SUBJECT: AGRONOMY (Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT-1

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.

UNIT-2

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states. 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 poly-houses. 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.

UNIT-3

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use. Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems. Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture. Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; fertilizer use efficiency and concept of fertilizer use in intensive cropping system. Plant ideotypes for dryland; plant growth regulators and their role in sustainability.

UNIT -5

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry. Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers. Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides. Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

UNIT -6

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 Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients. 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; economics of fertilizer use; integrated nutrient management; use of vermicompost and residue wastes in crops.

UNIT -7

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.

UNIT -8

Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture. Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions. Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions. Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); anti-transpirants; soil and crop management techniques, seeding and efficient fertilizer use. Concept of watershed resource management, problems, approach and components.

SUBJECT: AGRICULTURAL ECONOMICS (Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT -1

Theory of Consumer Behavior-Cardinal Utility Approach-Ordinal Utility Approach– Income effect and substitution effect–Applications of Indifference curve approach- Revealed Preference Hypothesis–Consumer surplus-Derivation of Demand curve–Elasticity of demand. Theory of Production-`Production functions–Returns to scale and economies of scale–Technical progress–Theory of Costs–Cost curves–Profit maximization and cost minimization–Derivation of supply curve–Law of Supply–Producer's surplus. Market Equilibrium-Behavior of Firms in Competitive Markets–Perfect Competition-Effect of Taxation and Subsidies on market equilibrium-Monopoly-Monopolistic-Oligopoly-Theory of Factor Markets. General Equilibrium Theory-Welfare Economics-Pareto Optimality–Social welfare criteria-Social Welfare functions.

UNIT -2

Nature and Scope of Macro Economics-Methodology and Keynesian Concepts National Income-Concepts and measurement-Classical theory of Employment and Say's Law-Modern theory of Employment and Effective Demand. Consumption function-Investment and savings-Concept of Multiplier and Accelerator-Output and Employment-Rate of interest-Classical, Neo classical and Keynesian version-Classical theory Vs Keynesian theory–Unemployment and Full employment. Money and classical theories of Money and Price. Inflation: Nature, Effects and control. IS & LM frame work-General Equilibrium of product and money markets-Monetary policy-Fiscal policy-Effectiveness of Monetary and Fiscal policy.

UNIT -3

Evolution of Economic Thought vs. Economic History. Ancient economic though– medieval economic thought. Development of Classical Thoughts (Adam Smith, Robert Malthus and David Ricardo).The birth of neoclassical economic thought–Marshall and Walras–General Equilibrium Theory-Welfare Theory–Keynesian economics. The Era of globalization–Experiences of developing world. Economic Thought in India–Naoroji and Gokhale–Gandhian Economics -Economic thought of independent India–Nehru's economic philosophy-Experiences of the Structural adjustment programmes of the post liberalization era.

UNIT -4

Nature, scope and significance of agricultural production economics-Agricultural. Factors of production, classification, interdependence, and factor substitution-Determination of optimal levels of production and factor application–Optimal factor combination and least cost combination of production-Theory of product choice; selection of optimal product combination. Cost functions and cost curves, components, and cost minimization Duality theory–cost and production functions and its applications-Derivation of firm's input demand and output supply functions. Measuring efficiency in agricultural production; technical, a locative and economic efficiencies.

UNIT -5

Agricultural marketing issues, and enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities. Characteristic of Agricultural product and Production-Problems in Agricultural Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role-Need for regulation in the present context-Marketable & Marketed surplus estimation. Marketing Efficiency-Structure Conduct and Performance analysis-Vertical and Horizontal integration-Integration over space, time and form-Vertical coordination. Marketing Co-operatives–APMC Regulated Markets-Direct marketing, Contract farming and Retailing- Supply Chain Management-State trading, Warehousing and other Government agencies-Performance and Strategies–Market infrastructure needs, performance and Government role-Value Chain Finance. Role of Information Technology and telecommunication in marketing of agricultural commodities- Market research-Market information service-electronic auctions (e-bay), e-Chaupals, Agmarket and Domestic and Export market Intelligence Cell (DEMIC) price forecasting–time series analysis–time series models. Price policy and economic development–non-price instruments. Theory of storage future trading Price discovery-Hedging and Basis-Fundamental analysis-Role of Government in promoting commodity trading and regulatory measures.

UNIT -6

Knowledge related to research process, data collection and data analysis etc. Importance and scope of research in agricultural economics. Types of research-Fundamental vs. Applied. Concept of researchable problem–research prioritization–selection of research problem. Hypothesis–meaning-characteristics-types of hypothesis–review of literature–setting of Course Objective and hypotheses-testing of hypothesis. Sampling theory and sampling design–sampling error-methods of sampling–probability and non-probability sampling methods. Project proposals– different types of projects to meet different needs. Research design and techniques–Types of research design. Data collection–assessment of data needs–sources of data collection. Mailed questionnaire and interview schedule. Scaling Techniques. Coding editing–tabulation– validation of data. Tools of analysis–data processing. Interpretation of results–Preparing research report / thesis–Universal procedures for preparation of bibliography–writing of research articles.

UNIT -7

Introduction–relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics-regression analysis. Basic two variable regression-assumptions estimation and interpretation approaches to estimation-OLS, MLE and their properties- extensions to multivariable models-multiple regression estimation and interpretation. Multicolinearity, heteroscedasticity, autocorrelation. Use of dummy variables-limited dependent variables–specification, estimation and interpretation. Simultaneous equation models–structural equations-reduced form equations-identification and approaches to estimation.

UNIT-8

Linear programming techniques. Decision Making-Concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of LP in different fields, graphic solution to problems, formulation of problems. Simple Method: Concept of simplex Method, solving profit maximization and cost minimizations problems. Formulation of farm and nonfarm problems as linear programming models and solutions. Extension of linear Programming models: dynamic programming. Game Theory- Concepts of game theory, two person constant sums, zero sum game.

UNIT -9

Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending–Direct and Indirect Financing-Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's-NGO, and SHG's. Lending to farmers–The concept of 5C's, 7P's and 3R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions–credit widening and credit deepening. Financial Decisions–Investment, Financing, Liquidity and Solvency. Preparation of financial statements-Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and assessing the performance of farm/firm. Project Approach in financing agriculture. Financial, economic and environ mental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques–Undiscounted measures. Time value of money–Use of discounted measures-B-C ratio, NPV and IRR.Agreements.Net work Techniques–PERT and CPM. Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes–review of different crop insurance schemes-yield loss and weather based insurance and their applications.

SUBJECT: ENTOMOLOGY (Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT-1

External morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions. Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration 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 modifications, 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). 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, metamorphosis 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.

UNIT-2

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 characters, 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 characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). 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.

UNIT-3

History and Definition. Basic Concepts. Organization of the Biological world. 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. Balance of life in nature- Concepts of Carrying capacity, Environmental Resistance. 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, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation. Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions – The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of niche, ecological homologues, competitive exclusion. Prey-predator interactions- Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies. Community ecology- Concept of guild, Organisation of communities. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity stability debate, relevance to pest management. Pest management as applied ecology.

UNIT-4

History and origin, scope and need for IPM, 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; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes. History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation. Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects. Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation. Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

UNIT-5

Definition and scope of insecticide toxicology; history of chemical control, 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 insecticides synergism, potentiation 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 resurgence. Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

UNIT-6

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors. Insect pests of cereals and millets and their management. Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.). Insect pests of pulses, tobacco, oilseeds and their management

SUBJECT: EXTENSION EDUCATION (Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT-1

Extension Education, Adult Education and Distance Education. Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development. Current Approaches in Extension: Decentralized Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centers, and NAIP.

UNIT-2

Communication and communication process, Communication skills, fidelity of communication, communication competence and empathy, communication effectiveness and credibility. Methods of communication: Meaning and functions, classification. Forms and types of communication, organizational communication. Key communicators– Meaning, characteristics and their role. Agricultural Journalism, Techniques of writing scripts for Radio and TV.

UNIT-3

The adoption and Diffusion process, covert and overt processes at stages. Adopter categories and their rate of adoption, factors influencing rate of adoption. Diffusion effect and concept of over adoption, opinion leadership- measurement and Characteristics of opinion leaders, multi-step flow of innovation; concepts of homophile and heterophily.

UNIT-4

Research, social research, Behavioural sciences research. Types and methods of Research**.** Review of literature, Research problem. Objectives, Concept & Construct, Variable, Hypothesis, Measurement. Validity and Reliability. Sampling – Universe, Sample and Sampling. Types of sampling and sampling procedures. Research Designs: types, advantages and limitations of each design. Data Collection devices – Interview, Enquiry forms, Schedules and Questionnaires Rating scales, Observation, Case studies and Social survey. Data processing and Report writing.

UNIT-5

ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities. ICTs projects, case studies in India and developing world. Different approaches (Models) to ICTs, ICT use in field of extension- Expert systems, Agricultural web sites and portals related crop production and marketing etc. Community Radio, Web, Tele, and Video Conferencing, Computer Aided Extension, Knowledge management, Information kiosks, Multimedia, Online, Offline Extension, Tools-Mobile technologies, e-learning concepts.

UNIT-6

Entrepreneur, Entrepreneurship and Agri – entrepreneurship, Theories of Entrepreneurship, Traits & Types of Entrepreneurs, Stages of establishing enterprise – Identification of sound enterprise. Project Management and Appraisal – Market, Technical,

Financial, Social Appraisal of Projects. Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC industries. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Management, Extension Management, Planning and Decision making, Steps in DM Process, Meaning of Organization, Concept, Principles, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations. Coordination, Staffing, Training and Development and Direction. Supervision, Managerial Control, Budgeting, Observation, PERT and CPM, MIS.

UNIT-7

Human Resource Development, Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions, Recruitment, Induction Staff Training and Development, Career planning; Social and Organizational Culture. Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA). Intra personal processes: Collective behaviour, learning, and perception; Stress and coping mechanisms; Inter-Personal Process, Helping Process – communication and Feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning, Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counseling and Mentoring. Training and development strategies – Training types, models, methods and evaluation. Main issues in HRD: HRD culture and climate – organizing for HRD – emerging trends and Prospective.

SUBJECT: PLANT BREEDING AND GENETICS
(Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT-1

Beginning of genetics; Cell structure and cell division; Mendel's laws; Multiple alleles, Sex determination, sex-linkage, Sex-influenced and sex-limited traits; in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance. Population Genetics; Hardy-Weinberg equilibrium. Structural and numerical changes in chromosomes; Central Dogma; Genetic fine structure analysis, Jumping gene theory; Overlapping genes, seudogenes, Oncogenes, Gene Regulationin Prokaryotes an eukaryotes; mutation; Bacterial plasmids, Molecular chaperones and gene expression. RNA editing. Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).Genomics and proteomics; Metagenomics. Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

UNIT-2

Architecture of chromosome in prokaryotes and eukaryoties; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; artificial chromosome construction and its uses; Special types of chromosomes. 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. Utilization of aneuploids in gene location somatic segregation and chimeras – Endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations – balanced lethal and chromosome complexes. Inter- varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding allopolyploids utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis Reversion of autopolyploids to dipoloids; Genome mapping in polyploids – Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) Gene transfer using amphidiploids – Bridge species. Fertilization barriers in crop plants at pre- and post fertilization levels- In vitro techniques to overcome the fertilization barriers in crops; of haploids, dihaploids and doubled haploids in genetics and breeding.

UNIT-3

History & objectives of plant breeding, patterns & characteristics of evolution of crop plants; centres of Origin-biodiversity; Genetic basis of breeding self- and cross - pollinated crops; components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding. Self-incompatibility and male sterility; Pure line theory, pure line election and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding; Breeding methods in cross pollinated crops; Heterosis& Hybrid

breeding ; seed production of hybrid and their parent arieties/inbreds. Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection. Self-incompatibility and male sterility; Concept of plant ideotype and its role in crop improvement; Transgressive breeding. 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.

UNIT-4

Mendelian traits vs polygenic traits; Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, Models of G X E; non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects. ANOVA; MANOVA, biplot analysis; Experimental Designs; Genetic diversity analysis; D2 analyses; correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices; Simultaneous selection models heritability and genetic advance. Generation mean analysis; Mating designs; Concepts of combining ability and gene action; adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis – principles and interpretation. QTL mapping; Marker assisted selection (MAS).

UNIT-5

Ultrastructure of the cell; eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus- Structure and chemical composition; Cell division and physiology of cell division. Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors. Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.

UNIT-6

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 (F2s, 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. Molecular breeding; Genomics and geno-informatics 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.

UNIT-7

Variety Development and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid and population; Variety testing, release and notification systems in India and abroad. DUS testing- Genetic purity concept and maintenance breeding. genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties; Principles & methods of seed production; Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology; of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

SUBJECT: PLANT PATHOLOGY (Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT-1

Classification of fungi, economic mycology, edible fungi and entomogenous fungi mycorrhizal association, cell organelles, their morphology, functions and chemical composition.

UNIT-2

Nature, composition and structure of viruses and viroids Symptomatology of important plant viral diseases, transmission, properties of viruses , host virus interaction, virus vector relationship. Virus nomenclature and classification, genome organization, replication and movement of viruses. Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics. Myco-viruses, satellite viruses, satellite RNAs, phages, prions. Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

UNIT-3

Importance of phytopathogenic bacteria. Evolution, classification and nomenclature of phytopathogenic procaryota and important diseases caused by them. Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procaryota. General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios. Procaryotic inhibitors and their mode of action against phytopathogenic bacteria. Survival and dissemination of phytopathogenic bacteria.

UNIT-4

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development. Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies-oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance. Disease management strategies.

UNIT-5

Pure culture techniques, use of selective media to isolate pathogens. Preservation of plant pathogens and disease specimens, use of haemo-cytometer, 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.

UNIT-6

Morphology and anatomy of typical monocotyledonous and dicotyledonous infected

seeds. Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens. Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens.

Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection. Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

UNIT-7

Molecular mechanisms of pathogenesis, process of infection, variability in plant pathogens. Mechanism of resistance. Host defense system. Antiviral protein.SAR, active oxygen radicals. Hypersensitivity and its mechanisms Tissue culture, elementary genetic engineering. Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

UNIT-8

Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications. Development of IDM-basic principles, biological, chemical and cultural disease management.IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed, mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.

SUBJECT: SOIL SCIENCE & AGRICULTURAL CHEMISTRY
(Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT-1

Chemical (elemental) composition of the earth`s crust and soils. Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics. Soil colloids: inorganic and organic colloids – origin of charge, concept of point of zero-charge (PZC) surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter – fractionation of soil organic matter and different fractions, clay- organic interactions. Ion exchange processes in soil; cation exchange – theories based on law of mass action adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange – innersphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, AEC, CEC; experimental methods to study ion exchange phenomena and practical implication in plant nutrition. Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation – dissolution equilibria; step and constant –rate K; management aspects. Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity. Chemistry of salt- affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments. Chemistry and electrochemistry of submerged soils.

UNIT-2

Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism. Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate mineral and their identification; clay minerals in Indian soils. Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformation; soil profile; weathering sequences of minerals with special reference to Indian soils. Concept of soil individual; soil classification system, soil mineralogy and soil maps – usefulness. Soil survey and its types; soil survey techniques – conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretation; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps. Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concepts and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

UNIT-3

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interaction; un-culturable soil biota. Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin activities and importance; soil

characteristics influencing growth and activity of microflora. Microbial transformation of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, humus formation; cycles of important organic nutrients. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil. Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost. Biofertilizers – definition, classification, specifications, method of production and role in crop production.

UNIT-4

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter. Sensor system – camera, microwave radiometers and scanners; fundamentals of aerial photographs and image processing and interpretations. Application of remote sensing techniques – land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, wasteland identification and management. Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo- statistical techniques of evolution of soil variability. Introduction to GIS and its application for spatial and non – spatial soil and attributes.

UNIT-5

Soil texture, textural classes, mechanical analysis, specific surface. Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage – basic concepts. Soil structure – genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting – mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation. Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil moisture characteristic curve; hysteresis, measurement of soil-moisture potential. Water flow in saturated and unsaturated soils, Poiseuille`s law, Darcy`s law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils. Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum. Composition of soil air; renewal of soil air – convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management. Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

UNIT-6

Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants – their CPC standers and effect on plants, animals and human beings. Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal. Pesticides – their classification, behavior in soil and effect on soil microorganisms. Toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health. Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases – carbon dioxide, methane and nitrous oxide. Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

UNIT-7

Soil fertility and soil productivity; nutrient sources; essential plant nutrients – functions and deficiency symptoms. Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation types, mechanism, microorganism and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency. Soil and fertilizer phosphorus – forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers – behavior in soils and management under field conditions. Potassium – forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers. Sulphur – source, forms, fertilizers and their behavior in soils; calcium and magnesium – factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers. Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability. Common soil test methods for fertilizer recommendation; quantity – intensity relationships; soil test crop response correlations and response functions. Fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management. Soil fertility evaluation; soil quality in relation to sustainable agriculture.

SUBJECT: HORTICULTURE (FRUIT SCIENCE)
(Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT-1

Importance and management of tropical sub tropical temperate and dry land fruits grown in India. Commercial varieties of regional, national and international importance. Recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bio-regulators. Physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential. Agri. Export Zones (AEZ) and industrial supports. Crops Mango, Banana, Citrus, Papaya, Guava, Sapota, Jackfruit, Aonla, Pomegranate, Ber, Apple, Pear, Grapes, Plums, Peach, Nuts- walnut, Almond Minor fruits- Bael, Fig and Jamun.

UNIT-2

Sexual propagation, apomixis, polyembryony, chimeras. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Rejuvenation through top working–Progeny orchard and scion bank. Micro-propagation–principles and concepts, commercial exploitation in horticultural crops. Nursery–types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

UNIT-3

Principles of biodiversity in germplasm conservation of fruit crops. Present status of gene centers; exploration and collection of germplasm *in situ* and *ex situ;*I ntellectual property rights. Crops Mango, citrus, guava, banana, papaya, coconut.

UNIT-4

Principles and practices of breeding of fruit crops. Breeding systems, breeding objectives, approaches for crop improvement-introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses in the following selected fruit crops. Crops Mango, banana, citrus, grapes, guava, papaya.

UNIT-5

Principles and practices in canopy management of fruit crops. Canopy management-importance and advantages; factors affecting canopy development. Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Canopy management through plant growth inhibitors, training and pruning and management practices in temperate fruits, grapes, mango, guava, citrus and ber. Role of hormones in different horticultural crops- fruit thinning, fruit drop, ripening, dormancy breaking and propagation.

SUBJECT: HORTICULTURE (VEGETABLE SCIENCE)
(Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT-1

Production technology of vegetable crops. 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 vegetable crops like - solanaceous crops, root crops, bulb crops, cucurbitaceous crops, sweet potato, okra and leafy vegetables.

UNIT-2

Breeding methods (introduction, selection, hybridization, mutation) of vegetable crops. Resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics like - Potato, tomato, okra, peas, cabbage, cauliflower, carrot, radish, melons and pumpkins.

UNIT-3

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.

UNIT-4

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production, methods of hybrid seed production. Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control. Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, okra and leafy vegetables.

UNIT-5

Production technology of underutilized vegetable crops. 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 production of: Asparagus, Elephant foot yam, lima bean, Sweet gourd, spine gourd and pointed gourd.

UNIT-6

Organic farming in vegetable production. Importance, principles, perspective, concept and component of organic production of vegetable crops. Organic production of vegetables crops, *viz.*, solanaceous crops, cucurbits, cole crops, root and tuber crops. Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavvya, Bio-dynamics, preparation etc.

SUBJECT: AGRICULTURE- BIOTECHNOLOGY
(Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT-1

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; 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, Animal husbandry, Environmental remediation, Energy production and Forensics; Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

UNIT-2

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 odifications; Operon concept; Attenuation of trp operon; important features of gene regulation in eukaryotes.

UNIT-3

General structure and constituents of cell; Similarities and distinction between plant and animal cells; Cell wall, cell membrane, structure and composition of biomembranes, cell surface related functions. Structure and function of major organelles: Nucleus, Chloroplasts, Mitochondria, Ribosomes, Lysosomes, Peroxisomes. Endoplasmic reticulum, Microbodies, Golgi apparatus, Vacuoles, etc. Organellar genomes and their manipulation; Ribosomes in relation to cell growth and division; Cyto-skeletal elements. Cell division and regulation of cell cycle; Membrane transport; Transport of water, ion and biomolecules; Signal transduction mechanisms; Protein targeting.

UNIT-4

History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; In vitrod differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on in vitro culture and regeneration; Molecular basis of plant organ differentiation. Micropropagation; Anther and microspore culture; Somaclonal variation; In vitro mutagenesis; In vitro fertilization; In vitro germplasm conservation; Production of secondary metabolites; Synthetic seeds. Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization: protoplast fusion, cybrids, asymmetric hybrids, etc. Methods of plant transformation; Vectors for plant transformation; Genetic and molecular analyses of transgenics; Target traits and transgenic crops; Biosafety issues, testing of transgenics, regulatory procedures for commercial approval.

UNIT-5

Introduction, scope and historical developments; Isolation, screening and genetic improvement (involving classical approaches) of industrially important organisms. Primary metabolism products, production of industrial ethanol as a case study; Secondary metabolites, bacterial antibiotics and non ribosomal peptide antibiotics; Recombinant DNA technologies for microbial processes; Strategies for development of industrial microbial strains with scale up production capacities; Metabolic pathway engineering of microbes for production of novel product for industry. Microbial enzymes, role in various industrial processes, production of fine chemicals for pharmaceutical industries ; Bio-transformations, Bio- augmentation with production of vitamin C as a case study; Bioreactors, their design and types; immobilized enzymes based bioreactors; Microencapsulation technologies for immobilization of microbial enzymes. Industrial biotechnology for pollution control, treatment of industrial and other wastes, biomass production involving single cell protein; Bio- remediation of soil; Production of eco-friendly agricultural chemicals, bio- pesticides, bio-herbicides, bio-fertilizers, bio-fuels, etc.

UNIT-6

Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Aspects of molecular breeding. Development of sequence based molecular markers - SSRs and SNPs; Advanced methods of genotyping; Mapping genes for qualitative and quantitative traits. QTL mapping using structured populations; AB-QTLanalysis; Association mapping of QTL; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene based markers; Allele mining by TILLING and Eco-TILLING; Use of markers in plant breeding. Marker assisted selection (MAS) in backcross and heterosis breeding; Transgenic breeding; Foreground and background selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples.

SUBJECT: PLANT PHYSIOLOGY (Ph.D. ENTRANCE TEST)
SECTION I (40 MARKS 40 QUESTIONS)

This section will contain 40 questions with multiple choices to test general awareness, research aptitude, reasoning, basics of computation, logic, data interrelation, presentation, analysis synthesis etc.

SECTION II (60 MARKS 30 QUESTIONS)

UNIT-1

Cell organelles and their physiological functions, Cell membrane structure and functions. Water and its role in plants, properties and functions of water in the cell. Water potential of plant cells. Mechanism of water uptake and transport in roots, aquaporins, Mycorhizal association on water uptake. Energy balance-Solar energy input-energy dissipation at crop canopy level- evapotranspiration, transpiration Stomata structure and function. Influence of water stress at cell, organ, plant and canopy levels. Indices for assessment of drought resistance. The role of mineral nutrients in plant metabolism. Essential elements. Mechanisms of uptake-translocation of minerals in plants. Metabolic functions of mineral elements, deficiency symptoms, and toxicity. Foliar nutrition. Synthesis of sucrose, starch, oligo and polysaccharides (composition of cell wall). Translocation of photosynthates. Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration. Lipid metabolism- Types of lipids. Biosynthesis of fattyacids, diacyl and triacyl glycerol, fatty acids of storage lipids. Secondary metabolites. Hormonal concept of growth and differentiation, plant growth hormones and their physiological role synthetic growth regulators. Growth retardants, Apical dominance, senescence, fruit growth, abscission. Photo morphogenesis- Photo receptors, physiology of flowering, Photoperiodism and Vernalisation.

UNIT-2

Plant Biodiversity, evolution in plants. General Aspects – Plant growth and development; Analysis of plant growth. Mobilization of food reserves during seed germination; Hormonal control of seed germination and seedling growth. Shoot, Leaf and Root Development –Floral Induction and Development – Photoperiodism and Vernalization, Molecular genetics of floral development and floral organ differentiation; Sex determination. Seed Development and Dormancy – Molecular and genetic determinants; Seed maturation and dormancy. Senescence and Programmed Cell Death (PCD) – PCD in the life cycle of plants. Light Control of Plant Development. Phytochromes and cryptochromes, Molecular mechanisms of light perception, signal transduction and gene regulation; Biological clocks Embryonic Pattern Formation –Maternal , Zygotic and Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants. Regeneration and totipotency; Organ differentiation and development; Pollen germination and pollen tube guidance; Phloem differentiation; Sex determination in plants. Self-incompatibility and its genetic control; Heterosis and apomixis.

UNIT-3

Definition of abiotic stresses. Abiotic stress factors. Water stress and Drought characteristic features. Physiological processes affected by drought. Drought resistance. mechanisms: Drought avoidance, Stress proteins. Water use efficiency as a drought resistant trait. Molecular responses to water deficit: Stress and hormones- ABA as a signaling molecule. Oxidative stress: Reactive Oxygen Species (ROS). High temperature stress: HSP's, Chilling stress: Salinity: Glycophytes and halophytes. Heavy metal stress: Phytochelatins

UNIT-4

Definition and classification of plant growth regulators- Hormones, endogenous growth substances and synthetic chemicals Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- Auxins, Gibberlins, cytokinins, Abscisic acid and Ethylene Brassinosteroids. Hormone

mutants and transgenic plants in understanding role of hormones. Signal perception. transduction, and effect at functional gene level of different hormones- Auxins- cell elongation, Gibberellins -, germination of dormant seeds, cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid-Stomatal closure and induction of drought resistance, Ethylene- fruit ripening. Interaction of hormones in regulation of plant growth and development processes. Synthetic growth regulators- Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

UNIT-5

Crop growth analysis, key growth parameters. Factors limiting crop growth and productivity- the concept of rate limitation. Phenology- Growth stages, Factors influencing flowering. Photoperiodic and thermo-periodic responses. Canopy architecture, light interception, energy use efficiency of different canopies. Source-sink relationships. Physiological and molecular control of sink activity. Plant growth analysis techniques, yield structure analysis, theoretical and actual yields. Plant ideotypes. Simple physiological yield models- Duncan's. Monteith's, and Passioura's. Crop growth models-empirical models testing and yield prediction.

UNIT-6

The cellular basis of growth and morphogenesis cyto-differentiation. The cell cycle-Cell division and cell organization. Cell structure, morphogenesis and cellular totipotency. Introduction to in vitro methods : Terms and definitions, Use of growth regulators. Beginning of in vitro cultures in our country. Embryo culture, embryo rescue Endosperm culture and production of triploids. Embryogenesis and organogenesis and their practical applications : Clonal Multiplication of elite species. (Micro-propagation) Haploids and their applications. Somaclonal variations. Protoplast isolation : Principles and applications. Testing of viability of isolated protoplast. Steps in the regeneration of protoplast. Somatic hybridization –Various methods for fusing protoplast. Use of makers for selection of hybrid cells. Practical applications of somatic hybridization (hybrids vs cybrids). Use of plant cells, protoplast and tissue culture for genetic manipulation of plant : Introduction to *A. tumefaciens*. Tumour formation on plants using *A. tumefaciens* (Monocots vs Dicots), Root – formation using *A. rhizogenes.*

UNIT-7

Photosynthesis- its significance in plant growth, development and bio-productivity. Physiological and biochemical aspects: chloroplast structure development and replication, photo systems, mechanism of light absorption, electron transport chain, Coupling factors and mechanisms of ATP synthesis, quantum yield. Photosynthetic carbon reduction cycle and its regulation. CO2Concentration Mechanism (CCM) as a complementary strategy for carbon fixation. CCM in photosynthetic bacteria, micro algae, Submerged Aquatic macrophages (SAM), C4, CAM and single celled C4 organisms. Rubisco structure, assembly and kinetics, photorespiration and its significance. Carbon fluxes between chloroplast and cytoplasm, the concept of RA, RS and RM. Pi recycling, starch and sucrose synthesis and export. Concept of canopy photosynthesis, influence of environmental factors such as water stress, high light

stress VPD etc. Molecular aspects: chloroplast genome organization, expression and regulation of plastid genes Genes regulating potential traits of photosynthesis, biotechnological approaches for improving photosynthetic rate and productivity – transgenics. Conceptual approaches of expressing C4 photosynthesis genes in C3 species. Photosynthesis and crop productivity, energy utilization efficiency by crops. Photo inhibition, photo oxidation, excitation energy dissipation mechanisms, photochemical and no-photochemical quenching of chlorophyll fluorescence. Photosynthesis and transpiration interaction, significance of WUE, carbon isotope discrimination concept. Nitrogen assimilation in photosynthesizing cells – NO_3 -NO_2 - reduction, GS-GOGAT pathway. Photorespiration loss of Ammonia and its re-assimilation and NUE