Ph.D. (Genetics and Plant Breeding)

Course List

Course Code	Course Name	Credit Hour (T+P)
GPB 601*	Advances in Plant Breeding Systems	3 (3+0)
GPB 602	Advances in Biometrical Genetics	3 (2+1)
GPB 603	Molecular Cytogenetics for Crop Improvement	2 (2+0)
GPB 604	Plant Genetic Resources, Conservation and Utilization	2 (2+0)
GPB 605*	Genomics in Plant Breeding	3 (3+0)
GPB 606	Population Genetics	2 (2+0)
GPB 607	Crop Evolution	3 (3+0)
GPB 608	Breeding Designer Crops	2 (1+1)
GPB 609*	IPR and Regulatory Mechanism (e-course)	1 (1+0)
GPB 691 / 692	Seminar I / II	1 each
GPB 699	Thesis / Research	75

Compulsory major courses. Programme: major courses minimum 12 credits including the starred courses; minor courses 6; supporting courses 5; seminars 2; research 75; total 100 credits. Comprehensive (pre-qualifying) examination is non-credit (100 marks, satisfactory / not satisfactory).

Course Title: Advances in Plant Breeding Systems*

Course Code: GPB 601

Credit Hours: (3+0)

This course is an advancement of principles, various plant breeding methodologies and procedures in the development of a complex population; MAS for selection of qualitative and quantitative traits, gene pyramiding, marker-based utilization of exotic germplasm and introgression libraries.

Aim of the course

To impart theoretical knowledge about advances in plant breeding.

Theory

Block 1: Reproductive biology and breeding methodologies

Unit I: Reproductive biology: Advances in reproductive biology of crops; genes governing the whorls formation and various models proposed; pollen-pistil interaction: biochemical and molecular basis, environmental factors governing anthesis and bottlenecks for gene transfer.

Unit II: Plant breeding methodologies: Classic versus modern; overview of pre- and post-Mendelian breeding methods in self and cross pollinated crops; molecular and transgenic breeding approaches; doubled haploid breeding, shuttle breeding, forward and reverse breeding, speed breeding, participatory plant breeding, breeding for organic situations.

Block 2: Population improvement and molecular breeding

Unit III: Complex populations and recurrent selection: Principles and procedures in the formation of a complex population; genetic basis of population improvement in crop plants; recurrent selection methods in self and cross pollinated crops and their modifications; convergent selection, divergent selection; recurrent selection, usefulness in hybrid breeding programs; reciprocal recurrent selection; selection in clonally propagated crops – assumptions and realities.

Unit IV: Molecular markers in breeding: Choice of molecular markers for plant breeding efficiency, fingerprinting and genetic diversity assessment, application of MAS for selection of qualitative and quantitative traits; gene pyramiding, accelerated backcrossing, marker-based utilization of exotic germplasm, introgression libraries.

Block 3: Genetic resources and male sterility

Unit V: Gene pools, self-incompatibility and male sterility: Genetic resources: primary, secondary, tertiary and alien transgene pool; molecular and biochemical basis of self-incompatibility and male sterility, nucleo-cytoplasmic interactions with special reference to male sterility – genetic, biochemical and molecular bases.

Unit VI: Engineered sterility, EGMS and incongruity: Genetic engineering technologies to create male sterility, prospects and problems, use of self-incompatibility and sterility in plant breeding – case studies; fertility restoration in male sterile lines and restorer diversification programs; conversion of agronomically ideal genotypes into male sterile: concepts and breeding strategies; case studies – generating new cyto-nuclear interaction system for diversification of male sterile; 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 in heterosis breeding; apomixis and its use in heterosis breeding; incongruity: factors influencing incongruity, methods to overcome incongruity mechanisms.

Block 4: Breeding for climate change

Unit VII: Breeding for climate change: Improving root systems, abiotic stress tolerance, water use efficiency, flooding and submergence tolerance; biotic stress tolerance; nutrient use efficiency, nitrogen fixation and assimilation, greenhouse gases and carbon sequestration; breeding for bio-fortification.

Learning outcome

After successful completion of this course,

- The students will know various plant breeding methodologies, principles and procedures for the formation of a complex population; MAS for selection of qualitative and quantitative traits, gene pyramiding, marker based utilization of exotic germplasm and breeding for climate change.

Suggested Reading

- Agarwal RL. 1996. Fundamentals of Plant Breeding and Hybrid Seed Production. Oxford & IBH.
- Allard RW. 1966. Principles of Plant Breeding. John Wiley & Sons.
- Briggs FN and Knowles PF. 1967. Introduction to Plant Breeding. Reinhold.
- Fehr WR. 1987. Principles of Cultivar Development: Theory and Technique. Vol. I. Macmillan.
- Hayes HK, Immer FR and Smith DC. 1955. Methods of Plant Breeding. McGraw-Hill.
- Kang MS and Priyadarshan PM (Eds.). 2007. Breeding Major Food Staples. Blackwell Publishing.
- Kole C. 2013. Genomics and Breeding for Climate-Resilient Crops. Vol. 2 – Target Traits. Springer.
- Mandal AK, Ganguli PK and Banerji SP. 1995. Advances in Plant Breeding. Vols. I, II. CBS.
- Richards AJ. 1986. Plant Breeding Systems. George Allen & Unwin.
- Sharma JR. 1994. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
- Simmonds NW. 1979. Principles of Crop Improvement. Longman.
- Singh BD. 1997. Plant Breeding: Principles and Methods. 5th Ed. Kalyani Publishers, New Delhi.
- Singh P. 1996. Essentials of Plant Breeding. Kalyani Publishers, New Delhi.
- Welsh JR. 1981. Fundamentals of Plant Genetics and Breeding. John Wiley.

Course Title: Advances in Biometrical Genetics

Course Code: GPB 602

Credit Hours: (2+1)

This course is essential to understand various qualitative and quantitative systems/techniques related to genetic improvement of crops, G×E interaction, construction of saturated linkage maps and Marker Assisted Selection (MAS).

Aim of the course

To impart theoretical knowledge and computation methods for non-allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

Block 1: Quantitative genetics

Unit I: Continuous variation: Continuous variation – evolutionary studies; genetic principles of continuous variation; qualitative and quantitative techniques – differences, population types, approaches; various types of metrics, F2, FD and mixed; selection of parents; simultaneous selection models; use of multiple regression analysis in selection of genotypes.

Unit II: Components of mean: Additive effect, breeding value, coefficient of gene dispersion, dominance; simple scaling test, expectation of mean of character in various types of families in coupling and dispersed phase; epistasis – specification, weighted and un-weighted joint scaling test; effect of linkage to generation mean, specification of mean to G×E interaction.

Unit III: Components of variance: Advantages, variances of different generations, balance sheet of variance; estimation of parameters – weighted and unweighted, least square analysis; random mating population; experimental population – BIPs, NCD-I, II, III, triple test cross for random mating population and inbreds; estimates of linkage and non-allelic interactions; combining ability analysis, Hayman's approach.

Block 2: G×E interaction and molecular mapping

Unit IV: G×E interaction and stability: G×E interaction, stability and adaptability; advanced models in stability analysis – pattern analysis, Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; merits and limitations of different stability analysis methods; analysis and selection of genotypes; methods and steps to select the best model – biplots and mapping genotypes.

Unit V: Linkage maps, QTLs and MAS: Construction of saturated linkage maps, concept of framework map development; QTLs – different types of markers and mapping populations, linkage maps, mapping – strategies for QTL mapping, desired populations, statistical methods; MAGIC populations; Marker Assisted Selection (MAS) – approaches to apply MAS in plant breeding – selection based on markers – simultaneous selection based on marker and phenotype – factors influencing MAS; heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods; use of advanced software packages for biometrical analysis, interpretation of analysed data.

Practical

- Generation mean analysis: ABC scaling test and joint scaling test – analysis and interpretation
- Estimation of variance of different filial generations and interpretations
- Diallel analysis: numerical, graphical and combining ability analysis; triallel analysis
- NC designs: triple test cross analysis
- Stability analysis: Eberhart and Russell model
- AMMI model – principal component analysis model – additive and multiplicative model – shifted multiplicative model – analysis and selection of genotypes – methods and steps to select the best model – selection systems – biplots and mapping genotypes
- Construction of linkage maps and QTL mapping – strategies for QTL mapping; statistical methods in QTL mapping
- Phenotype and marker linkage studies
- Use of advanced software in biometrical analysis

Learning outcome

After successful completion of this course,

- The students will understand various qualitative and quantitative techniques, G×E interaction, construction of saturated linkage maps and Marker Assisted Selection, and the use of advanced software packages for biometrical analysis and interpretation of analysed data.

Suggested Reading

- Bos I and Caligari P. 1995. Selection Methods in Plant Breeding. Chapman & Hall.
- Dabholkar AR. 1993. Elements of Biometrical Genetics. Concept Publishing Co., New Delhi.

- Falconer DS and Mackay J. 1996. Introduction to Quantitative Genetics. 4th Ed. ELBS/Longman, London.
- Mather K and Jinks JL. 1985. Biometrical Genetics. 3rd Ed. Chapman and Hall, London.
- Nandarajan N and Gunasekaran M. 2008. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
- Roy D. 2000. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi.
- Singh P and Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
- Singh RK and Choudhary BD. 1987. Biometrical Methods in Quantitative Genetics. Kalyani Publishers, New Delhi.
- Weir DS. 1990. Genetic Data Analysis: Methods for Discrete Population Genetic Data. Sinauer Associates.
- Wricke G and Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter.

Course Title: Molecular Cytogenetics for Crop Improvement

Course Code: GPB 603

Credit Hours: (2+0)

This course is needed to understand organization and structure of genome, karyotyping, pre-breeding and applications of cytogenetical methods for crop improvement.

Aim of the course

This course focuses on applications of cytogenetic techniques for crop improvement.

Theory

Block 1: Genome organization and karyotyping

Unit I: Genome organization: Organization and structure of genome, genome size, organization of organellar genomes, nuclear DNA organization, nuclear and cytoplasmic genome interactions and signal transduction; inheritance and expression of organellar DNA; variation in DNA content – C value paradox; sequence complexity – introns and exons, repetitive sequences, role of repetitive sequence.

Unit II: Karyotyping: Chromosome banding and chromosome painting; tracking introgressions using FISH, GISH, localization and mapping of genes/genomic segments.

Block 2: Cytogenetical methods in crop improvement

Unit III: Pre-breeding and gene location: Pre-breeding and applications of cytogenetical methods for crop improvement; location and mapping of genes on chromosomes: deficiency method; interchange genetic consequence, identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; multiple interchanges – use in producing inbreds, transfer of genes – linked marker methods; duplication – production and use; inversions and location of genes; B/A chromosome translocations and gene location.

Unit IV: Trisomics and monosomics: Trisomics – types, production, breeding behaviour and location of genes, use of balanced tertiary trisomics in hybrid seed production; monosomics – methods of production, breeding behaviour and location of genes; intervarietal substitutions – allelic and non-allelic interactions; telocentric method of mapping.

Block 3: Cytogenomics and polyploidy

Unit V: Cytogenomics: Concept, tools and techniques for crop improvement; chromosome sorting: isolation of specific chromosome for development of molecular maps and gene location.

Unit VI: Polyploidy and distant hybridization: Role of polyploidy in crop evolution and breeding; auto- and allopolyploids; distant hybridization, barriers to interspecific and intergeneric hybridization; behaviour of interspecific and intergeneric crosses.

Learning outcome

After successful completion of this course,

- The students will understand organization and structure of genome, karyotyping, pre-breeding, polyploidy and applications of cytogenetical methods for crop improvement.

Suggested Reading

- Clark MS and Wall WJ. 1996. Chromosomes: The Complex Code. Chapman & Hall.
- Conger BV (Ed.). 1981. Cloning Agricultural Plants via in-vitro Techniques. CRC Press.
- Constabel F and Vasil IK (Eds.). 1988. Cell Culture and Somatic Cell Genetics of Plants. Vol. V. Cell Culture and Phytochemicals in Plant Cell Cultures. Academic Press.
- Gupta PK. 2006. Cytogenetics. Rastogi Publisher.
- Lal R and Lal S (Eds.). 1990. Crop Improvement Utilizing Biotechnology. CRC Press.
- Mantel SH and Smith H. 1983. Plant Biotechnology. Cambridge University Press.
- Sen SK and Giles KL (Eds.). 1983. Plant Cell Culture in Crop Improvement. Plenum Press.
- Yao-Shan F. 2002. Molecular Cytogenetics: Protocols and Application. Humana Press.

Course Title: Plant Genetic Resources, Conservation and Utilization

Course Code: GPB 604

Credit Hours: (2+0)

This course is needed to make the student aware about the importance of plant genetic resources, their conservation and utilization in crop improvement.

Aim of the course

To impart knowledge on the methods of germplasm conservation and its utilization.

Theory

Block 1: In situ and ex situ conservation

Unit I: In situ conservation: Concept of natural reserves and natural gene banks; in situ conservation of wild species in nature reserves: in situ conservation components, factors influencing conservation value,

national plan for in situ conservation; in situ conservation of agro-biodiversity on-farm; scientific basis of in situ conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of in situ conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

Unit II: Ex situ conservation: Components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, perma-frost conservation, guidelines for seed multiplication and exchange to network of active/working collections, orthodox and recalcitrant seeds – differences in handling, clonal repositories, genetic stability under long term storage condition.

Block 2: Biotechnological conservation

Unit III: In-vitro storage: Maintenance of in-vitro culture under different conditions, in-vitro bank maintenance for temperate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems and prospects of in-vitro gene bank.

Unit IV: Cryopreservation: Procedure for handling seeds of orthodox and recalcitrant types – cryo-protectants, desiccation, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation in agricultural, horticultural and forestry crops; problems and prospects; challenges ahead.

Block 3: Management and utilization

Unit V: PGR management: Concept and procedure for PGR management, germplasm characterization, evaluation and utilization; concept of core and mini core; collections and registration of plant germplasm.

Learning outcome

After successful completion of this course,

- The students will know about the various techniques of conservation of plant genetic resources and their utilization in crop improvement.

Suggested Reading

- Ellis RH, Roberts EH and Whitehead J. 1980. A New More Economic and Accurate Approach to Monitor the Viability of Accessions During Storage in Seed Banks. FAO/IBPGR Plant Genetic Resources Newsletter 41: 3–18.
- Frankel OH and Hawkes JG. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press, Cambridge.
- Paroda RS and Arora RK. 1991. Plant Genetic Resources Conservation and Management. NBPGR, New Delhi.
- Simmonds NW. 1979. Principles of Crop Improvement. Longman.
- Westwood MN. 1986. Operation Manual for National Clonal Germplasm Repository. USDA-ARS and Oregon State Univ., Oregon, USA.

- Withers LA. 1980. Tissue Culture Storage for Genetic Conservation. IBPGR Tech. Rep., Rome, Italy.

Course Title: Genomics in Plant Breeding*

Course Code: GPB 605

Credit Hours: (3+0)

The knowledge of recent trends in plant genomics, genome sequencing, molecular maps, and concepts of high-throughput proteomics, metabolomics and phenomics is essential in rapid crop improvement programmes.

Aim of the course

To impart practical skills in advanced molecular techniques in genome mapping and structural/functional genomics.

Theory

Block 1: Plant genomes and sequencing

Unit I: Plant genomes: Introduction to the plant genomes: nuclear, chloroplast and mitochondrial genomes; concept of genome size and complexity: C-value paradox, repetitive and unique DNA.

Unit II: Genome sequencing: Principles and techniques of conventional approaches and next generation sequencing including sequencing-by-synthesis/ligation and single molecule real time (SMRT) technologies; applications of sequence information: structural, functional and comparative genomics; plant genome projects: strategies for genome sequencing including shot gun and clone-by-clone method.

Block 2: Molecular maps and functional genomics

Unit III: Molecular maps: Use of molecular markers/SNPs for development of genetic and physical maps; linkage and LD-based gene mapping approaches including gene/QTL mapping, genome wide association studies (GWAS) and association analysis; integration of genetic and physical map for map-based cloning of economically important genes; concept of allele mining; diversity array technology: concepts and applications.

Unit IV: Functional genomics: Concept of reverse and forward genetics; use of activation tagging, transposon tagging, insertional mutagenesis, TILLING and EcoTILLING for crop improvement; genome-wide and gene-specific transcriptomics approaches: serial analysis of gene expression, massively parallel signature sequencing, next generation sequencing, microarray, northern hybridization, RT-PCR, qRT-PCR and molecular beacon.

Block 3: Bioinformatics, omics and genome editing

Unit V: Bioinformatics and omics: Development and management of database; applications of bioinformatics tools/software in genomics for crop improvement; basic concepts of high-throughput proteomics, metabolomics and phenomics.

Unit VI: Genome editing and genomics-based breeding: Recent transgene-free genome editing tools such as CRISPR-Cas9 system, TALENs and ZFNs for crop improvement; cisgenesis and intragenesis tools as twin sisters for crop improvement; genomics-based plant breeding: genome-wide genetic diversity studies, identification of molecular markers linked to single genes and QTL, Marker Assisted Selection (marker assisted backcross selection, association mapping, breeding by design, genomic selection).

Learning outcome

After successful completion of this course,

- The students will have expertise on different techniques for genome sequencing, molecular maps, and concepts of high-throughput proteomics, metabolomics and phenomics in crop improvement.

Suggested Reading

- Alonso JM and Stepanova AN. 2015. Plant Functional Genomics: Methods and Protocols. Springer.
- Chopra VL, Sharma RP, Bhat SR and Prasanna BM. 2007. Search for New Genes. Academic Foundation, New Delhi.
- Hackett PB, Fuchs JA and Messing JW. 1988. An Introduction to Recombinant DNA Technology – Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publication Co.
- Primrose SB and Twyman RM. 2006. Principles of Gene Manipulation and Genomics. 7th Ed. Wiley-Blackwell Publishing.
- Sambrook J and Russel D. 2001. Molecular Cloning – A Laboratory Manual. 3rd Ed. Cold Spring Harbor Laboratory Press.
- Singh BD. 2005. Biotechnology: Expanding Horizons. Kalyani Publishers, New Delhi.
- Somers DJ, Langridge P and Gustafson JP. 2009. Plant Genomics: Methods and Protocols. Springer.
- e-Resources: http://gramene.org; https://www.arabidopsis.org; https://wheat.pw.usda.gov; http://ncbi.nlm.nih.gov; http://www.maizegenetics.net

Course Title: Population Genetics

Course Code: GPB 606

Credit Hours: (2+0)

Population improvement programmes are the basis of genetic enhancement in cross pollinated crops. This course is needed to make the students aware about population genetics and its role in crop improvement.

Aim of the course

To impart knowledge on structure, properties and breeding values of different populations.

Theory

Block 1: Populations and Hardy-Weinberg equilibrium

Unit I: Population: Properties of population, Mendelian population; genetic constitution of a population through time, space, age structure, etc.; frequencies of genes and genotypes; causes of change: population size, differences in fertility and viability, migration and mutation.

Unit II: Hardy-Weinberg equilibrium: Hardy-Weinberg law, proof and applications of the Hardy-Weinberg law, test of Hardy-Weinberg equilibrium; mating frequencies: non-dominance, codominance, Snyder's ratio, importance and its effect over random mating in succeeding generations.

Block 2: Gene frequencies and mating systems

Unit III: Gene frequencies and selection: Multiple alleles, more than one locus, sex linked genes; use of gene and genotypic frequencies evaluation in field population level; interpretations – changes of gene frequency, migration, mutation, recurrent and non-recurrent selection; balance between selection and mutation; selection favouring heterozygotes; overdominance for fitness.

Unit IV: Mating systems and polymorphism: Random mating population; non-random mating: selfing – inbreeding coefficient, panmictic index, sib mating, assortative mating and disassortative mating; pedigree populations and close inbreeding; estimation of linkage disequilibrium; correlation between relatives and estimation of F; effect of inbreeding and sibbing in cross pollinated crops; gene substitution and average effects; breeding value – genetic drift; genetic slippage, co-adapted gene complexes; homoeostasis – adaptive organization of gene pools; polymorphism – balanced and non-balanced polymorphism, heterozygous advantage – survival of recessive and deleterious alleles in populations.

Learning outcome

After successful completion of this course,

- The students will be well versed with population genetics, its components and applications in crop improvement.

Suggested Reading

- Chawla V and Yadava RK. 2006. Principles of Population Genetics – A Practical Manual. Dept. of Genetics, CCS HAU, Hisar.
- Falconer DS and Mackay J. 1996. Introduction to Quantitative Genetics. Longman.
- Jain JP, Jain J and Parbhakaran VT. 1992. Genetics of Populations. South Asia Books.
- Li CC. 1955. Population Genetics. The University of Chicago Press.
- Mather K and Jinks JL. 1982. Biometrical Genetics. Chapman & Hall.
- Sorensen D and Gianola D. 2007. Methods in Quantitative Genetics. Series: Statistics for Biology and Health.
- Tomar SS. 1992. Text Book of Population Genetics. Universal Publication.

Course Title: Crop Evolution

Course Code: GPB 607

Credit Hours: (3+0)

This course imparts knowledge about the origin and evolution of species, centres of diversity, speciation, domestication and significance of polyploidy.

Aim of the course

To impart knowledge on crop evolutionary aspects and role of mutations, hybridizations and polyploidy in crop evolution and improvement.

Theory

Block 1: Origin, speciation and domestication

Unit I: Origin and domestication: Origin and evolution of species; centres of diversity/origin, diffused centres; time and place of domestication; patterns of evolution and domestication – examples and case studies; domestication and uniformity – characteristics of early domestication and changes; concept of gene pools and crop evolution; selection and genetic drift – consequences.

Unit II: Speciation and exploitation of natural variation: The process of speciation, reproductive isolation barriers; genetic differentiation during speciation; hybridization – speciation and extinction; exploitation of natural variation: early attempts to increase variation, distant hybridization and introgression, inter-specific and inter-generic hybridization, scope and limitations, techniques to overcome the limitations; gene transfer into cultivated species, tools and techniques; validation of transferred genes and their expression; controlled introgressions.

Block 2: Polyploidy and methods to study evolution

Unit III: Processes in crop evolution: Processes in crop evolution and stabilization of polyploids, cytogenetic and genetic stabilization; genome organization – transgenesis in crop evolution, multifactorial genome, intragenomic interaction, intergenomic interaction, genome introgression; methods to study crop evolution – contemporary methods, based on morphological features, cytogenetic analysis, allozyme variations and crop evolution, DNA markers, genome analysis and comparative genomics.

Unit IV: Polyploidy and crop evolution: Evolutionary significance of polyploidy, evolution of crop plants through ploidy manipulations; polyploids: methods, use of autopolyploids; haploidy and DH – method of production and use; allopolyploids; synthesis of new crops; case studies – cereals, pulses, oilseeds, vegetables, fibre crops, plantation crops, forage crops, tuber crops, medicinal plants.

Learning outcome

After successful completion of this course,

- The students will have knowledge of origin and evolution of species, centres of diversity, speciation, domestication and significance of micro-mutations and polyploidy in genetic improvement of crop plants.

Suggested Reading

- Hancock JF. 2004. Plant Evolution and the Origin of Crop Species. 2nd Ed. CABI.
- Ladizinsky G. 1999. Evolution and Domestication. Springer.
- Miller AJ. 2007. Crop Plants: Evolution. John Wiley & Sons.

- Smartt J and Simmonds NW. 1995. Evolution of Crop Plants. Blackwell.

Course Title: Breeding Designer Crops

Course Code: GPB 608

Credit Hours: (1+1)

This course enlightens about developing varieties for special traits, physiological efficiency and nutritional enhancement. It gives the concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products.

Aim of the course

Breeding crops for higher physiological efficiency and nutritional enhancement.

Theory

Block 1: Ideotypes and physiological efficiency

Unit I: Crop ideotypes: 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: 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; breeding for special traits, viz., oil, protein, vitamins, amino acids, etc.; ecospecific ideotypes, ideotypes for high and low moisture conditions, low and high input conditions, conversion mechanism of C3 to C4 plants; determination of genetics of above mentioned traits.

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

Block 2: Biopharming and biosafety

Unit IV: Biopharming: 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: 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

Learning outcome

After successful completion of this course,

- The students will have a clear understanding of ideotypes of crops under varied agro-climatic situations and breed for physiologically efficient genotypes.
- The students can develop varieties for special traits having high therapeutic and nutraceutical value.

Suggested Reading

- Balint A. 1984. Physiological Genetics of Agricultural Crops. Akadémiai Kiadó.
- Hay RK. 2006. Physiology of Crop Yield. 2nd Ed. Blackwell.
- Pessarakli M. 1995. Handbook of Plant and Crop Physiology. Marcel Dekker.
- Taiz L and Zeiger E. 2006. Plant Physiology. 4th Ed. Sinauer Associates.

Course Title: IPR and Regulatory Mechanism (e-course)*

Course Code: GPB 609

Credit Hours: (1+0)

Biodiversity conservation and its judicious utilization are important in sustainable plant breeding programs. Breeders' and farmers' rights are important in the scenario of globalization of agriculture, so knowledge of IPRs is essential for a plant breeder to protect his varieties.

Aim of the course

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR), related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Block 1: Intellectual property and regulatory mechanism

Unit I: IPR and regulatory mechanism: Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPS and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian legislations for the protection of various types of intellectual properties; fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; national biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; licensing of technologies, material transfer agreements, research collaboration agreement, license agreement.

Learning outcome

After successful completion of this course,

- The students will have acquaintance of intellectual property rights, national and international laws on biodiversity and sustainable use of plant genetic resources through transfer and sharing.
- The students can assist in follow-up of various treatises and laws for research collaborations at international levels.

Suggested Reading

- Erbisch FH and Maredia K. 1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.