Genetics and Mendel's Laws

Introduction to the Fundamental Concepts of Heredity and Genetic Principles

Scientific Foundation

Complete Theory

Visual Diagrams

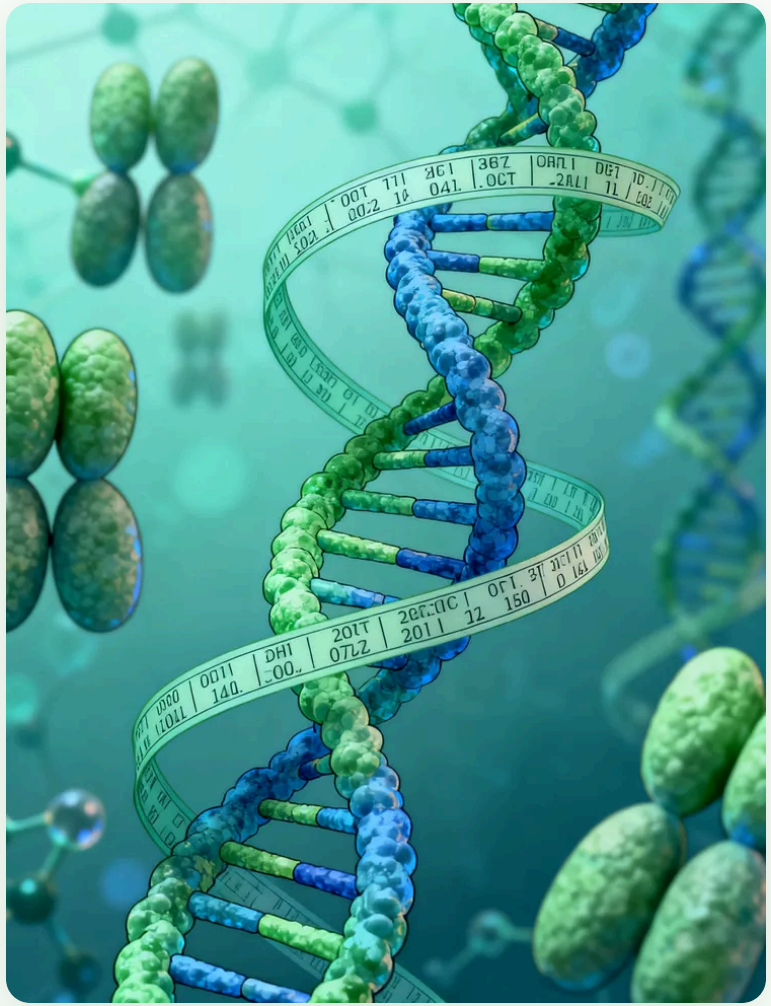
What is Genetics?

Definition

Genetics is the scientific study of **genes, heredity, and variation** in living organisms. It explores how traits are passed from parents to offspring.

Key Areas

- **Heredity:** Transmission of traits across generations
- **Variation:** Differences among individuals
- **Gene Expression:** How genes influence traits



Key Genetic Terms

Gene

A segment of DNA that contains instructions for building proteins and determines specific traits

Allele

Alternative forms of a gene that occupy the same position on homologous chromosomes

Genotype

The genetic makeup of an organism; the combination of alleles inherited from parents

Phenotype

The observable physical or biochemical characteristics resulting from genotype and environment

= Homozygous

Having two identical alleles for a particular gene (e.g., AA or aa)

≠ Heterozygous

Having two different alleles for a particular gene (e.g., Aa)

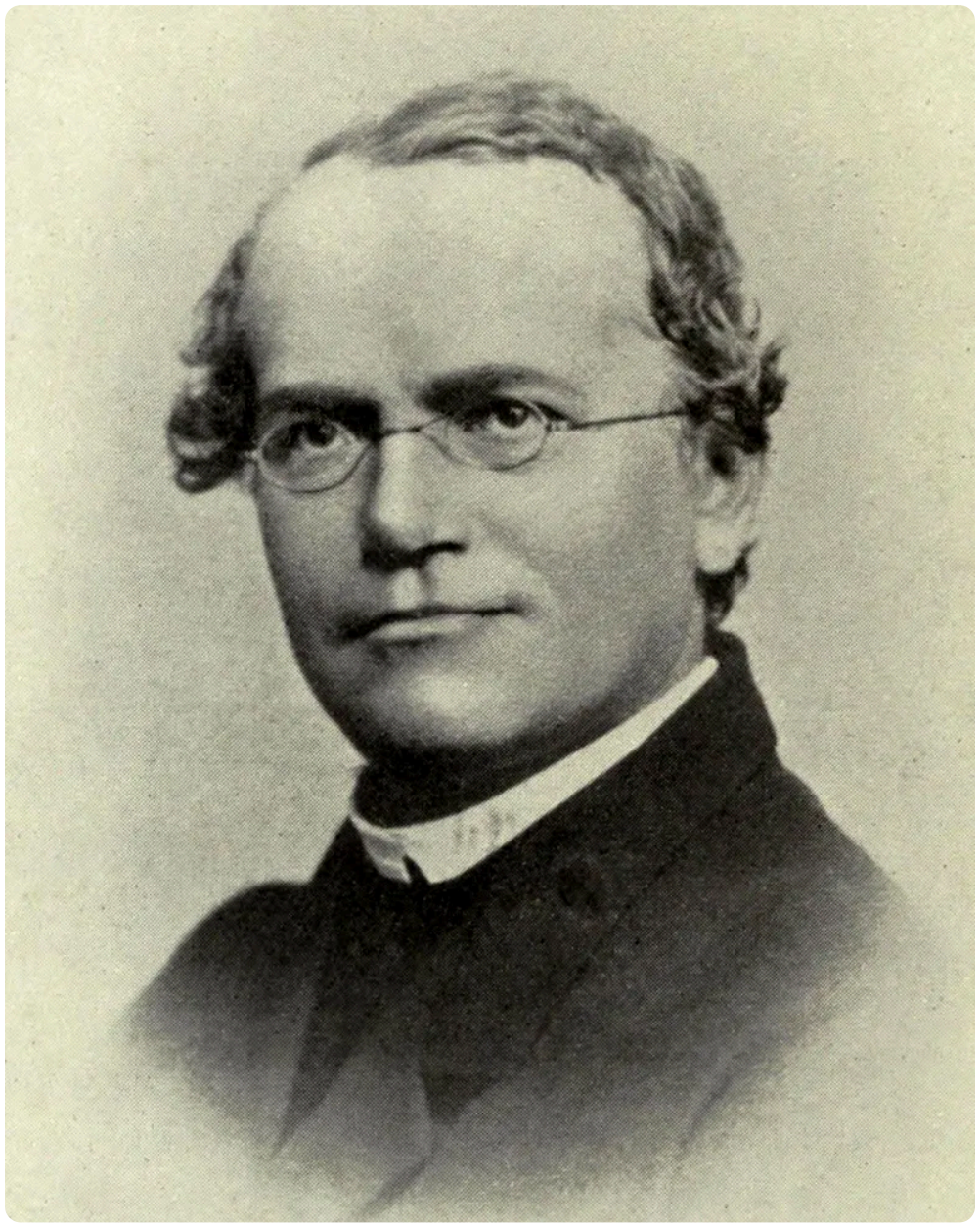
Dominant Trait

A trait that is expressed when at least one dominant allele is present

Recessive Trait

A trait that is only expressed when two recessive alleles are present

Gregor Mendel - The Father of Genetics



Biography

Born: 1822, Austria
Died: 1884
Occupation: Augustinian friar and scientist
Known for: Discovering the fundamental laws of inheritance

🌱 Pea Plant Experiments

Between 1856-1863, Mendel conducted systematic experiments on garden pea plants (Pisum sativum) in the monastery garden.

- Studied 7 distinct traits (height, seed shape, seed color, etc.)
- Analyzed over 28,000 pea plants
- Used mathematical analysis to identify patterns

🏅 Key Contributions

- Established the principles of heredity
- Introduced the concept of dominant and recessive traits
- Laid the foundation for modern genetics
- Published findings in 1866 (rediscovered in 1900)

Mendel's Pea Plant Experiments

Why Pea Plants?

- Easy to grow and maintain
- Short generation time
- Produce many offspring
- Distinct, observable traits
- Can self-pollinate or cross-pollinate

Experimental Method

- Selected pure-breeding plants
- Cross-pollinated different traits
- Observed F1 generation
- Self-pollinated F1 plants
- Recorded F2 generation ratios
- Analyzed patterns over multiple generations

Seven Traits Studied

Seed Shape
Round vs Wrinkled

Seed Color
Yellow vs Green

Pod Shape
Inflated vs Constricted

Pod Color
Green vs Yellow

Flower Color
Purple vs White

Flower Position
Axial vs Terminal

Stem Length
Tall vs Short

Mendel's Law of Segregation

The First Law

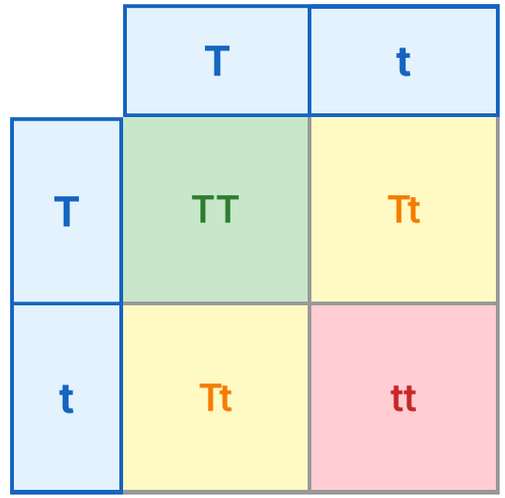
During gamete formation, the two alleles for each gene **segregate** (separate) from each other, so that each gamete receives only one allele.

Key Points:

- Each parent has two alleles for each trait
- Alleles separate during meiosis
- Each gamete carries only one allele
- Offspring inherit one allele from each parent

Punnett Square Example

Cross between two heterozygous parents (Tt × Tt)



Genotypic Ratio:

1 TT : 2 Tt : 1 tt

Phenotypic Ratio: **3 Tall : 1 Short**

Monohybrid Cross Example

Demonstrating the Law of Segregation

Cross Between:

Parent 1: Aa (Heterozygous)
Tall plant

Parent 2: Aa (Heterozygous)
Tall plant

Phenotypic Ratio:

3:1

3 Tall : 1 Short

Note: A = Dominant allele (Tall), a = Recessive allele (Short)

Punnett Square

	A	a
A	**AA** Tall Homozygous	**Aa** Tall Heterozygous
a	**Aa** Tall Heterozygous	**aa** Short Homozygous

Mendel's Law of Independent Assortment

The Second Law

During gamete formation, allele pairs for different traits segregate **independently** of each other. The inheritance of one trait does not affect the inheritance of another trait.

Key Points

- Applies to genes on **different chromosomes**
- Results in **9:3:3:1** phenotypic ratio in F2 generation
- Creates genetic **variation** through new combinations
- Demonstrated through **dihybrid crosses**

Dihybrid Cross Example (RrYy × RrYy)

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

9	3	3	1
Round Yellow	Round Green	Wrinkled Yellow	Wrinkled Green