ST. JOSEPH’S COLLEGE FOR WOMEN (AUTONOMOUS) VISAKHAPATNAM

B.SC.(HONORS) AGRICULTURE AND RURAL DEVELOPMENT WITH SINGLE MAJOR

# I SEMESTER **AGRICULTURE AND RURAL DEVELOPMENT** Time: 3hrs/week

AGRD111(2)  **FUNDAMENTALS OF PLANT BREEDING & GENETICS** Marks:100

w.e.f AK 2023-2024 (Admitted batch) **SYLLABUS**

**OBJECTIVES**

* To study Genetics in relation to plant breeding.
* To learn and apply concepts of modern transmission and molecular genetics.
* To study the purpose of the cell cycle
* To study about the mendel's laws
* To study identifying the characteristics of self- and cross-pollinated crops and their     breeding methodology for plants.

**Course Outcome**

**CO1:** Discuss details of cell cycle, heredity and laws of inheritance in genetics

**CO2:** Outline the concepts of karyotype, sex linkage and mutations and central dogma of

           genetic material and genetic code.

**CO3:** Explain historical development, concepts, nature and role of plant breeding and modes of reproduction and the different plant breeding methods.

**CO4:** Summarize the development of resistance and tolerance mechanisms.

**UNIT – I: (6hrs.)**

1. Pre Mendelian concepts of heredity – Early history of heredity, inheritance of acquired traits, preformation theory, pangenesis and germplasm theory. Mendelian principles of heredity -Terminology, Mendel’s Experiments-Reasons for selection of pea as experimental material characters studied - Reasons for mendel’s success. Mendel’s laws -Law of segregation- Law of independent assortment- Principle of dominance -Principle of unit characters- Exceptions to mendel’s laws-Rediscovery of mendelian principles.

2. Chromosome and cell division - Structure of chromosome, types of chromosomes based on position of centromere. Cell division – Cell cycle – Mitosis - Process of mitosis - Significance. Meiosis - Process - Differences between mitosis and meiosis - Significance.

3.  Gene interaction - Nonepistatic interaction – Interaction of factors; epistatic interactions - Complementary epistasis, dominant epistasis. Recessive epistasis, duplicate dominant gene action, dominant suppression or inhibitory gene action, duplicate genes with cumulative effect.

4. Multiple alleles – Characteristics of multiple alleles - Blood groups in humans, coat colour in rabbits, self-incompatibility alleles in plants - pleiotropism, penetrance and expressivity.

5. Linkage – Definition – Classification of linkage – Characteristic features of linkage. Linkage groups. Detection of linkage – Estimation of linkage - Importance of test cross in linkage studies significance in plant breeding.

**UNIT – II: (6hrs.)**

1. Chromosome mapping – point test cross – Cytological maps and genetical maps Coincidence and interference.
2. Sex determination and sex linkage - Various mechanisms of sex determination Chromosomal sex determination, genic balance mechanism of sex determination in Drosophila melanogaster, male haploidy, single gene effects etc. Sex linkage – White eye colour in Drosophila, colour blindness and haemophilia in humans - sex influenced traits – Horns in sheep, baldness in humans, sex limited - Milk production in cattle, beard in man – Pseudohermaphrodites – Gynandromorphs.
3. Qualitative and Quantitative traits, Polygenes and continuous variations - Definition - Inheritance and their differences, multiple factor hypothesis.

AGRD111(2)  **::2::**

1. Nature and structure of genetic material - DNA and its structure - Watson and Crick’s model - Function – Experiments to prove DNA as genetic material. Replication of DNA-Modes of DNA replication - Semi-conservative DNA replication Experimental proof. Types of RNA - Messenger RNA, ribosomal RNA and transfer RNA - structure of tRNA, differences between DNA and RNA.
2. Transcription and translational mechanism of genetic material - Genetic code – Properties of genetic code – Wobble hypothesis.
3. Mutation - Classification - Gene mutations - Introduction - Definition - Types of mutations - Spontaneous and induced mutations - Point mutations - Characters of mutations - Xenia and metaxenia – Chimeras Types and their significance in plant breeding.  Methods of inducing mutations, Physical and chemical mutagens - Detection of sex linked lethals in Drosophila (ClB method given by Muller). Molecular basis of mutations - Transitions, transversions and frame shift mutations Importance of mutations in plant breeding.

**UNIT – III: (6hrs.)**

1. Historical developments, concept, nature and role of plant breeding, major achievements and future prospects - Definition, aim, objectives, history and developments of plant breeding, scientific contributions of eminent scientists - Landmarks in plant breeding - Scope of plant breeding.
2. Plant introduction and Centre of Origin/Diversity - Plant introduction – Primary introduction and secondary introduction – Plant introduction agencies in India-Procedure, Merits and demerits of plant introduction. Classification of Centre of Origin/Diversity – law of homologous series – Types of centres of diversity – Germplasm collections – Genetic erosion – Main reasons of genetic erosion – Extinction - Gene sanctuaries - Introgression – Gene banks – Types of gene banks.
3. Modes of reproduction and pollination - Asexual reproduction (vegetative reproduction and apomixis) and sexual reproduction - Their classification and significance in plant breeding. Self-pollination – mechanisms promoting self-pollination – Genetic consequences of self pollination – Cross pollination – Mechanisms promoting cross pollination – Genetic consequences of cross pollination – Often cross pollinated crops.
4. Self– incompatibility and Male Sterility - Classification – Heteromorphic, homomorphic, gametophytic and sporophytic systems of incompatibility – Advantages and disadvantages – Utilization in crop improvement. Genetic consequences, cultivar options - Different types – Genetic, cytoplasmic and cytoplasmic genetic male sterility – Inheritance and maintenance– utilization of male sterile lines in hybrid seed production – Their advantages and disadvantages.
5. Breeding methods in self-pollinated crops - Modes of selection - Selection – Natural Hybridization techniques - Hybridization – Aims and objectives – Types of hybridization – Pre-requisites for hybridization – Procedure / steps involved in hybridization.

**UNIT – IV: (6hrs.)**

1. Mass selection and pureline selection – Procedure for evolving a variety by mass selection – Modification of mass selection – Merits, demerits and achievements. Pure line selection - Johannsen’s pure line theory and its concepts and significance – Origin of variation in pure lines – Characters of pure lines – Progeny test, genetic basis of pure line selection – General procedure for evolving a variety by pure line selection – Merits, demerits and achievements – Comparison between mass and pure line selection.

AGRD111(2)  **::3::**

1. Handling of segregating population - Pedigree method and bulk method– Procedure – Merits, demerits and achievements. Bulk method – Procedure – Merits, demerits and achievements – Comparison between pedigree and bulk methods - Single seed descent method – Merits and demerits. Backcross method of breeding–Its requirements and applications – Procedure for transfer of single dominant gene - Procedure for transfer of single recessive gene – Merits, demerits and achievements - comparison between pedigree and backcross method.
2. Multiline concept and Recurrent selection - Definition – Characteristics of a good multiline – Development of multiline varieties – Achievements. Concepts of population genetics and Hardy - Weinberg Law- Factors affecting equilibrium frequencies in random mating populations - Selection without progeny testing – Selection with progeny testing - Merits and demerits of progeny selection – Line breeding– achievements.Recurrent selection – Different types – Detailed procedure of simple recurrent selection and other recurrent selection methods.
3. Heterosis and hybrid vigour – Luxuriance – Heterobeltiosis – Brief history– heterosis in cross pollinated and self-pollinated species – Manifestations of heterosis. Genetic basis of heterosis – Dominance, over dominance and epistasis hypotheses – Objections and their explanations – Comparison between dominance and overdominance hypothesis. Inbreeding depression - Brief history – Effects of inbreeding – Degrees of inbreeding depression – Procedure for development of inbred lines and their evaluation. Development of inbred lines and hybrids - Exploitation of heterosis – History of hybrid varieties – Important steps in production of single and double cross hybrids.

1. Composite and synthetic varieties - Production procedures – Merits, demerits and achievements – Factors determining the performance of synthetic varieties – Comparison between synthetics and composites.
2. Breeding methods in asexually propagated crops, clonal selection,hybridization and wide hybridization - Characteristics of asexually propagated crops, clones –Clonal selection – Procedure – Advantages and disadvantages – Problems in breeding asexually propagated crops – Genetic variation within a clone – Clonal degeneration – Achievements – Interspecific hybridization.
3. Polyploidy in relation to plant breeding and Mutation breeding - Polyploidy – Autopolyploids – Origin and production – Morphological and cytological features– Applications in crop improvement – Limitations– Allopolyploidy – Morphological and cytological features– Applications in crop improvement – Limitations. Mutation breeding - Methods and uses - Mutation breeding – Procedure of mutation breeding – Applications – Advantages, limitations and achievements.

**UNIT-V: (6hrs.)**

1. Breeding for important biotic and abiotic stresses - Disease resistance – Mechanisms of disease resistance in plants (disease escape, tolerance, resistance, immunity and

      hypersensitivity) – Genetic basis of disease resistance – Gene for gene hypothesis –sources of disease resistance – Breeding methods for disease resistance – Achievements. Insect resistance – Mechanism of insect resistance in plants (non preference, antibiosis, tolerance and avoidance) – Genetics of insect resistance – Horizontal and vertical resistance– Sources of insect resistance – breeding methods for insect resistance – Problems in breeding for insect resistance – Achievements.

 AGRD111(2)  **::4::**

1. Drought resistance, salt tolerance and cold tolerance – Mechanisms of drought resistance (drought escape, avoidance, tolerance, and resistance) – Features- Sources of drought resistance – Breeding methods for drought resistance – Limitations – achievements. Salt tolerance – Response of plants to salinity – Symptoms – Mechanisms of salt tolerance – Breeding methods for salt tolerance – Problems – Achievements. Cold tolerance – Chilling resistance – Effects of chilling stress on plants – Mechanism of chilling tolerance – Sources of chilling tolerance – Selection criteria.
2. Biotechnological tools - DNA markers and marker assisted selection - Definition and classification of DNA markers and applications.

**References Text Books:**

1. Phundan Singh, 2014. Essentials of Plant Breeding. Kalyani Publishers, New Delhi. Singh, B.D. 2015. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi. Gupta, S.K. 2010. Plant Breeding Theory and Techniques.Wiley India Pvt. Ltd. New Delhi. Allard, R.W. 2010. Principles of Plant Breeding. John Wiley and Sons, New York.
2. Poehlman, J.M. and Borthakur, D. 1995. Breeding of Asian Field Crops. Oxford and IBH Publishing Co., New Delhi.
3. Sharma, J.R. 1994. Principles and Practice of Plant Breeding.Tata McGraw Hill, Publishing Company Ltd., New Delhi.
4. Pundhan Singh. 2006. Genetics. Kalyani Publishers, Ludhiana.
5. Singh, B.D. 2015. Fundamentals of Genetics. Kalyani Publishers, Ludhiana. 3. Gupta, P.K.2007. Genetics. Rastogi Publications, Meerut. 4. Khanna, V.K. 2002. Genetics Numerical Problems. Kalyani publishers. 2nd edition

\*\* \*\* \*\*