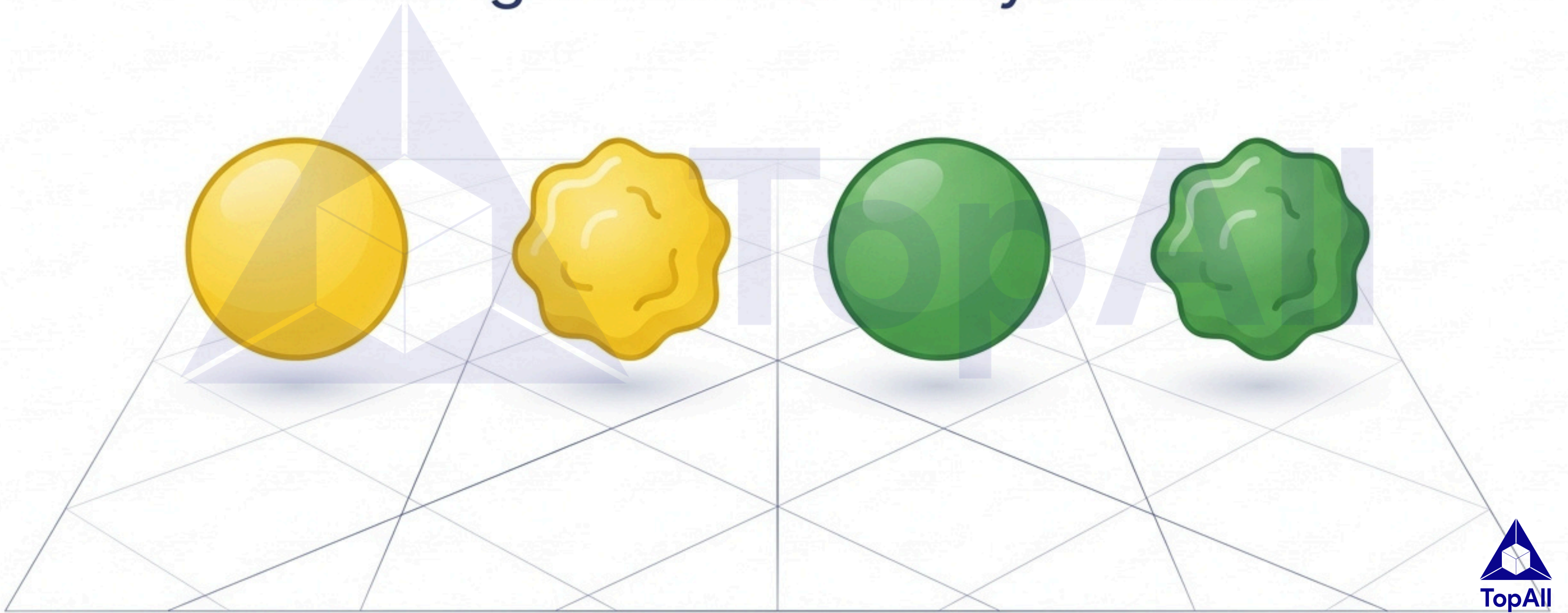


Law of Independent Assortment

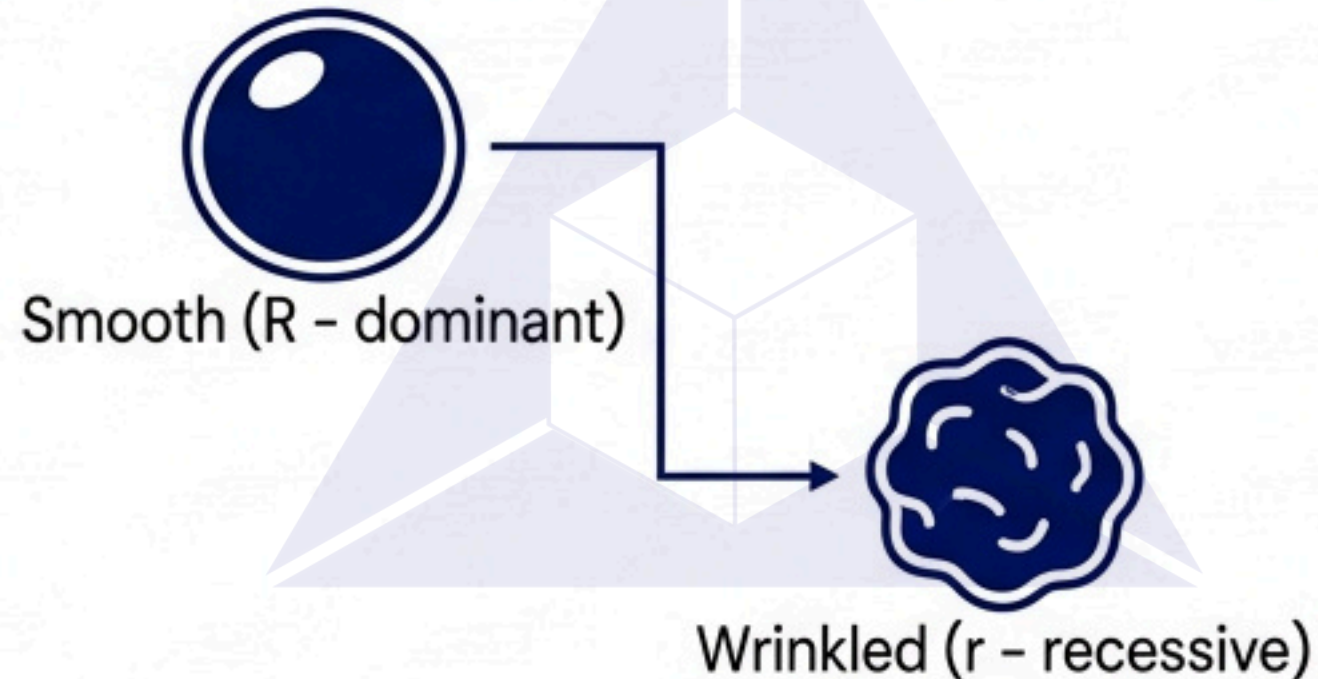
Decoding the 9:3:3:1 Dihybrid Ratio



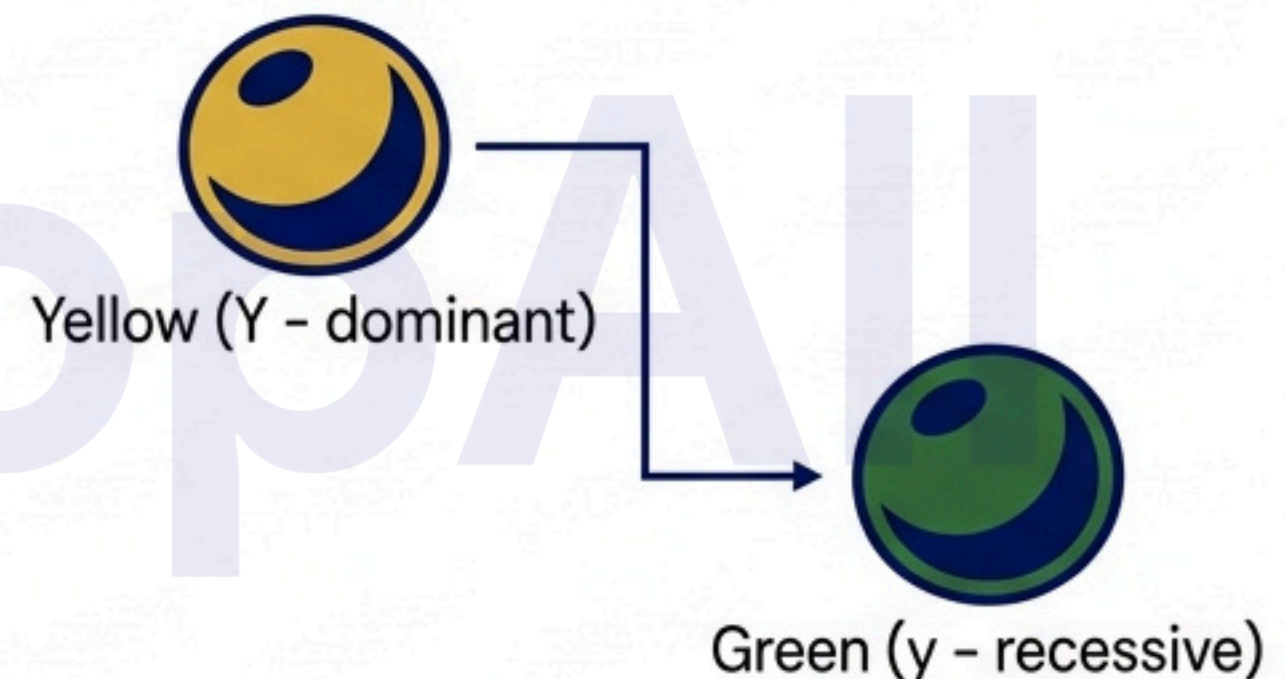
Tracking Two Traits Simultaneously

After establishing the monohybrid cross, Mendel escalated his experiments to track two pairs of contrasting traits at the same time: seed shape and seed color.

Trait 1: Seed Shape



Trait 2: Seed Color



Parental Cross: True-breeding Round Yellow (RRYY) × True-breeding Wrinkled Green (rryy)



F1 Hybrid: Round Yellow (RrYy)

The Linked Traits Misconception

Common Error

Assuming that because Round (R) and Yellow (Y) came from the same parent, they are permanently glued together and must be inherited as a single package.



If dominant traits always stuck together, genetic variation would be severely limited.

The Law of Independent Assortment

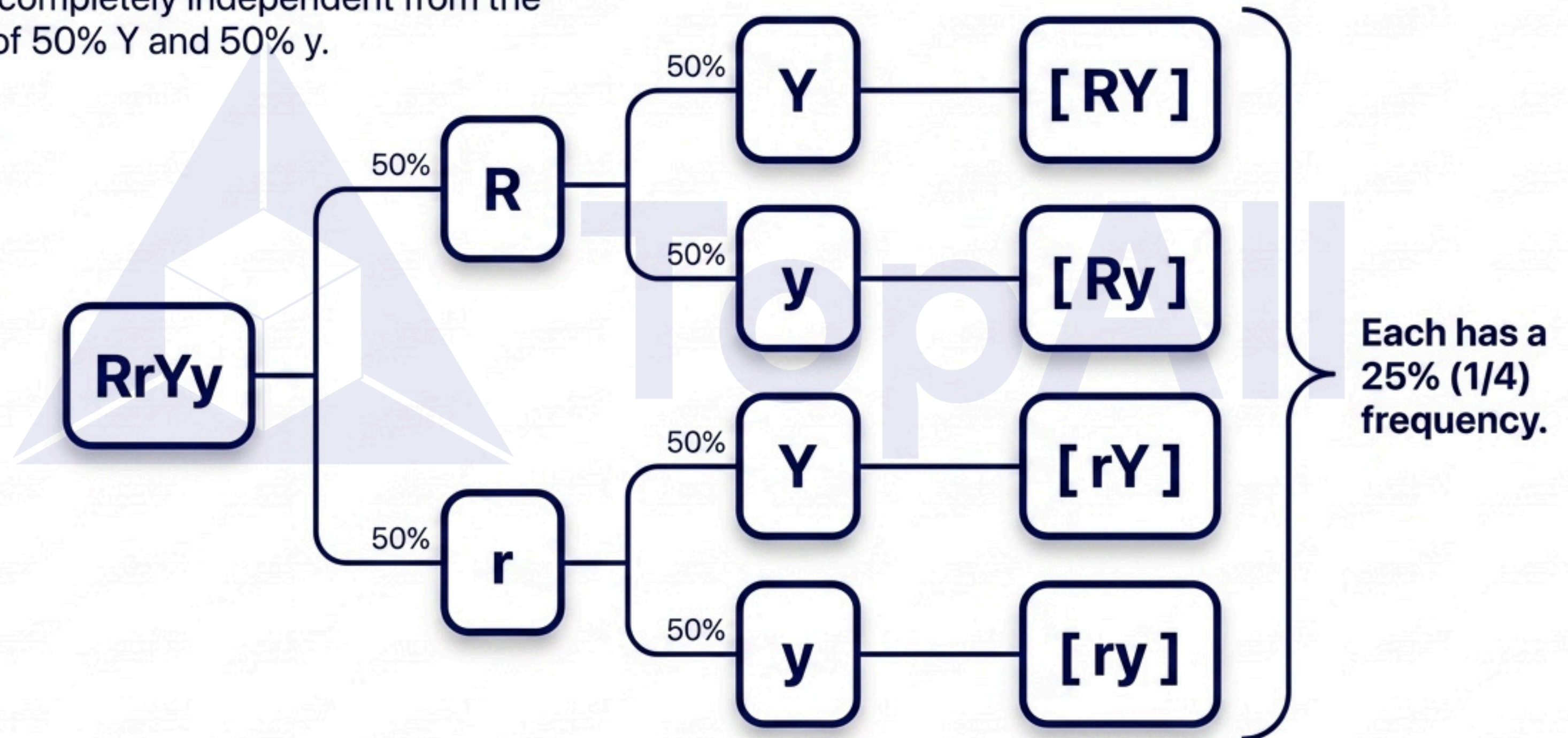


When two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent of the other pair of characters.



Gamete Formation in a Dihybrid

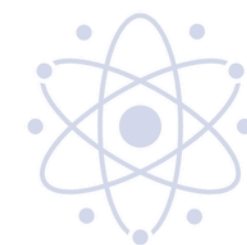
In an F1 hybrid ($RrYy$), the segregation of 50% R and 50% r is completely independent from the segregation of 50% Y and 50% y .





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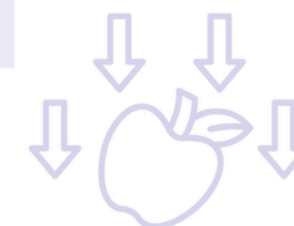
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Key Highlights

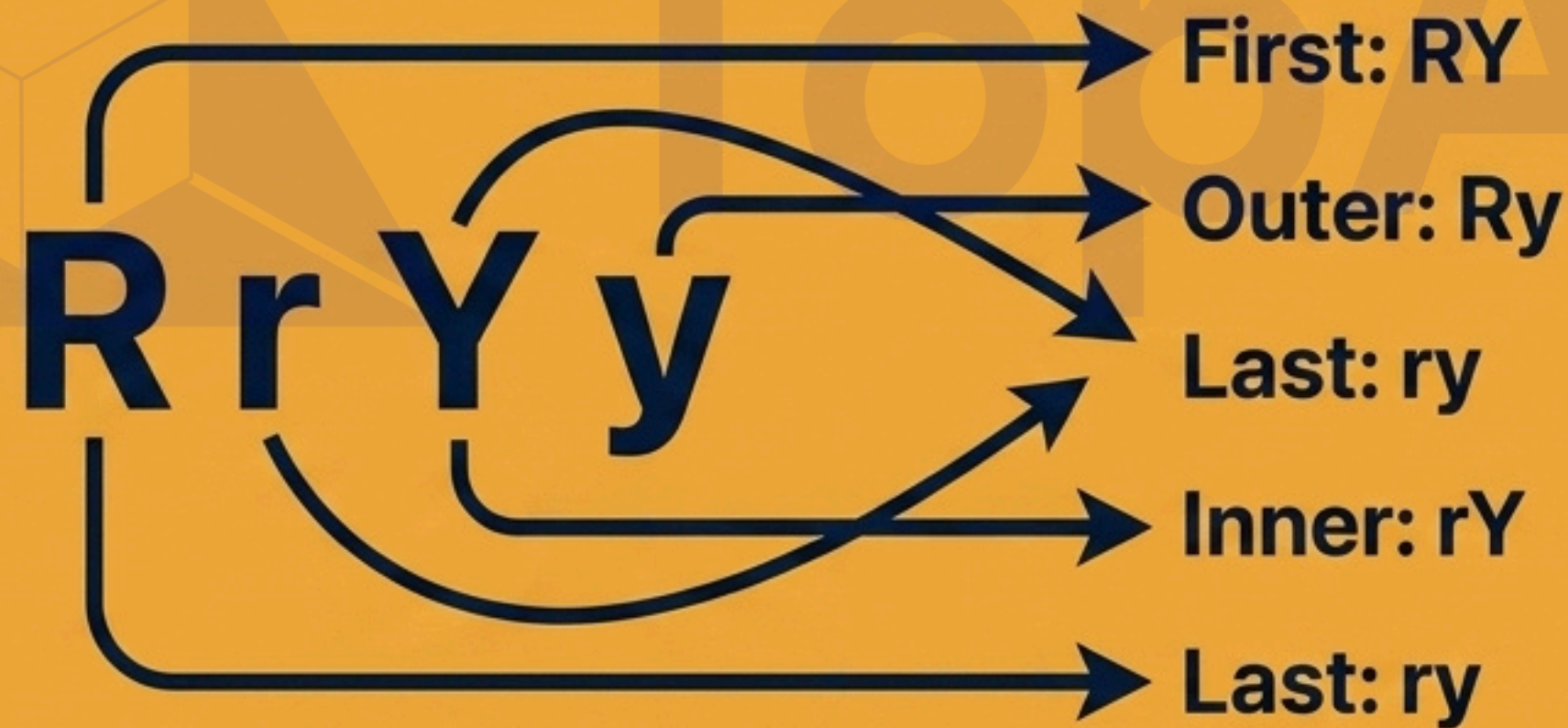
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Finding Gamete Combinations

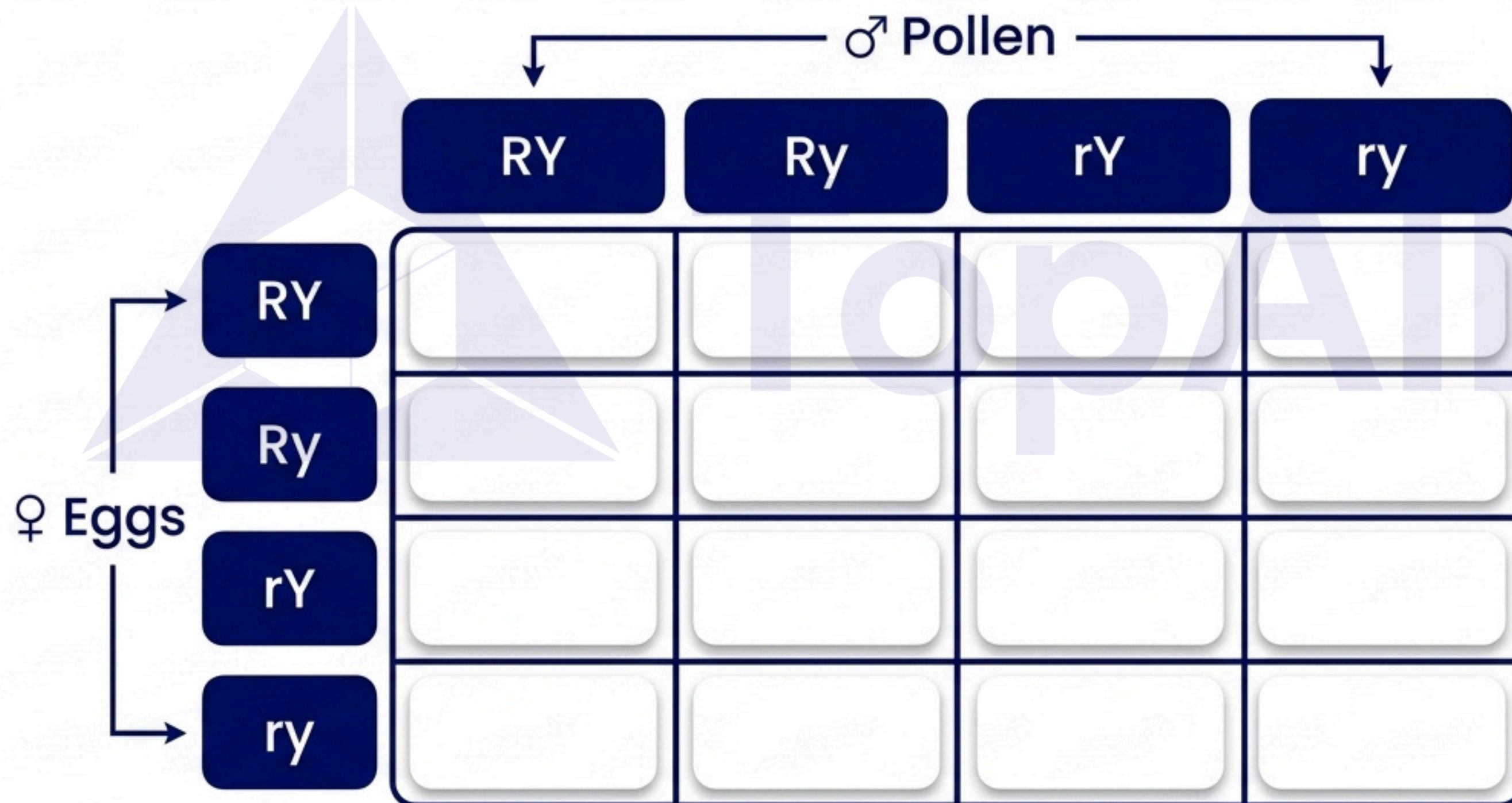
The FOIL Method

To easily find the four possible gametes from a dihybrid genotype (RrYy), use the FOIL method: First, Outer, Inner, Last.



Building the Combinatorics Grid

To predict the F₂ generation, we place the four possible egg gametes on one axis and the four possible pollen gametes on the other, creating a 16-box probability matrix.



The F2 Generation Punnett Square

		♂ Pollen			
		RY	Ry	rY	ry
♀ Eggs	RY	 RRYY	 RRYy	 RrYY	 RrYy
	Ry	 RRYy	 RRyy	 RrYy	 Rryy
	rY	 RrYY	 RrYy	 rrYY	 rrYy
	ry	 RrYy	 Rryy	 rrYy	 rryy

Extracting the Phenotypic Ratio

Grouping the 16 possibilities reveals a highly specific, repeatable mathematical ratio in the F2 generation.

9/16



Round Yellow

3/16



Wrinkled Yellow

3/16



Round Green

1/16



Wrinkled Green

9 : 3 : 3 : 1

The Proof is in the Recombinants

If traits were permanently linked, we would only see the original parental forms. The appearance of "new combinations" is the physical proof that genes sort independently.

Parental Phenotypes



Round Yellow (9)



Wrinkled Green (1)

New Combinations



Wrinkled Yellow (3)



Round Green (3)

The Mathematical Proof

The 9:3:3:1 ratio isn't random. It is exactly what happens when you multiply the probabilities of two independent 3:1 monohybrid crosses together.

(3 Round : 1 Wrinkled) × (3 Yellow : 1 Green)

**= 9 Round Yellow : 3 Wrinkled Yellow :
3 Round Green : 1 Wrinkled Green**

Summary

Key Takeaway

Allele pairs assort independently.

- F1 hybrids form 4 distinct gametes in equal 25% proportions (RY, Ry, rY, ry).
- A dihybrid cross creates a 16-box probability matrix.
- Independent segregation results in a 9:3:3:1 phenotypic ratio and introduces new, recombinant trait combinations.



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