Course: Genetics and Cytogenetics

Assessment	
Maximum marks	100
Continuous Internal Assessment (CIA)	25
Mid Semester Exam (MSE)	25
End Semester Exam (ESE)	50
Passing Marks	50

Course objectives

The course intends to provide the students with the detailed knowledge of applications of genetics and cytogenetics in fields like plant breeding, population genetics, evolutionary genetics and taxonomy.

Unit 1: Fungal Genetics

Introduction; Mutants and wild types- Isolation and characterisation of different mutants (complementation and functional allelism); functional mutants (auxotrophs, conditional lethals, resistance mutants, reverse mutants); Parasexual cycle - ~~Parasexual cycle~~, heterokaryosis, haploidisation, mitotic crossover and recombination, genetic analysis; Meiotic recombination - methods of analysis, linkage and tetrad analysis, gene mapping, gene conversion; Extra-chromosomal elements - Mitochondrial genome and plasmids, 2-micron plasmid, killer plasmid and linear plasmid;. Epigenetic gene silencing in filamentous fungi - RIP, MIP, Quelling, Heterothallism and mating type switch

Unit II: Eukaryotic Genome

Structure, organization evolution of plant genome; recombination- Molecular mechanism, linkage and crossing over; genetic and molecular markers, construction of linkage maps; Physical mapping of genes; correlation of genetic and physical maps; QTL mapping; concept of GWAS. Plant Genome Projects-History, organization and goals; case studies (*Arabidopsis thaliana, Oryza sativa* and *Cicer arietinum*); Indian scenario.

Unit III: Transposable Genetic Elements

Discovery; transposable elements in bacteria (IS, composite and non-composite Tn), transposable elements in Yeast and maize; host cell interaction in the regulation of

transposition. Role of transposons in plant genetic and epigenetic regulation, and speciation; gene creation; evolutionary significance of transposable elements.

Unit IV: Chromosome- physical structure, numerical and structural changes

Chromosome architecture – Linear differentiation; structure and role of centromere and telomere; unique and repetitive DNA; euchromatin and heterochromatin; banding patterns; karyotype evolution; DNA content and C-value paradox; transmission and characterization of mono-and trisomics and their use in chromosome mapping of diploid and polyploid species; breeding behaviour and genetics of complex translocation heterozygotes, translocation tester sets, Robertsonian translocations; breeding behaviour and genetics of inversion heterozygotes; production, characterization and utility of alien addition and substitution lines.

Unit V: Modern techniques in genetics and cytogenetics

Brief idea about application of- Chromosome banding; fluorescence in-situ hybridization (FISH); Genomic in-situ Hybridization (GISH); multicolor genomic in-situ hybridization (McGISH); primed in-situ (PRINS) DNA labeling; fiber-FISH; flow cytometry (Determination of nuclear DNA content, ploidy and genome size); chromosome microdissection and utilization of micro-isolated DNA; three-dimensional, live-cell imaging of chromatin dynamics in plant nuclei using chromatin tagging systems; chromatin immunoprecipitation for detecting epigenetic marks on plant nucleosomes; image analysis of DNA fiber and nucleus in plants.

SUGGESTED READINGS:

1. Swanson CP, Merz T, and Young WJ, (1967), Cytogenetics, Prentice Hall of India, Pvt. Ltd.
2. Russel PJ, (1998), Genetics, Benjamin/Cummings Publishing Co, Inc.
3. Sinnott EW, Dunn LC and Dobzhansky T (1958); Principles of Genetics, Kugakusha Co; Ltd.
4. Snustad DP and Simmons MJ (2000); Principles of Genetics, John Wiley & Sons. NY.
5. Klug and Cummings (2012) Concept of Genetics, 10th Edn; Pearson publications.
6. Acquaah G (2007) Principles of Plant Genetics and Breeding; Blackwell Publishing Ltd; USA.
7. Allard RW (1999) Principles of Plant Breeding (2nd Edition); John Wiley and Sons.
8. Hartl DL and Jones EW (2007) Genetics – Analysis of Genes and Genomes; 7th edition; Jones and Barlett publishers.

9. Hartwell LH, Hood L, Goldberg ML, Reynolds AE, Silver LM, Veres RC (2006) Genetics – From Genes to Genomes; 3rd edition; McGraw Hill.
10. Lewin B (2008) Genes IX; Jones and Barlett Publishers.
11. Singh RJ (2002) Plant Cytogenetics; 2nd edition; CRC Press.
12. Smartt J and Simmonds NW (1995); Evolution of Crop Plants (2nd Edition) Longman.
13. Strickberger MW (2008) Genetics; 3rd Edition; Pearson (Prentice Hall).
14. Weising K, Nybom H, Wolff K and Kahl G (2005) DNA Fingerprinting in Plants: Principles; Methods and Applications; 2nd ed; Taylor and Francis Group; Boca Raton.
15. JRS Fincham. (1979). Fungal Genetics. Botanical Monographs Vol 4. University of California Press.

Genetics and Cytogenetics Lab

Practicals

Assessment	
Max; Mark	50
Continuous Internal Assessment (CIA)	25
End Semester Exam (ESE)	25
Passing Marks	25

1. To study of mitotic chromosomes of *Allium cepa*, ~~*Avena*~~ *sativum*, *Hordeum vulgare* by squash technique - Pre-treatment; Fixation and Staining of Chromosomes
2. To study meiotic chromosomes of *Phlox drummondii*/ *Allium cepa*/ *Tradescantia* sp., *Delphinium* sp., *Aloe* sp.
3. Karyotype analysis and preparation of idiograms.
4. Analysis of molecular polymorphism in parental lines and derived mapping population using different types of molecular markers.
5. Construction of a linkage map using available data.
6. To demonstrate the effect of polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
7. To study the effect of mono and trisomy on fertility and meiotic behaviour.
8. To study the effect of translocation heterozygosity on chromosome behaviour, pollen and seed fertility.
9. To study the meiosis of complex translocation heterozygotes.
10. Experiments based on the chapter 5.