Department of Genetics and Plant Breeding

Ph.D Programme

Course No.	*Title of the course*	*Credits*
1st Semester		
GPB-701	Genomics in crop Improvement	1+2
GPB-702	Advanced Plant Breeding Systems	2+0
GPB-703	Advanced Breeding of Major Field Crops	3+0
2nd Semester		
GPB-751`	**Breeding Designer Crops**	**2+0**
GPB-752	**Biodiversity and Plant Resource Management**	**2+0**
GPB-799	Seminar-I	1+0
3rd Semester		
GPB-849	Seminar-II	1+0
4th Semester		
	Nil	
5th Semester		
	Nil	
6th Semester		
GPB-999	Seminar-III	1+0

Programme Details

1St Semester

1. GPB-601 Genomics in Crop Improvement 1+2

Theory

UNIT I: Introduction to the plant genome- Plant nuclear genomes and their molecular description - The chloroplast and the mitochondrial genomes in plants - Genome size and complexity.

UNIT II: Establishment of plant genome mapping projects - Genome mapping and use of molecular markers in plant breeding; Strategies for mapping genes of agronomic traits in plants- Approaches for mapping quantitative trait loci; Map based cloning of plant genes.

UNIT III: Regulation of Plant gene expression - Functional genomics – Expression Analysis using Microarrays – Transposon tagging and Insertional mutagenesis- methods and significance- Diversity Array Technology.

UNIT IV: Genome sequencing in plants–Principles and Techniques; Applications of sequence information in plant genome analyses; Comparative genomics–Genome Comparison Techniques-Classical and advanced approaches.

UNIT V: Detection of Single Nucleotide Polymorphism; TILLING and Eco-TILLING; Role of transcriptomics, proteomics and metabolomics inlinking genome and phenome; Importance of understanding the phenotypes for exploiting the outcome of genomic technologies- Knock out mutant studies and high throughput phenotyping.

UNIT VI: Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools in structural and functional genomics.

Practical

Chromosome analysis in major field crops - Comparative analysis of plant genomes using molecular markers – Genetic map construction using molecular markers – Mapping major genes using molecular markers – QTL mapping in plants – Comparison across mapping populations –

Understanding the need genetic algorithms in QTL mapping – Plant Genome Databases – Computational tools to explore plant genome databases – Comparative genomics – Comparison of genome sequences using tools of bioinformatics- Advanced genomic technologies: Linking genome sequences to phenotypes: Tools of transcriptomics, proteomics and metabolomics.

GPB-602 Advanced Plant Breeding Systems 2+0

Theory

UNIT I: Facts about plant breeding before the discovery of Mendelism; Evolutionary concepts of genetics and plant breeding - Flower development and its importance; genes governing the whorls formation and various models proposed; Mating systems and their exploitation in crop breeding; Types of pollination, mechanisms promoting cross pollination.

UNIT II: Self- incompatability and sterility – Types of self incompatability: Homomorphic (sporophytic and gametophytic) and heteromorphic -Breakdown of incompatibility - Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self incompatibility; Sterility: male and female sterility – Types of male sterility: genic, cytoplasmic and cytoplasmic-genic; Exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots – Case studies and breeding strategies; Nucleo-cytoplasmic interactions with special reference to male sterility – Genetic , biochemical and molecular bases.

UNIT III: Population formation by hybridization - Types of populations – Mendelian population, gene pool, composites, synthetics etc.; Principles and procedures in the formation of a complex population; Genetic basis of population improvement.

UNIT IV: Selection in self fertilizing crops; Creation of genetic variability selection methods - Selection methods: mass selection, pureline selection, pedigree method (selection in early generations vs advanced generations); Backcross, polycross and test cross.

UNIT V: Selection in cross fertilizing crops – Polycross and topcross selections, Mass and recurrent selection methods and their modifications – Mass selection: grided mass selection, ear to row selection, modified ear to row selection; Convergent selection, divergent selection; Recurrent selection: Simple recurrent selection and its modifications (restricted phenotypic selection, selfed progeny selection and full sib recurrent selection) Recurrent selection for general combining ability (GCA) – Concepts and utilization - Recurrent selection for specific combining ability (SCA) – usefulness in hybrid breeding programmes - Reciprocal recurrent selection (Half sib reciprocal recurrent selection, Half sib reciprocal recurrent selection with inbred tester and Full sib reciprocal recurrent selection); Selection in clonally propagated crops – Assumptions and realities.

UNIT VI: Genetic engineering technologies to create male sterility; Prospects and problems - Use of self- incompatability and sterility in plant breeding –case studies; - Fertility restoration in male sterile lines and restorer diversification programmes - Conversion of agronomically ideal genotypes into male steriles – Concepts and breeding strategies; Case studies - Generating new cytonuclear interaction system for diversification of male steriles - Stability of male sterile lines – Environmental influence on sterility– Environmentally Induced Genic Male Sterility (EGMS) – Types of EGMS; Influence on their expression, genetic studies; Photo and thermo sensitive genetic male sterility and its use in heterosis breeding - Temperature sensitive genetic male sterility and its use heterosis breeding - Apomixis and its use in heterosis breeding - Incongruity – Factors influencing incongruity - Methods to overcome incongruity mechanisms.

GPB-703 Advanced Breeding of Major Field Crops 3+0

Theory

UNIT I: History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, millets and non cereal crops like Rice Wheat, Maize, Pearlmillet, Sorghum, Pulses, oilseeds, cotton sugarcane, arid legumes and other forage crops etc.

UNIT II: Breeding objectives in rice, wheat, maize, pearlmillet, sorghum,. Pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Genetic resources and their utilization; Genetics of quantitative and qualitative traits.

UNIT III: Breeding for value addition and resistance to abiotic and biotic stresses.

UNIT IV: Conventional (line breeding, population improvement, hybrids) and other approaches (DH

Populations, Marker Assisted Breeding, Development of new male sterility systems), transgenics.

UNIT V: National and International accomplishments in genetic improvement of major field crops and their seed production.

2nd Semester

GPB-751 Breeding Designer Crops 2+0

Theory

UNIT I: Concept of ideotypes of Rice Wheat & Maize; New plant Types (NPT) Rice, Super Rice and Super Hybrid Rice; Breeding of crop ideotypes: Genetic manipulations through recombination breeding, genomics and transgenics for physiological efficiency, nutritional enhancement, special compounds-proteins,vaccines, gums, starch and fats.

UNIT II: Physiological efficiency as a concept, parametric and whole plant physiology in integrated mode; Physiological mechanism of improvement in nutrient use efficiency, water use efficiency, osmotic adjustment, photosynthetic efficiency, stay green trait and its significance in crop improvement.

UNIT III : Improvement in yield potential under sub-optimal conditions by manipulating source and sink, canopy architecture, plant-water relationships, effect of suboptimal conditions on cardinal plant growth and development processes, enhancing input use efficiency through genetic manipulations.

UNIT IV: Breeding for special traits viz. oil, protein, vitamins, amino acids etc.; Concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products; Success stories in vaccines, modified sugars, gums and starch through biopharming

UNIT V: Biosafety management, segregation and isolation requirements in designer crop production and post-harvest management

Practical

Demonstration of plant responses to stresses through recent techniques; Water use efficiency, transpiration efficiency, screening techniques under stress conditions such as electrolyte leakage, TTC, chlorophyll fluorescence, canopy temperature depression, stomatal conductance, chlorophyll estimation, heat/drought/salt shock proteins.

GPB-752 Biodiversity and Plant Resource Management 2+0

UNIT I: Biodiversity: range and implications,

Concentration and variation of biodiversity: ecological consideration, habitat and niches; ecotypes and ecolines. Hotspot concept and Warm spot concept; pattern and measurement.

UNIT II: Evolution of reproductive system: its need and consequences in vascular plants.

UNIT III: Knowledge of gene pools, land races and their real potential, vis-à-vis contrived projection; Genetic Drift-genetic erosion: causes and consequences.

UNIT IV: Competition in natural communities: biological invasion; introgressive hybridization.

UNIT V: Assessment of biodiversity: Conservation and application

UNIT VI: Knowledge-biopiracy, IPR, CBD and WTO.
