

Principles of Inheritance

A Foundational Architecture of Mendelian Genetics

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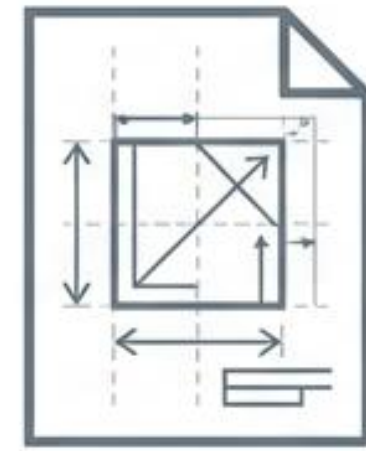
A structural review of the
mechanisms governing sexually
reproducing eukaryotic organisms.

The Experiment (Mendel)



Mendel conducted breeding experiments on *Pisum sativum*, concluding the foundational principles of inheritance, though he did not formally postulate them as laws.

The Formalization (Correns)



Later studies in Mendelian genetics by Correns transformed Mendel's experimental work into the formal framework known today as the Three Laws of Heredity.

Key Concepts in Mendelian Genetics

Alleles / Factors

Distinct units that control specific characters. In diploid organisms, these always occur in pairs.

Genotype vs. Phenotype

Genotype: The internal genetic pairing (e.g., TT, Tt).
Phenotype: The physical expression of that pairing (e.g., Tall).

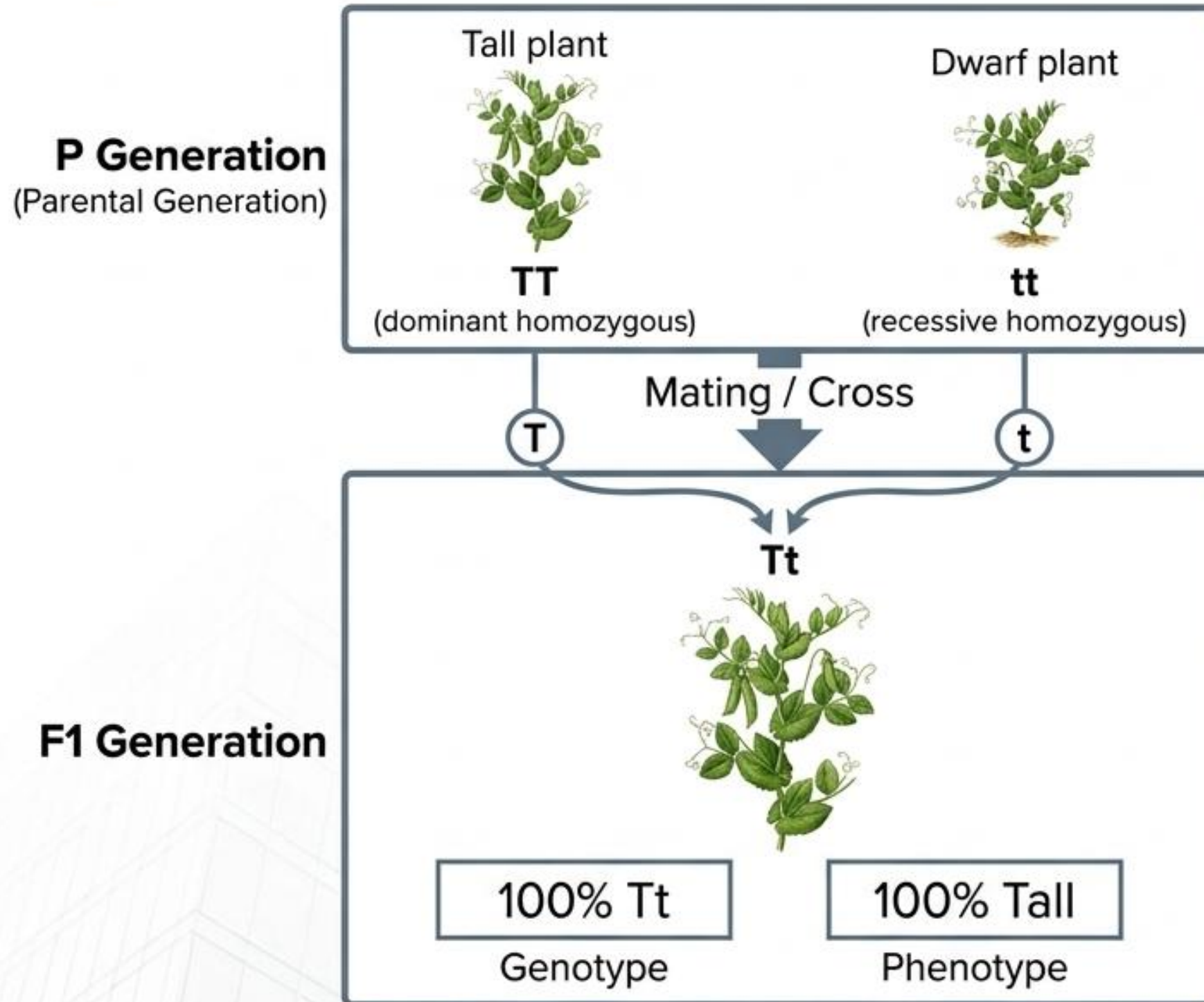
Homozygous

Pure pairings where both alleles are identical (e.g., TT or tt).

Heterozygous

Hybrid pairings containing two different alleles for a trait (e.g., Tt).

Single-Trait Cross: P and F1 Generations



The Dominance Mask



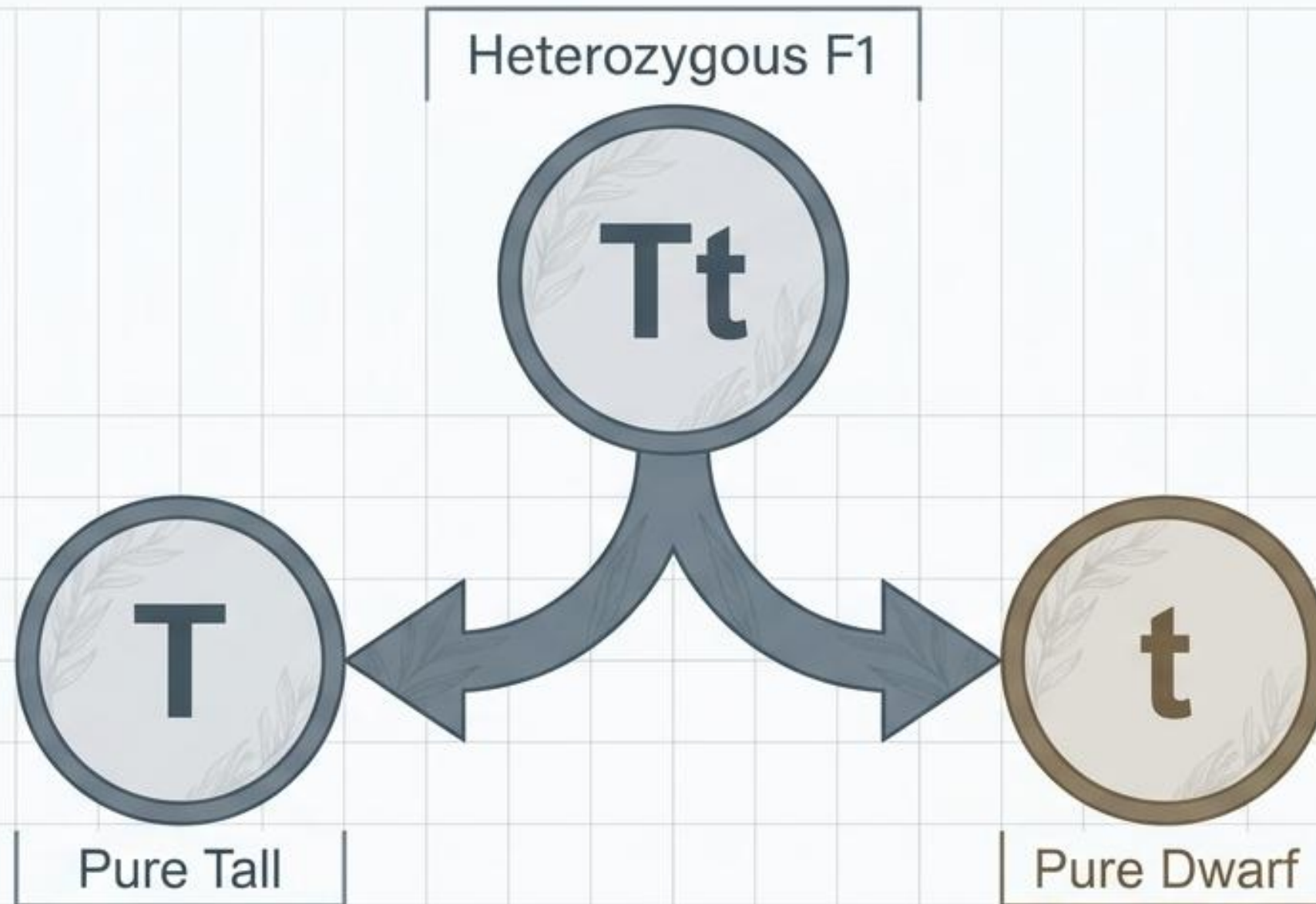
Law #1: Dominance

Core Rule:

When parents with pure, contrasting traits are crossed, offspring will exhibit only one form of the trait in the F1 generation.

Mechanism:

In a heterozygous pair (Tt), one factor always dominates the other. The expressed trait is dominant; the suppressed trait is recessive (masked).

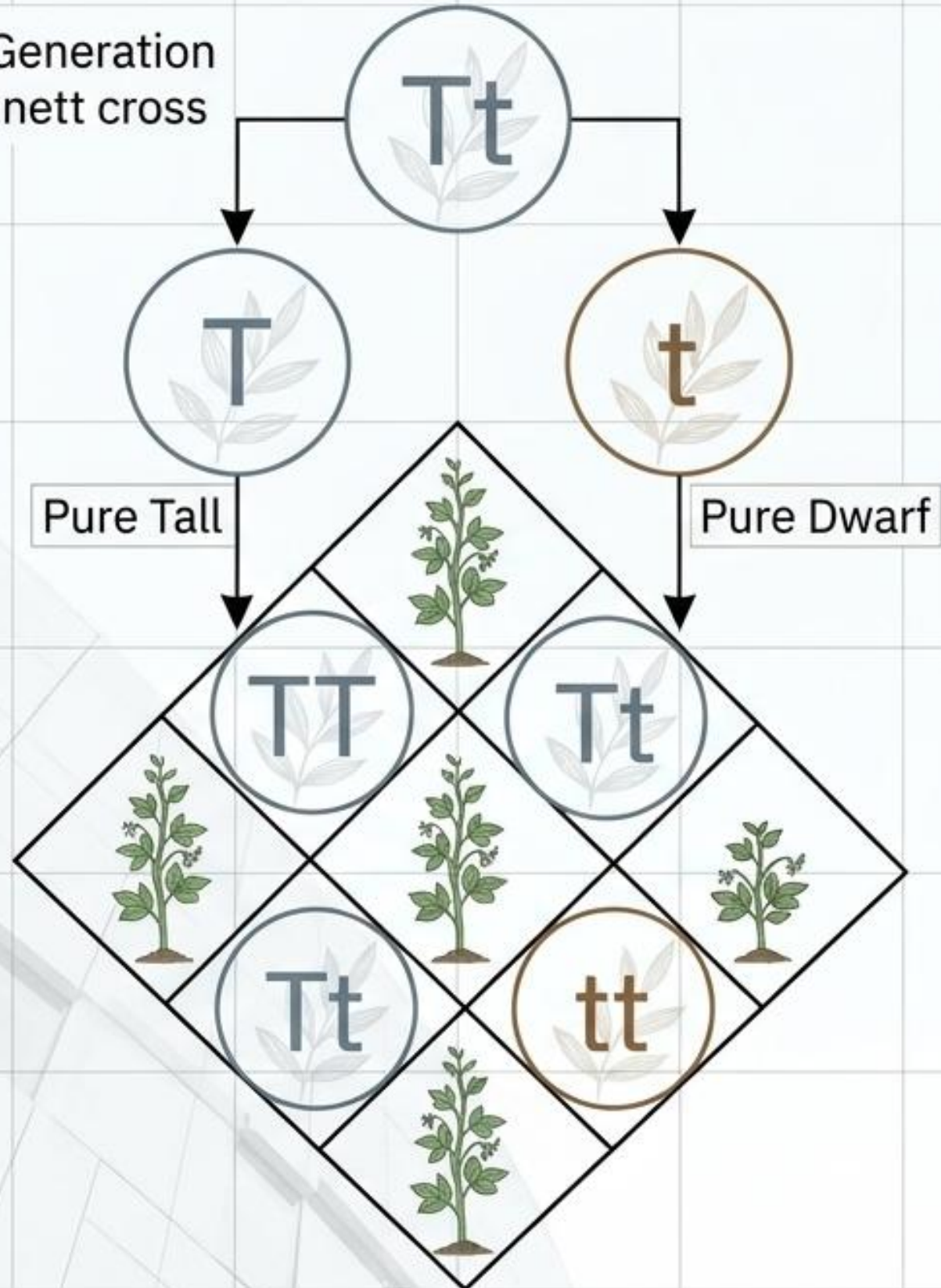


Law #2: Segregation (Purity of Gametes)

Core Rule: A pair of alleles remains together in an unchanged form in the F1 hybrid, but strictly **separates** at the time of gamete formation.

Mechanism: Each gamete receives only **one allele** (either **T** or **t**). Gametes are therefore pure for a specific character.

F2 Generation
Punnett cross



3 : 1

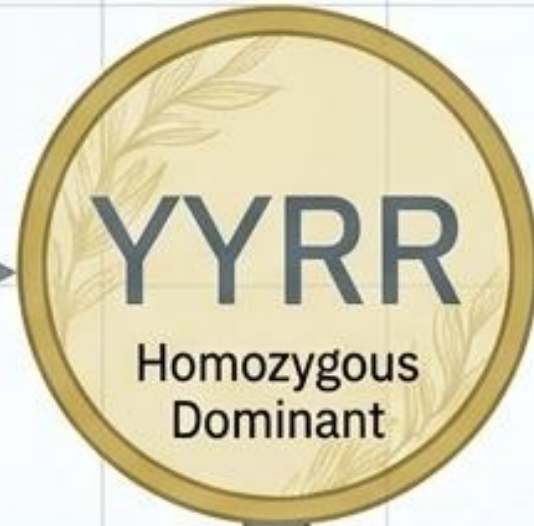
(Phenotypic Ratio)

1 : 2 : 1

(Genotypic Ratio: 1 TT : 2 Tt : 1 tt)

Random mixing of pure gametes reveals the hidden recessive trait in exactly 25% of the F2 generation.

P Generation:
Homozygous Dominant
(Yellow/Round) crossed
with ozygous Recessive
(Green/Wrinkled).



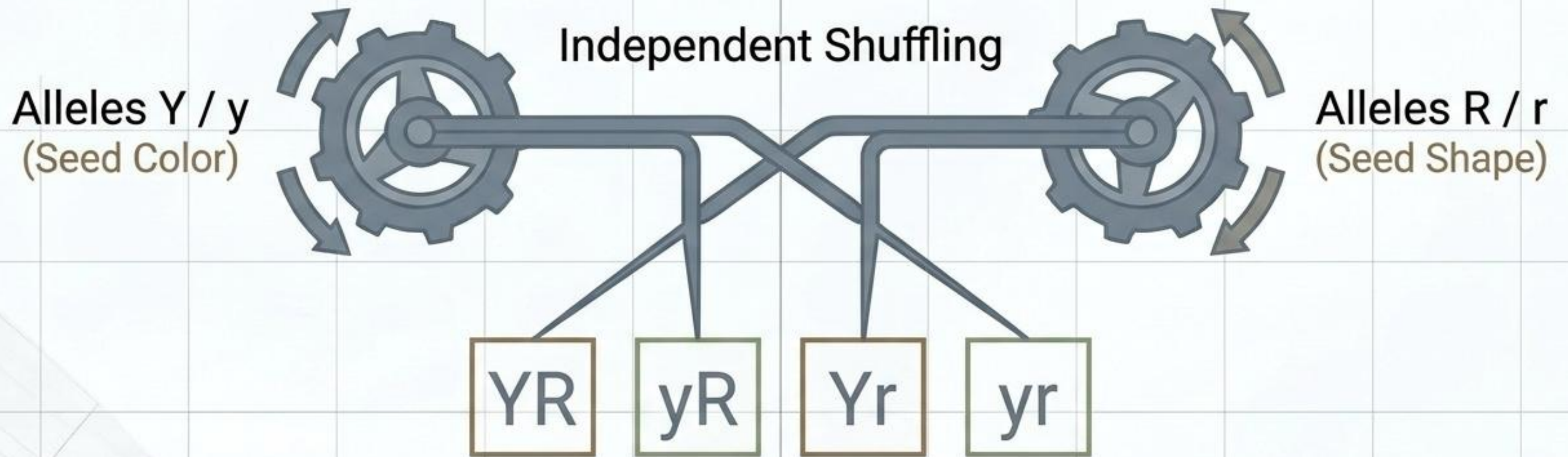
Homozygous
Recessive



Heterozygous F1

F1 Generation:
Yields 100% YyRr
(Heterozygous Hybrid).
Only the Yellow/Round
phenotype is expressed,
confirming the Law of
Dominance applies at scale.

Gamete Complexity: Unlike the monohybrid, this YyRr parent will
produce four distinct gamete combinations: YR, yR, Yr, yr.



Law #3: Independent Assortment

Core Rule: When two homozygous individuals differing in two or more pairs of contrasting characters are crossed, each character inherits independently in the F2 generation.

Mechanism: Seed color (Yellow/Green) does not dictate seed shape (Round/Wrinkled). The dominant and recessive alleles shuffle freely.

F2 Generation

	YR	yR	Yr	yr
YR	 YYRR	 YyRR	 YYRr	 YyRr
yR	 YyRR	 yyRR	 YyRr	 yyRr
Yr	 YYRr	 YyRr	 YYrr	 Yyrr
yr	 YyRr	 yyRr	 Yyrr	 yyrr

9

Yellow & Round
(YYRR, YyRR, YYRr, YyRr)

3

Yellow & Wrinkled
(YYrr, Yyrr)

3

Green & Round
(yyRR, yyRr)

1

Green & Wrinkled
(yyrr)

Diagnostic: Cross Frameworks

Monohybrid Cross	Dihybrid Cross
■ Focus: Single trait (e.g., Height) ■ F1 Gamete Types: 2 (T, t) ■ F2 Outcomes: 4 total squares ■ Phenotypic Ratio: 3:1	■ Focus: Two traits (e.g., Color + Shape) ■ F1 Gamete Types: 4 (YR, yR, Yr, yr) ■ F2 Outcomes: 16 total squares ■ Phenotypic Ratio: 9:3:3:1

Scaling up traits geometrically expands genotypic combinations, but the underlying mechanisms of dominance and segregation remain identical.

Synthesis: The Architecture of Mendelian Inheritance

Law	Alternate Name	Experimental Basis	Core Mechanism	Signature Ratio
Dominance	1st Law	Monohybrid	One allele completely masks the recessive counterpart in a heterozygote.	3:1 (F2)
Segregation	Purity of Gametes	Monohybrid	Alleles remain unblended in F1 and separate strictly into individual haploid gametes.	3:1 (F2)
Independent Assortment	2nd Law (Mendel)	Dihybrid	Multiple differing characters are inherited independently of one another.	9:3:3:1 (F2)