AMPB501 Principles of Genetics 2+1

Objective

This course is aimed at understanding 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. 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 II

Population - Mendelian population – Random mating population - Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium. Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis.

UNIT III

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

Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs). Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.

UNIT V

Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

Practical

1. Laboratory exercises in probability and chi-square;
2. Demonstration of genetic principles using laboratory organisms;
3. Chromosome mapping using three point test cross;
4. Tetrad analysis;
5. Induction and detection of mutations through genetic tests;
6. DNA extraction and PCR amplification - Electrophoresis – basic
7. principles and running of amplified DNA - Extraction of proteins and isozymes – use of *Agrobacterium* mediated method and Biolistic gun;
8. practical demonstrations - Detection of transgenes in the exposed plant material;
9. 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.

AMPB 502 Principles of Cytogenetics2+1

Objective

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

Theory

UNIT I

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, 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.

UNIT II

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, Structural and Numerical variations of chromosomes and their implications- Symbols and terminologies for chromosome numbers - euploidy -haploids, diploids and polyploids;Utilization of an euploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction.

UNIT III

Evolutionarsignificance of chromosomal aberrations - balanced lethals and chromosome complexes.Inter-varietal chromosome substitutions; Polyploidy and role of polyploidsin crop breeding; Evolutionary advantages of autopolyploids Vegetable Science allopolyploids –- Role of an euploids 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 a pomixes.

UNIT IV

Reversion of auto polyploids to diploids; Genome mapping inpolyploids –Inter specific 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 V

Fertilization barriers in crop plants at pre-and post fertilization levels- *Invitro*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

1. Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc.
2. Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope;
3. Preparing specimen for observation – Fixative preparation and fixing pecimen for light microscopy studies in cereals –
4. Studies on the course of mitosis in wheat, pearl millet –
5. Studies on the course of mitosis in onion and *Aloe vera*-
6. Studies on the course of meiosis in cereals, millets and pulses –
7. Studies on the course of meiosis in oilseeds and forage crops –
8. Using micrometers and studying the pollen grainsizeinvariouscrops.
9. Variousmethodsofstainingandpreparation

of temporary and permanent slides.

10. Pollen germination *in vivo* and *in vitro;* Microtomy and steps in microtomy;
11. Agents employed for the induction of various ploidy levels;
12. Solution preparation and application at seed, seedling level
13. Identification of polyploids in different crops –
14. Induction and identification of haploids;
15. Anther culture and Ovule culture –
16. Morphological observations on synthesized autopolyploids
17. Observations on C-mitosis, learning on the dynamics of spindle fibre assembly –
18. Morphological observations on lloployploids–
19. Morphological observations on an euploids-
20. Cytogenetic analysis of inter specific and intergeneric crosses
21. Maintenance of Cytogenetic stocks and their importance in crop breeding
22. Various ploidy levels due to somaclonal variation
23. Polyploidy inornamental crops. -Fluorescent *in situ* hybridization (FISH)
24. Genome *insitu*hybridizationGISH.

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'sFormulatory 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: Theoryand Practice*.Butterworth.

Sumner AT. 1982. *Chromosome Banding*. Unwin Hyman Publ.
Swanson CP. 1960. *Cytology and Cytogenetics*. Macmillan & Co.

AMPB 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.Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of variability, components of variation;

UNIT II

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 plantbreeding.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 III

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 interpopulation 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 IV

Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonalselection. Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressivebreeding.

UNIT V

Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses. Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Practical

1. Floral biology in self and cross pollinated species,
2. Selfing and crossing techniques.
3. Selection methods in segregating populations and evaluation of breeding material;
4. Analysis of variance (ANOVA); Estimation of heritability and genetic advance;
5. Maintenance of experimental records;
6. Learning techniques in hybrid seed production using male-sterility in fieldcrops.

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*.

AMPB 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 linkageeffects.

UNIT II

Principles of Anaylis 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 geneticadvance.

UNIT IV

Generation mean analysis; Mating designs- Diallel, partial diallel, line xtester 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 influencingMAS.

Practical

1. Problems on multiple factors inheritance
2. Partitioning of variance –
3. Estimation of heritability and genetic advance –
4. Covariance analysis –
5. Metroglyph analysis –
6. D2 analysis –
7. Grouping of clusters and interpretation –
8. Cluster analysis –
9. Construction of cluster diagrams and dendrograms -interpretation
10. Correlation analysis –
11. Path analysis –
12. Parent-progeny regression analysis –
13. Diallel analysis: Griffing’s methods I and II

14. Diallelanalysis: Hayman's graphical approach
15. Diallel analysis: interpretation of results
16. NCD and their interpretations
17. Line x tester analysis and interpretation of results
18. Estimation of heterosis : tandard, mid-parental and better-parental heterosis
19. - Estimation of inbreeding depression
20. Generationmeananalysis:AnalyticalpartandInterpretation
21. Estimation of different types of gene actions.
22. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions
23. Construction of saturated linkage maps and QTL mapping
24. Strategies for QTL mapping; statistical methods in QTL mapping;
25. Phenotype and Marker linkage studies
26. Working out efficiency of selection methods in different populations and interpretation,
27. Biparental mating, Triallel analysis,
28. Quadriallelanalysisand Triple Test Cross (TTC) – use of softwares in analysis and result interpretation,
29. Advanced biometrical models for combining ability analysis,
30. Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model
31. Principal Component Analysis model
32. Additive and multiplicative model
33. Shifted multiplicative model
34. Analysis and selection of genotypes
35. Methods and steps to select the best model
36. 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.

AMPB 505Biotechnology for Crop Improvement 2+1

Objective

To impart knowledge and practical skills to use biotechnological tools incrop improvement.

Theory

UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding. Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis;Anther culture; somatichybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT II

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 III

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, Genepyramiding.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 IV

Recombinant DNA technology, transgenes, method of transformation,selectable markers and clean transformation techniques, vector-mediatedgene 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 V

Biotechnology applications in male sterility/hybrid breeding, molecular farming. GMOs 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 Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.

Practical

1. Requirements for plant tissue culture laboratory-Techniques in plant tissue culture
2. Media components and media preparation
3. Aseptic manipulation of various explants - observations on the contaminants occurring in media –interpretations - Inoculation of

explants;

4. Callus induction and plant regeneration - Plant regeneration;
5. Standardizing the protocols for regeneration;
6. Hardening of regenerated plants;
7. Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit.
8. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues.
9. DNA isolation, DNA purity and quantification tests, gelelectrophoresis of proteins and isozymes,
10. PCR- based DNA markers, gelscoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computersoftware.

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 Technology - 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

AMPB 506 Maintenance Breeding and Concepts of Variety Release and Seed Production 1+1

Objective

To apprise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self &cross pollinated crops.

Theory

UNIT I

Variety Development and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid, and population; Variety testing, release and notification systems in India and abroad.

UNIT II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.

UNIT III

Factors responsible for genetic deterioration of varieties – safe guards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production.

UNIT IV

Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil).

UNIT V

Quality seed production technology of self and cross- pollinated crop varieties viz.Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and internationalsystems.

Practical

1. Identification of suitable areas/locations for seed production;
2. Ear-to-row method and nucleus seed production.
3. Main characteristics of released and notified varieties, hybrids and parental lines.

4. Identification of important weeds/objectionable weeds.
5. Determination of isolation distance and planting ratios in different crops.
6. Seed production techniques of varieties indifferent crops.
7. Hybrid seed production technology of importantcrops.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*.

Department of Plant Breeding.CCS HAU Hisar.Kelly AF. 1988. *Seed Production of Agricultural Crops*. Longman.

McDonald MB Jr& Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.

Musil AF. 1967. *Identification of Crop and Weed Seeds*. HandbookNo. 219, USDA, Washington, DC.

Poehlman JM &Borthakur D. 1969.*Breeding Asian Field Crops*.Oxford & IBH.

Singh BD. 2005. *Plant Breeding: Principles and Methods*. Kalyani.

Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.

Tunwar NS & Singh SV. 1985. *Handbook of Cultivars*. ICAR.

AMPB 507Cell 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

Ultrastructure 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; Ultrastructure 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 translationalfactors.

UNIT IV

Transposable elements; Mechanisms of recombination in prokaryote; DN Aorganization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes.

UNIT V

Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cellaging.

Practical

1. Morphological and Gram staining of natural bacteria.
2. Cultivation of bacteria in synthetic medium;
3. Determination of growth rate and doubling time of bacterial cells in culture;
4. Demonstration of bacteriophage by plaqueassay method;
5. Determination of soluble protein content in a bacterialculture.
6. Isolation, purification and raising clonal population of a bacterium;
7. Biological assay of bacteriophage and determination of phage population inlysate;
8. Study of lytic cycle of bacteriophage by one step growth experiment;
9. determination of latent period and burst size of phages per cell;
10. 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 F reeman& Co.
Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.

Schleif R. 1986. *Genetics and Molecular Biology*. Addison - Wesley Publ. Co.

MINOR COURSES

AMSS 503 SEED PHYSIOLOGY 2+1

Objective

To provide an insight into physiological processes governing seed quality and its survival.

Theory

UNIT I

Physiology of seed development and maturation; chemical composition, synthesis and accumulation of seed reserves, induction of desiccation tolerance, hormonal regulation of seed development.

UNIT II

Seed germination; factors affecting germination; role of embryonic axis; growth hormones and enzyme activities, effect of age, size and position of seed on germination. Physiological processes during seed germination.

UNIT III

Seed respiration, breakdown of stored reserves in seeds, mobilization and interconversion pathways.Seed dormancy- types, significance, mechanism, endogenous and exogenous factors regulating dormancy, role of phytochrome and PGR, genetic control of dormancy.

UNIT IV

Seed viability and longevity, pre and post-harvest factors affecting seed viability ; seed ageing ; physiology of seed deterioration ; lipid peroxidation and other viability

theories; means to prolong seed viability; mechanism of desiccation sensitivity and recalcitrance with respect to seed longevity.

UNIT V

Seed vigour and its concept, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield.Seed invigoration and its physiological and molecular control.

Practical

1. Proximate analysis of chemical composition of seed;
2. Methods of testing viability.
3. Kinetics of seed imbibition and solute leakage;
4. Seed germination and dormancy breaking methods;
5. Seed invigoration and priming treatments; accelerated ageing and controlled deterioration tests;
6. Enzymatic activities and respiration during germination and effect of accelerated ageing
7. Vigour testing methods etc.

Suggested Readings

Agrawal PK &Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.

Baskin CC & Baskin JM. 1998. *Seeds: Ecology, Biogeography andEvolution of Dormancy and Germination*. Academic Press.

Basra AS. 2006. *Handbook of Seed Science and Technology*. Food ProductPress.

Bench ALR & Sanchez RA. 2004. *Handbook of Seed Physiology*. FoodProduct Press.

Bewley JD & Black M. 1982.*Physiology and Biochemistry of Seeds inRelation to Germination*.Vols.I, II. Springer Verlag.

Bewley JD & Black M. 1985.*Seed: Physiology of Seed Development andGermination*. Plenum Press.

Copeland LO &Mc Donald MB. 1995. *Principles of Seed Science andTechnology*. 3rd Ed. Chapman & Hall.

Khan AA. 1977. *Physiology and Biochemistry of Seed Dormancyand Germination*. North Holland Co.

Kigel J &Galili G. (Eds.).*Seed Development and Germination*. MarcelDekker.

Murray DR. 1984. *Seed Physiology.*Vols.I, II.Academic Press.

Sadasivam S &Manickam A. 1996.*Biochemical Methods*.2nd Ed.NewAge.

AMSS 504 Seed Entomology 1+1

Objective

To apprise about the role of insects in seed production and their effect on seed quality during storage.

Theory

UNIT I

Principles of seed entomology; pollinator insects, insect pests and their classification based on mode of infestation etc.

UNIT II

Principles of insect pollination, role of pollinators in seed Production. Augmenting quality seed production through honeybee pollination in crucifers and forage legumes. Plant protection measures in bee pollinated crops. Management of pollinators for hybrid seed production.

UNIT III

Major insect pests of principal crops and their management practices. Methods of insect pest control. Classes of pesticides, their handling and safe use on seed crops.

UNIT IV

Storage insect pests infecting seeds, their development and economic importance. Storage losses due to pests, control of storage pests, Management of storage insects pests, mites and rodents, seed sampling and loss estimation.

UNIT V

Principles of fumigation and their use, effect of different fumigants; preservatives and seed protectants on seed quality; Type of storage structures – domestic and commercial.

Practicals

1. Collection and identification of insect-pollinators, collection and identification of important pests of stored seeds.
2. Detection and estimation of pest infestation vis- a- vis loss of seed quality.
3. Safe handing and use of fumigants and insecticides; safety measures in fumigating and disinfecting, exposure period, aeration etc. the storage structures.

4. Plant protection equipments, their operation and maintenance.
5. Pesticides, its dose determination, preparation of solution and its application.

Suggested Readings

- Agarwal, N.A. and Girish, G.K. 1977. *An Introduction to Action Programme to Regress on Farm Storage Losses in India*. FAO/NORAD Seminar on Farm Storage Grain in India, Nov. 29-Dec. 8, 1977.
- Anderson, J.A. and Aleock, A.W. 1954. *Storage of Cereal Grain & their Products*. American Assoc. Cereal Chemists, St. Pauls, Minn.
- Cottong, R.T. 1963. *Insect Pests of Stored Grain and Grain Products*. Burgess Publ. Co., Minneopolis, Minn., USA.
- Monro. 1969. *Manual of Fumigation for Insect Control*. FAO Rome Agril. Studies No. 79.
- Subramanyam, B. and Hagstrum, D.W. 1995. *Interrelated Management of Insects in Stored Products*. Marcel Dekker.

AMSS 505	**SEED PRODUCTION IN FIELD CROPS**	**2+1**

Objective

To impart a comprehensive knowledge of seed production in field crops with adequate practical training.

Theory

UNIT I

Basic principles in seed production and importance of quality seed.Floral structure, breeding and pollination mechanism in self-pollinated cereals and millets viz, wheat, barley, paddy, ragi etc.

UNIT II

Floral structure, breeding and pollination mechanism in cross-pollinated cereals and millets viz maize, sorghum, bajraetc ; methods and techniques of quality seed production incross-pollinated cereals and millets.

UNIT III

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in pulses (pigeon pea, chick pea, green garm, blackgarm, field beans, peas etc.).

UNIT IV

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in major oil seeds (groundnut, castor, sunflower, safflower, rape and mustard, linseed, sesame etc.).

UNIT V

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in commercial fibers (cotton, jute, mestaetc) and vegetatively propagated crops like sugar cane, potato etc.

Practical

1. Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate;
2. Seed production in cross pollinated crops with special reference to land, isolation, planting ratio of male and female lines,
3. synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage, hand emasculation and pollination in Cotton,
4. detasseling in Corn, identification of rogues and pollen shedders; Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc.

Suggested Readings

Kelly AF. 1988. *Seed Production of Agricultural Crops*. John Wiley.
McDonald MB Jr& Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.
Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.

SUPPORTING COURSES

AMST 101 STATISTICAL METHODS FORAPPLIEDSCIENCES 3+1

Objective

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data,Probability distributions, parameter estimation, tests of significance, regression and ultivariate analyticaltechniques.

Theory

UNITI

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

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 sampletheory.

UNITIII

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 likelihoodmethods, confidence interval for sensitivity; Testing for heterogeneity.

UNITIV

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.

UNITV

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 Factoranalysis.

Practical

1. Exploratory data analysis, Box-Cox plots;
2. Fitting of distributions ~ Binomial, Poisson, Negative Binomial,
3. NormalLarge sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F.
4. Confidence interval estimation and point
5. Estimation of parameters of binomial, Poisson and Normal distribution.
6. Correlation and regression analysis, fitting of orthogonal polynomial regression.
7. Applications of dimensionality reduction and discriminant function analysis.
8. Application of 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 WorldPress.
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.

AMST 201 EXPERIMENTALDESIGNS 2+1

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. 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 experimentaldata.

Theory

UNITI

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and localcontrol.

UNITII

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

UNITIII

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

UNITIV

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 designsand
their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces.Experiments with mixtures.

UNITV

Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potencyestimation.

Practical

1. Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law;
2. Analysis of data obtained from CRD, RBD, LSD;
3. Analysis of factorial experiments without and with confounding;
4. Analysis with missing data; Split plot and strip plot designs;
5. Transformation of data; Analysis of resolvable designs;
6. 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 COURSES

AMNC 101 LIBRARY AND INFORMATIONS SERVICES 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

1. Introduction to library and its services;
2. Role of libraries in education , research and technology transfer; Classification systems and organization of library;
3. 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.)

4. Tracing information from reference sources; Literature survey; Citation Online Public Access bibliography; Use of CD-ROM Databases,
5. Online Public Access catalogue and other computerized library services;
6. Use of Internet including search engines and its resources access methods.

AMNC 102 Technical Writing and communications skills 0+1

Objective

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

Practical

Technical Writing –

1. Various forms of scientific writings- theses, technical papers, reviews, manuals, etc;
2. Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
3. Writing of abstracts, summaries, précis citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; paginations, numbering of tables and illustrations;
4. Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills –

1. Grammar (Tenses, parts of speech, clauses, punctuation marks).
2. Error analysis (Common errors); analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription.
3. Accentual pattern: Weak forms in connected speech.
4. Participation in group discussion.
5. 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. Osford Advanced Learner's Dictionary ofof 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.Sth 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.

AMNC 103 Intellectual property and its management in agriculture (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

UNIT I

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement.

UNIT II

Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs: Indian Legislations for the protection of various types of Intellectual Properties.

UNIT III

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.

UNIT IV

Protectable subject matters protection in biotechnology, protection of other biological materials ownership and period of protection.

UNIT V

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

AMNC 104BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1

Objective

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

Practical

1. Safety measures while in Lab, Handling of chemical substances
2. Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware;
3. Drying of solvents chemicals. Weighing and preparation of solutions of different strengths and their dilution Handling techniques of solutions;
4. Preparation of different agro-chemical doses in field and pot applications;
5. Preparation ofNeutralisation of acid and bases;
6. Preparation of buffers of different strengths and pH values.
7. Use and handling of microscope, laminar flow vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens incubators, sandbath, waterbath, oilbath; Electric wiring and earthing
8. Preparation of media and methods of sterilization; Seed viability testing testing of pollen viability: Tissue culture of crop plants;
9. Description of owering plants in botanical terms in relation to taxonomy tion of

solutions of acids;

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.

AMNC 105 AGRICULTURAL RESEARCH, RESEARCIH ETHICSAND RURAL DEVELOPMENT PROGRAMMES1+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.

UNIT II

National Agricultural Research Systems NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels;

UNIT III

International fellowships for scientific mobilityResearch ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT IV

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive

Agricultural District Programme Special groupArea Specific Programme, Integrated Rural Development Programme (IRDP).

UNIT V

Panchayati Raj Institutions, Co- operatives, Voluntary Agencies/Non GovenmentalOrganisations.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. Mittal Publ.

Singh K. 1998. Rural Development Principles, Policies and Management.Sage Publ.

AMNC 106DISASTER MANAGEMENT 1+0

Objectives

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 capacity building

Theory

UNIT I

Natural Disasters Meaning and nature of natural disasters, their types and effects.Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic cruptions, Heat and cold waves.

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. oil fire, air pollution, water pollution, deforestation,

UNIT III

Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.Climatic change: Global warming, Sea level rise, Ozone depletion.

UNIT IV

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.

UNIT V

Central, state, district and local administration; Armed force 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.

COURSE CURRICULUM OF PhD. PROGRAMME 2019-21

DEPARTMENT OF GENETICS & PLANT BREEDING

PhD. IN PLANT BREEDING & GENETICS

Ist Semester

Course no.	Course Title	Credits
Major Courses		
APPB601	PLANT GENETIC RESOURCES AND THEIR UTILIZATION	2+0
APPB602	ADVANCES IN QUANTITATIVE GENETICS	2+1
APPB603**	GENOMICS IN CROP IMPROVEMENT	2+1
Minor Courses		
APSS 602@@	IN SITU AND EX SITU CONSERVATION OF GERMPLASM	2+1
APSS 603	TESTING FOR GENUINENESS & PURITY OF CULTIVARS	1+1
Supporting		**04**
AMST 101	Statistical methods for applied Sciences	3+1
Non-credit Courses		
AMNC 101	Library &Information Services	0+1

IInd Semester

Major Courses		
APPB604**	MOLECULAR AND CHROMOSOMAL MANIPULATIONS FOR CROP BREEDING	2+0
APPB605**	ADVANCED PLANT BREEDING SYSTEMS	2+0
APPB606	ADVANCES IN BREEDING OF MAJOR FIELD CROPS	3+0
APPB691	DOCTORAL SEMINAR I	1+0

Minor Courses		
APSS 608	PHYSIOLOGY OF SEEDS	2+1

Supporting Courses

AMST 201	Design of Experiments	2+1

IIIrdSemester

APPB692	DOCTORAL SEMINAR II	1+0
APPB699	DOCTORAL RESEARCH	0+15

IVthSemester

APPB699	DOCTORAL RESEARCH	0+15

VthSemester

APPB699	DOCTORAL RESEARCH	0+10

VIthSemester

APPB699	DOCTORAL RESEARCH	0+05

APPB 601	**PLANT GENETIC RESOURCES AND PRE-BREEDING**	**2+0**

Objective

To provide information about collection, evaluation, documentation, maintenance and use of plant genetic resources for crop improvement.

Theory

UNIT I

Historical perspectives and need for PGR conservation; Importance of plantgenetic resources; Taxonomical classification of cultivated plants; Genepool: primary, secondary and tertiary; Centres of origin and global patternof diversity; Basic genetic resources and transgenes.

UNIT II

Principles, strategies and practices of exploration, collection,characterization, evaluation and cataloging of PGR; Plant quarantine andphytosanitary certification; Germplasm introduction and exchange; Principles of *in vitro* and cryopreservation.Germplasm conservation- *in situ, ex situ*, and on-farm; short, medium andlong term conservation strategies for conservation of orthodox seed andvegetatively propagated crops; Registration of plant genetic resources.

UNIT III

PGR data base management; Multivariate and clustering analysis, descriptors; National and international protocols for PGR management; PGR for food and agriculture (PGRFA); PGR access and benefit sharing; Role of CGIAR system in the germplasm exchange; PBR, Farmers rights and privileges; Seed Act, *sui generis* system; Geographical indicators, Intellectual property; Patents, copyrights, trademarks and trade secrets.
UNIT IV

Journey from wild to domestication; Genetic enhancement- need for genetic enhancement; Genetic enhancement in pre Mendelian era and 21st century; Genetic enhancement and plant breeding; Reasons for failure in genetic enhancement; Sources of genes/ traits- novel genes for quality.
UNIT V

Distant Hybridization: Inter-specific, inter-generic hybridization, scope andlimitations, techniques to overcome the limitations; Gene transfer tools andtechniques into cultivated species; Validation of transferred genes and theirexpression.Post-genomic tools for genetic enhancement of germplasm; Prebreedingthrough chromosome manipulation; Application of biotechnology for Genetic enhancement-Achievements.Utilization of genetic resources, concept of core and mini-core collections, genetic enchancement/Prebreeding for crop improvement including hybrid development.

Suggested Readings

Frankel OH & Bennett E. 1970.*Genetic Resources in Plants – theirExploration and Conservation*. Blackwell.
Gautam PL, Dass BS, Srivastava U &Duhoon SS. 1998. *Plant GermplasmCollecting: Principles and Procedures*. NBPGR, New Delhi.
Painting KA, Perry MC, Denning RA &Ayad WG. 1993. *Guide Book for Genetic Resources Documentation*. IPGRI, Rome, Italy.
Paroda RS &Arora RK. 1991. *Plant Genetic Resources, Conservation and Management. Concepts and Approaches*.IPGRI Regional office forSouth and South Asia, New Delhi.
Puzone L &Hazekamp TH. 1996. *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, NewDelhi.
Rana RS, Sapra RL, Agrawal RC &Gambhir R. 1991.*Plant Genetic Resources, Documentation and Information Management*. NBPGR, New Delhi.
Singh RJ &Jauhar PP. 2005. *Genetic Resources, Chromosomal Engineering and Crop Improvement*.Vol. I. *Grain Legumes*, Vol. II.*Cereals*.CRC Press, Taylor & Francis Group, USA.

APPB 602	ADVANCED BIOMETRICAL AND QUANTITATIVE GENETICS 2+1

Objective

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

Theory

UNIT I

Basic principles of Biometrical Genetics; Selection of parents; Advanced biometrical models for combining ability analysis; Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes; Designs and Systems; Selection of stable genotypes.

UNIT II

Models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; Principal Component Analysis.

UNIT III

Additive and multiplicative model - Shifted multiplicative model; Analysis and selection of genotypes; Methods and steps to select the best model - Biplots and mapping genotypes.

UNIT IV

Genetic architecture of quantitative traits; Conventional analyses to detect gene actions - Partitioning of phenotypic/genotypic variance – Construction of saturated linkage maps, concept of framework map development; QTL mapping-Strategies for QTL mapping - desired populations, statistical methods.

UNIT V

Marker Assisted Selection (MAS) - Approaches to apply MAS inPlant 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.

Practical

1. Working out efficiency of selection methods in different populations and interpretation
2. Biparental mating – use of softwares in analysis and result interpretation
3. Triallel analysis– use of softwares in analysis and result interpretation
4. Quadriallel analysis – use of softwares in analysis and result interpretation
5. Triple Test Cross (TTC) – use of softwares in analysis and result interpretation
6. Advanced biometrical models for combining ability analysis
7. Selection of stable genotypes using stability analysis;
8. Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model

9. Principal Component Analysis model - Additive and multiplicative model
10. Shifted multiplicative model - Analysis and selection of genotypes
11. Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes.
12. Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies.

Suggested Readings

Bos I & P Caligari. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.
Falconer DS & Mackay J. 1996.*Introduction to Quantitative Genetics*.Longman.
Mather K & Jinks L. 1983.*Introduction to Biometrical Genetics*.Chapman & Hall.
Nadarajan N &Gunasekaran M. 2005.*Quantitative Genetics andBiometrical 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.

APPB 603	GENOMICS IN PLANT BREEDING	2+1

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

Regulation of Plant gene expression - Functional genomics - Expression Analysis using Microarrays – Transposon tagging and Insertional mutagenesis- methods and significance- Diversity Array Technology.Genome sequencing in plants–Principles and Techniques; Applications of sequence information in plant genome analyses; Comparative genomics–

Genome Comparison Techniques- Classical and advanced approaches.

UNIT IV

Detection of Single Nucleotide Polymorphism; TILLING and EcoTILLING; Role of transcriptomics, proteomics and metabolomics in linking genome and phenome; Importance of understanding the phenotypesfor exploiting the outcome of genomic technologies- Knock out mutantstudies and high throughput phenotyping.

UNIT V

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

Practical

1. Chromosome analysis in major field crops
2. Fluorescence *in situ*hybridization
3. Comparative genomic hybridization
4. Comparative analysisof plant genomes using molecular markers
5. Genetic map constructionusing molecular markers
6. Mapping major genes using molecular markers
7. QTL mapping in plants
8. Comparison across mapping populations
9. Understanding the need genetic algorithms in QTL mapping
10. PlantGenome Databases
11. Computational tools to explore plant genomedatabases
12. Comparative genomics
13. Comparison of genome sequencesusing tools of bioinformatics
14. Advanced genomic technologies: TILLINGand Eco-TILLING
15. DNA Array Technology
16. Linking genome sequencesto phenotypes: Tools of transcriptomics, proteomics and metabolomics.

Suggested Readings

Baxevanis AD & Ouellette BFF. 2001. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.*
Wiley Interscience.Brown TA. 2002. *Genomes*. Wiley-LISS.
Caetano-Anolles G &Gresshoff PM. 1998.*DNA Markers: Protocols, Applications and Overviews*. Wiley-VCH.
Cantor CR & Smith CL (2004).*Genomics*.Wiley, New York.
Galas DJ & McCormack SJ. 2002. *Genomic Technologies: Present and Future*. Calster Academic Press.
Jordan BR. 2001. *DNA Microarrays: Gene Expression Applications*. Springer-Verlag.

Liu BH. 1997. *Statistical Genomics: Linkage, Mapping and QTL Analysis*. CRS Press.
Lynch M & Walsh B. 1998. *Genetics and Analysis of Quantitative Traits*. Sinauer Associates.
Mount DW. 2001. *Bioinformatics. Sequence and Genome Analysis*.Cold Spring Harbor Laboratory Press.
Palzkill T. 2002. *Proteomics*.Kluwer.Paterson AH. 1996. *Genome Mapping in Plants*. Academic Press.

GP 604	MOLECULAR AND CHROMOSOMAL MANIPULATIONS FOR CROP BREEDING2+0

Objective

This course focuses on the advanced techniques in analyzing chromosome structure and manipulations for genome analysis in crop species.

Theory

UNIT I

Organization and structure of genome – Genome size – Organization of organellar genomes – Nuclear DNA organization – Nuclear and Cytoplasmic genome interactions and signal transduction; Transcriptional and Translational changes, 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, loclalization and mapping of genes/genomic segments; Distant hybridization - Role of polyploids in crop evolution and breeding - auto and allopolyploids.

UNIT III

Applications of cytogenetical methods for crop improvement; Location and mapping of genes on chromosomes: deficiency method; Interchangegenetic 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- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomicsmethods of production, breeding behavior and location of genes; Intervarietal substitutions-allelic and non-allelic interactions; Telocentric method of mapping.

UNIT V

Barriers to interspecific and intergeneric hybridization- Behaviour of interspecific and intergeneric crosses; Totipotency of cells – Morphogenesis: *in vivo* and *in vitro* – Meristem culture – anther and pollen culture – ovule, ovary, embryo and endosperm culture – protoplast isolation and culture – protoplast fusion, Different pathways of *in vitro* morphogenesis – organogenesis and somatic embryogenesis; *in vitro* mutant/somaclone selection for biotic and abiotic stresses.

Suggested Readings

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

APPB 605	ADVANCES IN PLANT BREEDING SYSTEMS	2+0

Objective

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

Theory

UNIT I

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

UNIT II

Self- incompatability and sterility – Types of self incompatability: Homomorphic (sporophytic and gametophytic) and heteromorphic -

Breakdown of incompatibility - Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self incompatibility; Sterility: male and female sterility – Types of male sterility: genic, cytoplasmic and cytoplasmic-genic; Exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots – Case studies and breeding strategies; Nucleocytoplasmic interactions with special reference to male sterility – Genetic , biochemical and molecular bases.

UNIT III

Population formation by hybridization - Types of populations - Mendelian population, gene pool, composites, synthetics etc.; Principles and procedures in the formation of a complex population; Genetic basis of population improvement.Selection in self fertilizing crops; Creation of genetic variability selection methods - Selection methods: mass selection, pureline selection, pedigree method (selection in early generations vs advanced generations); Backcross, polycross and test cross.

UNIT IV

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

Genetic engineering technologies to create male sterility; Prospects and problems - Use of self- incompatability and sterility in plant breeding – case studies; - Fertility restoration in male sterile lines and restorer diversification programmes - Conversion of agronomically ideal genotypesinto male steriles – Concepts and breeding strategies; Case studies -Generating new cytonuclear interaction system for diversification of malesteriles - Stability of male sterile lines – Environmental influence onsterility– Environmentally Induced Genic Male Sterility (EGMS) – Typesof EGMS; Influence on their expression, genetic studies; Photo and thermosensitive genetic male sterility and its use in heterosis breeding - Temperature sensitive genetic male sterility and its use heterosis breeding -Apomixis and its use in heterosis breeding - Incongruity - Factors

influencing incongruity - Methods to overcome incongruity mechanisms.**Suggested Readings**

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 & 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 & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.
Mandal AK, Ganguli PK &Banerji SP. 1995.*Advances in Plant Breeding*.Vol.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.
Singh P. 1996.*Essentials of Plant Breeding*.Kalyani.
Welsh JR. 1981.*Fundamentals of Plant Genetic and Breeding*.John Wiley.
Williams W. 1964.*Genetical Principles and Plant Breeding*. Blackwell.

APPB 606	ADVANCES IN BREEDING OF MAJOR FIELD CROPS	3+0

Objective

To provide insight into recent advances in improvement of cereals, millets and non cereal crops using conventional and modern biotechnological approaches.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Conventional (line breeding, population improvement, hybrids) and other approaches (DH Populations, Marker Assisted Breeding, Development of new male sterility systems), transgenics.

UNIT V

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

Suggested Readings

Chopra VL. 2001. *Breeding Field Crops - Theory and Practice*.Oxford & IBH.

Davis DD.1978.*Hybrid Cotton Specific Problems and Potentials*. Adv. Agron. 30: 129-157.

Heyne EG. 1987. *Wheat and Wheat Improvement*. 2nd Ed. ASA, CSSA, SSSA Inc Publ.

Khairwal, IS, Rai KN &Harinaryanan H. (Eds.). 1999. *Pearl Millet Breeding*. Oxford & IBH.

Khairwal I, Ram C &Chhabra AK. 1990. *Pearl Millet Seed Production and Technology*. Manohar Publ.

Nagarajan S, Singh G &Tyagi BS. 1998. *Wheat Research Needs Beyond 2000 AD*. Narosa.

Nanda JS. 2000. *Rice Breeding and Genetics - Research Priorities and Challenges*. Oxford & IBH.

Rao VS, Singh G &Misra SC. 2004.*Wheat: Technologies for Warmer Areas*. Annamaya Publ.

Reynolds MP, Rajaram S, McNab A. 1996. *Increasing Yield Potential in Wheat: Breaking the Barriers*. Proc. Workshop held in Ciudad, Obregon, Sonora, Mexico.

Seth BL, Sikka SM, Dastur RH, Maheshwari P, Rangaswamy NS &Josi AB. 1960. *Cotton in India – A Monograph*. Vol. I. ICAR.

Singh BD. 2006. *Plant Breeding - Principles and Methods*.Kalyani.

Singh P & Singh S. 1998.*Heterosis Breeding in Cotton*.Kalyani.

Singh P. 1998.*Cotton Breeding*.Kalyani.

Singh S & Singh P. 2006. *Trends in Wheat Breeding*.Kalyani Publ.

MINOR COURSES

APSS 602	***IN SITU*AND*EX SITU*CONSERVATION OF GERMPLASM 2+1**

Objective

To impart knowledge on the methods of germplasm conservation.

Theory

UNIT I

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 sending seeds to network of active/ working collections, orthodox, recalcitrant seeds- differences in handling ,clonal repositories, genetic stability under long term storage condition.

UNIT III

In vitro storage, maintanence of *in vitro* culture under different conditions, *in vitro* bank maintanence for temporate 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 , prospects of *in vitro* gene bank.

UNIT IV

Cryopreservation- procedure for handling seeds of orthodox and recalcitrants-cryoprotectants,dessication, rapid freezing, slow freezing,vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation in agriculture, horticulture and forestry crops.Problems and prospects; challenges aheads.

Practical

1. *In situ* conservation of wild species –case studies at national and international levels - *ex situ* techniques for active and long-term conservation of collections-Preparation and handling of materials, packaging, documentation;
2. Design of cold storage modules- Conservation protocols for recalcitrant and orthodox seeds;
3. Cytological studies for assessing genetic stability, *in vitro* cultures-embryo,cell/suspension
   cultures,pollen cultures, study of cryotank facility and vitrificationtechniques,
4. Visit to NBPGR/NBAGR -study using fruit crops and other horticultural crops.

Suggested Readings

- Ellis RH & Roberts EH & White Head J. 1980. *A New More Economic and Accurate Approach to Monitor the Viability of Accessions During Storage in Seed Banks*. FAO / IBPGR Pl. Genet. Resources News 41-3-18.
- Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow*. Cambridge University Press, Cambridge.
- Simmonds, N.W. 1979. *Principles of Crop Improvement* Longman.
- Westwood MN. 1986. *Operation Manual for National Clonal GermplasmRepository Processed Report*. USDA-ARS and Orgon State Univ. Oregon, USA.
- Withers LA. 1980. *Tissue Culture Storage for Genetic Conservation*. IBPGR Tech. Rep. IBPGR, Rome, Italy.

APSS 603	**TESTING FOR GENUINENESS & PURITY OF CULTIVARS**	**1+1**

To provide hands-on training on various field and laboratory methods of testing cultivar purity.

Theory

UNIT I

Objective of cultivar purity test, general principles and methods involved. Use and limitations of laboratory, green house and field plot methods in determination of genuineness of cultivars; a case study in hybrid cotton, reporting of results and inference.

UNIT II

Chemical-biochemical tests for species and cultivar purity: phenol test, seed and seedling tests.

UNIT III

Electrophoretic analysis of seed protein, isozymesetc, use of chromatography for analysis of secondary compounds etc.

UNIT IV

DNA finger printing (RAPD, SSR, AFLP etc) and their use in varietal purity testing and registration of new varieties.

UNIT V

Use of computer-based machine vision (MVT) for varietal identification and purity testing.

Practical

Chemical and biochemical tests for species and cultivar purity:

1. Phenol test,
2. Seed and seedling tests,
3. Electrophoretic analysis of seed protein and isozymes,
4. DNA fingerprinting using PCR techniques, use of chromatography for analysis of secondary compounds.

Suggested Readings

- Basra AS. (Ed.). 1995. *Seed Quality: Basic Mechanisms and Agricultural Implications*. Food Product Press.
- ISTA 2006. *Handbook of Variety Testing*. International Seed Testing Association, Switzerland.

APSS 608 PHYSIOLOGY OF SEEDS (2 +1)

Objective

To apprise students regarding seed germination, dormancy, physiological processes involved in regulation of seed development and physiological processes governing seed quality and its survival.

Theory

UNIT I

Introduction, importance of seeds, seed structure and function, chemical composition of seed, seed development and maturation – physiological and molecular aspects; hormonal regulation of seed development, desiccation tolerance and sensitivity in relation to seed longevity, LEA protein.

UNIT II

Physiological and biochemical changes during seed maturation assimilate movement to seeds, storage of carbohydrate, protein and fats in seeds and biosynthesis.

UNIT III

Seed germination, factors influencing, breakdown and mobilization of stored products, carbohydrate, fat, protein, respiration and pathways of interconversion, control process in the mobilization of food reserve, hormonal control of germination. Seed dormancy, different types, environmental influences, mechanism and control including phytochrome, methods of breaking seed dormancy.

UNIT IV

Factors influencing loss of seed viability during storage, physiological and biochemical changes associated with seed ageing,, theories of seed ageing, seed viability and its evaluation, seed storage, protection from water, temperature and contaminants, desiccation tolerance and sensitivity in relation to seed longevity.

UNIT V

Seed vigour, concept, importance, measurement; seed invigoration, methods, physiological and molecular basis of seed invigoration, effect of vigour on field emergence and yield, seed hardening.

Practicals

1. Chemical composition of seed,
2. Testing seed vigour and viability,
3. Treaking of seed dormancy,
4. Germination,
5. Seed invigoration and priming treatments,
6. Accelerated ageing treatments,
7. Seed imbibition and leakage,
8. Enzyme activities during germination,
9. Sink ability of ovules,
10. Seed respiration.

Suggested Readings

- Agrawal, P.K. and Dadlani, M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.
- Baskin, C.C. and Baskin, J.M. 1998. *Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination*. Academic Press.
- Basra, A.S. 2006. *Handbook of Seed Science and Technology*. Food Product Press.
- Bench, A.L.R. and Sanchez, R.A. 2004. *Handbook of Seed Physiology*. Food Product Press.
- Bewley, J.D. and Black, M. 1982. *Physiology and Biochemistry of Seeds in Relation to Germination*. Vols. I, II. Springer Verlag.
- Bewley, J.D. and Black, M. 1985. *Seed: Physiology of Seed Development and Germination*. Plenum Press.
- Copeland, L.O. and Mc Donald, M.B. 1995. *Principles of Seed Science and Technology*. 3rd Ed. Chapman & Hall.
- Khan, A.A. 1977. *Physiology and Biochemistry of Seed Dormancy and Germination*. North Holland Co.

- Kigel, J. and Galili, G. (Eds.). *Seed Development and Germination*. Marcel Dekker.
- Murray, D.R. 1984. *Seed Physiology.* Vols. I, II. Academic Press.
- Sadasivam, S. and Manickam A. 1996. *Biochemical Methods*. 2nd Ed. New Age.

SUPPORTING COURSES

AMST 101 STATISTICAL METHODS FORAPPLIEDSCIENCES 3+1

Objective

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data,Probability distributions, parameter estimation, tests of significance, regression and ultivariate analyticaltechniques.

Theory

UNITI

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

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 sampletheory.

UNITIII

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 likelihoodmethods, confidence interval for sensitivity; Testing for heterogeneity.

UNITIV

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.

UNITV

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 Factoranalysis.

Practical

9. Exploratory data analysis, Box-Cox plots;
10. Fitting of distributions ~ Binomial, Poisson, Negative Binomial,
11. NormalLarge sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F.
12. Confidence interval estimation and point
13. Estimation of parameters of binomial, Poisson and Normal distribution.
14. Correlation and regression analysis, fitting of orthogonal polynomial regression.
15. Applications of dimensionality reduction and discriminant function analysis.
16. Application of 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 WorldPress.

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.

AMST 201 EXPERIMENTALDESIGNS 2+1

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. 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 experimentaldata.

Theory

UNITI

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and localcontrol.

UNITII

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

UNITIII

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

UNITIV

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 designsand
their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces.Experiments with mixtures.

UNITV

Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potencyestimation.

Practical

7. Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law;
8. Analysis of data obtained from CRD, RBD, LSD;
9. Analysis of factorial experiments without and with confounding;
10. Analysis with missing data; Split plot and strip plot designs;
11. Transformation of data; Analysis of resolvable designs;
12. 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 COURSES

AMNC 101 LIBRARY AND INFORMATIONS SERVICES 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

7. Introduction to library and its services;
8. Role of libraries in education , research and technology transfer; Classification systems and organization of library;
9. 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.)
10. Tracing information from reference sources; Literature survey; Citation Online Public Access bibliography; Use of CD-ROM Databases,
11. Online Public Access catalogue and other computerized library services;
12. Use of Internet including search engines and its resources access methods.