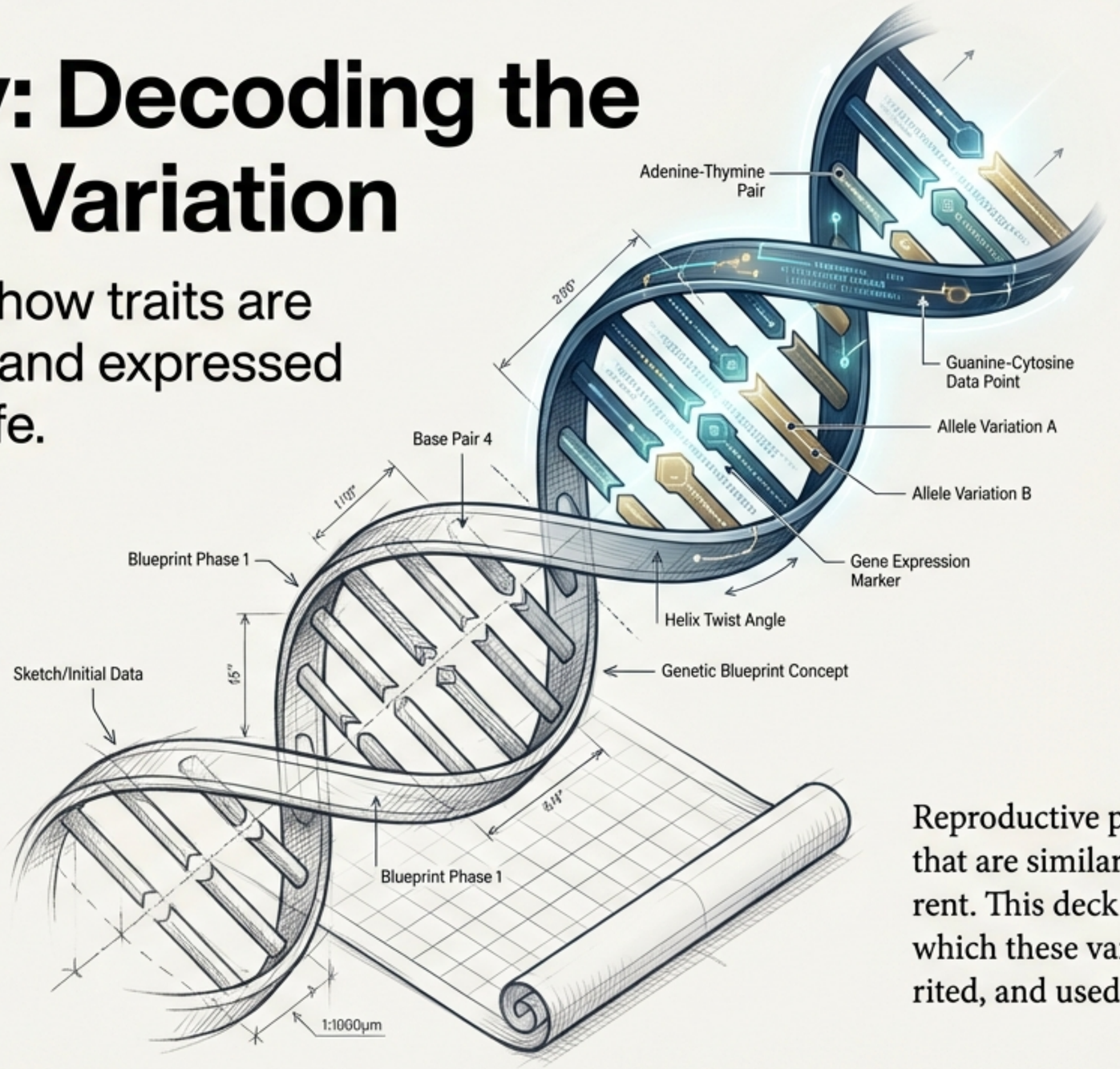
Heredity: Decoding the Rules of Variation

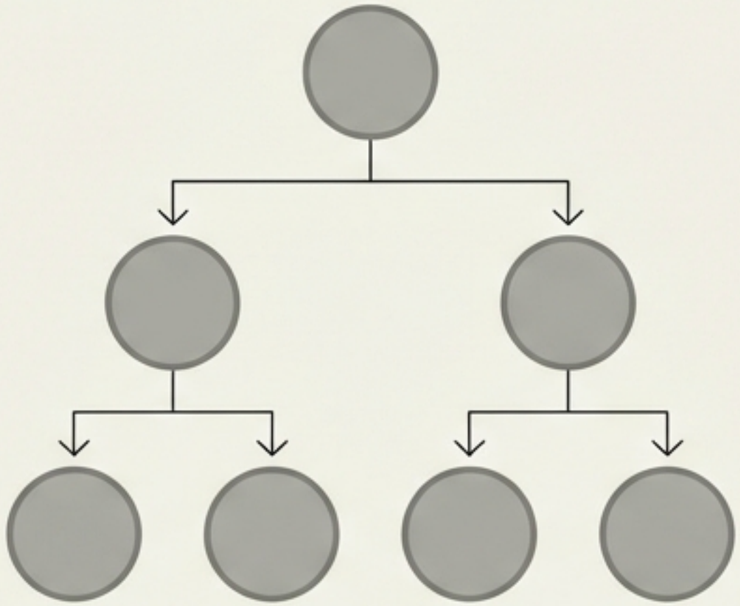
Understanding how traits are passed, mixed, and expressed in the code of life.



Reproductive processes create individuals that are similar in design but subtly different. This deck explores the mechanism by which these variations are created, inherited, and used for survival.

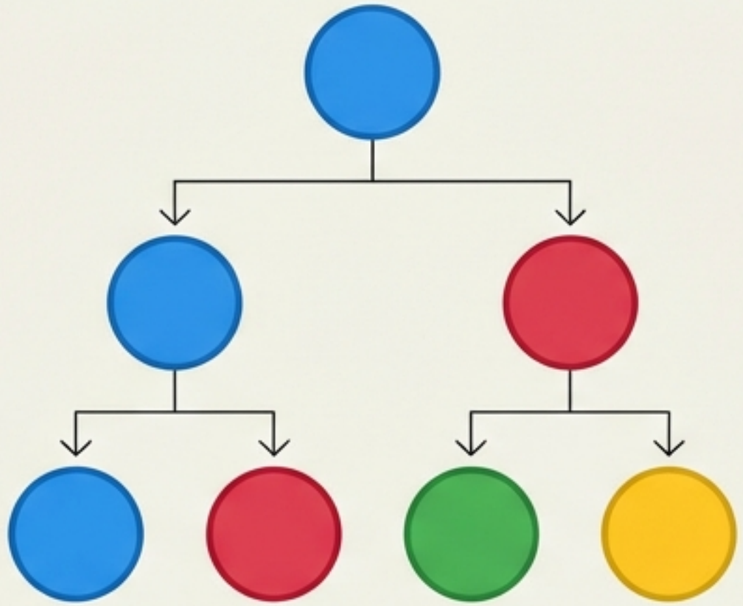
Variation is the engine of survival.

Asexual Reproduction: The Clone



In organisms like bacteria, reproduction is largely copying. Differences arise only from small inaccuracies in DNA copying. The result is a population of near-clones.

Sexual Reproduction: The Remix



In humans and animals, offspring inherit a mixed blueprint. This maximizes diversity. If a population encounters a threat (like a heat wave), these variations ensure that at least some resistant individuals survive to repopulate.

We inherit a body design, but the details are negotiable

Variant A:
Free Earlobe

Variant B:
Attached Earlobe

Human populations show great variation despite sharing a basic body plan. A classic example is the earlobe. Whether an earlobe hangs free or is attached to the head is a trait directly correlated to one's parents. This observation suggests a rigid set of rules governs how even the smallest physical features are handed down.

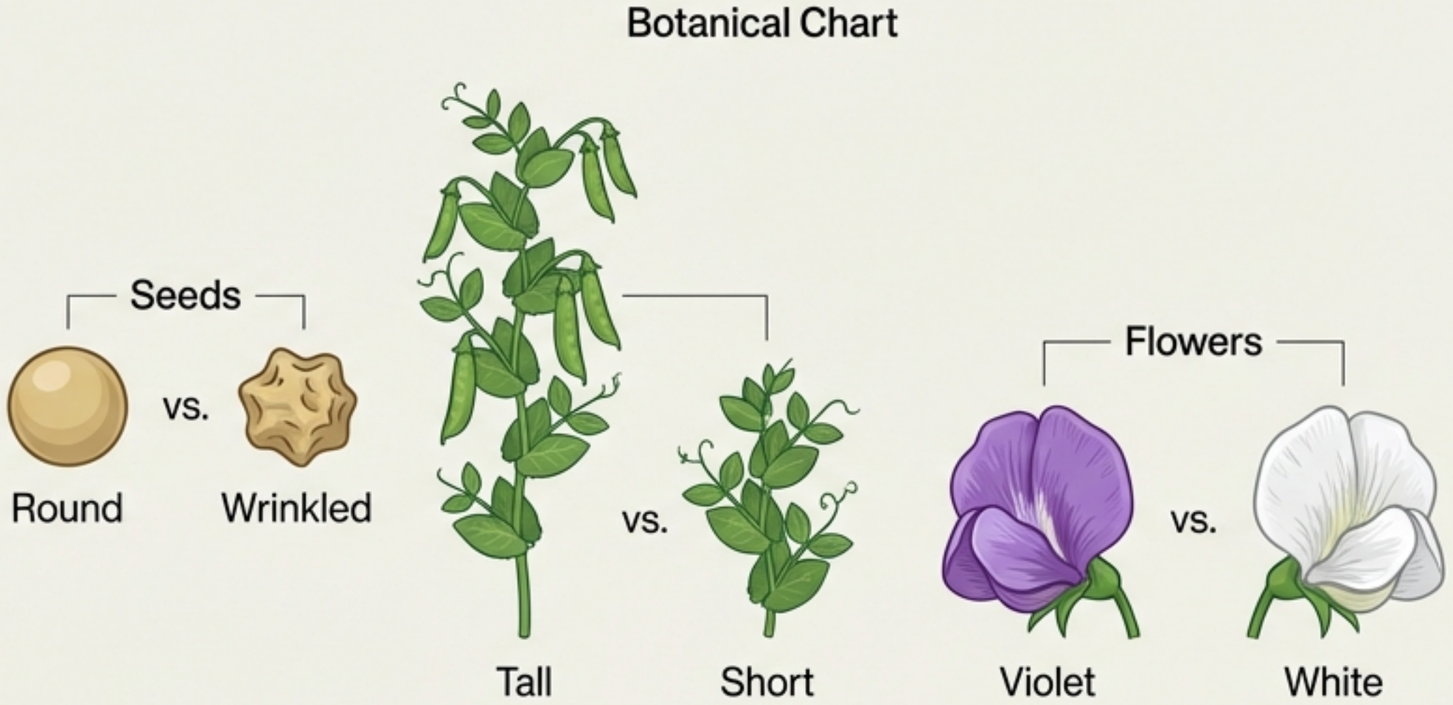
Gregor Mendel used mathematics to solve biology

The Person

Gregor Johann Mendel (1822–1884)

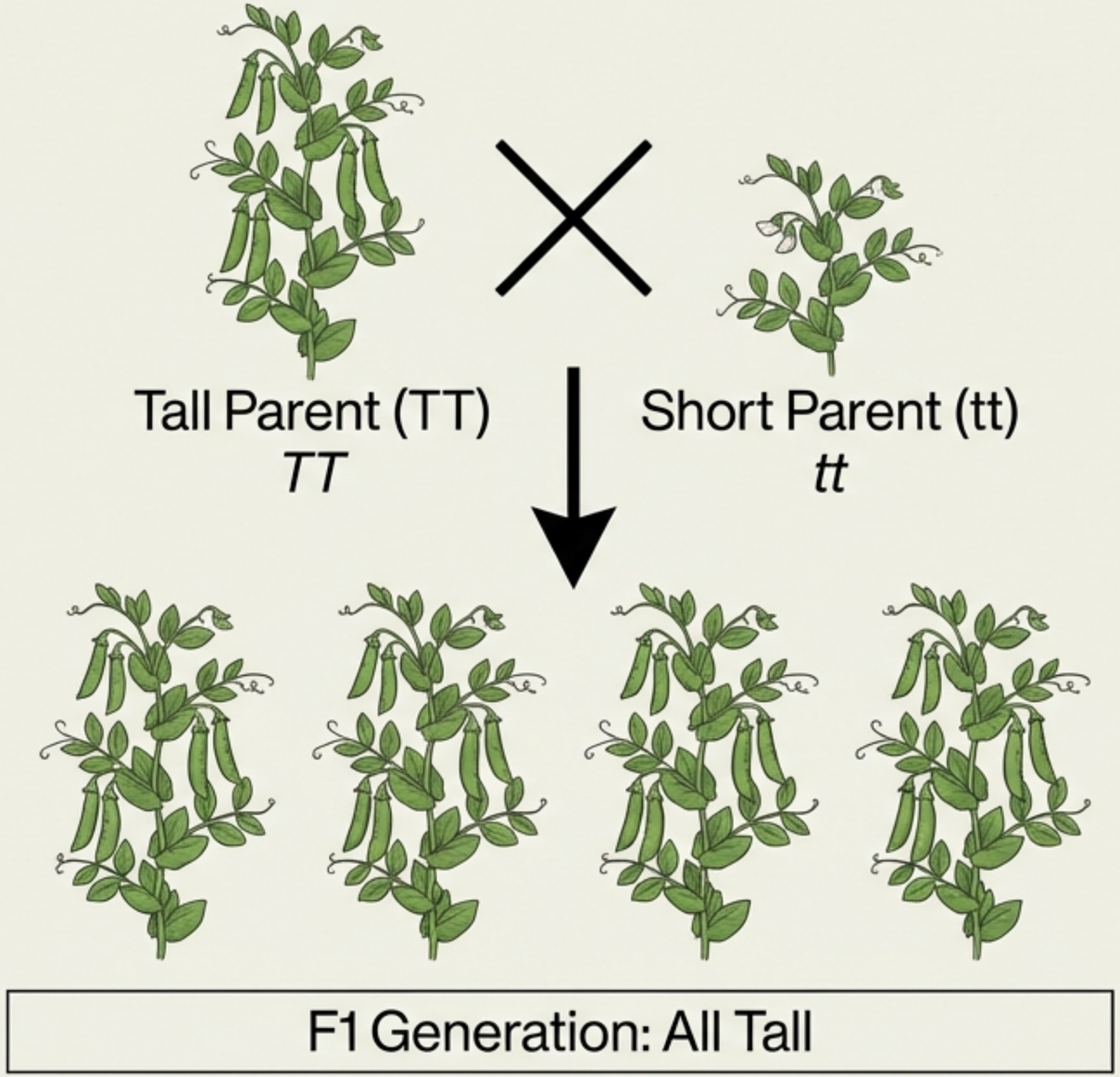
Educated in a monastery and the University of Vienna, Mendel was the first to blend science and math—keeping a strict statistical count of individuals exhibiting specific traits.

The Experiment



The Experimental Setup: Mendel chose garden peas for their clearly contrasting characters. His goal was to cross them and calculate the specific probability of the resulting traits.

Rule #1: Traits do not blend; one dominates the other

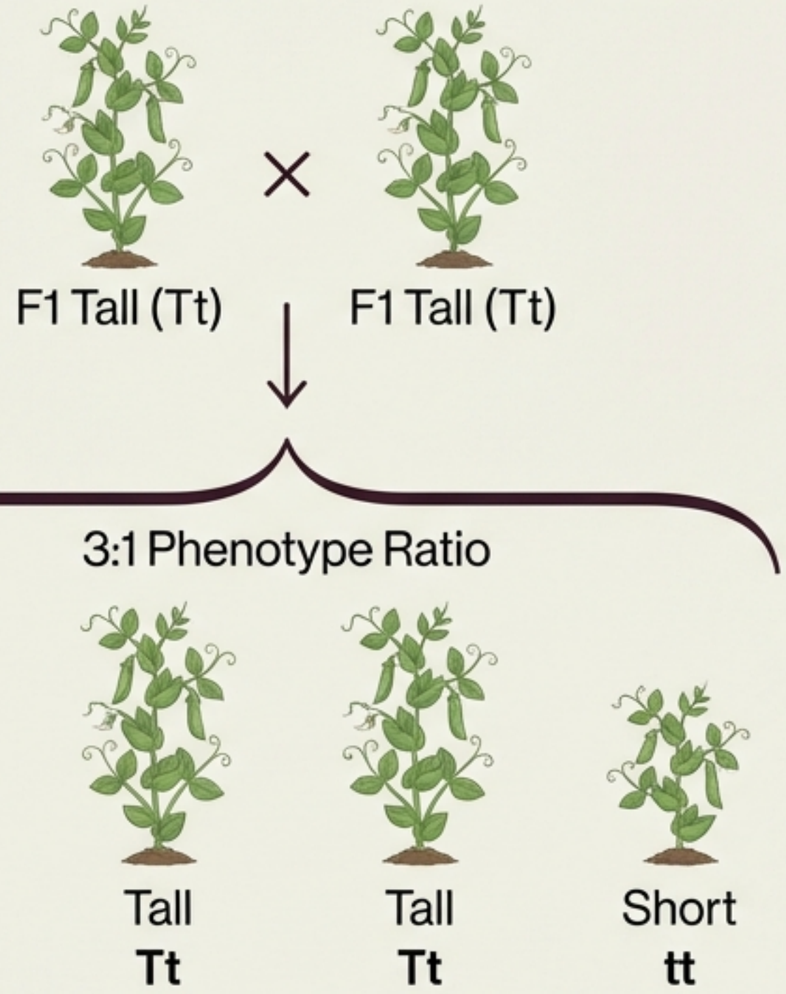


Mendel crossed a pure Tall plant with a pure Short plant.

The Result: No “medium-height” plants. All offspring were Tall.

The Insight: The “shortness” trait appeared to have vanished entirely. Only one parental trait was expressed.

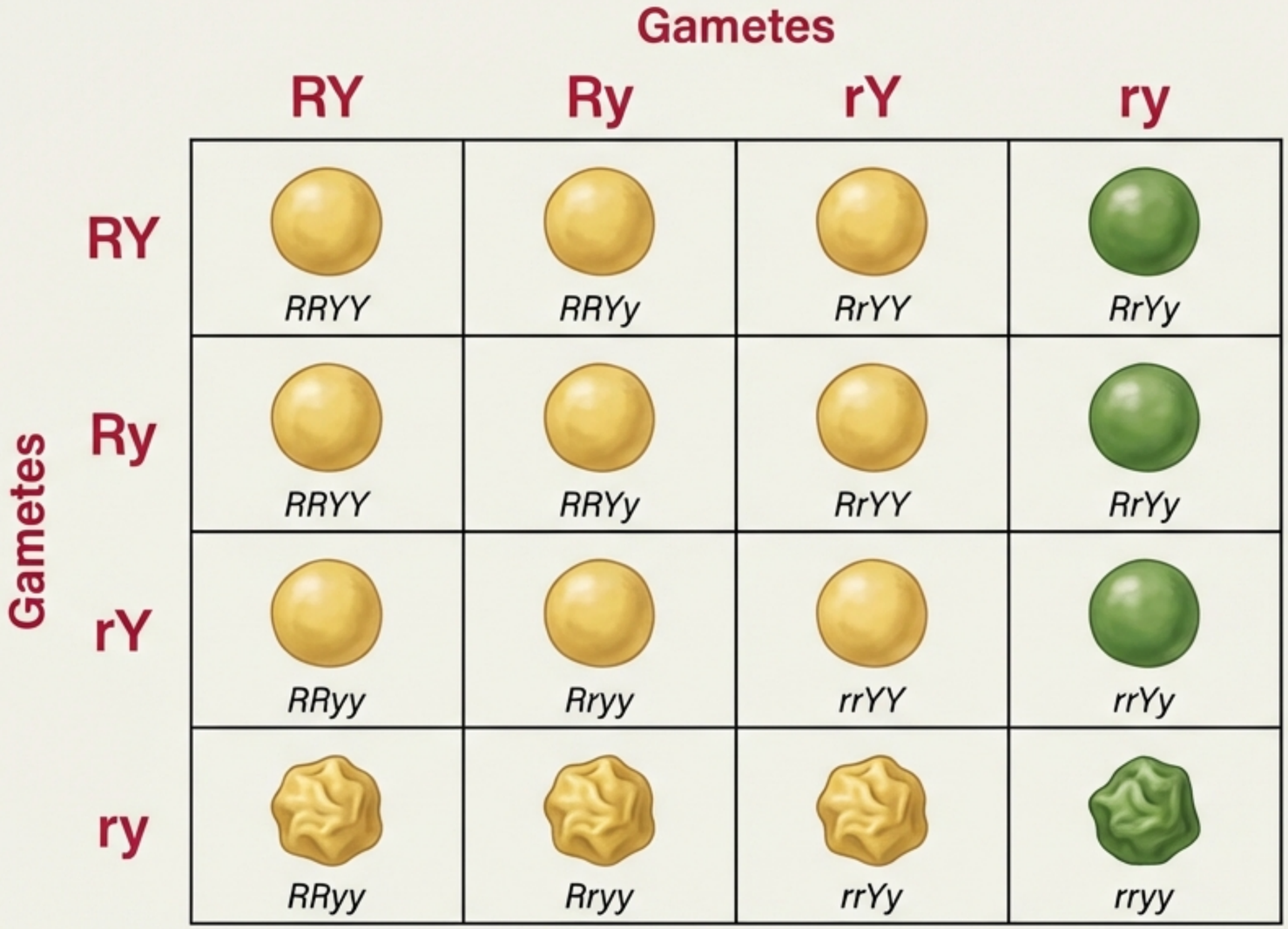
Rule #2: Hidden traits can resurface in the next generation



Mendel self-pollinated the F1 plants.
The Result: 75% were Tall, but 25% were Short.
The Conclusion: The F1 plants carried both traits, but Shortness was hidden.

definitions:
Dominant (T): A single copy makes the plant tall.
Recessive (t): Both copies must be ‘t’ for the plant to be short.

Rule #3: Different traits are inherited independently

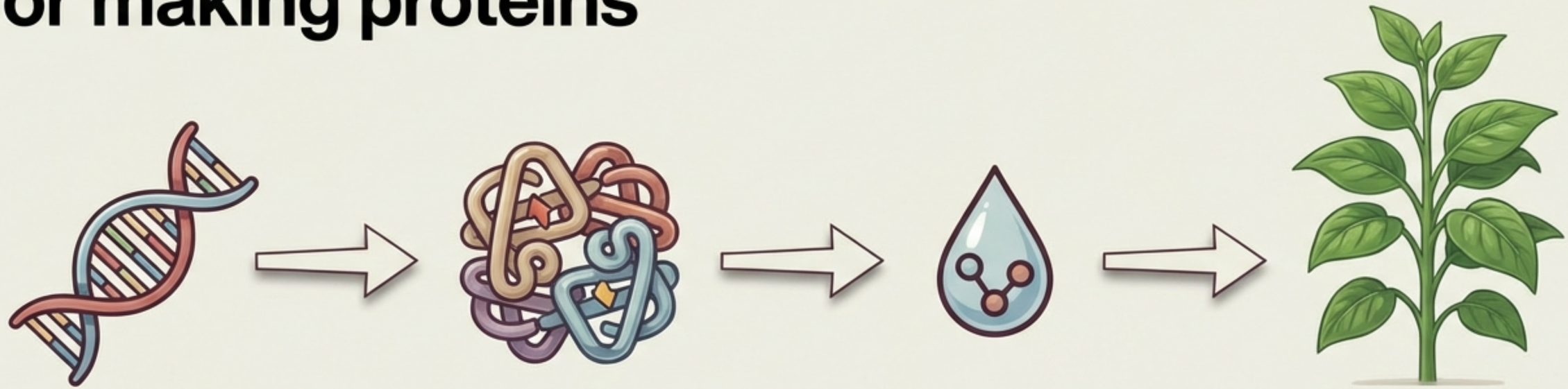


When breeding plants with two characteristics (e.g., Tall/Round vs. Short/Wrinkled), nature reshuffles the deck.

The F2 generation produced new combinations:
Tall / Wrinkled
Short / Round

The Logic: Factors controlling shape and color are not linked. They are inherited independently.

Cellular DNA is the information source for making proteins

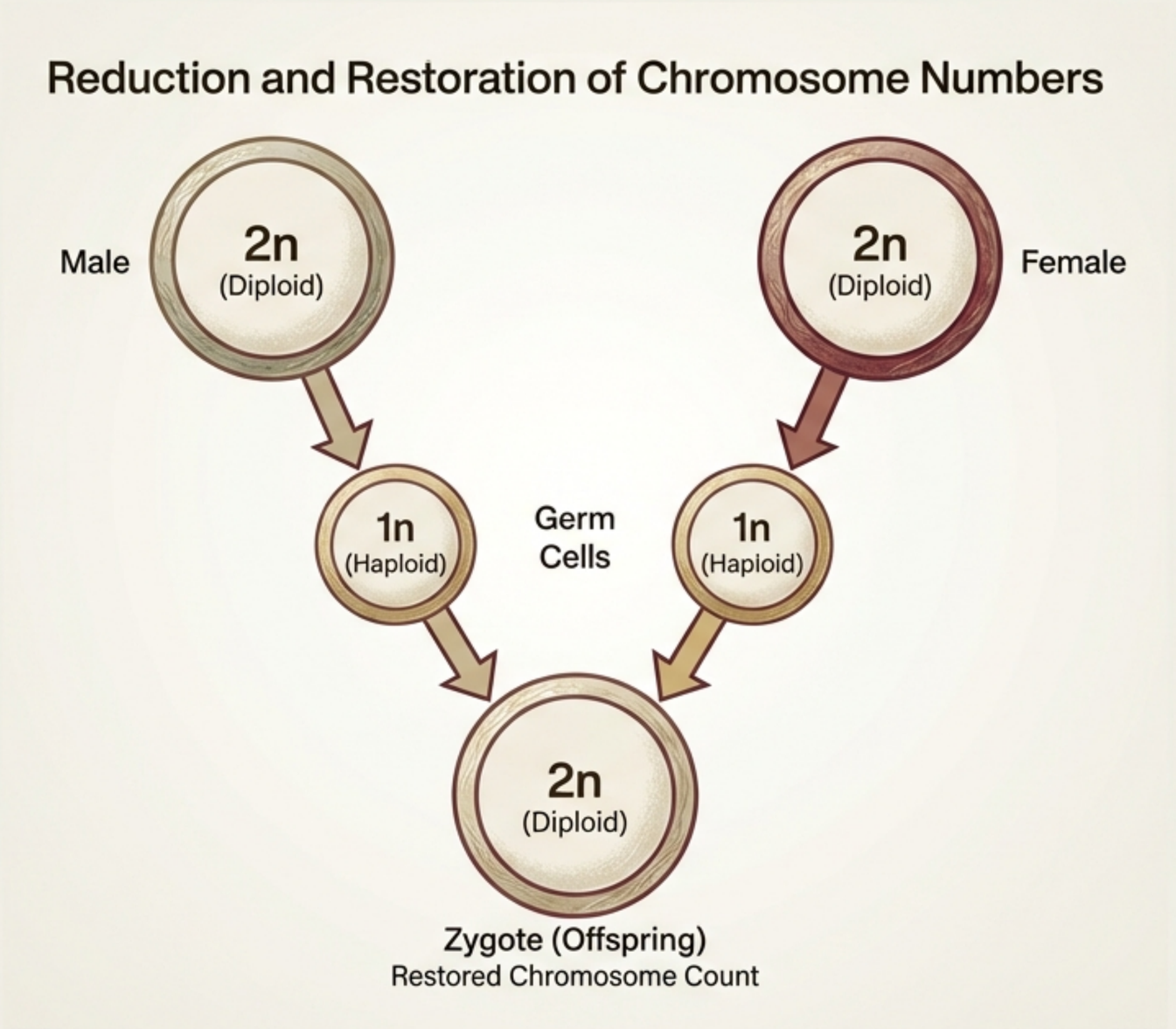


Gene → Enzyme (Protein) → Hormone → Trait (Height)

Scenario: How Tallness Works

1. The Gene provides the blueprint for an Enzyme.
2. If the Enzyme is efficient, it produces a lot of growth Hormone.
3. High Hormone levels result in a Tall Plant.
   (If the gene is altered, the enzyme is less efficient -> less hormone -> Short Plant).

The Paired Blueprint: Solving the math of reproduction



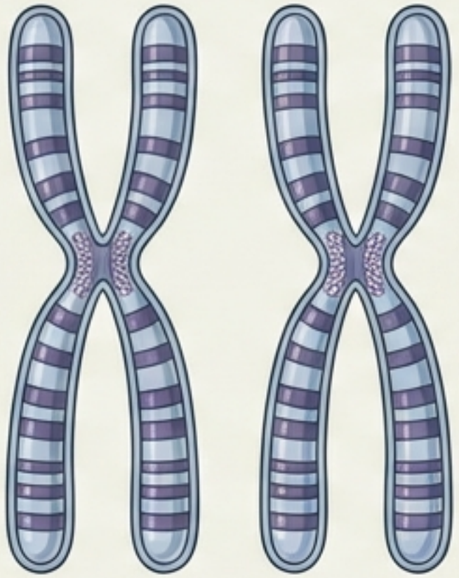
The Challenge:
If both parents contributed full DNA, the offspring would have double the necessary chromosomes.

The Solution:
Germ cells (gametes) reduce the chromosome count by half.

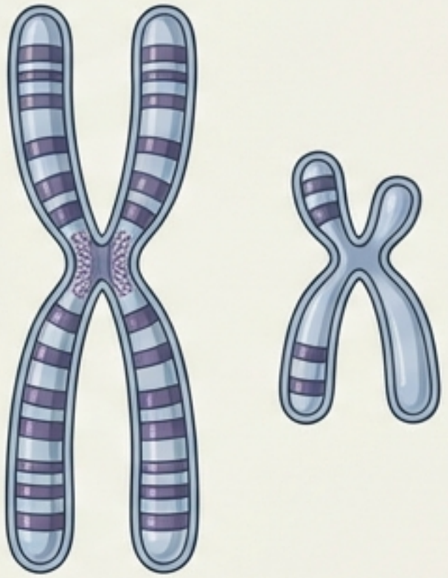
When fertilization occurs, the full count is restored, ensuring the stability of the species' DNA.

The Genetic Mismatch: X and Y

Female (XX)



Male (XY)



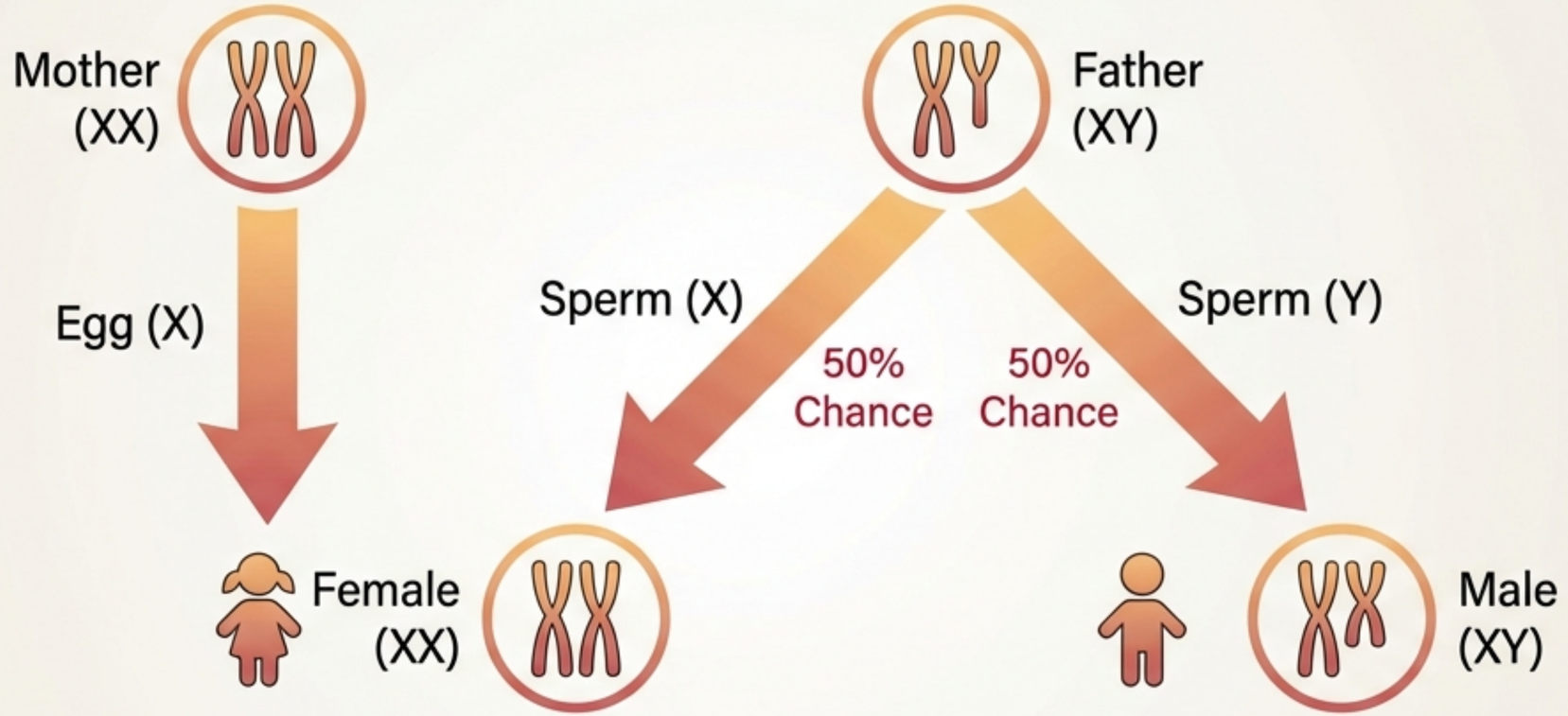
Humans have 22 perfect pairs of chromosomes. The 23rd pair (Sex Chromosomes) is the exception.

Females have a perfect pair (XX).

Males have a mismatched pair (XY).

This mismatch is the key to determining the sex of the offspring.

The 50/50 Lottery of Sex Determination



A child always inherits an X from the mother. The sex is determined solely by the father's contribution. Unlike reptiles (temperature-based) or snails (changeable), human sex is genetically determined at conception.

From DNA to Diversity: Summary

Variation

Errors in copying and sexual mixing create distinct individuals. This variation is the fuel for survival and evolution.

Inheritance Rules

We carry two copies of every gene. Dominant traits can mask recessive ones, but the hidden traits are preserved for future generations.

Independence

Traits are often inherited separately (e.g., shape vs. color), allowing for entirely new combinations in offspring.

The Mechanism

DNA genes code for proteins (enzymes). These enzymes regulate hormones, which physically express the traits (phenotypes) we see.