill methods and design consideration. Incineration; Construction and working of different types of incinerators, quench reactors, environmental quality monitors. Introduction: Earth processes and geological hazards. Earthquakes-a disaster and its nature. Earthquakes disasters: Prepredness and relief Measures. Long-term post Earthquakes planning. Tsunami and Seiche. Land use planning and building policies. Mass movement' Fragility of Himalayan mountain range. Landslides-types, causes and perception of hazards. Landslide zonation and microzonation maps. Prediction, preparedness and recovery. Avalanches- Nature, causes and effects of avalanches. Avalanche vulnerability on human, live-stock and property. Prediction and mitigation techniques. Climate vagaries; Global warming, Ozone depletion, El-Nino, Droughts- Causes, effects and assessment of losses. Mitigation measures. People's participation,

mass awareness programmes in combating the disasters. Nuclear holocaust-management of nuclear wastes and their disposal.

**Syllabus for PhD Entrance in FOOD SCIENCE & TECHNOLOGY Introduction to food technology** ,Food attributes *viz*. colour, texture, flavour, nutritive value and consumer preferences, Causes of food spoilage, sources of microbial contamination of foods, food borne illnesses, water activity and its relation to spoilage of foods, Spoilage of processed products and their detection, Principles and methods of food preservation, such as heat processing, pasteurization, canning, dehydration, freezing, freeze drying, fermentation, microwave, irradiation and chemical additives. Refrigerated and modified atmosphere storage. Aseptic preservation, hurdle technology, hydrostatic pressure technology and microwave processing. Use of non-thermal technologies (microfiltration, bacteriofugation, ultra high voltage electric fields, pulse electric fields, high pressure processing, irradiation, thermosonication), alternate-thermal technologies (ohmic heating, dielectric heating, infrared and induction heating) and biological technologies (antibacterial enzymes, bacteriocins, proteins and peptides) in food processing.

**Fruits and Vegetable Processing**: Post harvest handling and storage of fresh fruits and vegetables. Preparation of fruits and vegetables for processing. Minimally processed products. Cold chain logistics. ZECC (Zero Energy Cool Chambers), Thermal processing and process time evaluation for canned products, aseptic canning, methods for canning of different fruits, and vegetables; Dehydration and associated quality changes during drying and storage of dehydrated products. Intermediate moisture foods. Preparation and utilization of fruits and vegetables juices in non-fermented/ fermented/ aerated beverages, health drinks. Membrane technology. Chemistry and manufacture of pectin, role in gel formation and products like jellies and marmalade. Technology for preservation of fruits and vegetable products viz pickles, chutney's , sauces, jam, jellies, marmalades etc. Nature and control of spoilage in these products. By products utilization of fruits and vegetable processing industry, Processing methods of frozen fruits and vegetables, IQF products, packaging, storage and thawing, Role of Pectinases in fruits and vegetable processing. Tomato products such as juice, puree, paste, soup, sauce and ketchup, Other convenience foods from fruits and vegetables. Beverages, tea, cocoa and coffee processing. Medicinal and aromatic plants: their therapeutic values. Spice processing viz. cleaning, grading, drying, grinding, packaging and storage. Oleoresins and essential oils. **Food grain Processing**: Structure, composition of different grains like wheat, rice, Barley, oat, maize and millets, Antinutritional factors in food grains and oilseeds, Milling of different cereal grains, pulses and oil seeds. Wheat flour/semolina and its use in traditional/non-traditional foods like breads, biscuits, cakes, doughnuts, buns, pasta foods, extruded, confectionary products, breakfast and snack foods. Preparation of vital wheat gluten and its utilization, Enzymes (amylases and proteases) in milling and baking & parboiling of rice; by-products of rice milling and their utilization, Processed products from rice, Pearling, malting, brewing and preparation of malted milk feeds from barley, Significance of β-glucans, Milling of oats and its processing into flakes, porridge and oatmeal, Wet and dry milling of corn, manufacture of corn flakes, corn syrup, corn starch, corn steep liquor and germ oil, Structure and composition of pulses and their importance in Indian diet. Processing of pulses viz. germination, cooking, roasting, frying, canning and fermentation. Use in traditional products, protein concentrates and isolates. Oilseeds: edible oilseeds, composition and importance in India. Oilseed processing. Oil extraction and its processing, by-products of oil refining. Production, packaging and storage of vanaspati, peanut butter, protein concentrates, isolates and their use in high protein foods. Millets: composition, nutritional significance, structure and processing.

**Technology of Milk and Milk Products:** Milk and Milk production in India. Importance of milk processing in the country. Handling and maintenance of dairy plant equipment. Dairy plant operations viz. receiving, separation, clarification, pasteurization, standardization, homogenization, sterilization, storage, transport and distribution of milk. UHT, toned, humanized, fortified, reconstituted and flavoured milks. Technology of fermented milks. Milk products processing viz. cream, butter, *ghee*, cheese, condensed milk, evaporated milk, whole and skimmed milk powder, ice-cream, butter oil, *khoa*, *channa, paneer* and similar products. Judging and grading of milk products. Cheese spreads by spray and roller drying techniques. EMC (Enzyme modified cheese), Enzymes in dairy processing. Sanitization *viz*. selection and use of dairy cleaner and sanitizer.

**Technology of Meat / Fish / Poultry Products:** Scope of meat, fish and poultry. Processing industry in India, Ante mortem inspection, Post mortem examination, Rigor mortis, Factors affecting meat quality. Curing, smoking, freezing, canning and dehydration of meat, poultry and their products. Sausage making. Microbial factors influencing keeping quality of meat. Processing and preservation of fish and its products. Handling, canning, smoking and freezing of fish and its products. Preservation of eggs using oil coating, refrigeration, thermo stabilization and antibiotics. Packing, storage and transportation of eggs. **Importance and functions of quality control.** Quality systems and tools used for quality assurance including control charts, acceptance and auditing inspections, critical control points, reliability, safety, recall and liability. The principles and practices

of food plant sanitation. Food and hygiene regulations. Environment and waste management. Total quality management, good management practices, HACCP and codex alimentaria in food. International and National food laws. US-FDA/ISO-9000 and FSSAI. Food adulteration, food safety. Sensory evaluation, panel screening, selection methods. Sensory and instrumental analysis quality control. Quality control of food at all stages and for packaging materials. Nondestructive food quality evaluation methods. Biosensors and their use in quality evaluation of food products. Aspects of food safety.

**Food Engineering/Packaging** Unit operations of food processing viz. grading, sorting, peeling and size reduction machineries for various unit operations, energy balance in food processing .Principles of thermodynamics and heat transfer applied to food engineering; fundamentals of heat and analogy to mass transfer in food processing. - Modes of heat transfer and overall heat transfer; thermal properties of foods such as specific heat and thermal conductivity; Fourier's law, steady state and unsteady state conduction; heat exchange equipment; energy balances; rate of heat transfer; thermal boundary layer; heat transfer by forced convections; heat transfer to flat plate and in non Newtonian fluids; heat transfer in turbulent flow; heating and cooling of fluids in forced convection outside tubes; natural convection. Packaging materials *viz.* properties and testing procedures, packaging of fresh and processed foods. Shelf life studies. Recent trends in packaging, aseptic, modified atmosphere, vacuum and gas packaging, active and smart packaging, antimicrobial packaging, edible films and coatings, nanocomposite materials for food packaging. Nutritional labelling requirements of foods. Requirements and functions of containers. Principles of package design.

**Food Microbiology & Biotechnology** spoilage organisms of milk, fruits, vegetables, grains and oilseeds, meat and poultry; Physical and chemical methods to control microorganisms. Biochemical changes caused by microorganisms; Microbes in food fermentation, putrefaction, lipolysis; Antagonism and synergism in microorganisms; Food poisoning and food borne infections; Microbial toxins. Rapid methods in detection of microorganisms. Food Fermentations; Probiotics, prebiotics & symbiotic; **Food Chemistry and Technology** Definition and importance; major food constituents and their physicochemical properties; role of water in food. Carbohydrates, proteins and lipids: classification, physical, chemical, nutritional, and functional properties Properties of minerals, vitamins, pigments, anti-oxidants, flavour components, allergens, toxins and anti-nutritional factors in foods; Changes during storage and processing; Browning reactions in foods. Sampling techniques; Water activity, its measurements and significance in food quality; Chromatographic techniques: Adsorption, column, partition, affinity, ion exchange, size exclusion, GC, GLC, HPLC, HPTLC, GCMS, LCMS. Separation techniques: Gel filtration, dialysis, electrophoresis, sedimentation, ultrafiltration and ultracentrifugation, solid phase extraction, supercritical fluid extraction,

**Consumer Sciences/Food Product Development/Health Foods** Product development viz. to conceive ideas, evaluation of ideas, developing ideas into products, test marketing and commercialization. Role of food in human nutrition. Nutritional disorders, natural contaminants and health hazards associated with foods. Diet therapy. Therapeutic / Engineered / Fabricated and Organic foods/ Nutraceutical and functional foods. Food groups and their typical composition; essential nutrients- sources, functions, deficiency diseases; requirements and recommended dietary allowances

# Plant Pathology | PhD Entrance Syllabus

Introduction, definition of different terms, basic concepts. importance of mycology in agriculture, relation of fungi to human affairs, history of mycology .
Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi. Latest developments in fungal characterization, typification of fungi, importance of culture collection and herbarium.
Myxornycotina: General characters, somatic and reproductive structures, life cycle of Plasmodiophora brass icae (3). Eumycota: Mastigornycotina: Life cycle of Allomyces or Coelomomyces, Saprolegnea or Achyla, Pythiuni, Phylophthora (4). Peronosporales: Important genera, Albuginaceae and peronosporaceae (2). Zygomycotina: General characters of Zygomycetes ( Rhizopus. Mucor and Absidia) sexual , asexual stage (heterothallism and hornothallism) (5) Important characters of VAM fungi Endo gone, Glomus.
Ascomycotina: Fruiting structures of hemiascomycets, Plectornycetes, Pyrenomycetes, discomycetes loculoascomcetes and laboulbehiomycetes, characters of important orders (4). Deutero mycotina: Saccardo's spore group and conidiogenesis in Melanconiales, Sphaeropsidales and Pycnothyrailes (3). Basidiomycotina: important pathogenic genera and their life cycle in (Puccinia, Ustilago and Neovossia), fungal genetics, Sexuality in fungi, variability and different types o life cycles (6). Lichens: Important asco- and basidio- lichens.
History of plant viruses, composition and structure of viruses.
Transmission and host range: Symptomatology, Methods of transmission. Seed transmission, Biology of insect vectors and virus vector relationship, aphids leafhopper, whitefly, other insects, nematode, fungi.
Nomenclature and classification: Taxonomy of plant viruses. Induction of disease: Physiology of virus infected plants. Movement of viruses.
Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics. Important viral diseases: field crops, vegetable crops, fruits, plantation, forest trees.
Ecology and epidemiology: Ecology and epidemiology of viruses. Disease management General control measures. Biotechnological approaches to control viral diseases.
Mycoviruses phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, Principles of the working of electron microscope and ultra microtome
Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses. History and development: Origin of bacteria, directed pansperinia, fossil bacteria, Nobel Prizes, Whittaker's classification, milestones in bacteriology, endosymbiotic theory of evolution.
Microscopy, stains and staining: Phase contrast, TEM, SEM, classification of strains, simple/complex staining, acid fast staining, role of proteins in staining.
Methods in pure culture study, growth and nutrition: Koch's postulates, growth phases, nutritional classification, characteristic pigments of phytopathogenic bacteria, total/viable count, synchronous/log growth, chemostat, auxotrophy, selective media, nutritional growth factors.
Classification and identification: Groups of bacteria including archaebacteria and cyanobacteria, differiation of phytopathogenic bacterial genera and Adansonian principles.
Ultrastructure and chemical composition: Range of cellular structure, moir structure of bacteria, differences between prokaryotes, eukaryotes and archaeon; Capsule, slime, cell wall (murein), cytoplasmic membrane, mesosomes, genophore and its replication, penetration of ions/ molecules, cellular reserve food material, special prokaryotic organelles, resting cells in prokaryotes, biochemical differences between vegetative cells and endospores, osmoregulatory expanded cortex theory.
Outline of bacterial metabolism: Prokaryotic inhibitors, bacteriocins, fermentation, respiration, biological oxidation and reduction, hydrolytic enzymes.

Elementary bacterial genetics and variability: Mutation, fluctuation test, transformation, conjugation, recombination, transduction, transposons, coordinated enzyme induction or repression, role of plasmids (4). Phytoplasma, rickettsia, bacteriophages, bdellovibrios: Basic structure and life cycle.

Bacterial diseases: Seven current important bacterial diseases(blight of rice, blight of cotton, wilt of solanaeeous crops, soft rot of vegetables, citrus canker and two diseases of local importance), with details of variability in the causal organisms, disease cycle and integrated management.

Concept, nature and classification of diseases: Diseases with examples, mutual relationship between organisms (2), Terminology: Definitions and explanations of some of the terms used in Plant Pathology, losses

History: Landmarks in the development of science of plant pathology (2), Causes of plant diseases: Abiotic, biotic, air pollutants, mineral deficiencies and toxicities, non-parasitic plant pathogens, allelopathy in plant pathology

Symptomatology: Disease identification based on symptoms, external and internal (3), Pathogen identification: Koch's postulates, disease identification in field (2) Sporulation: Production, liberation, dissemination of inoculums, factors affecting sporulation, physiology of infection and host parasite interaction.

Disease resistance: mechanism of disease resistance, VR, HR, durable resistance, cytoplasmic resistance, nature of genes.

Pathogen variability: Physiologic specialization, procedures of virulence analysis, mechanism of variability Effect of environmental factors and host nutrition. Survival of pathogens: In seed, soil and living plants. Disease management: Solarization, cultural, biological, genetical and chemical, plant quarantine. Genetic engineering for disease resistance.

Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens.

Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida.

Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of references.

# GENETICS AND PLANT BREEDING | PhD Entrance Syllabus

Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance.

Multiple alleles,Gene interactions. Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.

Population - Mendelian population - Random mating population - Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium.

Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis.

Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression. Gene regulation in eukaryotes, RNA editing.

Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR- based cloning, positional cloning; Nucleic acid hybridization and immuno- chemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).

Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.

Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts.

Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes.

Chromosomal theory of inheritance - Cell Cycle and cell division - mitosis and meiosis; Differences, significance and deviations - Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - *in situ* hybridization and various applications.

Structural and Numerical variations of chromosomes and their implications - Symbols and terminologies for chromosome numbers - euploidy - haploids, diploids and polyploids ; Utilization of aneuploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras - endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes.

Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids -- Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer - Alien addition and substitution lines - creation and utilization; Apomixis - Evolutionary and genetic problems in crops with apomixes.

Reversion of autopolyploids to diploids; Genome mapping in polyploids - Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) - Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids - Bridge species.

Fertilization barriers in crop plants at pre-and postfertilization levels- *In vitro* techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization ; case studies - Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.

Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of variability, components of variation; Heritability and genetic advance, genotype- environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

Self-incompatibility and male sterility in crop plants and their commercial exploitation.

Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach).

Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter- population improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection.

Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding. Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses.

Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Mendelian traits *vs* polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.

Principles of Anaylis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.

Designs for plant breeding experiments - principles and applications; Genetic diversity analysis - metroglyph, cluster and $D^2$ analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices - selection of parents; Simultaneous selection models-concepts of selection - heritability and genetic advance.

Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis-principles and interpretation.

QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.

Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.), mapping populations ($F_2$s, back crosses, RILs, NILs and DH).

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.

Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

Biotechnology applications in male sterility/hybrid breeding, molecular farming.

MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights

Bioinformatics & Bioinformatics tools.

Nanotechnology and its applications in crop improvement programmes.

# Plant Biotechnology | PhD Entrance Syllabus

History, scope and importance; DNA structure, function and metabolism. DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; Gene libraries; PCR amplification; Plant and animal cell and tissue culture techniques and their applications. Molecular markers and their applications; RFLP, RAPD, SSR, SCAR, STM, SNPs. DNA sequencing; Applications of gene cloning in basic and applied research; Genetic engineering and transgenics; Genomics, transcriptomics and proteomics. General application of biotechnology in Agriculture, Medicine, Environmental remediation, Energy production and Forensics; Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology. Historical developments of molecular biology; Nucleic acids as genetic material; Chemistry, structure and properties of DNA and RNA. Genome organization in prokaryotes and eukaryotes; Chromatin structure and function; DNA replication; DNA polymerases, topoisomerases, DNA ligase, etc; Molecular basis of mutations; DNA repair mechanisms. Transcription process; RNA processing; Reverse transcriptase; RNA editing; Ribosomes structure and function; Organization of ribosomal proteins and RNA genes; Genetic code; Aminoacyl tRNA synthases. Translation and post-translational modifications; Operon concept; Attenuation of trp operon; important features of gene regulation in eukaryotes. Cell division and regulation of cell cycle; Membrane transport; Transport of water, ion and biomolecules; Signal transduction mechanisms; Protein targeting. Preparation of buffers and reagents, Principle of centrifugation, Chromatographic techniques (TLC, Gel Filtration Chromatography, Ion exchange Chromatography, Affinity Chromatography). Gel electrophoresis- agarose and PAGE (nucleic acids and proteins); Growth of bacterial culture and preparation of growth curve; Isolation of plasmid DNA from bacteria; Growth of lambda phage and isolation of phage DNA; Restriction digestion of plasmid and phage DNA; Isolation of high molecular weight DNA. Gene cloning– Recombinant DNA construction, transformation and selection of transformants; PCR and optimization of factors affecting PCR. Dot blot analysis; Southern hybridization; Northern hybridization; Western blotting and ELISA; Radiation safety and non-radio isotopic procedure. Genome Wide Association Studies, Genomic Selection, Molecular Farming.

# Plant Pathology | PhD Entrance Syllabus

Introduction, definition of different terms, basic concepts. importance of mycology in agriculture, relation of fungi to human affairs, history of mycology .
Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi. Latest developments in fungal characterization, typification of fungi, importance of culture collection and herbarium.
Myxornycotina: General characters, somatic and reproductive structures, life cycle of Plasmodiophora brass icae (3). Eumycota: Mastigornycotina: Life cycle of Allomyces or Coelomomyces, Saprolegnea or Achyla, Pythiuni, Phylophthora (4). Peronosporales: Important genera, Albuginaceae and peronosporaceae (2). Zygomycotina: General characters of Zygomycetes ( Rhizopus. Mucor and Absidia) sexual , asexual stage (heterothallism and hornothallism) (5) Important characters of VAM fungi Endo gone, Glomus.
Ascomycotina: Fruiting structures of hemiascomycets, Plectornycetes, Pyrenomycetes, discomycetes loculoascomcetes and laboulbehiomycetes, characters of important orders (4). Deutero mycotina: Saccardo's spore group and conidiogenesis in Melanconiales, Sphaeropsidales and Pycnothyrailes (3). Basidiomycotina: important pathogenic genera and their life cycle in (Puccinia, Ustilago and Neovossia), fungal genetics, Sexuality in fungi, variability and different types o life cycles (6). Lichens: Important asco- and basidio- lichens.
History of plant viruses, composition and structure of viruses.
Transmission and host range: Symptomatology, Methods of transmission. Seed transmission, Biology of insect vectors and virus vector relationship, aphids leafhopper, whitefly, other insects, nematode, fungi.
Nomenclature and classification: Taxonomy of plant viruses. Induction of disease: Physiology of virus infected plants. Movement of viruses.
Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics. Important viral diseases: field crops, vegetable crops, fruits, plantation, forest trees.
Ecology and epidemiology: Ecology and epidemiology of viruses. Disease management General control measures. Biotechnological approaches to control viral diseases.
Mycoviruses phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, Principles of the working of electron microscope and ultra microtome
Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses. History and development: Origin of bacteria, directed pansperinia, fossil bacteria, Nobel Prizes, Whittaker's classification, milestones in bacteriology, endosymbiotic theory of evolution.
Microscopy, stains and staining: Phase contrast, TEM, SEM, classification of strains, simple/complex staining, acid fast staining, role of proteins in staining.
Methods in pure culture study, growth and nutrition: Koch's postulates, growth phases, nutritional classification, characteristic pigments of phytopathogenic bacteria, total/viable count, synchronous/log growth, chemostat, auxotrophy, selective media, nutritional growth factors.
Classification and identification: Groups of bacteria including archaebacteria and cyanobacteria, differiation of phytopathogenic bacterial genera and Adansonian principles.
Ultrastructure and chemical composition: Range of cellular structure, moir structure of bacteria, differences between prokaryotes, eukaryotes and archaeon; Capsule, slime, cell wall (murein), cytoplasmic membrane, mesosomes, genophore and its replication, penetration of ions/ molecules, cellular reserve food material, special prokaryotic organelles, resting cells in prokaryotes, biochemical differences between vegetative cells and endospores, osmoregulatory expanded cortex theory.
Outline of bacterial metabolism: Prokaryotic inhibitors, bacteriocins, fermentation, respiration, biological oxidation and reduction, hydrolytic enzymes.

Elementary bacterial genetics and variability: Mutation, fluctuation test, transformation, conjugation, recombination, transduction, transposons, coordinated enzyme induction or repression, role of plasmids (4). Phytoplasma, rickettsia, bacteriophages, bdellovibrios: Basic structure and life cycle.

Bacterial diseases: Seven current important bacterial diseases(blight of rice, blight of cotton, wilt of solanaeeous crops, soft rot of vegetables, citrus canker and two diseases of local importance), with details of variability in the causal organisms, disease cycle and integrated management.

Concept, nature and classification of diseases: Diseases with examples, mutual relationship between organisms (2), Terminology: Definitions and explanations of some of the terms used in Plant Pathology, losses

History: Landmarks in the development of science of plant pathology (2), Causes of plant diseases: Abiotic, biotic, air pollutants, mineral deficiencies and toxicities, non-parasitic plant pathogens, allelopathy in plant pathology

Symptomatology: Disease identification based on symptoms, external and internal (3), Pathogen identification: Koch's postulates, disease identification in field (2) Sporulation: Production, liberation, dissemination of inoculums, factors affecting sporulation, physiology of infection and host parasite interaction.

Disease resistance: mechanism of disease resistance, VR, HR, durable resistance, cytoplasmic resistance, nature of genes.

Pathogen variability: Physiologic specialization, procedures of virulence analysis, mechanism of variability Effect of environmental factors and host nutrition. Survival of pathogens: In seed, soil and living plants. Disease management: Solarization, cultural, biological, genetical and chemical, plant quarantine. Genetic engineering for disease resistance.

Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens.

Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida.

Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of references.

## Vegetable Science | PhD Entrance Syllabus

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

**Kale***

Cole crops: cabbage, cauliflower, knol khol, sprouting broccoli, Brussels Sprout

Root crops: carrot, radish, turnip and beetroot

Bulb crops: onion and garlic

Peas and broad bean, green leafy cool season vegetables

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of: Tomato, eggplant, hot and sweet peppers, Okra, beans, cowpea and clusterbean, Cucurbitaceous crops

**Potato*,** Tapioca and sweet potato, Green leafy warm season vegetables, Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act., Potato and tomato, Eggplant, hot pepper, sweet pepper and okra, Peas and beans, amaranth, chenopods and lettuce, Gourds, melons, pumpkins and squashes, Cabbage, cauliflower, carrot, beetroot, radish, sweet potato and tapioca, Cellular structures and their functions; definition of growth and development, growth analysis and its importance in vegetable production., Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellilns, cyktokinins and abscissic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops; apical dominance.

Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening.

Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops.

# SYLLABUS FOR ENTRANCE TEST (Ph.D. Biochemistry)

Scope and importance of biochemistry in agriculture; Fundamental principles governing life; structure of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waals forces. Classification, structure and function of carbohydrates, lipids and biomembranes, amino acids, proteins, and nucleic acids. Structure and biological functions of vitamins & Plant Hormones, Bioenergetics. The living cell: a unique chemical system, Introduction to metabolism, transport mechanism, bioenergetics, biological oxidation. Catabolic and anabolic pathways of carbohydrates, lipids, and regulation. Energy transduction and oxidative phosphorylation. General reactions of amino acid metabolism, Degradative and biosynthetic pathways of amino acids and their metabolic disorders. Compartmentation of metabolic pathways, metabolic profiles of major organs and regulation of metabolic pathways. Enzyme nomenclature and classification, measurement of enzyme activity. Ribozymes isozymes & zymogens. Enzyme structure, enzyme specificity, active site, mechanism of enzyme catalysis. cofactors, coenzymes - their structure and role. Enzyme kinetics, enzyme inhibition and activation, multienzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity. Isolation and purification of enzymes, enzyme immobilization. Chromatographic and electrophoretic methods of separation, Principles and applications of Paper, Thin layer & HPTLC, Gas-liquid & Liquid chromatography, HPLC; gel electrophoresis, Different variants of polyacrylamide gel electrophoresis (PAGE) like native and SDS-PAGE, 2D-PAGE, capillary electrophoresis. Spectrophotometry: Principles and applications UV-Visible, Fluorescence, IR, NMR and FTNMR, ESR and X-Ray spectroscopy. Tracer techniques in biology: Concept of radioactivity, concept of α, β and γ emitters, scintillation counters, γ-ray spectrometers, autoradiography, applications of radioactive tracers in biology. Plant cell organelles, structure and function of cell organelle. Photosynthetic pigments in relation to their functions, photosynthesis, C3, C4 and CAM pathways, photorespiration. Sucrose-starch interconversion.. Biochemistry of seed germination and development, Biochemistry of fruit ripening, phytohormones and their mode of action. Nitrogen cycle- Biochemistry of nitrate assimilation and its regulation, Biological nitrogen fixation; structure function and regulation of nitrogenase; nif genes; biochemical basis of legume-Rhizobium symbiosis; Sulphur metabolism. Historical development of molecular biology, nucleic acids as genetic material, chemistry and structure of DNA and RNA, Genome organization in prokaryotes and eukaryotes, chromatin structure and function. DNA replication, DNA polymerases, topoisomerases, DNA ligase, reverse transcriptase, repetitive and non-repetitive DNA, satellite DNA; transcription process, RNA editing, RNA processing. Ribosomes structure and function, organization of ribosomal proteins and RNA genes, genetic code, aminoacyl tRNA synthases, inhibitors of replication, transcription and translation; translation and Post translational modification; nucleases and restriction enzymes, regulation of gene expression in prokaryotes and eukaryotes, molecular mechanism of mutation. Fundamentals of human nutrition, concept of balanced diet, biochemical composition, energy and food value of various food grains , fruits and vegetables. Physico-chemical, functional and nutritional characteristics of carbohydrates, proteins and fats and their interactions (emulsions, gelation, browning etc.). Biochemical and nutritional aspects of vitamins, minerals, nutraceuticals, antinutritional factors. Antioxidants, Enzymes in food industry, food additives (coloring agents, preservatives etc.), nutritional quality of plant, dairy, poultry and marine products.