BSG-111 Principles of Cytology and Genetics (2+1)


Practical:
Study of fixatives and stains; preparation of slides showing various stages of mitosis; Preparation of slides showing various stages of meiosis; Testing the viability and germination of pollen grains; Solving the problems on monohybrid and dihybrid crosses; Estimation of linkages/chromosome mapping.

TGR-121 Dendrology (2+1)

Theory: Introduction – importance and scope of dendrology, Morphology of woody plants and range of variation. Principles and systems of classification of plants. Bentham and Hooker’s, Engler and Prantles, and Hutchinson’s Systems. Plant Nomenclature – objectives, principles and International Code of Botanical Nomenclature. Role of vegetative morphology in identification of woody forest flora. Peculiarities of tree stems, twigs, general form of woody trunk and deviations like buttresses, flutes, crooks, etc. Morphology and description of barks of common trees. Characteristics of blaze on bark, colour, gums, latex, etc. Morphology of leaf, description of different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts. Floristics and procedures; herbarium techniques, collection, processing and preservation of plant material. General study of herbarium, arboretum and xylarium. Description of the plant in scientific terms, study of sport characteristics of plants, naming and classifying based on adopted system. Study of families, as survey of forest
resources: Magnoliaceae, Rhizophoraceae, Ebenaceae, Sapotaceae, Caesalpiniaceae, Santalaceae, Mimosaceae, Elaeagnaceae, Papilionaceae, Meliaceae, Salicaceae, Apocynaceae, Betulaceae, Verbenaceae, Fagaceae, Compositae, Moraceae, Poaceae, Tiliaceae, Liliaceae, Euphorbiaceae, Pinaceae, Dipterocarpaceae, Cupressaceae, Guttiferae, Taxaceae, Myrtaceae, Combretaceae. Geographical distribution of important Indian trees, native trees, exotic trees, endemism, allelopathy with respect to forest trees. Ranunculaceae, Brassicaceae (Cruciferae), Solanaceae, Rubiaceae, Arecaceae (Palmae), Musaceae, Orchidaceae and Cucurbitaceae.

Practical:
Morphological description of plant parts and methods of collection of plants. Techniques of preparing herbarium specimens. Study of woody flora of Magnoliaceae, Ebenaceae and Tiliaceae; Leguminosae, Betulaceae, Fagaceae; Dipterocarpaceae, Guttiferae and Liliaceae; Moraceae and Poaceae; Meliaceae, Elaeagnaceae and Salicaceae; Legumenosae and Apocynaceae; Combretaceae, Lythraceae, Myrtaceae and Santaleceae; Asteraceae, Ebenanceae, Sapotaceae and Verbenaceae; Euphorbiaceae, Pinaceae, Cupressaceae, Taxaceae.

TGR-122 Forest Ecology and Biodiversity (1+1)


Practical: Estimating productivity of a site. Study of microclimate and forest soils. Study of ecological modifications of leaves; Effects of fire on forest ecosystem; Study of population dynamics using model systems; Preparation of life tables; Study of spatial dispersion among plants; Study of Forest composition; Niche analysis; Computation of diversity indices; Measurement of diversity of plants and insects in a nearby forest; Study of succession in field and water bodies; Visit to different ecosystems.
TGR-212  Tree Seed Technology  (1+1)

Introduction – Seed and its importance – afforestation activity and seed requirements in India and HP. Role of seed technology in nursery stock production. Production of quality seed, identification of seed collection areas-seed orchards – maintenance of genetic purity-isolation and roguing, seed source provenance and stands. Selection of seed tree, genotypic and phenotypic selection, plus tree – pure stands, elite seed tree, isolated tree and their location. Locality factors. Seed Collection – Planning and Organization, Collection methods, Factors affecting seed collection, Seed maturity and tests. Seed processing – Seed extraction, drying, blending, cleaning, grading, treating, bagging, labeling and storage. Storage – orthodox and recalcitrant seeds, precautions of handling of recalcitrant seeds, natural longevity of tree seeds, factors affecting longevity – storage conditions, methods and containers. Seed testing, sampling, mixing and dividing, determination of genuineness, germination, moisture, purity, vigour, viability, seed dormancy and breaking of seed dormancy. Different viability and vigour tests, seed pelleting, seed health. Classes of tree seeds, certification procedures of tree seeds.

Practical:

Identification of seeds of tree species; Seed maturity tests; Physical purity analysis; Determination of seed moisture; Seed germination test; Hydrogen peroxide test; Tetrazolium test for viability; Seed vigour and its measurements; Methods of breaking dormancy in tree seeds; Testing membrane permeability; Study of seed collection and equipments; Planning and collection of Seeds; Seed extraction, Visit to seed production area and seed orchard; Visit to seed processing unit/testing laboratory; Study of seed sampling equipments.

Note: Region specific aspects may be changed based on the locality

Semester-V

TGR-311  Tree Physiology  (2+1)

Practical:

Measurement of growth and growth kinetics in seedlings; Measurement of linear growth in tree species; Biometric measurement of plant growth; Estimation of evapotranspiration; Measurement of WUE in trees; Pattern of light interception in different canopy architecture; Measurement of light use efficiency in tree species, using plant efficiency analysis; Growth as influenced by different spectral bands in visible light; Source sink relationship in plants; Translocation studies in plants; Effect of growth promoters on plants; Effect of growth retardants on plants; Use of biocides in tree species; Dormancy and germination studies in tree species; Methods of breaking dormancy in tree species; Studies on senescence in tree species; Regulation of senescence in tree species using agrochemicals; Chemical composition of tree species including shrubs, herbs and wood.

Semester VI

TGR-321 Principles and Methods of Tree Improvement (2+1)


Practical:

in plus-tree selection. Seed orchard designs. Recording the design and observations in teak, Eucalyptus seed orchards. Genetic engineering techniques in tree improvement.

**FOR 453 PRINCIPLES OF TREE IMPROVEMENT 2+1 (Deficiency Course)**

**Theory**


**Practical**

List of PG Courses

FOR 505   FOREST ECOLOGY AND BIODIVERSITY CONSERVATION   2+1

Objective

To develop understanding of students about ecological aspects of forest, conservation of forest resources & biodiversity, consequences of depleting biodiversity and sustainable use of biodiversity.

Theory

UNIT I

Advanced topics in forest ecology including forest population, forest community dynamics, forest community structure and analysis, forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity; Hierarchy issues in ecology.

UNIT II


UNIT III

Documentation and evaluation of forests genetical resources (FGR), \textit{in situ} and \textit{ex situ} conservation of gene resources. Biological diversity and its significance to sustainable use. Handling and storage of FGR. Intellectual property rights. Quarantine laws and FGR exchange.

Practical

Study of forest community structure and its successional status, Estimation of productivity of forest ecosystem, Trip to different regions of the state to study forest vegetation, Collection and preservation of specimen, Methods of vegetation analysis, Measurement of biomass and productivity, Quantification of litter production and decomposition, Visit to national parks, wildlife sanctuaries, botanical gardens and arboreta.

Suggested Readings


FOR 509 TREE IMPROVEMENT 1+1

Objective

To acquaint the students about general principles of tree breeding with examples of important trees.

Theory

UNIT I

General concept of forest tree breeding, tree improvement and forest genetics.

UNIT II

Reproduction in forest trees, dimorphism pollination mechanisms. Pollen dispersal, pollinators. Attractants for pollinators.

UNIT III

Variation in trees, importance and its causes. Natural variations as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races.

UNIT IV

Seed, seed formation, dispersal, storage and seed dormancy.

UNIT V
Selective breeding methods- mass, family, within family, plus within family. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breeding methods and progress in selective breeding in forest trees.

**UNIT VI**


**UNIT VII**

Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples – teak, sal, shisham, eucalypts, acacias etc.

**UNIT VIII**

Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy.

**UNIT IX**

Biotechnology in tree improvement.

**Practical**


**Suggested Readings**

Mandal AK & Gibson GL. (Eds). 1997. *Forest Genetics and Tree Breeding*. CBS.


Objective
To acquaint the students about the concepts of sub-selection, population structure for breeding and production, genetic testing and making designs.

Theory

UNIT I
Genetic constitution of tree populations, half-sib, full-sib family in trees. Hardy-Weinberg equilibrium, changes in gene frequency through selection, migration, mutation and population sizes.

UNIT II
Long-term and short-term breeding populations. Selective breeding methods- mass, family, within family, family plus within family. Grading system of plus trees in natural stands and plantations regression systems, mother tree selection, subjective evaluation. Selection for different traits.

UNIT III
Genetic testing programmes – mating designs, complete designs – nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs – open pollinated mating and polycross mating.

UNIT IV
Experimental designs in genetic testing. Selection for disease resistance, tolerance to herbicide, salt, metals, high and low temperature, water stress. Marker assisted selection.

UNIT V
Breeding methods for wood quality, agroforestry, diseases and pest resistance, drought and salt resistance.

UNIT VI
Tree improvement case histories. Calculating gene and genotype frequencies. Flow chart for different breeding methods.

Practical
Half-sib, full-sib family in trees. Grading system of plus trees in natural stands. Mating designs, complete designs – nested designs, factorial, single pair mating, full diallel, half diallel...
and partial diallel, incomplete pedigree designs – open pollinated mating and polycross mating. Selection for biotic and biotic stresses.

**Suggested Readings**


**FGR 522 REPRODUCTIVE BIOLOGY OF FOREST TREES 2+1**

**Objective**
To impart the knowledge of reproduction in forest tree species and to make them understand the mechanism of breeding, sex expression.

**Theory**

**UNIT I**
Importance and application of reproductive biology in tree breeding.

**UNIT II**
Modes of reproduction: sexual, asexual and vegetative and their breeding systems and sex expression, monoecy, dioecy and its evolution.

**UNIT III**
Out-crossing mechanism in forest trees.

**UNIT IV**
Environmental effects on sex expression. Floral biology. Initiation and development. Modes of pollination; Self and out-crossing.
UNIT V
Fertilization in hardwood and softwood species. Seed dispersal and gene flow.

Practical

Suggested Readings

FGR 523 TREE SEED ORCHARDS 2+1

Objective
To develop understanding of students about tree seed orchards.

Theory

UNIT I
Importance of genetically improved seed in plantation forestry. Status of seed production among major plantation species. Short term supply of superior seed.

UNIT II
Selection and delineation of seed stands, seed production areas, seed zones, seed ecological zones.
UNIT III
Seed orchard: need, evolving seed orchards, containerized seed, hybrid and research seed orchards; first, second and advanced generation seed. Seed orchard genetics: random mating, gamete exchange and parental balance. Estimation of genetic parameters from seed orchard data. Ortet age and its effect on seed production.

UNIT IV
Importance of progeny testing. Establishment of seed orchards, selection and preparation of orchard site, isolation, orchard size, and designs. Seed orchard management: rouging, silvicultural practices to increase seed yield. UNIT V
Pest and disease management. Seed collection and record keeping, seed orchard registration and documentation. Importance of seed orchards in gene conservation.

Practical

Suggested Readings
Objective
To impart knowledge in the field of biometry as applied to breeding, population, provinces and making experiment in forest genetics and tree breeding.

Theory

UNIT I
Historical aspects of quantitative genetics; multiple-factor-hypothesis. Population structure, mating systems.

UNIT II

UNIT III
In breeding in pedigreed population, inbreeding coefficient under regular systems of inbreeding. Statistical parameters used in studying polygenic traits.

UNIT IV
Testing and estimating: population mean and components of phenotypic value, breeding value, dominance, interaction and environment deviation. Models of gene action, significance of different genetic components, G x E component of variance.

UNIT V

UNIT VI

UNIT VII
Effect of inbreeding on mean and variance. Heterosis and causes for heterosis in F1 and later generations. Combining ability effects, variances and selection for combining ability. Threshold characters.
Suggested Readings


FGR 525    FOREST GENETIC DIVERSITY AND CONSERVATION    3+0

Objective
To provide the students knowledge about the genetic diversity in forest tree species, their distribution, assess and analysis laws and methodologies of in-situ and ex-situ conservation.

Theory

UNIT I

UNIT II
Molecular approaches for assessing genetic diversity. Inventory and monitoring biodiversity: sampling strategies for genetic diversity assessments sufficiency of sampling procedures, neutral allele model and optimal allocation of sampling efforts.

UNIT III
UNIT IV
Laws and policies. Methods for maintenance of conservation: Gene banks, arboreta, gardens, breeding populations as repositories of gene conservation. Rare, endangered and endemise plants (IUCN).

UNIT V

UNIT VI

Suggested Readings
Objective

To develop understanding of students in application of mendelian principles to forest trees and integration of physiological and molecular techniques for tree improvement programmes.

Theory

UNIT I

Mendelian concepts as applied to forest trees. Cytological and chromosomal systems of forest trees. Cytoplasmic inheritance in trees. Colchiploid and mutation breeding for forest trees.

Physiological basis of tree improvement. Pollution responses of trees. Pollen handling and hybridization techniques in forest trees. Tissue culture of trees.

UNIT III

Molecular genetics as applied to forest trees, recent trends in tree improvement, somatic hybrids, transformation, gene sequencing. Inheritance of monoterpenes composition in conifers.

UNIT IV

Indirect selection for improvement of desired traits, molecular markers. Juvenile traits and their role in genetic evaluation in tree improvement programmes.

UNIT V


Practical

Cytology of pine root tips, karyotypic analysis, mutagenic treatments with colchicine and MH, tissue culture of organs, and transformation experiments, resin tapping and observation of trees for monecium and dioecium.

Suggested Readings


**FGR 621 ADVANCES IN FOREST GENETICS AND TREE BREEDING 1+1**

**Objective**

To develop understanding of students about methodologies involved in the study of gene flow of forests tree through pollen, seed and gene flow development of hybrids.

**Theory**

**UNIT I**

Assessment of genetic diversity, gene conservation, breeding populations, taxonomy and phylogenetic studies, pollen collection storage, extension, theories of pollen dispersal, mating designs.

**UNIT II**

Gene structure and expression, gene regulation, bioregulators, protein synthesis and polygenic inheritance, genetics of heterosis, overcoming incompatability, hybrid embryo rescue and studies in hybrid development in forest trees.

**Practical**

Emasculation and pollination studies in conifers and broadleaved tree species (dioecious, monoecious and bisexual). Pollen vector analysis and traplining distances.

**Suggested Readings**


GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

**FGR 622 ADVANCES IN QUANTITATIVE FOREST GENETICS** 2+1

**Objective**
To develop understanding principles of biometrical genetics and utility of various biometrical techniques in Tree Improvement programmes.

**Theory**

**UNIT I**
Concepts in Quantitative genetics, quantitative inheritance, historical aspects, Galton (1869) methods for studying quantitative traits, qualitative and quantitative traits and their inheritance, property of nuclear born genes (segregation and linkages).


**UNIT II**
Genetic components of continuous variation gene models (additive, dominance, epistasis) features of additive gene action, features of non-additive gene action, genetic variance in F2 population in various gene models, important principles established by NCSU (North Carolina State University) for forest Tree Improvement, Origin of variation, estimation of hereditary parameters, variance derivation in F2 and backcrosses, genotype X environment interaction, its measurement and significance, concepts of heritability and genetic advance, random mating in forest trees, their population structure and response to selection.
UNIT III
Quantitative genetics in relation to efficient breeding methodology – partitioning of means and variances, simple scaling and joint scaling tests line X teester analysis and diallel analysis mating designs in tree improvement, choice classification, incomplete pedigree design and complete pedigree design.

UNIT IV
Usefulness of Biometrical techniques, Assessment of variability, variance analysis metroglyph analysis, D₂ Statistic, aids to selection, correlation, path analysis, discriminant function, aids to choice of parents : line X teester analysis, diallel analysis, Assessment of adaptability, Stability analysis, software in forest genetic analysis and their interpretation.

UNIT V
Molecular Diversity analysis, methods for mapping Qtls.

Practical
Working out genotypic and phenotypic variance in forest trees, Detection of linkage in coupling, Proof that gene and genotypic frequencies remain constant in random mating populations, Stability analysis Eberhart and Russel Model 91966), Perkins and Jinks Model (1971), Problems on demonstrating the effects of selection, mutation, migration and genetic drift in random mating population through graphs, Simple scaling tests, Joint scaling tests, Heritability estimation (Analysis of variance, parent offspring correlation and regression), Heritability in narrow sense estimation, Line X Teester analysis, Diallel analysis, Calculation of genotypic and phenotypic correlations, Path Analysis, Discriminant Function, D² Statistics, Principal components analysis, Diversity Analysis Based on RAPD/SSR

FGR 623 ADVANCES IN FOREST REPRODUCTIVE BIOLOGY 2+1

Objective
To develop understanding of students about phenology, phenodynamics breeding behaviour pollination biology and breeding systems in forest trees.

Theory
**UNIT I**

**UNIT II**
Pollenation, biology, pollination ecology of tropical and temperate forest tree species, plant-pollination interactions. Pollinator energetic and nectar production.

**UNIT III**
Genetic consequences of variation in reproductive biology. Pollen biotechnology for improved production.

**UNIT IV**

**Practical**
Phenological studies in forest trees, nectar collection and analysis, pollination trapping distances, foraging behaviour, pollinator identification and visitation.

---

**Suggested Readings**

Mandal AK & Gibson GL.(Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.
FGR 624 MOLECULAR GENETICS OF FOREST TREES 2+1

Objective
To develop understanding of students about molecular markers, gene mapping, genotypic influences, protein and DNA markers.

Theory

UNIT I
Molecular markers, quantification of genetic diversity, characterization of cellular molecules and their variants, assessment of morphological and quantitative traits.

UNIT II
Genotype verification and delineation, influences of environmental factors on developmental stages.

UNIT III
Isozymes, RFLPs, RAPDs, microsatellites, and genetic finger-printing in forest trees, marker assisted selection, binary vectors, selectable and screenable markers, and transgenics, gene maps of selected forest trees.

Practical
Isolation of DNA, RNA from forest tree species, isozyme analysis, use of molecular markers and RAPD and RFLPs for clonal identification.

Suggested Readings
Mandal AK & Gibson GL.(Eds.). 1997. Forest Genetics and Tree Breeding. CBS.
Objective

To make the students understand the mechanisms responsible for farm and structure in trees and how physiological and genetic concepts mingle to develop an ecosystem.

Theory

UNIT I

Introduction - tree forms in relation to environmental factors - mechanism responsible for differences in tree forms - stand structure and micro-climate.

UNIT II

Carbon fixation by tree canopies - leaf area, interception of solar adiation and tree growth - Leaf area index and dry matter production – Radiation attenuation through canopies - strategies for maximising solar energy utilisation - stomatal conductance.

UNIT III

Carbon consumption and export - carbon balance in trees - canopy photosynthesis - Transport and partitioning - Factors influencing net photosynthesis in trees - Relationship between the CO2 compensation point and carbon fixation efficiency in trees - Physiology of formation of early and late woods-Resource sharing in mixed Agroforestry system.

UNIT IV


UNIT V

Biochemical and molecular aspects - water logging - physiology of resistance to water logging - Salt and ion stress.

UNIT VI

Suggested Readings


**SUPPORTING COURSES**

**FOR 613 FOREST ECOLOGICAL MODELING 1+1**

**Objective:**
To develop understanding of students in the concepts of modeling techniques in ecology and analysis of different models for population structure.

**Theory**

**UNIT I**
Systems and Models - Descriptive and explanatory models - Dynamic systems and models - Deterministic and Stochastic models - Usefulness of ecological research using models.

**UNIT II**

**UNIT III**
Optimization of resources under constraints - Linear and non-linear programming - Formulation and their applications in ecological modeling. Simulation - Elements and
basic concepts - Deterministic simulation - state variables, rate variables and drying variables - Feedback models and their solutions - analytic integration and system behaviour in time-dynamic simulation using numerical integration.

**Practical**

**Suggested Readings**