

Introduction to Plant Genetics

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Key concepts, terminology, and foundational principles for beginners

1. What Is Plant Genetics?

Aspect	Description
Definition	The study of how hereditary information is transmitted, expressed, and altered in plants.
Scope	Includes DNA structure, gene function, inheritance patterns, mutation, breeding, and molecular tools.
Why It Matters	Enables crop improvement, conservation of biodiversity, understanding evolution, and biotechnological applications (e.g., biofuels, pharmaceuticals).

2. Basic Genetic Terminology

Term	Meaning	Example in Plants
Gene	A DNA segment that encodes a functional product (protein or RNA).	<i>R</i> gene ? resistance to powdery mildew.
Allele	Alternative versions of a gene.	<i>A</i> (purple flower) vs. <i>a</i> (white flower).
Locus	Physical location of a gene on a chromosome.	Locus <i>P</i> on chromosome 3.
Dominant / Recessive	Dominant allele masks the effect of a recessive allele in a heterozygote.	<i>T</i> (tall) dominates <i>t</i> (short).
Homozygous	Two identical alleles at a locus (<i>AA</i> or <i>aa</i>).	<i>AA</i> ? always purple flowers.
Heterozygous	Two different alleles (<i>Aa</i>).	<i>Aa</i> ? phenotype depends on dominance.
Phenotype	Observable trait (e.g., leaf shape).	Lobed leaves.
Genotype	Genetic makeup at a locus.	<i>RR</i> (homozygous resistant).

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Polyploidy	Possession of more than two complete sets of chromosomes.	Wheat (hexaploid, 6x).
Linkage	Genes located close together on the same chromosome tend to be inherited together.	A and B loci on chromosome 5.
Recombination	Exchange of DNA between homologous chromosomes during meiosis, creating new allele combinations.	Crossing over in pollen mother cells.

3. Plant Chromosome Basics

Feature	Detail
Chromosome Number	Varies widely (e.g., <i>Arabidopsis thaliana</i> : $2n = 10$; maize: $2n = 20$).
Ploidy Levels	Diploid (2x), triploid (3x), tetraploid (4x), etc. Polyploidy is common in plants and often leads to new species.
Sex Determination	Many plants are hermaphroditic; some have separate sexes (dioecious) with sex chromosomes (e.g., <i>Silene</i>).
Mitosis vs. Meiosis	Mitosis ? somatic growth, identical clones. Meiosis ? gamete formation, genetic diversity.

4. Mendelian Inheritance in Plants

1. Monohybrid Cross – single gene trait.

- **F₁ generation:** cross $AA \times aa$? all Aa (heterozygous).
- **F₂ generation:** self-pollinate Aa ? phenotypic ratio 3:1 (dominant:recessive).

2. Dihybrid Cross – two independent genes.

- Expected F₂ ratio 9:3:3:1 (if genes assort independently).

3. **