# **GENETICS**

#### 1. SECTION A: FOREST GENETICS

Basic principles – Introduction to forest genetics, tree breeding and its applications. Inheritance of genetic information: Cell division, regulation of cell cycle, sexual reproduction and Mendelian genetics. Chromosomes, chromosomal structure, extra chromosomal inheritance.

Variation: causes and kinds of variation, variation in natural and artificial stands, forces that shape variation, uses of variation. Estimates of variance components and covariance among relatives.

Population Genetics – Gene frequencies, Hardy-Weinberg law, evolution and migration, Wahlund effect.

Evolutionary Genetics – Natural selection, mutation, genetic drift, gene flow, speciation.

Quantitative Genetics – Heritability- broad and narrow sense, selection differential, selection intensity, response to selection, genetic gain and combining ability and their application. Genotype x environment interaction and stability of performance, Genetic correlation. Multiple factor inheritance. Linkage disequilibrium, genetic load. Mating system and mating design. Juvenile mature correlations.

Conservation Genetics – Objectives in gene conservation, Landscape genetics. Genetic markers- morphological, biochemical and molecular markers and their structure, *In situ* and *ex situ* gene conservation, applications in forest conservation and tree improvement. Molecular markers – PCR and non PCR based. Cryopreservation and plant regeneration for *ex situ* conservation.

Molecular Genetics,. Molecular basis of inheritance & genome organization. Organization of prokaryotic and eukaryotic genes and genomes including operon, exon, enhancer promoter sequences and other regulatory elements. The molecular basis of transmission of genetic information: nucleic acids and proteins. DNA replication, DNA damage and repair, mutations–spontaneous, induced and site-directed, recombination in bacteria, fungi and viruses, transformation, transduction, conjugation, transposable elements and transposition, recombination, transcription, and translation. Methods of gene isolation and identification, split gene, overlapping genes and pseudo gene. Restriction mapping, genetic libraries, cloning, Gene

sequencing: conventional and next generation sequencing, PCR. Construction and use of molecular marker-based chromosome maps. MAS, comparative and association mapping and genome analysis. Epigenetics, bioinformatics

### 2. SECTION B: FOREST TREE BREEDING

Techniques of tree breeding: Self- and cross-pollinated tree species, natives and exotics with their origin and distribution.

Definition and scope of tree breeding, its objectives and application. Selective methods of breeding. Controlled pollination and development of hybrids in forestry. Apomixes, incompatibility and male sterility system. Advance generation breeding- multiple populations and nucleus breeding

Polyploidy and mutation breeding. Breeding for specific traits viz. wood properties, resistance to insect and diseases. Ideotype breeding. Genetic and physiological basis of abiotic stress tolerance.

### 3. SECTION C: APPLIED TREE IMPROVEMENT

Species and provenance testing, plus trees and their selection methods, progeny testing and identification of elite trees. Production of quality seeds and seed certification. Seed orchards and seed production areas their establishment and management. Advanced generation breeding/seed orchards. Layout and designing of experimental trials.

Vegetative propagation, principles, methods and applications in trees. Plant tissue cultureprinciples, history and development, field of application, progress and prospects with special reference to tree crops. Establishment and maintainance of cultures. Stages of Micropropagation. Production of virus free plants. Soma-clonal and gameto-clonal variation, factors influencing, exploitation for crop improvement. Anther and haploid culture and production of homo-diploids, protoplast isolation, culture and regeneration; hybrid embryo culture and embryo rescue, protoplast fusion for somatic hybridization, cybridization and its application. Techniques for direct gene transfer to protoplasts. Somatic embryogenesis.

Genetically modified trees: direct and indirect gene transfer, transgene expression and stability. Regulation of biosafety. Clonal forestry- Clonal development, testing and selection Concept of juvenility. Establishment of VMGs and their management. Propagation structures and their management. Hardening of clonal plantlets. deployment of clones. *the sites*. Release and registration of clonal material.

Plant exploration, germplasm introduction, exchange, conservation, and evaluation of forest genetic resources. Intellectual property Rights, Plant Variety Protection and Farmers' Right Act. System of variety release and notification. Seed production and certification. Geographical Indicators.

## 4. SECTION D: STATISTICAL METHODS AND EXPERIMENTAL DESIGNS

Frequency distribution, measures of central tendency, probability theory and its application in genetics. Tests of significance, Null hypothesis, Z test, t- test,  $x^2$  (chi-square) test, F-test. Correlation-linear, partial multiple regression, Genetic divergence. Multivariate analysis, basic principles of design of experiment, RBD, CRBD, SPD, IRBD, Augmented design, Grid and honeycomb design.