Post Graduate Courses
Department of Plant Breeding and Molecular Genetics
Core Courses for M.Sc. (Hons.) Students

PBMG 701	Principles of Plant Breeding	3(2-1)
PBMG 702	Advanced Genetics	3(3-0)
PBMG 703	Molecular Plant Breeding	3(2-1)
PBMG 704	Cytogenetics of Crop Plants	3(2-1)

General Courses for Post Graduate Students

PBMG-705	Breeding and Genetics of Fodder Crops	3(2-1)
PBMG-706	Breeding for Stress Environments	3(2-1)
PBMG-707	Mutation Breeding	3(2-1)
PBMG-708	Population Genetics	3(3-0)
PBMG-709	Cereal Genetics and Breeding	3(2-1)
PBMG-710	Cotton Genetics and Breeding	3(2-1)
PBMG-711	Genetics and Breeding of Oilseed Crops	3(2-1)
PBMG-712	Genetics and Breeding of Sugar Crops	3(2-1)
PBMG-713	Genetic Engineering in Plants	3(2-1)
PBMG-714	Evolution of Field Crops	3(3-0)
PBMG-715	Advanced Cytogenetics	3(3-0)
PBMG-716	Plant Genomics	3(2-1)
PBMG-717	Advanced Methods in Plant Breeding	3(2-1)
PBMG-718	Genetics of Plant Disease and Insect Resistance	3(2-1)
PBMG-719	Development of Hybrid and Seed Production	3(2-1)
PBMG-720	Biometrical Techniques in Plant Breeding	3(2-1)
PBMG-721	Principles of Marketing & Commercialization	3(3-0)
PBMG-722	Special Problem	1(1-0)
PBMG-723	Seminar (M.Sc. Hons.)	1(1-0)
PBMG-724	Thesis (M.Sc. Hons.)	10(0-10)
PBMG-725	Seminar-I (Ph.D)	1(1-0)
PBMG-726	Seminar-II (Ph.D)	1(1-0)
PBMG-727	Ph.D Dissertation	20(0-20)

PBMG 701	**Principles of Plant Breeding**	3(2-1)

Theory

Role of Plant Breeding in crop improvement. Variability in natural populations and its exploitation. Creation of genetic variation using conventional and non-conventional techniques. Specific objectives in various self and cross pollinated crops. Breeding methods in self- pollinated crops. Breeding methods in cross pollinated crops. Heterosis and its exploitation in crop improvement. Development, evaluation and improvement of inbred lines. A, B and R lines in hybrid seed production. Variety evaluation committee. Novelty and DUS characteristics in varietal registration. Seed certification. Seed production system of approved, pure line and hybrid varieties. Reverse breeding. Marker assisted selection in plant breeding.

Practical

Hybridization techniques in self-pollinated and cross pollinated crops. Handling of segregating and inbred generations. Layout of experiments and collection of experimental data, its tabulation and interpretation. Estimating effective population and sample size. Visits to various research institutes.

Books Recommended

1. Sleper D.A. and J.M. Poehlman. 2006. Breeding Field Crops. Blackwell Publishers, Iowa Sate University Press, Ames, USA.
2. Singh, B.D. 2004. Plant Breeding, Principles and Methods. Kalyani Publishers, New Delhi, India
3. Khan, M.A., E. Bashir, and R. Bantel (Editors). 1994. Plant Breeding. National Book Foundation, Islamabad.
4. Fehr, W.R. 1987. Principles of Cultivar Development. Volume I. Theory and Technique. MacMillan Publishing Co., New York.
5. Allard, R. W. 1999. Principles of Plant Breeding. John Wiley and Sons, New York, USA.
6. Chahal, G.S. and S.S. Gosal. 2002. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Alpha Science International Ltd., Oxford, UK.
7. Acquaah, G. 2009. Principles of Plant Genetics and Breeding. John Wiley & Sons, UK.

PBMG 702	**Advanced Genetics**	3(3-0)

Theory

Classical and modern concepts of gene. Genetic material: a brief review: structure, function, organization, replication and properties of genetic material. Gene, genetic code, Wobble hypothesis and one gene-one polypeptide concept. Gene expression and regulation in prokaryotes and eukaryotes. Genetic recombination. Gene interaction: control, basis and importance. Mutation: classification, biochemical basis, factors affecting the rate of mutation and repair mechanism. Transposable genetic elements. Cytoplasmic inheritance: Origin and biological implications, genetics of killer traits. Introduction to non-conventional gene manipulation techniques: epigenetics and gene cloning. DNA sequencing techniques.

Books Recommended

1. Klug, W.S. and M.R. Cummings. 2010. Concepts of Genetics. Dorling Kindersley, Pvt. (Ltd.), New Delhi, India.
2. Snustad, D.P. and M.J. Simmons. 2009. Principles of Genetics. John Wiley and Sons, Inc., New York, USA.
3. Hartl, D.L. 2005. Genetic Analysis of Genes and Genomes. 6th ed. John and Bartlett Publishers, NY, USA.
4. Lewin, B. 2004. Genes VIII. John Wiley and Sons, NY, USA.
5. Reece, R.J. 2004. Analysis of Genes and Genomes. John Wiley & Sons, NY, USA.
6. Brown, T.A. 2010. Gene cloning and DNA analysis: An introduction. Willy-Blackwell, UK

PBMG 703	**Molecular Plant Breeding**	3(2-1)

Theory

Introduction to molecular breeding. Quantitative genetics and plant improvement. Genotype x environment interaction (GEI). Molecular dissection of GEI. Applications of molecular markers. Development of mapping populations. Molecular dissection of complex traits. Molecular maps and types of mapping. Introduction to quantitative trait loci. QTL mapping. Understanding the genetic architecture of quantitative traits. Multiple QTLs. Bayesian and linkage disequilibrium mapping. Linkage analysis, map construction, experimental design and testing marker segregating patterns. Assumptions of different map functions. Problems and possible solutions in QTL analysis. Construction of molecular linkage map – a case study from cereals. Fine mapping of QTL and map based cloning. Markers assisted selection. Validation of marker-trait associations. Marker assisted gene introgression, selection for QTLs. Future prospects in molecular plant breeding. Genotyping by sequencing.

Practical

DNA extraction. Primer designing. PCR, gel scoring, phenotypic and genotypic data collection. Software based data analysis to develop QTLs. *In silico* mapping – physical position of a marker- a case study in completely sequenced plant genome. Analysis of upstream and downstream genes of a marker. Genome browsing of sequenced plant genomes. Promoter analysis.

Books Recommended

1. Camp N.J., and A. Cox 2002. Quantitative Trait Loci: Methods and Protocols: Humana Printing Inc.
2. Kang, M.S. 2002. Quantitative Genetics, Genomics, and Plant Breeding: CABI Publishing.
3. Kole, C. 2007. Genome Mapping and Molecular Breeding in Plants: Springer.
4. Wu, R, C. Ma and G. Casella. 2010. Statistical Genetics of Quantitative Traits: Linkage, Maps and QTL: Springer Publishing Company, Incorporated.
5. Xu, Y. 2010. Molecular Plant Breeding: CABI Publishing.

PBMG 704	**Cytogenetics of Crop Plants**	3(2-1)

Theory

Cytogenetics and its importance in crop improvement. Ultra fine structure of cell and its organelles. Overview of cell cycle. Cytological evidences of crossing over. Chromosomal aberrations; deficiencies and duplications, their phenotypic effects, genetic and cytological tests. Use of translocations and inversions in genetic studies and evolution. Methods of locating break points. Genetic studies in translocations and inversions in different crops. Heteroploidy, genetic and cytological behavior.

Practical

Use of various microscopes in cytological studies. Slide preparation of mitotic and meiotic cell divisions from different plant material. Karyotype study of different crop plants. Banding techniques (ISH, FISH & GISH).

Books Recommended

1. Bass, H.W. and J.A. Brichler. 2010. Plant Cytogenetics: Genome Structure and Chromosome Function. Springer Publishers, New York, USA
2. Gupta, R.K. 1999. Cytogenetics. Rastogi Publishers, Meerut, India.
3. Singh, R.J. 2003. Plant Cytogenetics. CRC Press, London, UK.
4. Prasad, G. 1998. Introduction to Cytogenetics. Kalyani Publishers, New Delhi, India.
5. Sinha, U, and S. Sinha. 1998. Cytogenetics, Plant Breeding and Evolution. Vikas Publishing House Pvt Ltd, New Delhi, India.

PBMG 705	**Breeding and Genetics of Fodder Crops**	3(2-1)

Theory

Reproductive mechanisms in various fodder crops. Male sterility and self-incompatibility factors and their consequences. Genetic systems in fodder crops. Breeding objectives in fodders. Genetics of high productivity and quality parameters. Breeding procedures and techniques, introduction, selection and evolution of new varieties/species. Testing of inbred lines; production of hybrid fodder. Interspecific and intergeneric crosses in fodder species such as sorghum-sudangrass hybrid, bajra-napier hybrid. Use of polycross methods in fodders. Developing synthetic varieties. Evaluation for quality; proteins, carbohydrates and digestibility. Breeding for greater seedling vigour, persistence of stand and disease and insect resistance.

Practical

Classification of various rabi and kharif fodders. Study of floral structure in different fodder crops. Selfing and crossing techniques for various fodders; handling breeding material and its evaluation.

Books Recommended

1. Sleper, D.A. and J.M. Poehlman. 2006. Breeding Field Crops. Iowa State University Press, Ames, Iowa, USA.
2. Bhatti, M.B. and S. Khan (Eds.) 1996. Fodder production in Pakistan. Proceedings of the National Conference on the Improvement, Production and Utilization of Fodder Crops in Pakistan, held on March 25-27, 1996 at NARC, Pakistan Agricultural Research Council, Islamabad.
3. Poehlman, J.M. 1995. Breeding Field Crops. Iowa State University Press, Ames, Iowa, USA.
4. Rognli, O.A., E.T. Solberg, and I. Schjelderup. (eds.). 1994. Breeding Fodder Crops for Marginal Conditions. Series: Developments in Plant Breeding, Springer Link, USA.

PBMG 706	**Breeding for Stress Environments**	3(2-1)

Theory

Definition and types of stresses: environmental, soil and physiological. Importance of stress breeding in local and global scenarios. Response of crop plants to environmental stresses. Concepts of resistance and tolerance. Genetic variability for stress tolerance and its evaluation for improvement. Selection indices under various stresses: salinity, water and temperature shocks. Induction of stress tolerance, adaptive mechanisms. Identification of genetic resources for tolerant genes and their transfer to indigenous varieties. Screening and micro-screening techniques; breeding and selection strategies for stress tolerance in perspectives of climatic changes. Molecular basis of stress tolerance.

Practical

Field and laboratory study of stress parameters. Screening under simulated stress conditions. Genetic analysis of tolerance related traits. Visits to research institutes.

Books Recommended

1. Goyal, S.S., S.K. Sharma and D.W. Rains (Ed) 2003. Crop Production in Saline Environments: Global and Integrative Perspectives. Haworth Press, London UK.
2. Hall, A.E. 2001. Crop Responses to Environment. CRC Press LLC, Boca Raton, Florida, UK.
3. Gupta, U.S. 1997. Crop Improvement Vol. 2 Stress Tolerance. Oxford and IBH Publishing Co. (Pvt) Ltd., New Delhi, India.
4. Pessarakli, M. (ed.) 1994. Handbook of Plant and Crop Stress. Marcel Dekker Inc., New York. USA.
5. Mooney, H.A., W.E. Winner, and E.J. Pell. 1991. Response of Plants to Multiple Stresses. Academic Press, San Diego, California, USA.
6. Singh, B.D. 2004. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi, India

PBMG 707	**Mutation Breeding**	3(2-1)

Theory

Mutation: importance and achievements in plant breeding. Classes of mutagens. Induction of mutation, detection, evaluation and utilization of induced mutants. Factors modifying the effectiveness of irradiation in seed treatment. Determination of LD50. Effectiveness and efficiency for inducing cytological changes. Gamma garden. Induced mutations through transposable elements. Molecular basis of Mutation: Targeting Induced Local Lesions in Genomes (TILLING); making Kill Curve, development and handling of TILLING populations, high throughput screening of point mutations. Observations in M1 and procedure for selection in later generations. Use of mutants in hybridization program. Improvement of specific characters through induced mutation. Mutation breeding research in some vegetatively propagated crops. Bio-safety concerns.

Practical

Radiation treatment techniques. Radio sensitivity of field crops. Cytological analysis of mutants. Field observations and selection procedure of mutagenic material. Visit to various mutation research facilities.

Books Recommended

1. Purohit, S.S. 2010. Mutation Breeding. Agrobios, India.
2. Datta, S.K. 2005. Role of Classical Mutation Breeding in Crop Improvement. Daya, New Delhi, India
3. Van Harten, A.M. 1998. Mutation breeding. Theory and Practical Applications. Cambridge University Press, Cambridge, U.K.
   Amir, M. and R.C. Borstel. 1985. Basic and Applied Mutagens. Plenum Press, New York, USA.5.Singh, B.D. 2004. Plant Breeding, Principles and Methods. Kalyani Publishers, New Delhi, India
4. Shu, Q.Y. (ed) 2009. Induced plant mutations in the genomics era.Joint FAO/IAEA Program for Nuclear Techniques in Food and Agriculture, Rome, Italy.

World Wide Web

http://tilling.fhcrc.org:9366/files/Welcome_to_ATP.html
http://www.licor.com/bio/applications/4300_applications/tilling.jsp

PBMG 708	**Population Genetics**	3(3-0)

Theory

Definition and scope of population genetics; Allelic frequency and polymorphism. Organization of genetic diversity. Hardy-Weinberg law and factors affecting population structure. Mating systems: random, assortative and dis-assortative. Population models: consequences of genetic drift. Genetic differentiation of populations. Inbreeding in small populations, effective population size. Wahlund's Principle, patterns of migration; natural selection; over-dominance, heterozygote inferiority. Mutation, selection and shifting balance. Genetic erosion: consequences and gene conservation

Books recommended

1. Hamilton, M. B. 2009. Population Genetics. Wiley and Blackwell. Sussex, UK.
2. Harrl, D.L. 2007. Principles of Population Genetics. Sinauer Associates, Sunderland, Massachusetts, USA.
3. Neal, D. 2003.Introduction to Population Biology. Cambridge University Press, Cambridge, UK.
4. Falconer, D.S. and T.E.C. Mackay. 1996. Introduction to Quantitative Genetics. Longman, London.
5. Brown, A.G.D., M.T. Clegg, A.L. Kahler and B.S. Weir. 1990. Population Genetics, Breeding and Genetic Resources. Sinauer Associates, Sunderland, Massachusetts, USA.

PBMG 709	**Cereal Genetics and Breeding**	3(2-1)

Theory

Role of cereals in human food. Genomic relationship among various species of cereal crops: wheat, rice, maize, barley, oats and triticale. Genetics of morphological, physiological and grain quality characters in cereal crops. Genetics of disease and insect resistance. Genetic basis of resistance/tolerance against abiotic stresses. Strategies for improvement of cereal crops for specific traits.

Practical

Problems relating to genetic analysis in wheat, rice, maize and barley. Estimation of grain quality. Identification and scoring of cereal diseases, screening of cereal cultivars for drought resistance and salt tolerance in lab and field conditions. Visit to various cereal research institutes.

Books recommended

1. Datta, S.K. 2008. Rice improvement in the genomics era. CRC Press, New York, USA.
2. Sleper D.A. and J.M. Poehlman. 2006. Breeding Field Crops. Blackwell Publishers, Iowa Sate University Press, Ames, USA.
3. Nevo, E., A.B. Korol, A. Beiles and T. Fahima. 2002. Evolution of wild emmer and wheat improvement. Springer-Verlag, Germany.
4. Slafer, G.A., J.L. Molina-Cano, J.L. Araus and I. Romagosa (eds.). 2002. Barley science: recent advances from molecular biology to agronomy of yield. Food Product Press, New York, USA.
5. Hallauer, A.R. (ed.). 2001. Specialty Corns. CRC press, Florida, USA.

PBMG 710	**Cotton Genetics and Breeding**	3(2-1)

Theory

Importance of cotton in national and global economy. Description of various species of cotton. Evolutionary history and cultivated species of cotton. Cotton genomics, Transgenic Cotton, Contemporary issues in transgenic cotton production and CLCuD susceptibility. Breeding Cotton for Stress Environments. Organic and coloured cotton. Introduction to genome organization and sources of resistance/tolerance (gene families) against CLCuD and other stresses. Utilization of wild species of Gossypium in breeding programs. Components of genetic defense umbrella, R gene mediated resistance. Cotton fibre quality traits, cotton fibre developmental stages, control of fibre elongation and maturity. Strategies to improve cotton fiber quality.

Practical

Methods of measuring cotton fibre strength, fineness and maturity. Cladogram construction of various gene families involved in fiber development. Exploring cotton fibre EST databases. DNA markers for various traits. Data recording on plant and fibre characters and genetic analyses.

Books recommended

1. Sleper, D.A. and J.M. Poehlman. 2006. Breeding Field Crops. 5th Ed. Iowa State University Press Ames, USA.
2. Rafiq, M. 2004. Cotton: An Introduction. ICAC Washington DC, USA.
3. Shiron, J. (Editor). 2004. Transgenic Cotton. Science press, 16 Donghuangchenggen North Street Beijing, China.
4. Singh, P. 2004. Cotton Breeding. Kalyani Publishers. New Delhi. India.
5. Johnie, N.J. and S. Saha. 2001. Genetic improvement of Cotton-emerging techniques. Oxford and IBH Publishing Co., New Delhi, India.

World Wide Web:

http://www.cotton.org/journal/archive.cfm

PBMG 711	**Genetics and Breeding of Oilseed Crops**	3(2-1)

Theory

Significance of edible oil in the economy of Pakistan. Major issues of oilseed crops: conventional and non-conventional. Genetic relationship among different Brassica species. Genetic resources and their exploitation in oilseed crops. Genetic basis of qualitative, quantitative and oil quality traits. Genetics of double low traits and its utilization. Genetics of male sterility and its use in sunflower and canola hybrid seed production. Strategies for genetic improvement of oilseeds. Progress in oilseed crops genomics. Exploitation of innovative tools in oilseed crops breeding. New trends in long chain fatty acids.

Practical

Specification and characteristics of edible oil, oil content, fatty acid, iodine number, acid value, hydrogenation and sponification. Methods and equipments used for oil extraction and analysis. Fatty acid profile of various edible and industrial oils. Genetic evaluation of different fatty acids in oilseeds. Visit to various vegetable oil and ghee industries.

Books recommended

1. Ramanath, T. 2004. Applied Genetics of Oilseed Crops. Daya, New Delhi, India
2. Nagata, T. and S. Tabata (ed).2003. Brassica and Legumes: From Genome Structure to Breeding. Springer Verlag, New York, USA.
3. Kimber, D. and D.I. McGregor. 1995. Brassica Oilseeds: Production and Utilization. Cambridge, UK.
4. Verma, D.P.S. 1996. Soybean: Genetics, Molecular Biology and Biotechnology. Biotechnology in Agriculture Series, No 14. CABI Publishing Co. USA.
5. Robbelen, G. and R.K. Downey. 1990. Oil Crops of the World: Their Breeding and Utilization, McGraw-Hill Publishing Company, New York, USA.

World Wide Web

1. http://www.parc.gov.pk/1SubDivisions/NARCCSI/CSI/rapeseed.html
2. http://archive.idrc.ca/library/document/091017/chap3_e.html
3. http://www.soygenetics.org/

PBMG 712	**Genetics and Breeding of Sugar Crops**	3(2-1)

Theory

Evolutionary history of sugarcane and sugar beet. Genetic barriers in sugarcane flowering and their possible solutions. Management of fuzz production and germination. Genetic determination of quality parameters and their utilization. Genetics of different parameters in sugarcane and sugar beet. Role of polyploidy in sugar crops. Genetic relationship between cane yield and sugar recovery. Strategies for genetic improvement in sugar crops. Role of biotechnology in sugar crops improvement.

Practical

Estimation of Brix value of sugarcane. Collection of data for various plant traits in sugar crops and their statistical analysis. Visit to research institutes and sugar industries.

Books recommended

1. Henry, R.J. and C. Kole. 2010. Genetics, Genomics and Breeding of Sugarcane. Taylor and Francis, London, UK.
2. Malik, K.B. 2009. Cane and Sugar Production. Punjab Agriculture Research Board, Lahore, Pakistan.
3. Draycott, A.P. 2006. Sugar beet. Blackwell Publishing Ltd., Oxford, UK.
4. Sleper, D.A. and J.M. Poehlman. 2006. Breeding Field Crops. 5th ed. Iowa State University Press, Ames, Iowa, USA.

PBMG 713	**Genetic Engineering in Plants**	3(2-1)

Theory

Molecular approaches of gene manipulation in plants. Techniques for locating genes. Importance of gene cloning in industry. Restriction endonucleases and ligases. Cloning vehicles. DNA probing and blotting techniques. Types of PCR, cDNA synthesis and expression analysis. Genetic transformation and its types. Selection for recombinants: identification and selection of cloned gene. Development of transgenic plants. Benefits and problems related with transgenic plants. Bioinformatics.

Practical

Extraction and purification of plasmid, genomic DNA and RNA. Restriction mapping. PCR and electrophoresis. Genetic transformation of bacteria and plants. Visit to National Institutions working in Genetic Engineering and Biotechnology.

Books recommended

1. Slater, A., N.W. Scott and M.R. Fowler. 2008. Plant Biotechnology: the genetic manipulation of plants. Oxford University Press, Oxford, UK.
2. Liang, G.H. and D.Z. Skinner. 2005. Transgenic Crops. Haworth Press. Inc., NY, USA.
3. Chawla, H.S. 2004. Introduction to Plant Biotechnology. Science Publishers, New Hampshire, USA.
4. Watson, J.D., T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick. 2004. Molecular Biology of the Gene. Pearson Education, London, UK
5. Jackson, J.F. and Linskens. 2002 (Ed) Testing for Genetic Manipulation in Plants (Molecular Methods of Plant Analysis Vol 22) Springer-Verlag, Berlin, Germany.
6. Old, R.W. and S.B.P. Primose. 2000. Principles of Gene Manipulation: An introduction to genetic engineering. Blackwell, London, UK.

PBMG 714	**Evolution of Field Crops**	3(3-0)

Theory

Theories of evolution. Co-evolution, phylo-genetic history of evolution. Concept of species, isolating mechanisms, different types/modes of speciation. Various sources of variation, role of genetic polymorphism, migration, mutation, hybridization and polyploidy in evolution. Natural selection, patterns of selection. Wide crosses and species resynthesis in crops. Evolution and species relationship in important field crops. Evolutionary trends in crops, important plant adaptations in climatic vagaries. Evolution of genes and genomes of field crops. Introduction of various software for phylo-genetic relationships.

Books recommended

1. Hancock, J. 2004. Plant Evolution and the Origin of Crop Species. (2nd ed) Oxford University Press, USA
2. Willis, K.J. and J.C. McElwain. 2002. Evolution of Plants. Oxford University Press, Oxford, UK.
3. Strickberger, M.W. 2000. Evolution. Jones and Bartlett, New York, USA.
4. Ladizinsky, G. 1998. Plant evolution under domestication. Kluwer Academic Publishers New York, USA.
5. Smartt, J. and N.W. Simmonds (eds.) 1995. Evolution of Crop Plants. (2nd ed.). Longman Scientific and Technical, Essex, England.
6. Fehr, W.R. 1987. Principles of Cultivar Development, Vol. 2: Crop Species. Macmillan Pub Co., NY, USA

PBMG 715	**Advanced Cytogenetics**	3(3-0)

Theory

Endosymbiotic theory of evolution of organelles. Heteroploidy. Autopolyploidy: occurrence and general characteristics. Haploids vs monoploids, artificial production of haploids and dihaploids. Theoretical genetic ratios for single gene locus, genetic data, linkages in autopolyploids. Allopolyploidy: origin, evidences of homology between chromosomes. Aneuploidy: trisomics, monosomics, nullisomics, their transmission and factors influencing transmission. Substitution lines and their use in crop improvement. Cytogenetics of apomixes. Introduction to florescent and genomic *in situ* hybridization techniques.

Books recommended

1. Puertas, M.J. and T. Naranjo. 2005. Plant Cytogenetics: Cytogenetic and Genome Research. S. Karger Publishers.
2. Schulz-Schaeffer, J. 1981. Cytogenetics. Plants, animal, humans. Springer-Verlag, New York. USA.
3. Singh, R. J. 2005. Plant Cytogenetics. CRC Press, London, UK.
4. Swanson, C.P., T. Merz and W.J. Young. 1981. Cytogenetics. 2nd ed. Prentice Hall international Inc., Englewood Cliff, New Jersey, USA.

PBMG 716	**Plant Genomics**	3(2-1)

Theory

Introduction to plant genomics. The structure of plant genomes. Origin and evolution of plant nuclear, mitochondrial and plastid genomes. Physical organization and gene contents of cytoplasmic genomes. Organization of DNA into chromosomes. Construction of genomic DNA libraries. Physical mapping of plant chromosomes. Molecular marker systems for gene mapping. DNA based markers. Genome sequencing strategies. Gene discovery from sequence data. ESTs and full length cDNA libraries. Transposable elements and transcription factors. Identification of genes by mutagenesis – forward and reverse genetic approaches. T-DNA mutagenesis, RNAi, TILLING, delete a gene and combinatorial gene silencing. Comparative genomics – case study of cereal genomes. Epigenomics and its applications in crop plants. Current prospectus and future scenario of plant genomics.

Practical

Taxonomic and molecular identification of various crop progenitors in the field. Analysis of gene family evolution. *In silico* expression profiling of genes. Analysis of *cis* and *trans* acting elements.

Books recommended

1. Cullis C.A., and J. Wiley. 2004. Plant genomics and proteomics: Wiley Online Library.
2. Daniell, H, and C. Chase. 2004. Molecular biology and biotechnology of plant organelles: chloroplasts and mitochondria: Kluwer Academic Pub.
3. Leister, D. 2005. Plant functional genomics: CRC.
4. Meksem, K, G. Kahl, and H. Shapiro. 2005. The handbook of plant genome mapping: Wiley Online Library.
5. Somers, D.J., Langridge, P and J.P. Gustafson. 2009. Plant Genomics Methods and Protocols; Series: Methods in Molecular Biology, Vol. 513. Humana Press.

PBMG 717	**Advanced Methods in Plant Breeding**	3(2-1)

Theory

Ideotype concept; its genetic basis, identification and development of an ideotype. Current scenario and future concerns. Participatory plant breeding. Components of variation, estimation of additive and non-additive variances. Heritability and its role in selection. Testing G × E; Stability analysis; Enhancement of genetic gain in plant breeding. Mating designs: Diallel, North Carolina design I, II and III. Uses of mating design in plant breeding. Selection indices and their uses. Significance and utilization of wide crosses. Marker assisted selection and its application in plant breeding.

Practical

Expected mean squares and their use in plant breeding. Response to selection, Estimation of variance components and heritability from the mating designs. Application of various mating designs and selection indices. Use of computer softwares.

Books recommended

1. Singh, R.K. and B.D. Chaudhary, 2004. Biometerical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi, India.
2. Falconer, D.S. 2003. Introduction to Quantitative Genetics. Textbook Publisher, London, U.K.
3. Kang, M.S. (ed). 2003. Handbook of Formulas and Software for Plant Geneticists and Breeders. Harworth Press Inc, LA, USA.
4. Kang, M.S. (Ed) 2002. Quantitative Genetics, Genomics and Plant Breeding. CABI, Sussex, UK.
5. Kang, M.S. and H.G. Gauch. 1996. Genotype by Environment Interaction. CRC Press, New York, USA.
6. Kearsey, M.J. and H.S. Pooni. 1996. The Genetical Analysis of Quantitative Traits. Chapman and Hall, Ltd. London, U.K.

PBMG 718	**Genetics of Plant Disease and Insect Resistance**	3(2-1)

Theory

Nature of parasitism, pathogenicity and expression of disease resistance. Mendelian, quantitative and cytoplasmic resistance in host. Genetics of host-pathogen interaction and various models. Horizontal and vertical resistance. Identification of disease resistance sources. Host/non-host resistance. Nature and genetic mechanism of resistance. Transfer of genetic resistance. Pyramiding genes for resistance. Evaluation of plant resistance to insect and diseases. Molecular approaches to insect and disease resistance.

Practical

Inoculation techniques for various plant diseases. Study of differentiation among disease susceptibility, disease escape, tolerance, resistance and immunity. Measurement of resistance by using different scoring scales and their statistical analysis. Visit to specialized research institutes.

Books recommended

1. Agrios, G.N. 2005. Plant pathology. Elsevier Academic Press. Burlington, USA.
2. Singh, D.P. and A. Singh. 2005. Disease and Insect Resistance in Plants. Science Publishers, New Hampshire, USA.
3. Sadasivam, S., and B. Thayumanavan (Ed). 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker, New York, USA.
4. Kranz, J. (Ed) 2002. Comparative Epidemiology of Plant Diseases. Springer, NY, USA
5. Gunasekaran, M. and D.J. Weber (Ed). 1995. Molecular Biology of the Biological Control of Pests and Diseases of Plants. Department of Botany and Range Science, Brigham Young University, Provo, Utah.
6. Johnson, R. 1992. Breeding for Disease Resistance. Kluwer Academic Publishers Group, Dordrecht. The Netherlands.
7. Vanderplank, J.E. 1984. Disease Resistance in Plants. 2nd ed. Academic Press, Inc., Orlando, Florida, USA.

PBMG 719	**Development of Hybrid and Seed Production**	3(2-1)

Theory

Principles for hybrid seed production. Heterosis, classification and its genetic basis. Hybrid types. Two and three-line systems of hybrid development. Development and maintenance of parental lines (A, B and R lines). Evaluation of inbred lines for general and specific combining ability. Production technology for hybrid seed in field crops and vegetables. Isolation (temporal and spatial), planting ratios and synchronization of male and female parents. Commercial use of hybrid vigor. Field standards, genetic purity, harvesting and handling of hybrid seed. Economic aspects of hybrid seed production.

Practical

Development of inbred lines. Estimation of GCA and SCA. Selection and maintenance of A, B and R lines under field conditions. Use of gametocytes, induction of male sterility and evaluation of hybrids. Visit to private and public research institutes engaged in commercial hybrid seed production.

Books recommended

1. Sleper D.A. and J.M. Poehlman. 2006. Breeding Field Crops. Blackwell Publishers, Iowa Sate University Press, Ames, USA.
2. Singal, W.C. 2004. Hybrid Seed Production. Kalyani Publishers, New Delhi, India.
3. Basra, A.S. 2000. Hybrid Seed Production in Vegetables: Rationale and Methods in selected crops. Food Product Press. New York, USA.
4. Feistritzer, W.P. and A.F. Kelly (eds.) 1987. Hybrid Seed Production of Selected Cereal, Oil and Vegetable Crops. FAO Plant Production and Protection Paper 82, FAO, Rome, Italy.

PBMG 720	**Biometrical Techniques in Plant Breeding**	3(2-1)

Theory

Importance of biometry in plant improvement. Selection indices. Diallel cross system. Genetic analysis of additive-dominance model, adequacy tests, limitations and assumptions for additive-dominance model, combining ability analysis, line x tester analysis and generation mean analysis. Regression and correlation analysis. Genotypic and phenotypic correlation analysis. Path coefficient analysis. Heritability and its role in selection. Multivariate analysis. Principal Component and Bi-plot Analysis.

Practical

Numerical examples regarding genetic analysis. Assessment of genotypic and phenotypic correlations, and partitioning of genotypic correlation into direct and indirect path ways. Use of software for biometrical analysis.

Books recommended

1. Singh, R.K. and B.D. Chaudhary. 2004. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi, India.
2. Mead, R., R.N. Curnow and A.M. Hasted. 2003. Statistical Methods in Agriculture and Experimental Biology. Chapman and Hall, London, UK.
3. Townend, J. 2002. Practical Statistics for Environmental and Biological Statistics. John Wiley, New York, USA.
4. Becker, W.L. 1993. Manual of Quantitative Genetics. Washington State University Press, Pullman, Washington, USA.

PBMG-721	Principles of Marketing & Commercialization	3(3-0)

Theory

Understanding the marketing concept, the marketing process, marketing in a changing world, creating customer value and satisfaction, strategic planning and the marketing process, the marketing environment, analyzing marketing opportunities, marketing research and information systems, consumer markets, consumer buyer behavior, business markets, business buyer behavior, selecting target markets, positioning for competitive advantage, measuring and forecasting demand, developing the marketing mix, details of marketing mix, designing products, brands, packaging, and services. Designing products: new product development, product life-cycle strategies. Pricing products: pricing considerations, approaches and strategies, logistics and supply chain management. Promoting products: advertising, sales promotion and public relations. Promoting products: personal selling and sales management, building customer relationships through satisfaction, value and quality. Creating competitive advantage: competitor analysis and competitive marketing strategies, marketing services, organizations, persons, places, and ideas. Marketing and society: responsibility and marketing ethics.

Recommended Books

1. Philip Kotler, Gary Armstrong, Ehsan Ul Haq. Principles of Marketing, A South Asian Perspective. 13th edition, Pearson.

2. Michael J. Etzel, Bruce J. Walker and William Stanton. Marketing. International Edition

PBMG 722	**Special Problem**	1(1-0)

Student will be assigned a special topic for searching literature relevant to a particular problem or conducting an experiment or any other appropriate activity. Student has to compile a comprehensive report on the title assigned.

PBMG 723	**Seminar (M.Sc. Hons.)**	1(1-0)

Student will be given a topic on a particular problem in the field of plant breeding and genetics. Student has to deliver a presentation in an open house gathering on the title assigned.

PBMG 724	**Thesis (M.Sc. Hons.)**	10(0-10)

PBMG 725	**Seminar-I (Ph.D)**	1(1-0)

Student must defend his/her Ph.D Synopsis in an open house gathering.

PBMG 726	**Seminar-II (Ph.D)**	1(1-0)

Public defense of PhD thesis/ thesis defense

PBMG 727	**Ph.D Dissertation**	20(0-20)