Department of Plant Breeding and Genetics

Degree programme M.Sc. (Ag) Genetics and Plant Breeding

Courses offer

Group		Number	Title of Course	Credit
Major	1.	GP 501	Principles of Genetics	3 (2+1)
	2.	GP 502	Principles of Cytogenetics	3 (2+1)
	3.	GP 503	Principles of Plant Breeding	3 (2+1)
	4.	GP 504	Principles of Quantitative Genetics	3 (2+1)
	5.	GP 508	Cell Biology and Molecular Genetics	3 (2+1)
	6.	GP 509	Biotechnology for Crop Improvement	3 (2+1)
	7.	GP 510	Breeding for Biotic and Abiotic Stress Resistance	3 (2+1)
	Total			**21 (14+7)**
Seminar	1	GP 591	Credit Seminar	**1(1+0)**
Research	1	GP 599	Research	**20(0+20)**
Minor	1.	SST 508	Seed Quality Testing	2 (1+1)
	2.	MBB 504	Plant tissue culture and genetic transformation	3 (1+2)
	3.	PL PATH 510	Seed Health Technology	3 (2+1)
	Total			**8 (4+4)**
Supporting	1.	MCA 502	Introduction to networking & internet application	3 (2+1)
	2.	STAT 511	Statistical methods for applied sciences	4 (3+1)
	3.	STAT 512	Experimental Design	3 (2+1)
	Total			**10(7+3)**
Non-Credit Compulsory Course	1.	PGS-501	Library & Information Services	1(0+1)
	2.	PGS-504	Basic Concept in Laboratory Techniques	1(0+1)
	3.	PGS-505	Agril. Research, Res. Ethics & Rural Development Programme (e-course)	1(1+0)
	4	PGS-506	Disaster Management	1(1+0)
	5	PGS-502	Technical writing and communication skill	1(0+1)
	6	PGS-503	Intellectual properties and its management	1(1+0)
	7	HVE	Human values and professional ethics	2(1+1)
	Total			**8(4+4)**
Grand total				**68(30+38)**

Department of Plant Breeding and Genetics

Programme M.Sc. (Ag) Genetics and Plant Breeding

Minimum credit requirements

Subject	Master
Major	20
Minor	10
Supporting	07
Seminar	01
Thesis research	20
Total	58

Department of Plant Breeding and Genetics

Programme M.Sc. (Ag) Genetics and Plant Breeding

Semesters wise distribution of courses

Course	Course Title	Code	Credits
Semester-I			
Major	Principles of Genetics	GP 501	3 (2+1)
	Principles of Cytogenetics	GP 502	3 (2+1)
	Principles of Plant Breeding	GP 503	3 (2+1)
	Principles of Quantitative Genetics	GP 504	3 (2+1)
Supporting	Introduction to networking & internet application	MCA 502	3 (2+1)
Compulsory NC	Library and information services	PGS 501	1 (0+1)
	Basic concepts in laboratory techniques	PGS 504	1 (0+1)
	Intellectual property and its management in Agriculture	PGS- 503	1 (0+1)
Semester-II			
Major	Cell Biology and Molecular Genetics	GP 508	3 (2+1)
	Biotechnology for Crop Improvement	GP 509	3 (2+1)
	Breeding for Biotic and Abiotic Stress Resistance	GP 510	3 (2+1)
	Master Seminar	GP 591	1 (0+1)
Minor	Seed Quality Testing	SST 508	2 (1+1)
	Plant tissue culture and genetic transformation	MBB 504	3 (1+2)
	Seed Health Technology	P.PI 510	3 (2+1)
Supporting	Experimental Design	STAT 512	3 (2+1)
Compulsory NC	Agricultural research, research ethics and rural development programmes	PGS 505	1 (0+1)
	Disaster management	PGS506	1 (0+1)
	Technical writing and communication skills	PGS- 502	1 (0+1)
Semester-III			
	Written Comprehensive Examination	-	
	Seminar	GP 591	1 (1+0)
	Master's Research	GP 599	10 (0+10)
Semester-IV			
	Master's Research	GP 599	10(0+10)

GP 501 Principles of Genetics 2+1

Objective To understand the basic concepts of genetics, helping students to develop their analytical, quantitative and problem solving skills from classical to molecular genetics.

Theory

UNIT I Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance.

UNIT II Multiple alleles, Gene interactions. Sex determination, differentiation and sex- linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.

UNIT III Population - Mendelian population – Random mating population - Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium.

UNIT IV Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis.

UNIT V Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

UNIT VI Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression. Gene regulation in eukaryotes, RNA editing.

UNIT VI Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCRbased cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro RNAs (miRNAs).

UNIT VIII Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.

UNIT IX Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts.

UNIT X Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

Practical Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification - Electrophoresis – basic principles and running of amplified DNA - Extraction of proteins and isozymes – use of *Agrobacterium* mediated method and Biolistic gun; practical demonstrations - Detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.

Suggested Readings:

Gardner EJ & Snustad DP. 1991. *Principles of Genetics*. John Wiley & Sons.
Klug WS & Cummings MR. 2003. *Concepts of Genetics*. Peterson Edu.
Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ.
Russell PJ. 1998. *Genetics*. The Benzamin/Cummings Publ. Co.
Snustad DP & Simmons MJ. 2006. *Genetics*. 4th Ed. John Wiley & Sons.
Strickberger MW. 2005. *Genetics (III Ed)*. Prentice Hall, New Delhi, India
Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publs.
Uppal S, Yadav R, Subhadra & Saharan RP. 2005. *Practical Manual on Basic and Applied Genetics*. Dept. of Genetics, CCS HAU Hisar.

GP 502 Principles of Cytogenetics 2+1

Objective To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.

Theory

UNIT Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes.

UNIT II:- Chromosomal theory of inheritance – Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - *in situ* hybridization and various applications.

UNIT III:- Structural and Numerical variations of chromosomes and their implications – Symbols and terminologies for chromosome numbers - euploidy - haploids, diploids and polyploids ; Utilization of aneuploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations – balanced lethals and chromosome complexes.

UNIT IV:- Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids –- Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis - Evolutionary and genetic problems in crops with apomixes.

UNIT V:- Reversion of autopolyploids to diploids; Genome mapping in polyploids – Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) – Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids – Bridge species.

UNIT VI:- Fertilization barriers in crop plants at pre-and post-fertilization levels- *In vitro* techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization ; case studies – Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical: Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. - Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope; Preparing specimen for observation – Fixative preparation and fixing specimen for light microscopy studies in cereals - Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion and *Aloe vera* - Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds and forage crops - Using micrometers and studying the pollen grain size in various crops -Various methods of staining and preparation of temporary and permanent slides - Pollen germination *in vivo* and *in vitro;* Microtomy and steps in microtomy; Agents employed for the induction of various ploidy levels; Solution preparation and application at seed, seedling level - Identification of polyploids in different crops - Induction and identification of haploids; Anther culture and Ovule culture – Morphological observations on synthesized autopolyploids - Observations on C-mitosis, learning on the dynamics of spindle fibre assembly – Morphological observations on alloployploids - Morphological observations on aneuploids - Cytogenetic analysis of interspecific and intergeneric crosses - Maintenance of Cytogenetic stocks and their importance in crop breeding - Various ploidy levels due to somaclonal variation ; Polyploidy in ornamental crops. -Fluorescent *in situ* hybridization (FISH)- Genome *in situ* hybridization GISH.

Suggested Readings:

Becker K & Hardin. 2004. *The World of Cell*. 5th Ed. Pearson Edu.
Carroll M. 1989. *Organelles*. The Guilford Press.
Charles B. 1993. *Discussions in Cytogenetics*. Prentice Hall.
Darlington CD & La Cour LF. 1969. *The Handling of Chromosomes*. Georger Allen & Unwin Ltd.
Elgin SCR. 1995. *Chromatin Structure and Gene Expression*. IRL Press.
Gray P. 1954. *The Mirotomist's Formulatory Guide*. The Blakiston Co.
Gupta PK & Tsuchiya T. 1991. *Chromosome Engineering in Plants: Genetics, Breeding and Evolution*. Part A. Elsevier.Gupta PK. 2000. *Cytogenetics*. Rastogi Publ.
Johannson DA. 1975. *Plant Microtechnique*. McGraw Hill.
Karp G. 1996. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons.
Khush GS. 1973. *Cytogenetics of Aneuploids*. Academic Press.
Sharma AK & Sharma A. 1988. *Chromosome Techniques: Theory and Practice*.
Butterworth.Sumner AT. 1982. *Chromosome Banding*. Unwin Hyman Publ.
Swanson CP. 1960. *Cytology and Cytogenetics*. Macmillan & Co.

GP 503 Principles of Plant Breeding 2+1

Objective: To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

Theory:

UNIT I History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.

UNIT II Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

UNIT III Self-incompatibility and male sterility in crop plants and their commercial exploitation. UNIT III:- Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach).

UNIT IVL:- Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter population improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

UNIT V Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection.

UNIT VI Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant videotape and its role in crop improvement; Transgressive breeding.

UNIT VII Special breeding techniques- Mutation breeding; Breeding for a biotic and biotic stresses.

UNIT VIII Cultivar development-testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Practical: Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops.

Suggested Readings:

Allard RW. 1981. *Principles of Plant Breeding*. John Wiley & Sons.
Chopra VL. 2001. *Breeding Field Crops*. Oxford & IBH.
Chopra VL. 2004. *Plant Breeding*. Oxford & IBH.
Gupta SK. 2005. *Practical Plant Breeding*. Agribios.
Pohlman JM & Bothakur DN. 1972. *Breeding Asian Field Crops*. Oxford & IBH.
Roy D. 2003. *Plant Breeding, Analysis and Exploitation of Variation*. Narosa Publ. House.
Sharma JR. 2001. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.
Simmonds NW. 1990. *Principles of Crop Improvement*. English Language Book Society.
Singh BD. 2006. *Plant Breeding*. Kalyani.
Singh P. 2002. *Objective Genetics and Plant Breeding*. Kalyani.
Singh P. 2006. *Essentials of Plant Breeding*. Kalyani.

Singh S & Pawar IS. 2006. *Genetic Bases and Methods of Plant Breeding*. CBS.

GP 504 Principles of Quantitative Genetics 2+1

Objective: To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects.

Theory;

UNIT I Mendelian traits *vs* polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.

UNIT II Principles of Analysis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance. UNIT III:- Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D2 analyses - Association analysis – phenotypic and genotypic correlations; Path analysis and Parent – progeny regression analysis; Discriminant function and principal component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance.

UNIT IV Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis – principles and interpretation.

UNIT V QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.

Practical: Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Metroglyph analysis - D2 analysis - Grouping of clusters and interpretation - Cluster analysis - Construction of cluster diagrams and dendrograms - interpretation - Correlation analysis - Path analysis - Parent-progeny regression analysis - Diallel analysis: Griffing's methods I and II – Diallel analysis: Hayman's graphical approach - Diallel analysis: interpretation of results - NCD and their interpretations - Line x tester analysis and interpretation of results - Estimation of heterosis : standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression - Generation mean analysis: Analytical part and Interpretation – Estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions - Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies - Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross – use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction 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.

Suggested readings:

Bos I & Caligari P. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.
Falconer DS & Mackay J. 1998. *Introduction to Quantitative Genetics*. Longman.
Mather K & Jinks JL. 1971. *Biometrical Genetics*. Chapman & Hall.
Mather K & Jinks JL. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.
Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani.
Naryanan SS & Singh P. 2007. *Biometrical Techniques in Plant Breeding. Kalyani.*
Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*. Kalyani.

Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics*. Kalyani.
Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.
Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

GP 508 Cell Biology and Molecular Genetics 2+1

Objective: To impart knowledge in theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

Theory:

UNIT I Ultra structure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles – nucleus, plastidschloro/ chromoplast mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.

UNIT II Bioenergetics; Ultra structure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus-Structure and chemical composition; Cell division and physiology of cell division.

UNIT III Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors.

UNIT IV Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.

Practical:

Morphological and Gram staining of natural bacteria; Cultivation of bacteria in synthetic medium; Determination of growth rate and doubling time of bacterial cells in culture; Demonstration of bacteriophage by plaque assay method; Determination of soluble protein content in a bacterial culture. Isolation, purification and raising clonal population of a bacterium; Biological assay of bacteriophage and determination of phage population in lysate; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; Quantitative estimation of DNA, RNA and protein in an organism; Numericals: problems and assignments.

Suggested Readings:

Bruce A.2004. *Essential Cell Biology*. Garland.
Karp G.2004. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley.
Klug WS & Cummings MR 2003. *Concepts of Genetics*. Scot, Foreman & Co.
Lewin B. 2008. *IX Genes*. John Wiley & Sons
Lodish H, Berk A & Zipursky SL. 2004. *Molecular Cell Biology*. 5th Ed. WH Freeman.
Nelson DL & Cox MM. 2005. *Lehninger's Principles of Biochemistry*. WH Freeman & Co.
Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.
Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley Publ. Co.

GP 509 Biotechnology for Crop Improvement 2+1

Objective To impart knowledge and practical skills to use biotechnological tools in crop improvement.

Theory

UNIT I Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.

UNIT II Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT III Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH).

UNIT IV Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.

UNIT V Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

UNIT VI Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

UNIT VII Biotechnology applications in male sterility/hybrid breeding, molecular farming.

UNIT VIII MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights.

UNIT IX Bioinformatics & Bioinformatics tools.

UNIT X Nanotechnology and its applications in crop improvement programmes.

Practical:

Requirements for plant tissue culture laboratory-Techniques in plant tissue culture - Media components and media preparation -Aseptic manipulation of various explants ; observations on the contaminants occurring in media – interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. DNA isolation, purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

Suggested Readings:

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.

Gupta PK. 1997. *Elements of Biotechnology*. Rastogi Publ.
Hackett PB, Fuchs JA & Messing JW. 1988. *An Introduction to Recombinant DNA echnology - Basic Experiments in Gene Manipulation.* 2nd Ed. Benjamin Publ. Co.
Sambrook J & Russel D. 2001. *Molecular Cloning* - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.
Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani.

GP 510 Breeding for Biotic and Abiotic Stress Resistance 2+1

Objective: To apprise about various abiotic and biotic stresses influencing crop yield, mechanisms and genetics of resistance and methods to breed stress resistant varieties.

Theory:

UNIT I Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops - Concepts in insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defense mechanisms against viruses and bacteria.

UNIT II Types and genetic mechanisms of resistance to biotic stresses – Horizontal and vertical resistance in crop plants. Quantitative resistance/Adult plant resistance and Slow rusting resistance - Classical and molecular breeding methods – Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies.

UNIT III Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications.

UNIT IV:- Classification of abiotic stresses - Stress inducing factors –moisture stress/drought and water logging & submergence; Acidity, salinity/alkalinity/sodicity; High/low temperature, wind, etc. Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

UNIT V Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging & submergence, high and low/freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants insoil, water and environment.

UNIT VI Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops - Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitnases and Bt for diseases and insect pest management- Achievements.

Practical:

Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level - Phenotypic screening techniques for nematodes and borers; Ways of combating them; Breeding strategies - Weeds – ecological, environmental impacts on the crops; Breeding for herbicide resistance - Evaluating the available populations like RIL, NIL etc. for pest resistance; Use of standard MAS procedures - Phenotypic screening methods for diseases caused by fungi and bacteria; Symptoms and data recording; use of MAS procedures - Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation - Screening crops for drought and flood resistance; factors to be considered and breeding strategies - Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies; Understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them.

Suggested Readings:

Blum A. 1988. *Plant Breeding for Stress Environments*. CRC Press.
Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less Favourable Environments*. Wiley International.
Fritz RS & Simms EL. (Eds.). 1992. *Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics*. The University ofChicago Press.
Li PH & Sakai A. 1987. *Plant Cold Hardiness*. Liss, New York
Luginpill P. 1969. *Developing Resistant Plants - The Ideal Method of Controlling Insects*. SDA, ARS, Washington DC. Maxwell FG & Jennings PR. (Eds.). 1980. *Breeding Plants Resistant to Insects*. John Wiley & Sons.
Painter RH. 1951. *Insect Resistance in Crop Plants*. MacMillan, New York. Russel GE. 1978. *Plant Breeding for Pest and Disease Resistance*. Butterworths.
Sakai A & Larcher W. 1987. *Frost Survival in Plants*. Springer-Verlag.
Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.
Van der Plank JE. 1982. *Host-Pathogen Interactions in Plant Disease*. Academic Press.

Minor course

SST (508) Seed Quality Testing (2+1)

Objective : To provide a comprehensive knowledge on all aspects of seed quality evaluation and their relevance to crop performance.

Theory

UNIT – I Introduction : Structure of monocot and dicot seeds: seed qualtiy: Objectives, concept and components and their role in seed quality control; instruments, devices and tools used in seed testing. ISTA and its role in seed testing.

UNIT – II Seed Sampling: definition, objectives, seed-lot and its size; types of samples; sampling devices; procedure of seed sampling; sampling intensity; methods of preparing composite and submitted samples; sub-sampling techniques, dispatch, receipt and registration of submitted sample in the laboratory, sampling in the seed testing laboratory.

UNIT – III Physical purity: definition, objective and procedure, weight of working samples for physical purity analysis; components of purity analysis and their definitions and criteria; pure seed definitions applicable to specific genera and families; multiple seed units; general procedure of purity analysis; calculation and reporting of results, prescribed seed purity standards; determination of huskless seeds; determination of weed seed and other seed by number per kilogram; determination of other distinguishable 60 varieties (ODV); determination of test weight and application of heterogeneity test.

UNIT – IV Seed moistur econtent; importance of moisture content; equilibrium moisture content; principles and methods of moisture estimation- types, instruments and devices used; predrying and grinding requirements, procedural steps in moisture estimation; calculation and reporting of results.

UNIT – V Germination; importance; definition; requirements for germination, instrument and substrata required; principle and methods of seed germination testing; working sample and choice of method; general procedure for each type of method; duration of tes; seedling evaluation; calculation and reporting of results; dormancy; definition, importance, causal mechanisms, types and methods for breaking dormancy.

UNIT – VI Viability and Vigour Testing: definition and importance of viability tests; different viability tests; quick viability test (TZ- test) advantages, principle, preparation of seeds and solutions, procedure, evaluation and calculation of test results. Vigour testing; concept, historical development, definitions, principles and procedures of different methods used for testing vigour.

UNIT – VII Genetic purity testing: objective and criteria for genetic purity testing; types of test; laboratory, Growth Chamber and field testing based on seed, seedling and mature plant morphology; principles and procedures of chemical, biochemical and molecular tests.

UNIT – VIII Seed health Testing : field ad seed standards; designated diseases, objectionable weeds- significance of seed borne disease vis-à-vis seed quality – seed health testing and detection mehtods for seed borne fungi, bacteria, viruses and nematodes.

UNIT – IX Testing of GM seeds and trait purity, load of detection (LOD).

UNIT – X Preparation and dispatch of seed testing reports; storage of guard samples; application and use of seed standards and tolerances.

Practical

Structure of monocot and dicot seeds of important plant species; identification and handling of instruments used in seeds testing laboratory; identification of seeds of weeds and crops; physical purity analysis of samples of different crops; estimation of seed moisture content (oven method); seed dormancy breaking methods requirements for conducting germination test, specifications and proper use of different substrata for germination; seed germination testing in different agri-horticultural crops; seedling evaluation; viability testing by tetrazolium test in different crops; seed and seedling vigour tests applicable in various crops; species & cultivar identification; genetic purity testing by chemical, biochemical and molecular mentods; seed health testing for designated diseases, blotter 61 methods, agar mehtod and embryo count mehtods; testing coated/ pelleted seeds.

Suggested Readings

Agarwal RL. 1997, *Seed Technology*, Oxford & IBH.
Agrawal PK & Dadlani M. 1992, *Techiques in Seed Science and Technology* 2nd Ed. South Asian Publ.
Agrawal PK. (Ed.). 1993 *Handbook of Seed Testing* Ministry of Agricultur, GOI, New Delhi.
Copland LO & MeDonald MB. 1996 Principles of Seed Science and Technology, Kluwer.
ISTA 2006. *Seed Testing Manual*. ISTA, Switzerland.
Martin C & Barkley D. 1961 *Seed Identification Manual*. Oxford & IBH. Tunwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Borad Ministry of Agriculture, New Delhi.

Minor course

MBB 504 **Plant Tissue Culture and Genetic Transformation** **1+2**

Objective To familiarize the students and provide hands on training on various techniques of plant tissue culture, genetic engineering and transformation.

Theory

UNIT I History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; *In vitro* differentiation organogenesis and somatic embryogenesis; Plant growth regulators mode of action, effects on *in vitro* culture and regeneration; Molecular basis of plant organ differentiation.

UNIT II Micropropagation; Anther and microspore culture; Somaclonal variation; *In vitro* mutagenesis; *In vitro* fertilization; *In vitro* germplasm conservation; Production of secondary metabolites; Synthetic seeds.

UNIT III Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization protoplast fusion, cybrids, asymmetric hybrids, etc.

UNIT IV Methods of plant transformation; Vectors for plant transformation; Genetic and molecular analyses of transgenics; Target traits and transgenic crops; Biosafety issues, testing of transgenics, regulatory procedures for commercial approval.

Practical

- Laboratory set-up.
- Preparation of nutrient media; handling and sterilization of plant material; inoculation, subculturing and plant regeneration.
- Anther and pollen culture.
- Embryo rescue.
- Suspension cultures and production of secondary metabolites.
- Protoplast isolation, culture and fusion.
- Gene cloning and vector construction
- Gene transfer using different methods, reporter gene expression, selection of transformed tissues/plants, molecular analysis.

Suggested Readings

Bhojwani SS. 1983. Plant Tissue Culture Theory and Practice. Elsevier.
Christou P & Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.
Dixon RA. 2003. Plant Cell Culture. IRL Press.
George EF, Hall MA & De Klerk GJ. 2008. Plant Propagation by Tissue Culture. Agritech Publ.
Gupta PK. 2004. Biotechnology and Genomics. Rastogi Publ.
Herman EB. 2005-08. Media and Techniques for Growth, Regeneration and Storage. Agritech Publ.
Pena L. 2004. Transgenic Plants Methods and Protocols. Humana Press.
Pierik RLM. 1997. In vitro Culture of Higher Plants. Kluwer.
Singh BD. 2007. Biotechnology Expanding Horiozon. Kalyani.

Minor course

PL PATH 510 Seed Health Technology 2+1

Objective To acquaint with seed-borne diseases, their nature, detection, transmission, epidemiology, impacts/loses and management.

Theory

UNIT I History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO. Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.

UNIT II Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens.

UNIT III Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.

UNIT IV Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

Practical

- Conventional and advanced techniques in the detection and identification of seed-borne fungi, bacteria and viruses.
- Relationship between seed-borne infection and expression of the disease in the field.

Suggested Readings

Agarwal VK & JB Sinclair. 1993. Principles of Seed Pathology. Vols. I & II, CBS Publ., New Delhi.

Paul Neergaard. 1988. Seed Pathology. MacMillan, London.

Bhale MS & A Gaur, 2012. Seed borne diseases of field crops and their management . Agrobios (India), Jodhpur, Rajasthan. 446p(ISBN:978-81-7754-476-3)

Khare, MN & MS Bhale. 2013. Seed pathology in Modern Agriculture, Agrobios (India), Jodhpur, Rajasthan. 358p (ISBN: 978-81-7754-487-9)

Agarwal VK (2006). Seed Health. International Book Distributing Co. Lucknow, Uttar Pradesh. 553p (ISBN:81-8189-111-2)

Khare D. & MS Bhale (2014). Seed Technology, II edition scientific publisher, Jodhpur, Rajasthan. 944p (ISBN: 978-81-7233-883-1)

Supporting course

MCA 502 **Introduction to Networking and Internet Applications** **1+1**

Objective

The course is aimed to provide fundamentals of networking and application protocols with the emphasis on developing web based applications.

Theory

UNIT I Networking fundamentals, types of networking, network topology; Introduction to File Transfer Protocol (FTP), Telnet, Simple Mail Transfer Protocol (SMTP).

UNIT II World Wide Web (WWW), working with Internet; Web pages, web sites, web servers; Web Applications.

UNIT III Hyper Text Markup Language (HTML), DHTML, web based application development.

Practical

- Network and mail configuration; Using Network Services; Browsing of Internet; Creation of web pages; Creation of websites using HTML and Creation of websites using DHTML.

Suggested Readings

- Buyens J. 2002. Microsoft FrontPage -Inside Out. Microsoft Press. Cox V, Wermers L & Reding EE. 2006. HTML Illustrated Complete. 3rd Ed. Course Technology.
- Niederst J. 2001. Web Design in a Nutshell. O'Reilly Media.
- Tanenbaum AS. 2003. Computer Networks. Prentice Hall of India.

Supporting course

STAT 511 Statistical Methods for Applied Sciences 3+1

Objective The student is exposed statistical methods and statistical inference to help them in understanding the concepts involved in data presentation, analysis and interpretation.

Theory

UNIT I Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.

UNIT II Discrete and continuous probability distributions Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions. Large sample theory.

UNIT III Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination. Polynomial regression models and their fitting. Probit regression analysis by least squares and maximum likelihood methods, confidence interval for sensitivity; Testing for heterogeneity.

UNIT IV Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

UNIT V Introduction to multivariate analytical tools- Hotelling's T^2 Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function, D^2 - statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.

Practical

- Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F; Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution; Correlation and regression analysis, fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis; Nonparametric tests.

Suggested Readings

Anderson TW. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley.
Dillon WR & Goldstein M. 1984. Multivariate Analysis - Methods and Applications. John Wiley.
Goon AM, Gupta MK & Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.
Goon AM, Gupta MK & Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.
Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley.
Hogg RV & Craig TT. 1978. Introduction to Mathematical Statistics. Macmillan.
Morrison DF. 1976. Multivariate Statistical Methods. McGraw Hill.
Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.
Learning Statistics http//freestatistics.altervista.org/en/learning.php.
Electronic Statistics Text Book
http//www.statsoft.com/textbook/stathome.html.

Supporting course

STAT 512 Experimental Designs 2+1

Objective The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

UNIT I Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

UNIT II Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

UNIT III Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

UNIT IV Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

UNIT V Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.

Practical

- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Analysis of resolvable designs; Fitting of response surfaces.

Suggested Readings

Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
Federer WT. 1985. Experimental Designs. MacMillan.
Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
Pearce SC. 1983. The Agricultural Field Experiment A Statistical Examination of Theory and Practice. John Wiley.
Design Resources Server www.iasri.res.in/design.

Non-Credit Compulsory Courses

PGS 501 Library and Information Services 1(0+1)

Objective To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; ere sources access methods.

PGS 504 Basic Concepts in Laboratory Techniques 1(0+1)

Objective To acquaint the students about the basics of commonly used techniques in laboratory.

Practical Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings

Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

PGS 505 Agriculture Research, Research Ethics and Rural Development Program's 1(1+0)

Objective To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I History of agriculture in brief; Global agricultural research system need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR) International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II Research ethics research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III Concept and connotations of rural development, rural development policies and strategies. Rural development programmes Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture- Four Decades of Development. Sage Publ.
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
Rao BSV. 2007. Rural Development Strategies and Role of Institutions- Issues, Innovations and Initiatives.
Singh K.. 1998. Rural Development Principles, Policies and Management. Sage Publ.

PGS 506 Disaster Management 1(1+0)

Objective To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and apacity building.

Theory

UNIT I Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change Global warming, Sea Level rise, Ozone Depletion

UNIT II Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response Police and other organizations.

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe A Handbook of Disaster Management. Routledge.
Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

PGS 502 Technical Writing and Communications Skills 1(0+1)

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

- **Technical Writing -** Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering

of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

- **Communication Skills -** Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern Weak forms in connected speech Participation in group discussion Facing an interview; presentation of scientific papers.

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India. Collins' Cobuild English Dictionary. 1995. Harper Collins. Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. Comp.Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. Speaking English Effectively. MacMillan India. Richard WS.1969. Technical Writing.
Barnes & Noble. Robert C. (Ed.). 2005. Spoken English Flourish Your Language.
Abhishek. Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

PGS 503 Intellectual Property and Its management in Agriculture 1(1+0)

Objective

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

- 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.

Suggested Readings

Erbisch FH & 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. Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries A Compendium on Law and Policies. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments;
Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.