|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Course N0.** | **Course Title** | **Credit** | **Theory Marks** | | **Practical**  **Marks** | **Total** |
| **Mid Term** | **Final** |
| **GPB 501** | **Principles of Genetics** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 502** | **Principles of Cytogenetics** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 503** | **Principles of Plant Breeding** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 504** | **Principles of Quantitative Genetics** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 508** | **Cell Biology and Molecular Genetics** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 509** | **Biotechnology for Crop Improvement** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 510** | **Breeding for Biotic and Abiotic Stress Resistace** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 511** | **Breeding Cereal, Forage and Sugarcane** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 512** | **Breeding Legume,Oilseed and Fibre crop** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 515** | **Maintenance Breeding,Concepts of Variety Release and Seed Production** | **1+1** | **30** | **50** | **20** | **100** |
| **GPB 591** | **Master Seminar** | **1+0** | **-** | **-** | **-** | **100** |
| **GPB 599** | **Master Research** | **20** |  |  |  | **100** |
| **STAT 551** | **Statistical Methods** | **3+0** | **50** | **50** | **-** | **100** |
| **STAT 552** | **Experimental Design** | **2+0** | **50** | **50** | **-** | **100** |
|  | **Total** | **55** |  |  |  |  |
| **Semester wise Course Distribution** | | | | | | |
| **Ist Semester** | |  |  |  |  |  |
| **GPB 501** | **Principles of Genetics** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 502** | **Principles of Cytogenetics** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 503** | **Principles of Plant Breeding** | **2+1** | **30** | **50** | **20** | **100** |
| **STAT 551** | **Statistical Methods** | **3+0** | **50** | **50** | **-** | **100** |
|  | **Total** | **12** |  |  |  |  |
| **IInd Semester** | |  |  |  |  |  |
| **GPB 504** | **Principles of Quantitative Genetics** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 510** | **Breeding for Biotic and Abiotic Stress Resistace** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 511** | **Breeding Cereal, Forage and Sugarcane** | **2+1** | **30** | **50** | **20** | **100** |
| **STAT 552** | **Experimental Design** | **2+0** | **50** | **50** | **-** | **100** |
|  | **Total** | **11** |  |  |  |  |
| **IIIrd Semester** | |  |  |  |  |  |
| **GPB 508** | **Cell Biology and Molecular Genetics** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 512** | **Breeding Legume,Oilseed and Fibre crop** | **2+1** | **30** | **50** | **20** | **100** |
|  | **Total** | **6** |  |  |  | **200** |
| **IVth Semester** | |  |  |  |  |  |
| **GPB 509** | **Biotechnology for Crop Improvement** | **2+1** | **30** | **50** | **20** | **100** |
| **GPB 515** | **Maintenance Breeding,Concepts of Variety Release and Seed Production** | **1+1** | **30** | **50** | **20** | **100** |
| **GPB 591** | **Master Seminar** | **1+0** | **-** | **-** | **-** | **100** |
| **GPB 599** | **Master Research** | **20** | **-** | **-** | **-** | **100** |
|  | **Total** | **26** |  |  |  |  |
|  | **Grand Total** | **55** |  |  |  |  |

**M.Sc. Ag. Genetics and Plant Breeding**

**GENETICS AND PLANT BREEDING**

**Course Contents**

**GPB 501 PRINCIPLES OF GENETICS 3(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**

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 andsex-linkage, Sex-influenced and sex-limited traits; Linkage-detection,estimation; Recombination and genetic mapping in eukaryotes, Somatic

cell genetics, Extra chromosomal inheritance.

Population - Mendelian population – Random mating population -

Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg

equilibrium.Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis.

Genetic fine structure analysis, Allelic complementation, Split genes,

Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

Regulation of gene activity in prokaryotes; Molecular mechanisms of

mutation, repair and suppression; Bacterial plasmids,Gene regulation in eukaryotes, RNA editing.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.

**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.

**GPB 502 PRINCIPLES OF CYTOGENETICS 3(2+1)**

**Objective**

To provide insight into structure and functions of chromosomes,

chromosome mapping, polyploidy and cytogenetic aspects of crop

evolution.

**Theory**

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, 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 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.

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.

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.

Fertilization barriers in crop plants at pre-and postfertilization 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 -

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.

**GPB 503 PRINCIPLES OF PLANT BREEDING 3(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**

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; Heritability and genetic advance, genotype environment

interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and roleof plant genetic resources in plant breeding.

Self-incompatibility and male sterility in crop plants and their commercial

exploitation.

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).

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.

Breeding methods in asexually/clonally propagated crops, clonal selection

apomixes, clonal selection.

Self-incompatibility and male sterility in crop plants and their commercial

exploitation; Concept of plant ideotype and its role in crop improvement;

Transgressive breeding.

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**

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.

**GPB 504 PRINCIPLES OF QUANTITATIVE GENETICS 3(2+1)**

**Objective**

To impart theoretical knowledge and computation skills regarding

component of variation and variances, scales, mating designs and gene

effects.

**Theory**

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.

Principles of Anaylis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.

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.

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.

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 (TTC) – 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 (AMMI) model - Principal

Component Analysis model - Additive and multiplicative model - Shifted

multiplicative model - Analysis and selection of genotypes - Methods and

steps to select the best model - Selection systems - Biplots and mapping

genotypes.

**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 inPlant Breeding*. Walter de Gruyter.

**GPB 508 CELL BIOLOGY AND MOLECULAR GENETICS 3(2+1)**

**Objective**

To impart knowledge in theory and practice about cell structure, organelles

and their functions, molecules like proteins and nucleic acids.

**Theory**

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.Bioenergetics; Ultrastructure and function of mitochondria and biologicalmembranes; Chloroplast and other photosynthetic organelles; Interphasenucleus- Structure and chemical composition; Cell division and physiology of cell division.

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.

**GPB 509 BIOTECHNOLOGY FOR CROP IMPROVEMENT 3(2+1)**

**Objective**

To impart knowledge and practical skills to use biotechnological tools in

crop improvement.

**Theory**

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; somatic hybridization techniques;

Meristem, ovary and embryo culture; cryopreservation.

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).

Molecular mapping and tagging of agronomically important traits.

Statistical tools in marker analysis, Marker-assisted selection for

qualitative and quantitative traits; QTLs analysis in crop plants, Gene

pyramiding.

Genomics and geo informatics 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.

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.

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**

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, DNA 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 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.

**GPB 510 BREEDING FOR BIOTIC AND ABIOTIC STRESS RESISTANCE 3(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**

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.

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.

Phenotypic screening methods for major pests and diseases; Recording of

observations; Correlating the observations using marker data - Gene

pyramiding methods and their implications.

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.

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 in soil, water and environment.

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 of

Chicago Press.

Li PH & Sakai A. 1987. *Plant Cold Hardiness*. Liss, New York

Luginpill P. 1969. *Developing Resistant Plants - The Ideal Method of*

*Controlling Insects*. USDA, 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.

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Academic Press.

**GPB 511 BREEDING CEREALS, FORAGES AND SUGARCANE 3(2+1)**

**Objective**

To provide insight into recent advances in improvement of cereals and

forage crops and sugarcane using conventional and modern

biotechnological approaches.

**Theory**

Rice: Evolution and distribution of species and forms - wild relatives and

germplasm; Genetics – cytogenetics and genome relationship - Breeding

objectives- yield, quality characters, biotic and abiotic stress resistance *etc.*

– Hybrid rice breeding- potential and outcome - Aerobic rice, its

implications and drought resistance breeding.

Wheat: Evolution and distribution of species and forms - wild relatives and

germplasm; cytogenetics and genome relationship; Breeding objectivesyield,

quality characters, biotic and abiotic stress resistance, exploitation of

heterosis etc; Sorghum: Evolution and distribution of species and forms -

wild relatives and germplasm - cytogenetics and genome relationship -

Breeding objectives- yield, quality characters, biotic and abiotic stress

resistance etc; Pearl millet: Evolution and distribution of species and forms

- wild relatives and germplasm; Cytogenetics and genome relationship;

Breeding objectives- yield, quality characters, biotic and abiotic stress

resistance etc.

Maize: Evolution and distribution of species and forms - wild relatives and

germplasm; Cytogenetics and genome relationship; Breeding objectives:

yield, quality characters, biotic and abiotic stress resistance etc - QPM and

Bt maize – strategies and implications - Heterosis breeding attempts taken

in Sorghum, Pearl Millet and Maize.

Sugarcane: Evolution and distribution of species and forms - wild relatives

and germplasm; Cytogenetics and genome relationship - Breeding

objectives- yield, quality characters, biotic and abiotic stress resistance etc -

Forage grasses: Evolution and distribution of species and forms - Wild

relatives and germplasm; Cytogenetics and genome relationship; Breeding

objectives- yield, quality characters and palatability studies; Biotic and

abiotic stress resistance etc., synthetics, composites and apomixes.

Forage legumes: Evolution and distribution of species and forms; Wild

relatives and germplasm; Cytogenetics and genome relationship; Breeding

objectives- yield, quality characters, biotic and abiotic stress resistance etc -

**Practical**

Floral biology – emasculation - pollination techniques ; Study of range of

variation for yield and yield components – Study of segregating

populations and their evaluation - Trait based screening for stress resistance

in crops of importance– Use of descriptors for cataloguing Germplasm

maintenance; learning on the Standard Evaluation System (SES) and

descriptors; Use of softwares for database management and

retrieval.Practical learning on the cultivation of fodder crop species on

sewage water; analysing them for yield components and palatability;

Laboratory analysis of forage crops for crude protein, digestibility percent

and other quality attributes; Visit to animal feed producing factories,

learning the practice of value addition; visiting the animal husbandry unit

and learning the animal experiments related with palatability and

digestibility of fodder.

**Suggested Readings**

Agarwal RL. 1996. *Identifying Characteristics of Crop Varieties*. Oxford &

IBH.

Bahl PN & Salimath PM. 1996. *Genetics, Cytogenetics and Breeding of*

*Crop Plants*. Vol. I. *Pulses and Oilseeds*. Oxford & IBH.

Chandraratna MF. 1964. *Genetics and Breeding of Rice*. Longmans.

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Kannaiyan S, Uthamasamy S, Theodore RK & Palaniswamy S. 2002. *New*

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Directorate of Extension Education, TNAU, Coimbatore.

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*Management*. ICRISAT, Patancheru, India.

Nanda JS. 1997. *Manual on Rice Breeding*. Kalyani.

Ram HH & Singh HG. 1993. *Crop Breeding and Genetics*. Kalyani.

Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994.

*Crop Breeding in India*. International Book Distributing Co.

Slafer GA. (Ed.). 1994. *Genetic Improvement of Field Crops*. Marcel

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Walden DB. 1978. *Maize Breeding and Genetics*. John Wiley & Sons.

**GPB 512 BREEDING LEGUMES, OILSEEDS AND FIBRE CROPS 3(2+1)**

**Objective**

To provide insight into recent advances in improvement of legumes,

oilseeds and fibre crops using conventional and modern biotechnological

approaches.

**Theory**

Pigeonpea: Evolution and distribution of species and forms; Wild relatives

and germplasm; Genetics, cytogenetics and genome relationship;

Morphological and molecular descriptors used for differentiating the

accessions; Breeding objectives- yield, quality characters, biotic and abiotic

stress *etc* - Hybrid technology; maintenance of male sterile, fertile and

restorer lines, progress made at ICRISAT and other Institutes.

Chickpea: Evolution and distribution of species and forms - Wild relatives

and germplasm - cytogenetics and genome relationship; Breeding

objectives- yield, quality characters, biotic and abiotic stress etc; Protein

quality improvement; Conventional and modern plant breeding approaches,

progress made - Breeding for anti nutritional factors.

Other pulses: Greengram, blackgram, fieldpea, lentil, Evolution, cytogenetics and genome relationship;Learning the descriptors; Breeding objectives- yield, quality characters,biotic and abiotic stress etc; Interspecific crosses attempted and its

implications, reasons for failure, ways of overcoming them.

Groundnut: Evolution and distribution of species and forms; Wild relatives

and germplasm; Cytogenetics and genome relationship; Pod and kernel

characters; Breeding objectives- yield, quality characters, biotic and abiotic

stress etc.

Rapeseed and Mustard: Breeding objectives, utilization of wild relatives for

yield and quality improvement, biotic and abiotic stress etc; Oil quality –

characteristics in different oils; Evolution and distribution of species and

forms; Wild relatives and germplasm; Genetics, cytogenetics and genome

relationship.

Soybean: Breeding objectives, utilization of wild relatives for yield and

quality improvement, biotic and abiotic stress etc. - Oil quality –

characteristics; Evolution and distribution of species and forms; Wild

relatives and germplasm; Genetics, cytogenetics and genome relationship.

Other oilseed crops: Sunflower, sesame, safflower, Evolution and

distribution of species and forms; Wild relatives and germplasm;

Cytogenetics and genome relationship; breeding objectives- yield, quality

characters, biotic and abiotic stress; Sunflower: Evolution and distribution

of species and forms; Wild relatives and germplasm; Cytogenetics and

genome relationship, hybrid sunflower, constraints and achievements

Cotton: Evolution of cotton; Breeding objectives- yield, quality characters,

biotic and abiotic stress etc; Development and maintenance of male sterile

lines – Hybrid development and seed production – Scenario of Bt cottons,

evaluation procedures for Bt cotton. Jute: Evolution and distribution of

species and forms; Wild relatives and germplasm; Cytogenetics and

genome relationship; breeding objectives- yield, quality characters, biotic

and abiotic stress etc;

**Practical**

Use of descriptors for cataloguing – Floral biology - emasculation –

pollination techniques; Study of range of variation for yield and yield

components - Study of segregating populations in Redgram, Greengram,

Blackgram and other pulse crops; Attempting crosses between blackgram

and greengram. Use of descriptors for cataloguing – Floral biology,

emasculation, pollination techniques of oilseed crops like Sesame,

Groundnut, Sunflower and Castor, Cotton: Use of descriptors for

cataloguing – Floral biology - Learning on the crosses between different

species - Cotton: Study of range of variation for yield and yield

components - Study of segregating populations - evaluation - Trait based

screening for stress resistance - Cotton fibre quality evaluation –

conventional and modern approaches; analysing the lint samples of

different species, interspecific and interracial derivatives for fibre quality

and interpretation –Development and maintenance of male sterile lines

Evaluation of cotton cultures of different species for insect and disease

resistance – Learning the mechanisms of resistance, quantifying the

resistance using various parameters; Evaluating the germplasm of cotton

for yield, quality and resistance parameters – learning the procedures on

development of Bt cotton - Visit to Cotton Technology Laboratory and

Spinning Mills – Learning on cotton yarn production, its quality evaluation

and uses.

**Suggested Readings**

Agarwal RL. 1996. *Identifying Characteristics of Crop Varieties*. Oxford &

IBH.

Bahl PN & Salimath PM. 1996. *Genetics, Cytogenetics and Breeding of*

*Crop Plants*. Vol. I. *Pulses and Oilseeds*. Oxford & IBH.

Chahal GS & Ghosal SS. 2002. *Principles and Procedures of Plant*

*Breeding - Biotechnological and Conventional Approaches*. Narosa

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Chopra VL. 1997. *Plant Breeding*. Oxford & IBH.

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Nath V & Lal C. 1995. *Oilseeds in India*. Westvill Publ. House.

Nigam J. 1996. *Genetic Improvement of Oilseed Crops*. Oxford & IBH.

Ram HH & Singh HG. 1993. *Crop Breeding and Genetics*. Kalyani.

Singh DP. 1991. *Genetics and Breeding of Pulse Crops*. Kalyani.

Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994.

*Crop Breeding in India*. International Book Distributing Co.

Smartt J. 1994. *The Groundnut Crop - a Scientific Basis for Improvement*.

Chapman & Hall.

**GPB 515 MAINTENANCE BREEDING AND CONCEPTS OF 2(1+1)**

**VARIETY RELEASE AND SEED PRODUCTION**

**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**

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.

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

maintenance breeding.

Factors responsible for genetic deterioration of varieties - safeguards 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.

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 ); Pulses (greengram, blackgram, cowpea,

pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean,

castor, sunflower, safflower, rapeseed and mustard);Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

**Practical**

Identification of suitable areas/locations for seed production; Ear-to-row

method and nucleus seed production - Main characteristics of released and

notified varieties, hybrids and parental lines; Identification of important

weeds/objectionable weeds; Determination of isolation distance and

planting ratios in different crops; Seed production techniques of varieties in

different crops; Hybrid seed production technology of important crops.

**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.

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

*Practices*. Chapman & Hall.

Musil AF. 1967. *Identification of Crop and Weed Seeds*. Handbook No.

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.

**STAT 551 STATISTICAL METHODS 3(3+0)**

UNIT I

Summarization of data, classification and tabulation of data , Diagrammatic and Graphical Representations, utility and limitations of graphical Representation.

Measure of central central tendency, definition, merit, demerit, uses and properties of different measure of central tendency, measure of dispersion , moments, skewness and kurtosis.

UNIT II

Probability distribution, discrete probability distribution-Bernouli, poission, normal distribution.Theorem of addition of probability, theorem of multiplication of probability, Defnition-(simple and compound events independent and dependents, mutually exclusive, complimentary events.)

UNIT III

Statistical Hypothesis, Null hypothesis, Two type of error, Statistical significance, parametric and nonparametric hypothesis, critical region, level of significance, practical application of simple test of significance viz,”t” and “F”test.X2 test as a goodness of Fit, properties of X2 distribution, conditions for application of X2 test.

UNIT IV

Correlation and its test of significance, line of regression and its test of significance. Correlation, measurement of correlation, limit and range of „r, correlation coefficient expressed in term of regression coefficients. Rank correlation and its computations, regression equation.

**STAT 552 EXPERIMENTAL DESIGNS 2(2+0)**

UNIT I

Principles of experimental design, precision and accuracy, advantage of replication, experimental technique.Analysis of variance, fundamental principles of analysis of variance.Critical difference, limitations of the analysis of variance.

UNIT II

Statistical analysis and advantage and disadvantage of basic design-completely randomized design, randomized block design, Latin square design.

UNIT III

\Factorial concept: simple effects, main effects and interaction, factorial experiments (without confounding), Yates method. Confounding, principles of confounding in a 23 factorial experiments. Split plot design.

UNIT IV

Missing plot technique; Bartlett‟s techniques for missing plots, cross-overdesign or switch-over trials, Rotational experiments, progeny selection, compact family block design, uniformity trial, sire index, sampling in field experiments.