Department of Plant Physiology

Ph.D Programme:

Course no.	Title of the course	Credit
1st Semester		
PPH 701	Advances in Photo Biology	2+0
PPH 702	Functional Genomics and Genes Associated with a Few Physiological Processes	2+0
2nd Semester		
PPH 751	Signal Perceptions and Transduction and Regulation of Physiological Processes	2+0
PPH752	Molecular Approaches for Improving Physiological Traits	2+1
PPH 799	Seminar-I	1+0
3rd Semester		
PPH801	Weed Physiology and Herbicide Action	1+1
PPH 849	Seminar-II	1+0
4th Semester		
PPH 901	Post Harvest Technology	2+1
PPH 902*	Climate Change and Crop Growth	2+0
5th Semester		
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6th Semester		
PPH 999	Seminar -III	1+0

*Pre-requisite course is to be completed before enrollment in this course

Ph.D. Courses

PPH 701: Advances in Photo Biology 2+0

UNIT I: Physical properties of light, energy content of different wave length of light, interaction between radiant energy and matter. Laws of photo chemical reactions, measurement of light.

UNIT II: Light absorption by different pigments, bio-luminescence, fluorescence, phosphorescence.

UNIT III: Chlorophyll biosynthesis, solar energy consumption and biomass production. Structure, properties and physiological roles of the photo-receptors: chlorophylls, Carotenoids, phycobillins, cryptochrome, UV-B receptor, anthocyanin.

UNIT IV: Photo-morphogenesis: phototropism, photo-periodism, photo-induction.

UNIT V: Phytochrome structure, Role of phytochrome in photo-morphogenesis and developmental processes of plants, dark reversion, VLFR, LFR, HIR, photo-regulation of enzymatic activities, circadian rhythms.

PPH 702 Functional Genomics and Genes Associated with a Few Physiological Processes 2+0

Theory

UNIT I: Gene discovery: Finding Genes in Complex Plant System, Constructing Gene-Enriched Plant Genomic Libraries, *In Silico* Prediction of plant Gene Function, Quantitative Trait Locus Analysis as a Gene Discovery Tool.

UNIT II: Genetic tools for plant development- Understanding the importance of mutants in unraveling the physiological processes – T-DNA insertion mutants, Transposon mutagens, Transposition, Physical and Chemical mutagenesis, Gene and Enhancer Traps for Gene Discovery, High-Throughput TAIL-PCR as a Tool to identify DNA Flanking insertions, High-Throughput TILLING for functional Genomics.

UNIT III: Gene knock out approaches: Antisense technology, Virus induced gene silencing (VIGS), Custom Knock-outs with Haripin RNA-mediated Gene Silencing and other silencing tools, Complementation studies, DNA micro arrays.

UNIT IV: Gene Over expression approaches: Vector Construction for Gene Overexpression as a Tool to Elucidate Gene Function; Transient expression, Transgenics.

UNIT V: Proteomics: Networking of Biotechnology for interpreting gene functions. Yeast two hybrid systems to study protein –protein interaction to study gene functions, Proteomics as a

Functional Genomics Tool, Crystallographic and NMR approaches to determine protein structures.

UNIT VI: Functional characterization of genes associated with important cellular processes influencing crop growth and development, Metabolomics.

UNIT VII: Case studies of genes controlling photosynthesis, respiration, photorespiration, fatty acid biosynthesis, nutrient uptake, flowering, seed protein quality and quantity.

PPH 751 Signal Perceptions and Transduction and Regulation of Physiological Processes 2+0

Theory

UNIT I: General aspects: Introduction to signaling-Long range (Diffusible) signaling and short range (contact) signaling. Components of signaling-Upstream components: receptor and ligands concept-types of ligands and its relevance, receptor kinases, two component sensing system. Down stream components: G. proteins, second messengers, Cyclic AMP, adenylate cyclase cascade, cyclic GMP, calcium-calmodulin, kinases.

UNIT II: Hormone signaling: Hormone binding receptors-Transduction process, Effector molecules and gene expression, transcription factors.

UNIT III: Specific signaling pathways of Auxins, Cytokinisn, Gibberllins, Ethylene, ABA, Brassinosteroids, The cross talk in the signaling of different hormones, significance of studies with hormone action mutants.

UNIT IV: Light signaling: Perception, light-pigments involved-activation of phytochrome/cryptochrome (study of mutants). Light signal transduction- Multiple signaling cascades, identification of signaling components through mutant analysis, changes in gene expression.

UNIT V: Abiotic stress signaling: Sensing of environmental factors (Temperature-Osmoticum-Ionic stress) Activation of specific molecules and secondary messengers, Activation of Down stream components. Case studies with different abiotic stresses.

UNIT VI: Cross talk between signaling pathways.

UNIT VII: Signal perception and transduction in plant defense responses: Role of salicylic acid and active oxygen species.

UNIT VIII: Signaling cascade during leaf senescence, abscission, flowering and tuberisation.

UNIT IX: Transcription factor as signaling regulatory tools for improving growth processes- Case studies: Tbi- lateral branch development, Shi 4- grain shattering, GA1- Dwarfing. MADS, KNOX- flowering development, HAT 4- Shade development, AP2-EREBP- biotic/abiotic stresses.

PP 752 Molecular Approaches for Improving Physiological Traits 2+1

Theory

UNIT I: Importance of Molecular Breeding for complex multi-gene controlled physiological traits and its relevance in augmenting trait based breeding. Physiological traits with relevance to growth, development, abiotic stress tolerance, nutrient acquisition, Approaches for accurate phenotyping of large germplasm accessions and/or mapping populations.

UNIT II: The advantages of "Trait based" breeding approaches. Concept of segregation, independent assortment and linkage. The concept of molecular markers, various types of Dominant and Co-dominant marker systems.

UNIT III: Relevance and development of mapping populations and genetic analysis using marker systems. Advantages of association mapping and the concept of linkage.

UNIT IV: Statistical analysis to assess the variance in phenotypic traits and molecular data. Assessment of genetic parameters such as heritability, genetic advance etc.

UNIT V: Strategies for QTL introgression and Marker Assisted Selection (MAS), Map based cloning of novel genes and alleles. Allele mining.

UNIT VI: Transgenic approach in improving physiological processes- Introduction to GMOs and application in crop improvement; gene mining, sequence structure and function analysis using bioinformatics tools, identification of candidate genes for various physiological process associated with specific traits (such as stress tolerance) and their potential benefits in transgenic crops.

UNIT VII: Cloning full-length candidate genes, stress inducible promoters, strategies to clone and characterize and make constructs for specific crops, gene stacking strategies, tissue specific expression and functional validation of genes.

UNIT VIII: Transformation of crop plants-*Agrobacterium* and use of other organisms for transformation-particle gun transformation and other methods.

UNIT IX: Selection of transformants- molecular analysis on the basis of qRT-PCR, Southern, Northern analysis and immunoassays; estimation of copy number. Concept of desirable number of independent events.

UNIT X: Evaluation of transgenics on basis of empirical/physiological/biochemical process under specific conditions on the basis of gene function. Generation of T1 populations, event characterization and generation of molecular data as per the regulatory requirements.

UNIT XI: Issues related to Biosafety and Registration of Transgenic Agricultural Organisms, methods to detect GMOs from agricultural products.

Practical

Phenotyping approaches for the different physiological traits. Genotyping options using gene-scan systems. Development of SSR, SNP and SCAR markers, resolution of polymorphism on agarose gels and PAGE, genotyping using a DNA sequencing machine, scoring of gels and assessment of polymorphism, Statistical approaches to assess genetic variability, heritability and other parameters, Phylogenic analysis, Principal component analysis and construction of dendrograms. Construction of Linkage map, QTL maps, population structure, LD decay etc leading to identification of QTLs, Bioinformatics – sequence analysis, structure analysis, Molecular biology - genomic/plasmid DNA isolation, RNA isolation. Full-length gene cloning, vector construction with specific promoter, gene stacking & transient assays. Transformation in model system, Crop transformation - *Agrobacterium* mediated transformation, particle-gun transformation, Evaluation of transgenics –semiquantitative & quantitative RT-PCR, southern blot, northern blot, western blot and ELISA, biochemical/physiological assay based on the function of gene.

PPH 801 Weed Physiology and Herbicide Action 1+1

Theory

UNIT I: Weed biology, ecology and physiology. Weed and crop competition, allelochemicals, their nature and impact. Weed-seed physiology.

UNIT II: Classification of herbicides and their selectivity. Recent concepts on entry, uptake, translocation and metabolism of soil and foliar applied herbicides. Environmental and plant factors influencing entry, uptake and translocation of herbicides.

UNIT III: Classification and chemistry of common herbicides. Physiological, biochemical and molecular mechanism of action of different groups of herbicides, ACC synthase inhibitors, ALS inhibitors, Mitotic inhibitors, Cellulose biosynthesis inhibitors, Inhibitors of fatty acid biosynthesis, inhibitors of Photosynthesis, Auxinic Herbicides, New herbicides,

UNIT IV: Metabolic pathway of herbicide degradation in plants and soil. Herbicide adjuvants and their classification.

UNIT V: Molecular mechanism of action of herbicide synergists and antagonists.

UNIT VI: Physiological and molecular mechanism of herbicide selectivity.

UNIT VII: Herbicide resistant crops; transgenic and tissue culture approaches to develop herbicide tolerant varieties.

Practical

Adjuvants and their effect on spray droplets, chemical entry and transport. Determination of physiological and biochemical processes like photosynthesis, respiration, cell division, Protein and fatty acid synthesis, membrane permeability as affected by herbicides. Quantification of pigment levels in leaves, specific enzyme activities affected by herbicides. Demonstration of translocating type of herbicides by radio labeling studies.

PPH 901 Post Harvest Physiology 2+1

Theory

UNIT I: PCD, senescence in plants, Environmental factors influencing senescence, ripening and post harvest life of flowers, vegetables and seeds.

UNIT II: Molecular mechanism of senescence and ageing. Physiological, biochemical and molecular aspects of senescence and fruit ripening.

UNIT III: Senescence associated genes and gene products.

UNIT IV: Functional and ultrastructural changes in chloroplast membranes, mitochondria and cell wall during senescence and ripening.

UNIT V: Regulatory role of ethylene in senescence and ripening, ethylene biosynthesis, perception and molecular mechanism of action.

UNIT VI: Post harvest changes in seed and tubers, biochemical constituents and quality parameters. Effect of environmental factors on post harvest changes in seed and tubers.

UNIT VII: Biotechnological approaches to manipulate ethylene biosynthesis and action.

UNIT VIII: Alternate post harvest methodology and quality attributes. Scope for genetic modification of post harvest life of flowers and fruits.

UNIT IX: Uses of GM crops and ecological risk assessment.

Practical

Physiological and biochemical changes during senescence and ripening, Estimation of ethylene during senescence and ripening, determination of Reactive Oxygen Species and scavenging enzymes, Measurement of dark and alternate respiration rates during senescence and ripening. Estimation of ripening related enzyme activity, Cellulases, pectin methyl esterases, polygalacturonase etc.

PPH 902 Climate Change and Crop Growth 2+0

(Pre-requisite course : PPH 501)

Theory

UNIT I: History and evidences of climate change and its implications, Effect of climate change on monsoons, hydrological cycle and water availability.

UNIT II: Natural and anthropogenic activities and agricultural practices on green house gas production, monitoring of green house gases and their influence on global warming and climate change. Ionizing radiation, UV-B, chlorinated fluorocarbon (CFC) - their impact on ozone depletion leading to ozone hole and its implications on plant ecosystem.

UNIT III: Study of the effect of elevated CO_2 on plant growth and development. Concept of Open top chamber (OTC) and Free air CO_2 enrichment (FACE) technology to study the interaction of elevated CO_2 and high temperature on plant growth and productivity.

UNIT IV: Direct and indirect effects of climate change on plant processes – phenology, net carbon assimilation, water relations, grain development and quality, nutrient acquisition and yield.

UNIT V: International conventions and global initiatives on carbon sequestration and carbon trading.