Syllabus for Ph.D. (Genetics & Plant Breeding) Entrance Test

UNIT I

Historical perspective on Genetics. Mendelian principles; Gene interactions; Linkage: detection and estimation in various organisms. Multiple alleles. Mechanisms of sex determination- Sex linked, sex- influenced and sex-limited traits. Inter-genic and intragenic complementation, recombination and complex loci. Fine structure of gene; Genetic control of metabolism. Gene-protein-polypeptide relationships. Genetic material: nature, organization, structure and replication. Genetic code transcription and translation. Gene regulation in prokaryotes and eukaryotes with models. Split genes, alternative splicing, transcriptional and post-transcriptional regulation. Mobile genetic elements and dynamic nature of genome. Mutations: induction, detection and mechanisms. Environmental influence on gene expression. Extra nuclear inheritance. Polygenic inheritance. Population genetics: Hardy-Weinberg equilibrium, changes in gene and genotype frequencies. Human genetics: genetic disorders and gene therapy. Introduction to recombinant DNA technology.

Secondary structure of DNA (A, B, C, Z and P-DNA), Denaturation and renaturation of DNA, Secondary and tertiary structures of RNA. Physico-chemical organization of chromatin, nucleosome concept and higher order organization of chromatid. Mobile genetic elements in pro- and eukaryotes and their significance. Aims and principles of gene transfer, vectors, restriction enzymes, distinguishing transferred genes from endogenous genes. *In vitro* synthesis of recombinant DNA and gene cloning. Gene transfer methods – Agrobacterium mediated and direct gene transfer method. Role of genetic engineering – transgenic crops, current status and prospects, potential hazards of gene cloning. Construction of genomic libraries. Molecular markers, types and significance. Genome projects, genomics and proteamics. Bioinformatics.

UNIT II

Introduction of plant breeding – history and objectives. Plant introduction, domestication and acclimatization. Center of origin. Germplasm collection, evaluation and conservation. Gene pool concept. Mechanisms controlling pollination and their consequences – mode of reproduction, male sterility and self incompatibility .Mating system and their genetic consequences Breeding self pollinated crops – methods, their basic and achievements. Pure line theory and concept of pure line. Mass selection, pure line selection, pedigree selection, bulk method, single seed descent and back cross method. Population breeding – population and role of population, intra and inter population improvement methods. Hybrid breeding – gene pool development, development of inbreds, production of hybrid, improvement of inbreds and achievements. Synthetic varieties. Breeding vegetatively propagated crops. Role of Mutation in Plant Breeding. Application of biotechnology in plant breeding. Intellectual property rights in relation to plant breeding.

UNIT III

Historical background of quantitative inheritance. Probability laws and distributions. Elementary concepts of matrix theory, modulation of equation through matrix theory (linear models). Expectation of fixed and random effect models. Partitioning of mean and variances. Single gene and multiple gene models-estimation of genetic parameters and scaling tests. Covariance between relatives. Gene and genotype frequency- Hardy-Weinberg law, mean and variance. Heritability, selection differential, response to selection and correlated response. Concept of combining ability and its relevance to gene action. Inbreeding and heterosis- simple model and extension to polygenic situations. Mating designs- Diallel, North Carolina, Line x Tester and Triple test cross. Genotype x environment interaction and stability analysis. Correlation, path coefficient, Selection indices and Genetic divergence.

A detailed study of variability, its nature, origin and measurement. Generation means and analysis of gene effects. Principles of second degree statistics in relation to biometrical genetics. Balance sheet of variation in different generations. Development of mating designs. Weighted analysis. Genetic divergence, its estimation and importance in plant breeding.

Genotype-environment interaction, its estimation and importance in plant breeding. Analysis and interpretation of mating designs – Diallel, Partial diallel, Line x Tester, NCD I, II & III, Tripal test cross, Three way and Double cross. Marker assisted selection and QTL analysis. Stability parameters, estimation and inlocpretation.