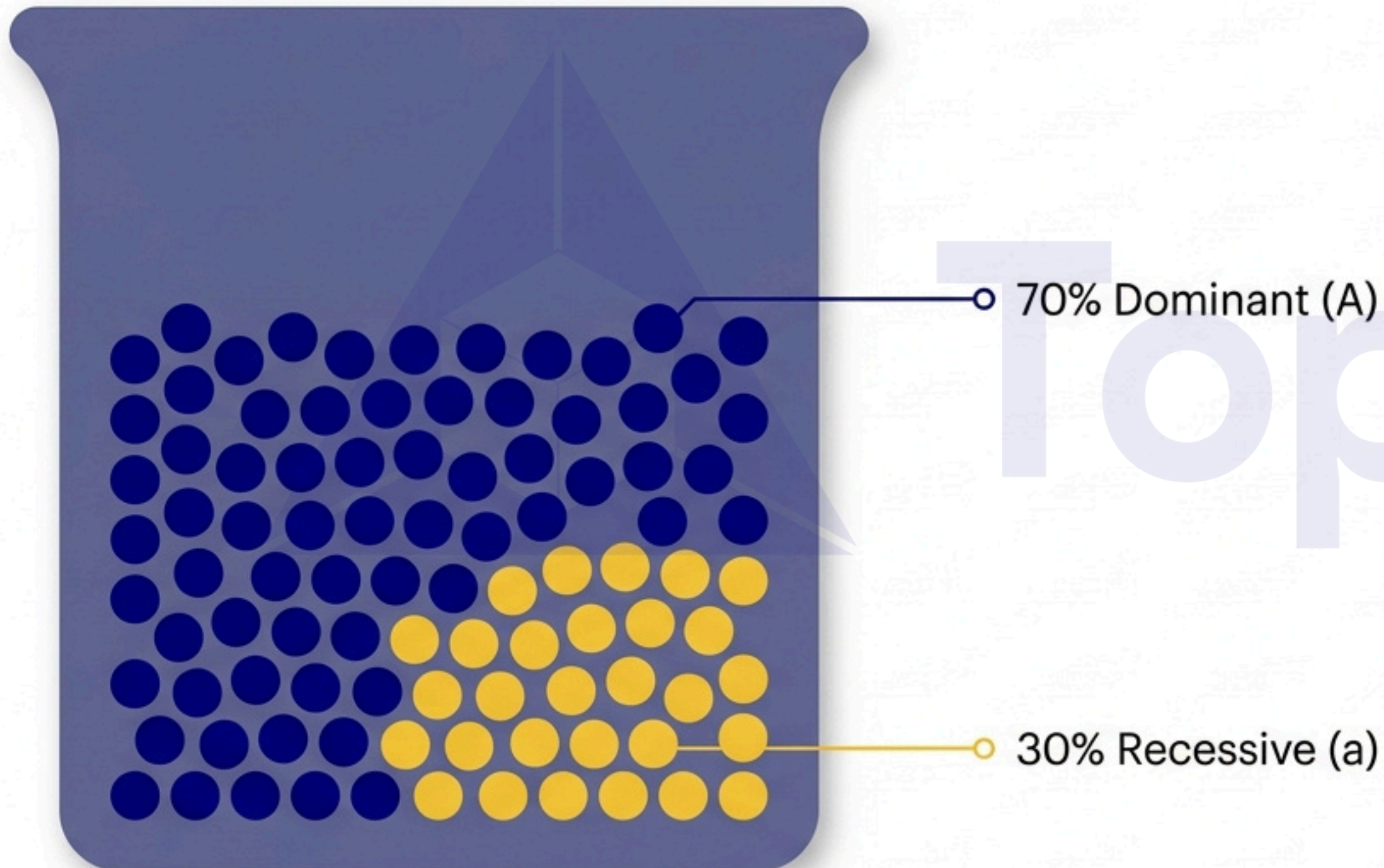


The Hardy-Weinberg Principle

The Mathematical Baseline of Evolution

The Ingredients of a Population



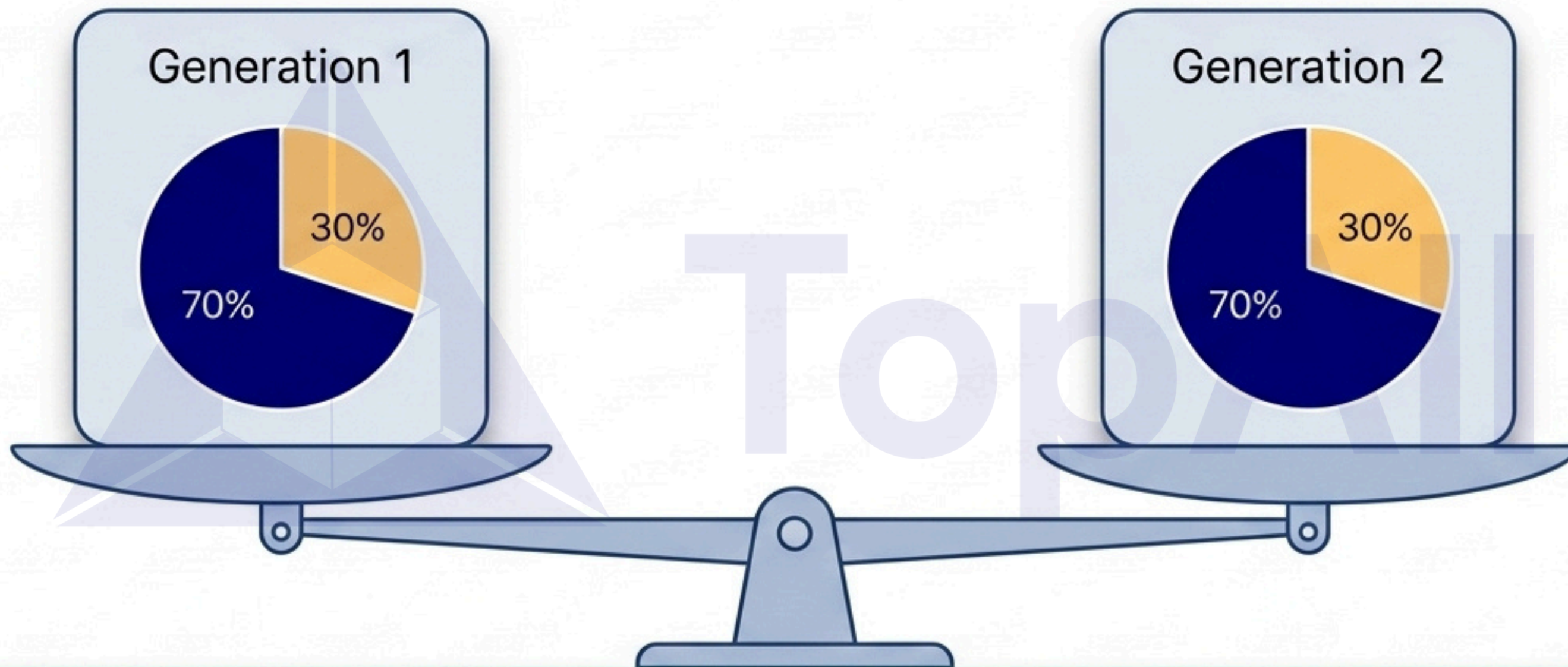
Gene Pool

The sum total of all genes and their alleles in a given population.

Allele Frequency

The proportion of a specific allele out of the total gene pool. This frequency is supposed to remain fixed across generations.

Genetic Equilibrium



The Core Rule: In a stable population, the gene pool remains constant from generation to generation. The sum total of all allelic frequencies is exactly 1.



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$$E=mc^2$$



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Assigning the Variables in a Diploid

p



p = Frequency of the dominant allele (A)

q



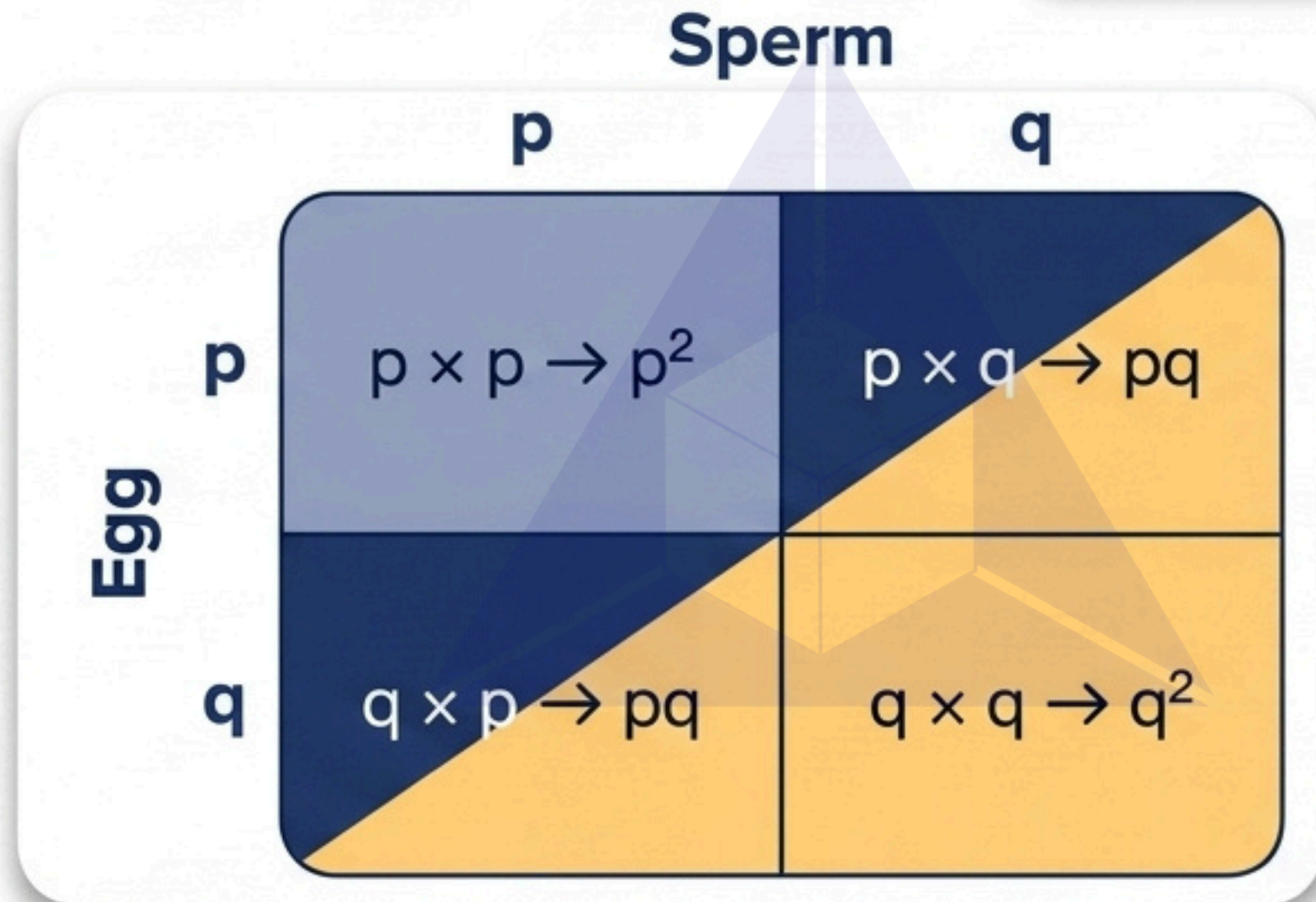
q = Frequency of the recessive allele (a)

$$p + q = 1$$

(Because the sum of all allele frequencies must equal 100%)

Expanding Alleles into Individuals

$$p^2 + 2pq + q^2 = 1$$



- p^2 = Frequency of Homozygous Dominant (AA)
- $2pq$ = Frequency of Heterozygous (Aa)
- q^2 = Frequency of Homozygous Recessive (aa)

Soft Amber Quick-Tip

The biological distribution is simply the binomial expansion of $(p+q)^2$. The probabilities multiply.

The Reality Check

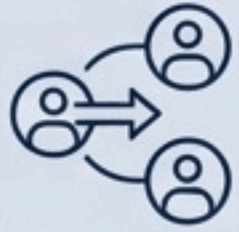
Expected Hardy-Weinberg Values

Disturbance in Equilibrium

When measured frequencies differ from the expected calculated values, the difference indicates the extent of evolutionary change. A failure of the equation is evolution in action.

Measured Real-World Values

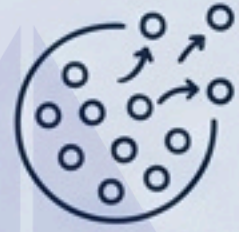
The 5 Disruptors of Equilibrium



Gene Flow

Migration adds new alleles or removes old ones.

Repeated migration causes constant gene flow.



Genetic Drift

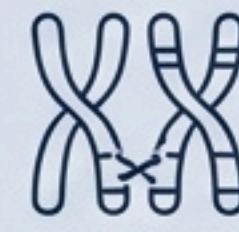
Random chance fluctuations.

If severe enough, a drifted population becomes founders of a new species (Founder Effect).



Mutation

Pre-existing advantageous mutations are selected, altering the baseline phenotypes.



Genetic Recombination

Variations arising during gametogenesis shuffle the genetic deck.



Natural Selection

Differential survival. Can lead to stabilisation, directional change, or disruption.



The Hardy-Weinberg Principle is the null hypothesis of biology.

If allele frequencies stay exactly the same, evolution is not happening. If they change, the population is evolving.



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