MAHATMA GANDHI KASHI VIDYAPEETH

VARANASI

COURSE STRUCTURE FOR

M.Sc. (AGRICULTURE)

GENETICS AND PLANT BREEDING

UNDER SEMESTER SYSTEM TO COME INTO FORCE FROM

ACADEMIC SESSION-2013-14

M.Sc.(AGRICULTURE)

GENETICS AND PLANT BREEDING

SEMESTER SYSTEM

SYLLABUS

M.Sc. (Agriculture) – GENETICS & PLANT BREEDING

In the area of Genetics &Plant Breeding an effort has been made to retain relevant core concepts and principles of Plant Breeding & Genetics as such. However, new topics and also new courses have been added to infuse new blood in the area.

• All the courses have been designed/redesigned/updated as per present and future needs.
• New courses have been introduced to keep pace with the latest developments.
• In order to help the students, Course objectives and Suggested readings have also been provided for each course.
• List of Journals have been provided to keep pace with latest developments in the area.
• Suggested Areas of Research have also been added for providing directions to future researches in the area
•The present courses and syllabi have been prepared and incorporated herein as per ICAR recommendation with suitable and needful mutatis mutandis.

This programme also requires proper infrastructure, trained teachers, and computers with internet connections. Industrial linkages, guest lectures, industry and farm visits will also be required to provide real life exposure.

M.Sc. (Agriculture) – Genetics & Plant Breeding
COURSE STRUCTURE – AT A GLANCE

FIRST SEMESTER M.M.: 400

PAPER – 101 PRINCIPLES OF GENETICS	75 MARKS
PAPER – 102 PRINCIPLES OF CYTOGENETICS	75 MARKS
PAPER – 103 PRINCIPLES OF PLANT BREEDING	75 MARKS
PAPER – 104 STATISTICAL METHODS	75 MARKS
PRACTICAL (ALL PAPERS)	100 MARKS

M.Sc. (Agriculture) –Genetics & Plant Breeding
COURSE STRUCTURE – AT A GLANCE

SECOND SEMESTER M.M.: 400

PAPER – 201 PRINCIPLES OF QUANTITATIVE GENETICS	75 MARKS
PAPER – 202 MUTAGENESIS AND MUTATION BREEDING	75 MARKS
PAPER – 203 CELL BIOLOGY AND MOLECULAR GENETICS	75 MARKS
PAPER – 204 EXPERIMENTAL DESIGNS	75 MARKS
PRACTICAL (ALL PAPERS)	100 MARKS

M.Sc. (Agriculture) – Genetics & Plant Breeding

COURSE STRUCTURE – AT A GLANCE

THIRD SEMESTER M.M.: 400

PAPER – 301 BIOTECHNOLOGY FOR CROP IMPROVEMENT 75 MARKS
PAPER – 302 BREEDING FOR BIOTIC AND ABIOTIC STRESS RESISTANCE 75 MARKS
PAPER – 303 BREEDING CEREALS, SUGARCANE LEGUMES, OILSEEDS AND FIBRE CROPS 75 MARKS
PAPER – 304 HETEROSIS BREEDING 75 MARKS
PRACTICAL (ALL PAPERS) 100 MARKS

M.Sc. (Agriculture) – Genetics & Plant Breeding

COURSE STRUCTURE – AT A GLANCE

FOURTH SEMESTER M.M.: 400

PAPER – 401 MAINTENANCE BREEDING, CONCEPTS OF VARIETY RELEASE AND SEED PRODUCTION 100 MARKS
PAPER – 402 SEMINAR 50 MARKS
PAPER – 403 THESIS (THESIS EVALUATION) 150 MARKS

OR

PAPER-403-A (Special Paper-I) (CONSERVATION & UTILIZATION OF PLANT GENETICS RESOURCES) 75 MARKS
PAPER-403-B (Special Paper-II) **(PLANT BREEDING PERSPECTIVE)** 75 MARKS
PRACTICAL (SPECIAL PAPERS) **OR** THESIS *VIVA-VOCE* 100 MARKS

REGULATIONS

M. Sc. (Ag.) Examination in Genetics & Plant Breeding

Semesters/Papers	Title of the papers	**Theory**		**Practical**	
		Max. Marks	Mini Pass Marks	Max. Marks	Mini. Pass marks
SEMESTER I					
Paper 101	(Theory Paper)	75	**23**	-	-
Paper 102	(Theory Paper)	75	23	-	-
Paper 103	(Theory Paper)	75	23	-	-
Paper 104	(Theory Paper)	75	23	-	-
PRACTICAL	(All Theory Papers)	-	-	100	30
Total aggregate pass marks of First Semester is 36%		Max. Marks – 400 Min.Marks – 144			
SEMESTER II					
Paper 201	(Theory Paper)	75	23	-	-
Paper 202	(Theory Paper)	75	23	-	-

Paper 203	(Theory Paper)	75	23	-	-
Paper 204	(Theory Paper)	75	23	-	-
PRACTICAL	(All Theory Papers)	-	-	100	30
Total aggregate pass marks of Second Semester is 36%		**Max. Marks – 400 Min. Marks – 144**			
SEMESTER III					
Paper 301	(Theory Paper)	75	23	-	-
Paper 302	(Theory Paper)	75	23	-	-
Paper 303	(Theory Paper)	75	23	-	-
Paper 304	(Theory Paper)	75	23	-	-
PRACTICAL	(All Theory Papers)	-	-	100	30
Total aggregate pass marks of Third Semester is 36%		**Max. Marks – 400 Min. Marks – 144**			
SEMESTER IV					
Paper 401	(Theory Paper)	100	30	-	-
Paper 402	SEMINAR	50	15	-	-
Paper 403 Paper 403-A Paper 403-B	THESIS(Thesis Evaluation) **OR** SPECIAL PAPER-I SPECIAL PAPER-I	- 75 75	- 23 23	150	45
PRACTICAL /THESIS VIVA-VOCE	(Special Papers/Thesis)	-	-	100	30
Total aggregate pass marks of Forth Semester is 36%		**Max. Marks – 400 Min. Marks – 144**			

Consolidated Performa for allotments of all semester marks is as follows:-

First Semester	400	144
Second Semester	400	144
Third Semester	400	144
Fourth Semester	400	144
Grand Total	===== 1600	==== 576

Note:

1. The research work may be initiated in any of II or III semester but the thesis shall be submitted at the end of IV semester.
2. The evaluation of seminar presentation shall be done by the departmental committees.

FIRST SEMESTER
M.Sc. (AGRICULTURE) GENETICS & PLANT BREEDING

COURSE CONTENTS – DETAILED SYLLABUS

PAPER – 101 -PRINCIPLES OF GENETICS

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.

UNIT I

Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws, Chromosomal theory of inheritance. Multiple alleles, Gene interactions

UNIT II

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.

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

UNIT III

Structural and numerical changes in chromosomes; 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, Transposable genetic elements, Overlapping genes, Pseudo genes and Oncogenes.

UNIT IV

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.

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.

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.

PAPER – 102

PRINCIPLES OF CYTOGENETICS

Objective

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

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.

UNIT II

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

UNIT III

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

UNIT IV

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

Practical

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, 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 microscop. Studies on the course of mitosis in onion and Studies on the course of meiosis in oilseeds and forage crops and studying the pollen grain size in various crops -Various methods of staining and preparation of temporary and permanent slides

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

PAPER – 103
PRINCIPLES OF PLANT BREEDING
Objective : -
To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

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; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

UNIT II

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 multi-line method; Population breeding in self pollinated crops (diallel selective mating approach).

UNIT III

Breeding methods in cross pollinated crops; Population breeding-mass selection and earto-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.

UNIT IV

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.

PAPER – 104
STATISTICAL METHODS
Objective

This course lays the foundation of probability distributions and sampling distributions and their application which forms the basis of Statistical Inference. Together with probability theory, this course is fundamental to the discipline of Statistics. The students are also exposed to correlation, regression, and their applications.

UNIT I

Summarization of data, classification and tabulation of data, diagrammatic and graphical representations, utility and limitations of graphical representation. Measure of central tendency, characteristics of an ideal measure, merit and demerit of different measres. Measure of Dispersion,coefficient of variability , Moments, Skewness and kurtosis.

UNIT II

Probability distribution, discrete probability distribution-binomial, poission, normal distribution. theorem of addition of probability, theorem of multiplication of probability, defnition-(simple and compound events independent and dependent, mutually exclusive, complimentary events.)

UNIT III

Statistical hypothesis, Null hypothesis, Two type of error, Statistical significance, parametric and nonparametric hypotheses, critical region, level of significance, practical application of simple test of significance *viz*,"t" and "F"test.X^2 test as a goodness of Fit, properties of X^2 distribution, conditions for application of X^2 test.

UNIT IV

Bivariate population, arrays and correlation table, scatter diagram, lines of regression, regression coefficients, correlation, measurement of correlation, limits and range of the correlation coefficient. Testing of significance of correlation coefficients, intraclass correlation coefficient, rank correlation, multiple correlation.

Practical

Measurement of central tendency and dispersion, standard deviation and standard error ,principle uses of X^2 ,F and 't, test, Correlation Coefficient, Regression coefficient and Regression equation.

Suggested Readings

• Agresti A. 2002. *Categorical Data Analysis*. 2nd Ed. John Wiley.
• Arnold BC, Balakrishnan N & Nagaraja HN. 1992. *A First Course in Order Statistics*. John Wiley.
• David HA & Nagaraja HN. 2003. *Order Statistics*. 3rd Ed. John Wiley.
• Dudewicz EJ & Mishra SN. 1988. *Modern Mathematical Statistics*. John Wiley.
• Huber PJ. 1981. *Robust Statistics*. John Wiley.
• Johnson NL, Kotz S & Balakrishnan N. 2000. *Continuous Univariate Distributions*. John Wiley.
• Johnson NL, Kotz S & Balakrishnan N. 2000. *Discrete Univariate Distributions*. John Wiley.
•Chandel S.R.S. *A Hand Book of Agricultural Statistics*. Kalyani publ.

PRACTICAL (ALL THEORY PAPERS)

SECOND SEMESTER

M.Sc. (AGRICULTURE) GENETICS & PLANT BREEDING

COURSE CONTENTS – DETAILED SYLLABUS
PAPER – 201
PRINCIPLES OF QUANTITATIVE GENETICS

Objective

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

UNIT I

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

UNIT II

Principles of Anaylis of Variance (ANOVA) - Expected variance components. Comparison of means and variances for significance.

UNIT III

Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance.

UNIT IV

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

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, Line x tester analysis and interpretation of results - Estimation of heterosis : standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression . Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions .

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.

PAPER – 202
MUTAGENESIS ANDMUTATION BREEDING
Objective : -

To impart the knowledge about general principles of radiation and various tests/methods for detection of radiation effects on the living cells, genetic risks involved and perspectives of advancesmade.

UNIT I

Mutation and its history - Nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations - Detection of mutations in lower and higher organisms – paramutations.

Mutagenic agents: physical -- Radiation types and sources: Ionizing and non-ionizing radiations *viz*., X rays, γ rays, , α and ß particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations.

UNIT II

Effect of mutations on DNA - Repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects .Factors influencing mutation: dose rate, acute *vs* chronic irradiation, recurrent
irradiation, enhancement of thermal neutron effects - Radiation sensitivity and modifying factors: External and internal sources- Oxygen, water content, temperature and nuclear volume.

Chemical mutagens- Classification - Base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action - Dose determination and factors influencing chemical mutagenesis - Treatment methods using physical and chemical mutagens - Combination treatments; other causes of mutation - direct and indirect action, Comparative evaluation of physical and chemical mutagens.

UNIT III

Observing mutagen effects in M2 generation: plant injury, lethality, sterility, chimeras *etc*., - Observing mutagen effects in M1 generation - Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations -– Mutations in traits with continuous variation.

Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage *etc*. - IndividType equation here.ual plant based mutation analysis and working out effectiveness

and efficiency in M3 generation - Comparative evaluation of physical and chemical mutagens for creation of variability in the same species – Case studies.

UNIT IV

Use of mutagens in creating oligogenic and polygenic variations – Case studies - *In vitro* mutagenesis – callus and pollen irradiation; Handling of segregating generations and selection procedures; Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement, etc) in different crops- Procedures for micro-mutations breeding/polygenic mutations- Achievements of mutation breedingvarieties released across the world- Problems associated with mutation breeding.

Practical

Learning the precautions on handling of mutagens. Radiation hazards - Monitoring – safety regulations and safe transportation of radioisotopes - Visit to radio isotope laboratory ; learning on safe disposal of radioisotopes - Hazards due to chemical mutagens - Treating the plant propagates at different doses of physical and chemical mutagens .Study of M1 generation – Parameters to be observed; Study of M2 generation – Parameters to be observed; Mutation breeding in cereals and pulses – Achievements made and an analysis – Mutation breeding in oilseeds and cotton – Achievements and opportunities - Mutation breeding in forage crops and vegetative propagated crops; Procedure for detection of mutations for polygenic traits in M2 and M3 generations.

Suggested Readings

• Alper T. 1979. *Cellular Radiobiology*. Cambridge Univ. Press, London.

• Chadwick KH & Leenhouts HP. 1981. *The Molecular Theory of Radiation Biology*. Springer-Verlag.

• Cotton RGH, Edkin E & Forrest S. 2000. *Mutation Detection: A Practical Approach*. Oxford Univ. Press.

• International Atomic Energy Agency. 1970. *Manual on Mutation Breeding*. International Atomic Energy Agency, Vienna, Italy.

• Singh BD. 2003. *Genetics*. Kalyani.

• Strickberger MW. 2005. *Genetics*. 3rd Ed. Prentice Hall.

PAPER – 203

CELL BIOLOGY AND MOLECULAR GENETICS

Objective : -

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

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, plastids- chloro/chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.

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 II

Historical background of molecular genetics; Genetic material in organisms; Structure and

properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors.

UNIT III

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.

Introduction: Gene regulation-purpose; Process and mechanisms in prokaryotes and eukaryotes; Levels of gene controls.

UNIT IV

Gene expression-Transposons in plant gene expression, cloning-transposon tagging; Light regulated gene expression-model systems in *Arabidopsis* and maize; Para mutations and imprinting of genes and genomes.

Trans-gene expression and gene silencing mechanisms; Regulatory genes horizontal and vertical homology; Transformation-regulatory genes as visible markers; Reporter systems to study gene expression; combinatorial gene control.

Practical

Morphological and Gram staining of natural bacteria .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.
• Lewin B. 2008. *Genes IX*. John Wiley & Sons.
• Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley.
• Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.
• Brown TA. 2002. *Genomes.* Bios Scientific Publ.
• Tamarin RH. 1999. *Principles of Genetics*. Wm C Brown Publ.
• Griffiths AJF. 2000. *An Introduction to Genetic Analysis*. WH Freeman.
• Hexter W & Yost HT. 1976. *The Science of Genetics*. Prentice Hall.
• Singer M & Berg P.1991. *Genes and Genomes*. John Wiley & Sons.
• Hartl DL & Jones EW. 1998. *Genetics Principles and Analysis*. Jones & Barlett Publ.

PAPER – 204
EXPERIMENTAL DESIGNS
Objective:-

Design of Experiments provides the statistical tools to get maximum information from least amount of resources. This course is meant to expose the students to the basic principles of design of experiments. The students would also be provided with mathematical background of various basic designs involving one-way and two way elimination of heterogeneity and their characterization properties. This course would also prepare the students in deriving the expressions for analysis of experimental data.

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 2^3 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.

PRACTICAL (ALL THEORY PAPERS)

Practical

Analysis of data generated from completely randomized design, randomized block design; Latin square design, factorial experiments in2^2, 2^3 Split plot designs, Missing plot techniques, Analysis of covariance, Sampling in field experiments.

Suggested Readings

• Chakrabarti MC. 1962. *Mathematics of Design and Analysis of Experiments*. Asia Publ. House.
• Cochran WG & Cox DR. 1957. *Experimental Designs*. 2nd Ed. John Wiley.
• Dean AM & Voss D. 1999. *Design and Analysis of Experiments*. Springer.
• Dey A & Mukerjee R. 1999. *Fractional Factorial Plans*. John Wiley.
• Dey A 1986. *Theory of Block Designs*. Wiley Eastern.
• Hall M Jr. 1986. *Combinatorial Theory*. John Wiley.
• John JA & Quenouille MH. 1977. *Experiments: Design and Analysis*. Charles & Griffin.
• Kempthorne, O. 1976. Design and Analysis of Experiments. John Wiley.
• Khuri AI & Cornell JA. 1996. *Response Surface Designs and Analysis*. 2nd Ed. Marcel Dekker.
• Montgomery DC. 2005. *Design and Analysis of Experiments*. John Wiley.
• Raghavarao D. 1971. *Construction and Combinatorial Problems in Design of Experiments*. John Wiley.
•Chandel S.R.S. *A Hand Book of Agricultural Statistics*. Kalyani publ.

THIRD SEMESTER

M.Sc. (AGRICULTURE) GENETICS & PLANT BREEDING

COURSE CONTENTS – DETAILED SYLLABUS

PAPER – 301
BIOTECHNOLOGY FOR CROP IMPROVEMENT

Objective : -

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

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; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT II

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.

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,

UNIT III

Recombinant DNA technology, transgenes, method of transformation, vector-mediated gene transfer, physical methods of

gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

UNIT I V

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

MOs and related issues (risk and regulations); GMO; International regulations, bio-safety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights

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; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micro-propagation unit. Transformation using *Agro-bacterium* strains.

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.

PAPER – 302

BREEDING FOR BIOTIC AND ABIOTIC STRESS RESISTANCE

Objective : -

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

UNIT I

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

UNIT II

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants. Quantitative resistance. Classical and molecular breeding methods - Measuring plant resistance using plant fitness. Phenotypic screening methods for major pests and diseases; Recording of observations;

Correlating the observations using marker data – Gene pyramiding methods and their implications.

UNIT III

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

UNIT IV

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 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. Breeding strategies - Weeds – ecological, environmental impacts on the crops. Phenotypic screening methods for diseases caused by fungi and bacteria; Symptoms and data recording; 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 strategy

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.
• Van der Plank JE. 1982. *Host-Pathogen Interactions in Plant Disease*. Academic Press.

PAPER – 303

BREEDING CEREALS, SUGARCANE, LEGUMES, OILSEEDS AND FIBRE CROPS

Objective : -

To provide insight into recent advances in improvement of cereals and forage crops, sugarcane legumes, oilseeds and fibre crops using conventional and modern biotechnological approaches.

UNIT I (CEREAL CROPS)

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 objectives- yield, 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; Minor millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - Minor millets: breeding objectives-yield, quality

characters, biotic and abiotic stress resistance etc.

UNIT II (CASH CROP)

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.

Cotton: Evolution of cotton; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Development and maintenance of male sterilelines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton.

UNIT III(PULSE CROPS)

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.

UNIT IV (OILSEED CROPS)

Groundnut: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Pod and kernel characters; Breeding objectivesyield, 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.

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.

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.

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.
• Chopra VL & Prakash S. 2002. *Evolution and Adaptation of Cereal Crops*. Oxford & IBH.
• Gill KS. 1991. *Pearl Millet and its Improvement*. ICAR.
• IRRI. 1964. *Rice Genetics and Cytogenetics*. Elsevier.
• IRRI. 1986. *Rice Genetics*. Proc. International Rice Genetics Symposium.
• IRRI, Los Banos, Manila, Philippines.
• IRRI. 1991. *Rice Genetics II*. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
• IRRI. 1996. *Rice Genetics III*. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
• IRRI. 2000. *Rice Genetics IV*. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
• Jennings PR, Coffman WR & Kauffman HE. 1979. *Rice Improvement*. IRRI, Los Banos, Manila, Philippines.
• Kannaiyan S, Uthamasamy S, Theodore RK & Palaniswamy S. 2002. *New Dimensions and Approaches for Sustainable Agriculture*.
• Directorate of Extension Education, TNAU, Coimbatore. Murty DS, Tabo R & Ajayi O. 1994. *Sorghum Hybrid Seed Production and 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 Dekker.
• Smartt J. 1994. *The Groundnut Crop - a Scientific Basis for Improvement*. Chapman & Hall.

PAPER – 304
HETEROSIS BREEDING
Objective : -
To provide understanding about mechanisms of heterosis and its exploitation for yield improvement through conventional and biotechnological approaches.

UNIT I

Historical aspect of heterosis - Nomenclature and definitions of heterosis - Heterosis in natural population and inbred population; Evolutionary aspects - Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops crops. Pre Mendelian and Post-Mendelian ideas - Genetic theories of heterosis – Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; - Evolutionary concepts of heterosis.

UNIT II

Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies. - Relationship between genetic distance and expression of heterosis – case studies; Divergence and Genetic Distance

analyses-morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm / genetic stocks and inbreds, their improvement for increasing heterosis.

UNIT III

Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of selfing compatibility in development of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids. Creation of male sterility through genetic engineering and its exploitation in heterosis.

UNIT IV

Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops; Male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagated crops; problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid.

Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

Practical

Selection indices and selection differential – Calculations and interpretations - Male sterile line characterization in millets; Using morphological descriptors; Restorer line identification and diversification of male sterile sources - Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; Ways of overcoming them - Male sterile line creation, diversification and restoration in forage crops; Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops - Estimation from the various models for heterosis parameters -Hybrid seed production in field crops – an account on the released hybrids; their potential; Problems and ways of overcoming it; hybrid breeding at National and International level; Opportunities ahead.

Suggested Readings

• Proceedings of *Genetics and Exploitation of Heterosis in Crops* - An International Symposium CIMMYT, 1998.

• Akin E. 1979. *The Geometry of Population Genetics*. Springer-Verlag.

• Ben Hiu Lin. 1998. *Statistical Genomics – Linkage, Mapping and QTL Analysis*. CRC Press.

• De Joung G. 1988. *Population Genetics and Evolution*. Springer-Verlag.

• Hartl DL. 2000. *A Primer of Population Genetics*. 3rd Ed. Sinauer Assoc.

• Mettler LE & Gregg TG. 1969. *Population Genetics and Evolution*. Prentice-Hall.

• Montgomery DC. 2001. *Design and Analysis of Experiments*. 5TH Ed., Wiley & Sons.

• Richards AJ. 1986. *Plant Breeding Systems*. George Allen & Unwin.

• Srivastava S & Tyagi R. 1997. *Selected Problems in Genetics*. Vols. I, II. Anmol Publ.

PRACTICAL (ALL THEORY PAPERS)

FOURTH SEMESTER

M.Sc. (AGRICULTURE) GENETICS & PLANT BREEDING

COURSE CONTENTS – DETAILED SYLLABUS

PAPER – 401

MAINTENANCE BREEDING AND CONCEPTS OF 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.

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 - 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.

UNIT IV

Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties *viz*. cereals & Millet (wheat, barley, paddy, pearl millet, sorghum, maize etc.); Pulses (greengram, blackgram, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

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 andPractices*. 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.

PAPER – 402 SEMINAR

PAPER – 403
THESIS (THESIS AND VIVA – VOCE)
Suggested Broad Topics for Research Work

- Studies on introgressions, gene transfers, gene identification, location and localization with the application of technologies such as, *in situ* hybridization, chromosome identification like FISH (Fluorescent *In Situ* Hybridization), GISH (Genomic *In Situ* Hybridization), Spectral Karyotyping (SKY) and Multiplex Fluorescence *In Situ* Hybridization (M-FISH) etc.
- Studies on stay-green traits in relation to genes affecting efficiency of photosynthethesis, biotic/abiotic stress tolerance
- MAS based mobilization of transgenes for tolerance to biotic and abiotic stresses into desirable agronomic backgrounds
- Breeding methodologies to enhance selection efficiency
- Component approaches and development of selection criteria for quantitiative trait improvement
- Stability analyses and methods to estimate the G X E components in breeding materials
- Relative efficiency analyses of genetic component estimation for reliable use in developing selection criteria in crop plants
- Distance and divergence statistics for identification of similarity assessment among genetic stocks and parental genetic material
- Linear and quadratic distance measures to identify relative contribution of component traits for complex traits
- Studies on genetic and molecular bases of stress tolerance to develop molecular diagnostics for screening/identification of stress tolerant genotypes
- Use of aneuploids for gene location and source for transfer through wild species
- Development and trisomic and monosomic series in diploids and polyploids
- Dependable marker systems for detection of introgression in wide crosses with minimized linkage drag
- Analysis of Resistance Gene analogues and their use in MAS with enhanced disease resistance
- Refinements in embryo rescue and consequent diplodization for production of double haploids
- Use of molecular markers in phylogenetic analysis
- Breeding through distant hybridization route for New Plant Type for breaking yield barriers
- Genetics of durable, quantitative resistance and adult plant resistance in major crops against known pathogens
- Development of tools and methodologies for identification of genes responsible for resistance against polyphagus insects
- Development of alien addition lines and telocentric lines in crops
- Microarray technique and robotics for identification of useful genes in crops
- Characterization of germplasm through molecular and serological techniques
- Induction of novel variation through mutagenesis tools and identify novel genes for different traits
- Development of heterotic pools for maximized heterosis in cross and self pollinated crops where hybrid seed production tools are available
- Genetics and traits responsible for terminal and initial heat tolerance in wheat, maize and mustard
- Genetics of cold tolerance related traits in maize, rice and pigeonpea
- Widening the QPM base in maize and prebreeding to add value to the genetic stocks of QPM
- Comparison of relative efficiency of different softwares in analysis of quantitative trait loci and linkages
- Biochemical and molecular bases of signal transduction in host-pathogen interactions
- Metal binding proteins for identification of phytoremediators
- Crop improvement for biomass energy and industrial use

- Development of cytogenetic stocks through varietal/alien chromosome substitutions

OR

PAPER – 403-A (SPECIAL PAPER-I)

CONSERVATION & UTILIZATION OF PLANT GENETICS RESOURCES

Objective : -

To provide information about collection, germplasm exchange, quarantine, maintenance and use of plant genetic resources including genetically modified plants.

UNIT I

History and importance of germplasm exploration; Distribution and extent of prevalent genetic diversity; Phyto-geographical regions/ecological zones and associated diversity; Mapping eco-geographic distribution of diversity, threatened habitats, use of flora.

UNIT II

Concept of population and gene pool; Variations in population and their classification; Gene frequencies in populations, rare and common alleles; Gene pool sampling in self and cross pollinated and vegetatively propagated species; Non-selective, random and selective sampling strategies; Strategies and logistics of plant exploration and collection; Practical problems in plant exploration; Use of *in vitro* methods in germplasm collection.

UNIT III

History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange; Documentation and information management; Plant quarantine introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India; Pest risk analysis, pest and pathogen information database; Quarantine in relation to integrated pest management; Economic significance of seed borne pests.

UNIT IV

Detection and identification of pests including use of recent techniques like ELISA, PCR etc., quarantine; weaknesses and future thrust.

Management and utilization of germplasm collections; Concept of core collection, molecular markers and their use in characterization; Evaluation and utilization of genetic resources; Pre-breeding/ genetic enhancement, utilizing wild species for crop improvement; Harmonizing agro-biodiversity and agricultural development crop diversification- participatory plant breeding.

Practical

• Plant exploration and collection;Identification of wild relatives of crop plants- Example of collection, cataloguing and preservation of specimens; Sampling techniques of plant materials; Visiting ports,airports to study the quarantine regulations; Use of visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques(controlled green houses/growth chambers, etc); Detection of GMOs and GEPs; Study of post-entry quarantine operation, seed treatment .

Suggested Readings

• Briggs D. 1997. *Plant Variation and Evolution*. Science Publ.
• Cronquist AJ. 1981. *An Integrated System of Classification of Flowering Plants*. Columbia Univ. Press.

• Dhillon BS, Varaprasad KS, Kalyani S, Singh M, Archak S, Srivastava U & Sharma GD. 2001. *Germplasm Conservation A Compendium ofAchievements*. NBPGR, New Delhi.
• di Castri F & Younes T. 1996. *Biodiversity Science and Development: Towards New Partnership*. CABI & International Union for Biol.Sci. France.
• Gurcharan Singh. 2004. *Plant Systematics: An Integrated Approach*. Science Publ.
• Lawrence GMH. (Ed.). 1951. *Taxonomy of Vascular Plants*. London.
• Paroda RS & Arora RK. 1991. *Plant Genetic Resources Conservation and Management Concepts and Approaches*. IPGRI Regional office for South and South Asia, New Delhi.
• Pearson LC. 1995. *The Diversity and Evolution of Plants*. CRC Press.
• Singh BP. 1993. *Principles and Procedures of Exchange of Plant Genetic Resources Conservation and Management.* Indo-US PGR Project Management.
• Sivarajan VV. 1991. *Introduction of Principles of Plant Taxonomy*. Science Publ.
• Stace CA. Plant Taxonomy and Biosystematics 2nd Ed. Cambridge Univ. Press.
• Takhrajan A. 1997. *Diversity and Classification of Flowering Plants*. Columbia Univ.Press.
• Wiersema JH. 1999. *World Economic Plants: A Standard Reference*Blanca Leon.
• Painting KA, Perry MC, Denning RA & Ayad WG. 1993. *Guide Book forGenetic Resources Documentation*. IPGRI, Rome, Italy.
• Puzone L & Th. Hazekamp 1996. *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, New Delhi.
• Rana RS, Sapra RL, Agrawal RC & Gambhir R. 1991. *Plant Genetic Resources, Documentation and Information Management*. NBPGR, New Delhi.

PAPER – 403-B (SPECIAL PAPER-II) (PLANT BREEDING PERSPECTIVE)

UNIT I

Plant Breeding – Historical Perspective: Earliest steps in Plant Breeding, Plant Breeding following hybridization, Plant Breeding developments before 1900, Plants Breeding after 1900, Goals of Plant Breeding, recent trends in Plant Breeding, Eminent of Plant Breeding.

UNIT II

Modes of Reproduction in relation to Plant Breeding:
Mode of Reproduction in crop Plants, Flowering biology, Sporogenesis, Anthesis, Fertilization, Mechanism of pollution control, determination of pollution system and relevance of mode of reproduction to Plant Breeding.

UNIT III

Breeding Techniques applicable in the Future:
Current Breeding Methods, F1 hybrids, Apomixis, Breeding for stability of Yield, Resistance Breeding, Haploids, Polyploids and Wide crosses, DNA transfer, converting C3 plants into C4 plants, Adapting crops to new Environments, Breeding nutritionally balanced varieties.

UNIT IV

Organizations for Crop Improvement in India and International Institutions:
Cooperative researches and release of variety, All India coordinated research projects, International Collaborations in Plant Breeding.
Cultivar Release, Seed Certification & Multiplication and Property Protection:
Cultivar Licensing, Breeder Seed, Multiplication from Breeder Seed, Seed Certification, Plant Breeder's Right.

PRACTICAL

1. Study of Taxonomy and Floral Biology of Cereal, Pulse, Oilseed and Fiber Crops.
2. Study of the technique of Hybridization and Selection in field important Cereal, Pulse, Oilseed and Fiber Crops.
3. Study of Seed Certification procedures in field in important Cereal, Pulse, Oilseeds and Fiber Crops.
4. A visit to Plant Breeding Experimental Research Station.
5. Presentation of Practical record, Charts, Models, etc.

PRACTICAL (SPECIAL PAPERS) OR THESIS *VIVA-VOCE*

GENETICS & PLANT BREEDING

List of Journals

- Australian Journal of Biological Sciences, Australia
- Australian Journal of Agricultural Research, Australia
- Biometrics, UK
- Bio-Techniques
- Cereal Research Communication, Hungary
- Cotton Research and Development, Hisar, India
- Crop Improvement, Ludhiana, India
- Crop Science, USA
- Current Science, Bangalore, India
- Critical Reviews in Plant Sciences
- Czech Journal of Plant Breeding Genetics, Prague,
- Electronic Journal of Biotechnology
- Euphytica, The Netherlands
- FABIS Newsletter
- Forage Research, Hisar, India
- Genetics, USA
- Genome, Canada
- Genetic resources and crop evolution, Netherlands
- Haryana Agricultural University Journal of Research, Hisar, India
- Heredity
- Hilgardia, Sweden,
- Indian Journal of Agricultural Research, New Delhi
- Indian Journal of Genetics and Plant Breeding, New Delhi
- Indian Journal of Plant Genetic Resources, New Delhi
- International Chickpea Newsletter, ICRISAT
- International Rice Research Notes, IRRI, Philippines
- Journal of Agricultural Research, U.K.
- Journal of Biochemistry and Biotechnology, New Delhi , India
- Journal of Genetics and Breeding, Italy
- Journal of Heredity
- Journal of Pulses Research, Kanpur, India
- Legume Research, Karnal, India
- MILWAI Newsletter
- Madras Agricultural Journal, Coimbatore, India
- Molecular Breeding, USA
- Mutation Research

- National Journal of Plant Sciences, Hisar, India
- Nucleic Acids Research, USA
- Oryza, Cuttack, India
- PGR Newsletter, Syria
- Plant Breeding, Germany
- Plant Molecular Biology, The Netherlands
- Rachis, Syria
- Sorghum and Millet Newsletter, ICRISAT
- Theoretical and Applied Genetics, Germany
- Wheat Research, Japan