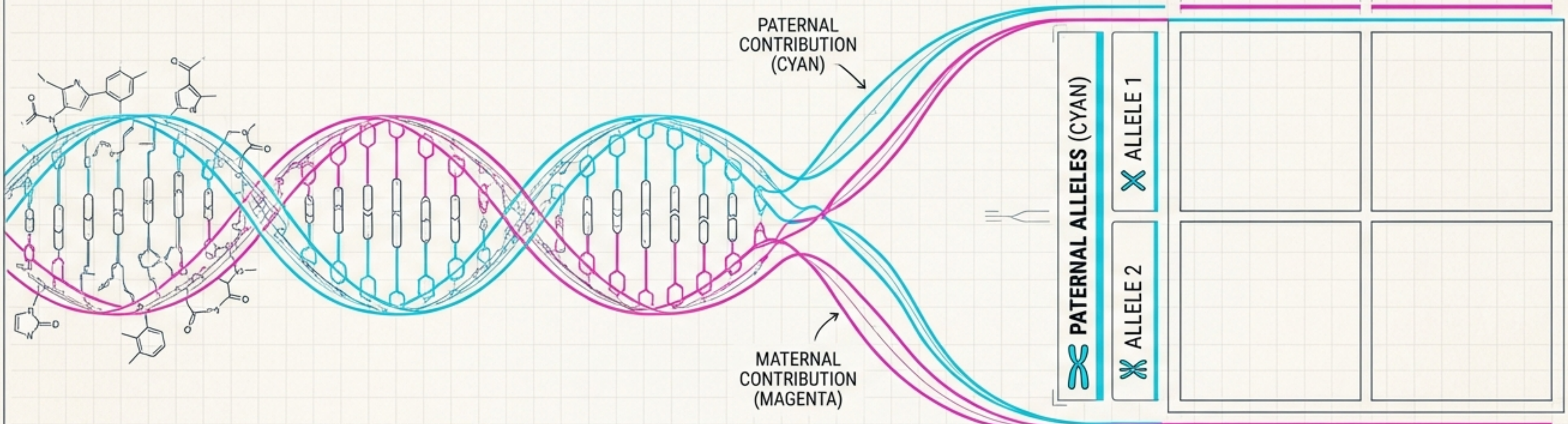


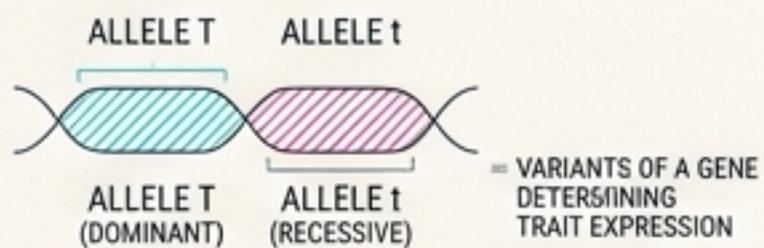
# THE BLUEPRINT OF LIFE: GENES AND INHERITANCE

Understanding alleles, traits, and predictive genetics



## INHERITANCE MECHANICS: PREDICTIVE MATRIX

### ALLELES & TRAITS: DEFINING VARIABLES



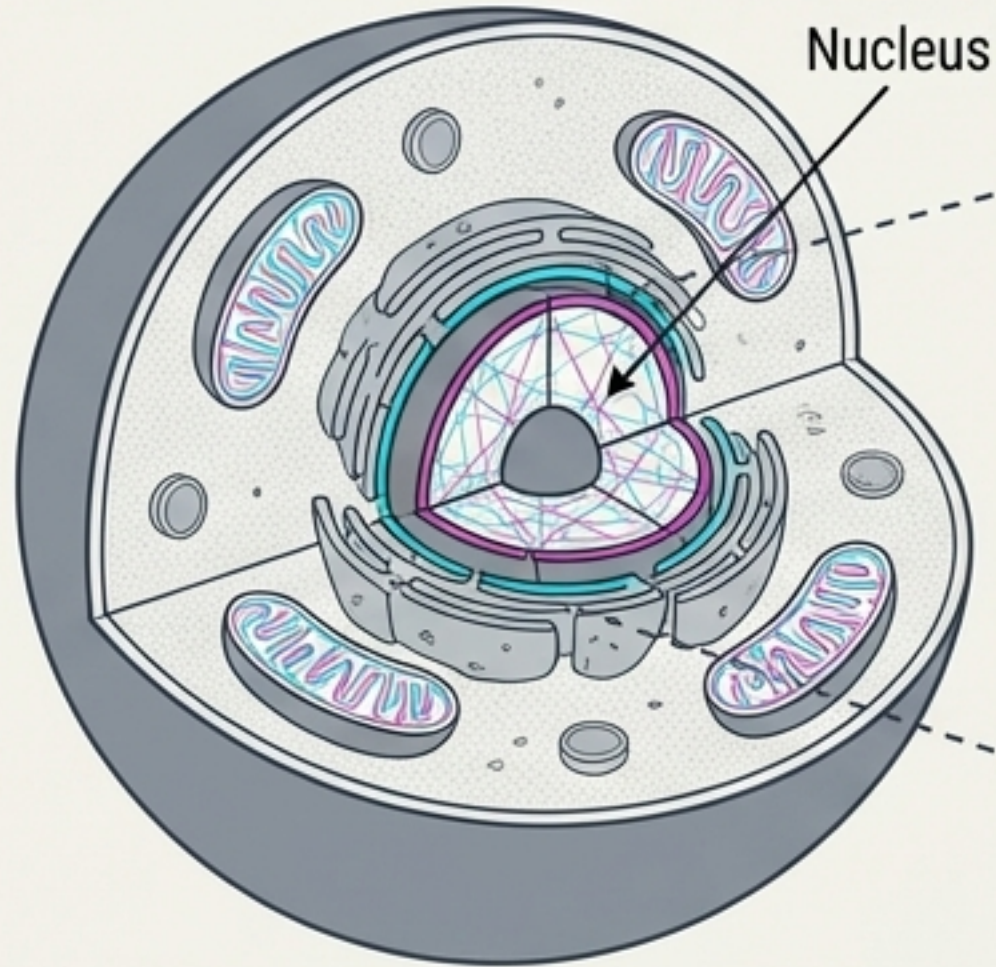
### PREDICTIVE GENETICS: PROBABILITY CALCULATIONS

	— (Cyan)	— (Magenta)	
— (Cyan)	25%	50%	= STATISTICAL MODELS FORECASTING OFFSPRING GENOTYPES & PHENOTYPES
— (Magenta)	25%	25%	

# THE PHYSICAL BASIS OF INHERITANCE

## STAGE 1: CELL OVERVIEW

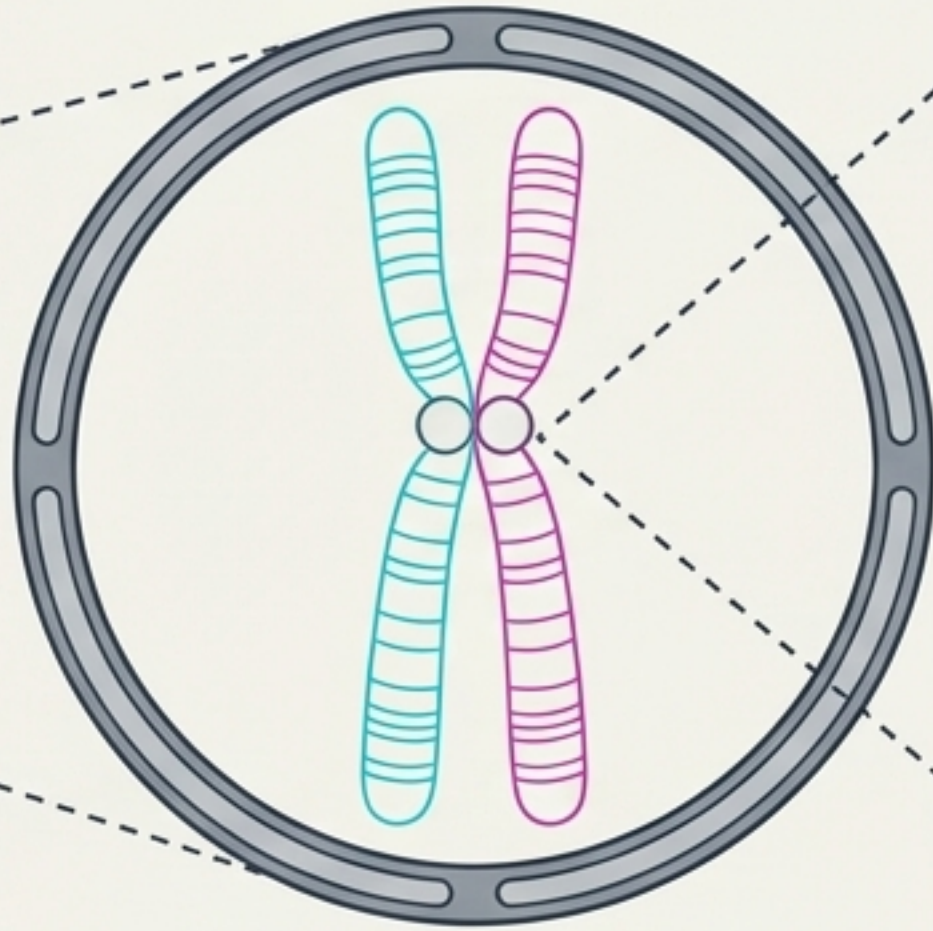
**Nucleus:** The control center of the cell.



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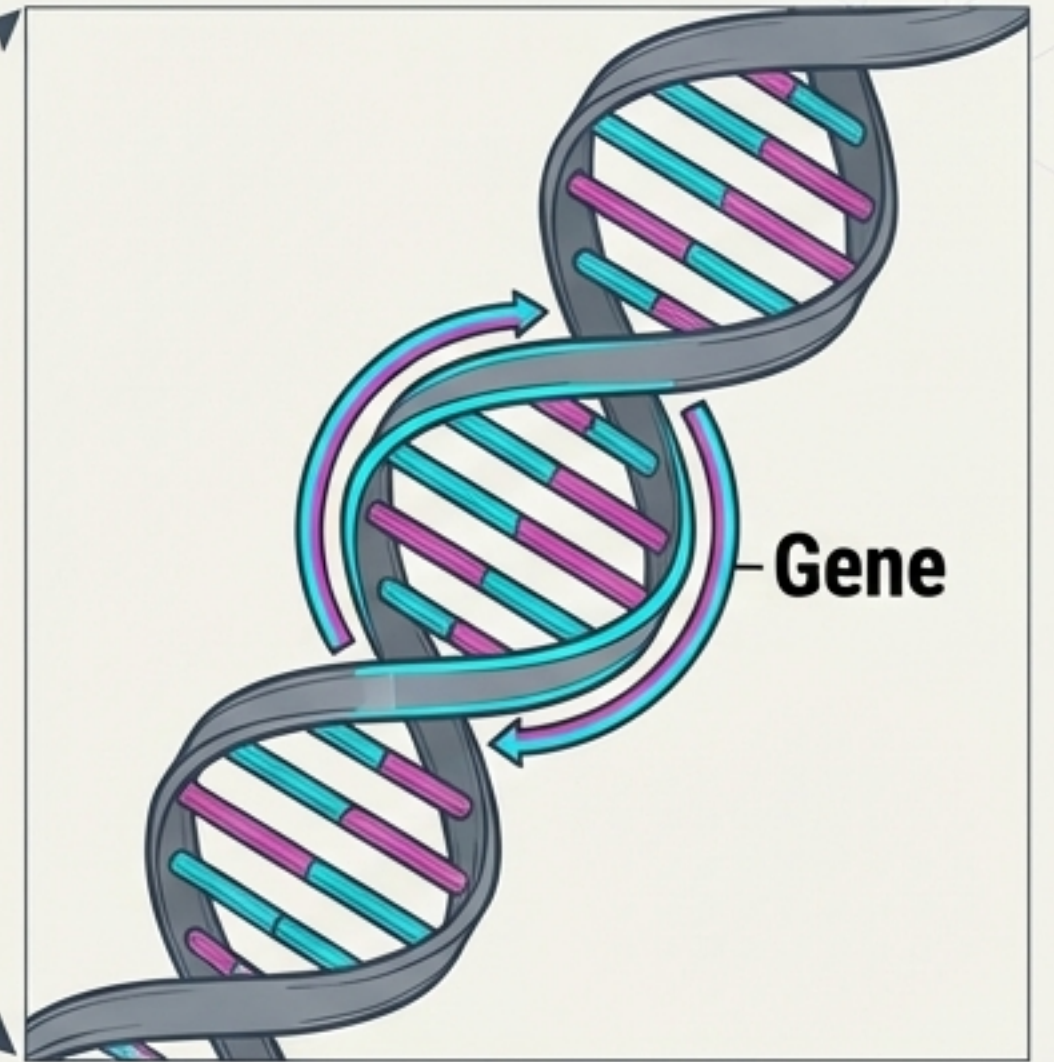
## STAGE 2: CHROMOSOME STRUCTURE

**Chromosomes:** Thread-like structures of DNA. Human cells contain exactly 46 chromosomes (23 pairs).



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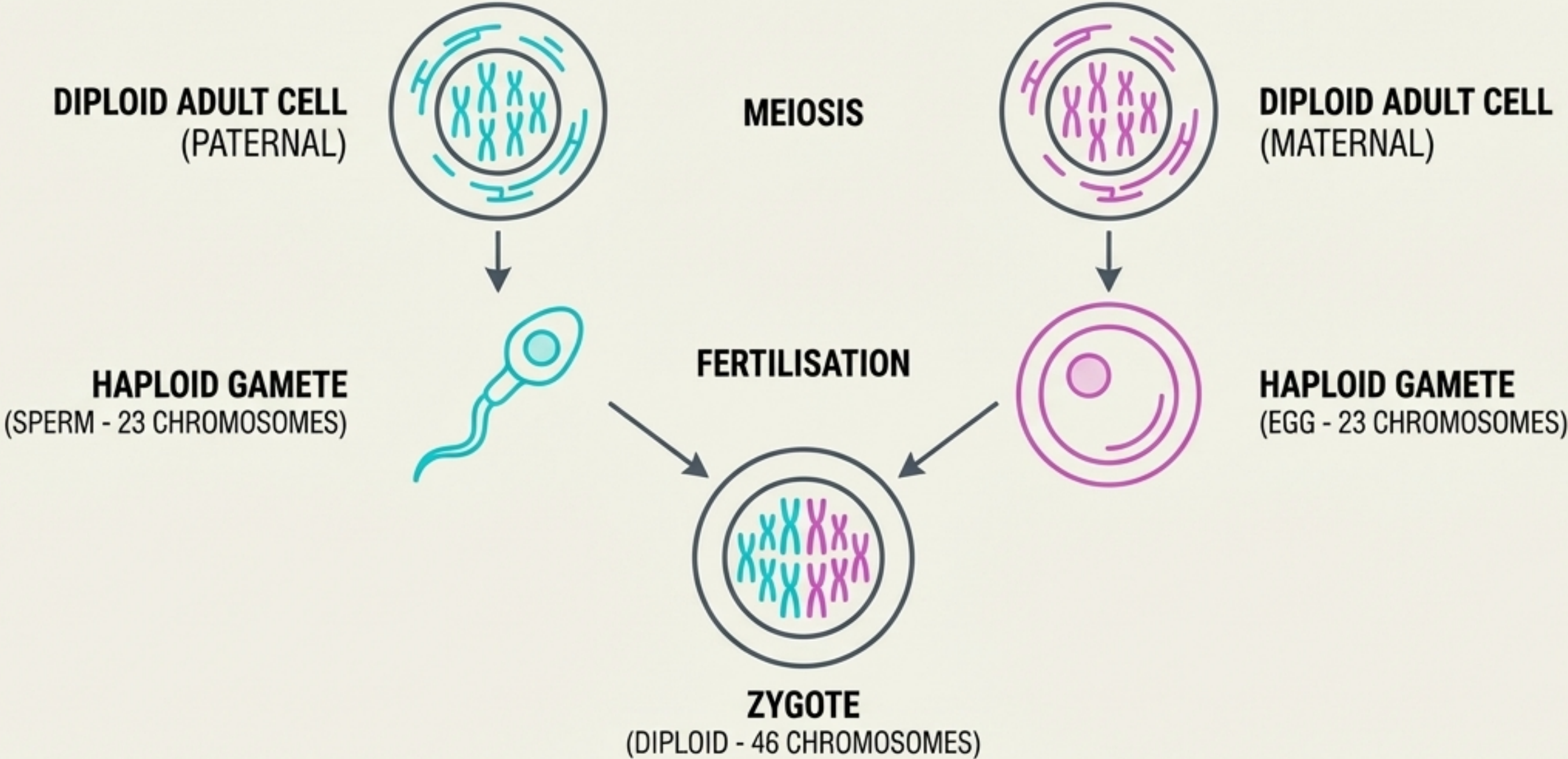
## STAGE 3: GENE IDENTIFICATION



**Gene:** A specific section of DNA that acts as an instructional manual to determine which proteins a cell can make.

**KEY INSIGHT:** A gene is a discrete instructional manual; chromosomes are the bookshelves.

# MEIOSIS & THE GENETIC SHUFFLE



**YOU ARE EXACTLY 50% OF YOUR MOTHER'S GENETIC CODE AND 50% OF YOUR FATHER'S.**

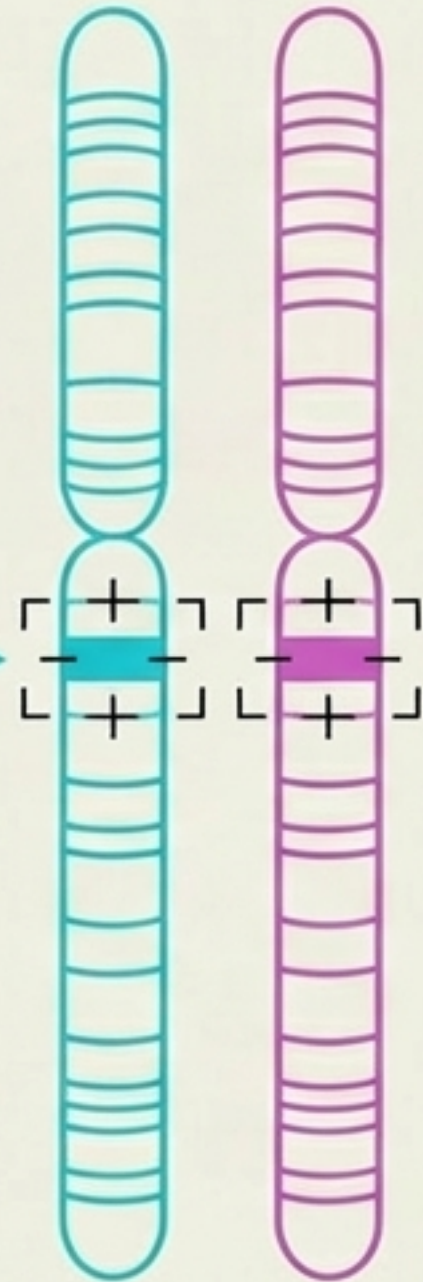
# THE LANGUAGE OF GENETICS: ALLELES

PATERNAL  
CONTRIBUTION

MATERNAL  
CONTRIBUTION

Because you receive 23 chromosomes from each parent, you possess two copies of every gene.

Code for  
Blue Eyes



Code for  
Brown Eyes

Alleles are different versions of the same gene.

**YOUR TRAITS ARE DETERMINED BY HOW THESE PAIRED ALLELES INTERACT WITH ONE ANOTHER.**

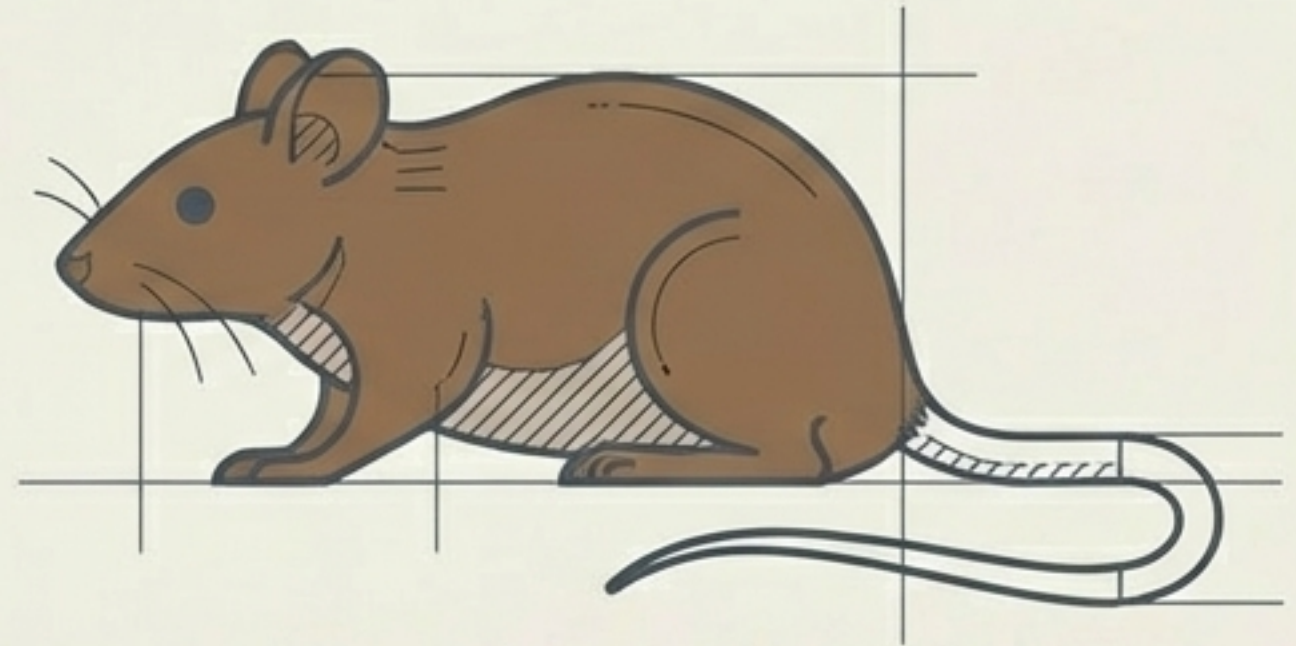
# DISTINGUISHING THE CODE FROM THE RESULT

## GENOTYPE



The specific combination of alleles an organism holds. The hidden script.

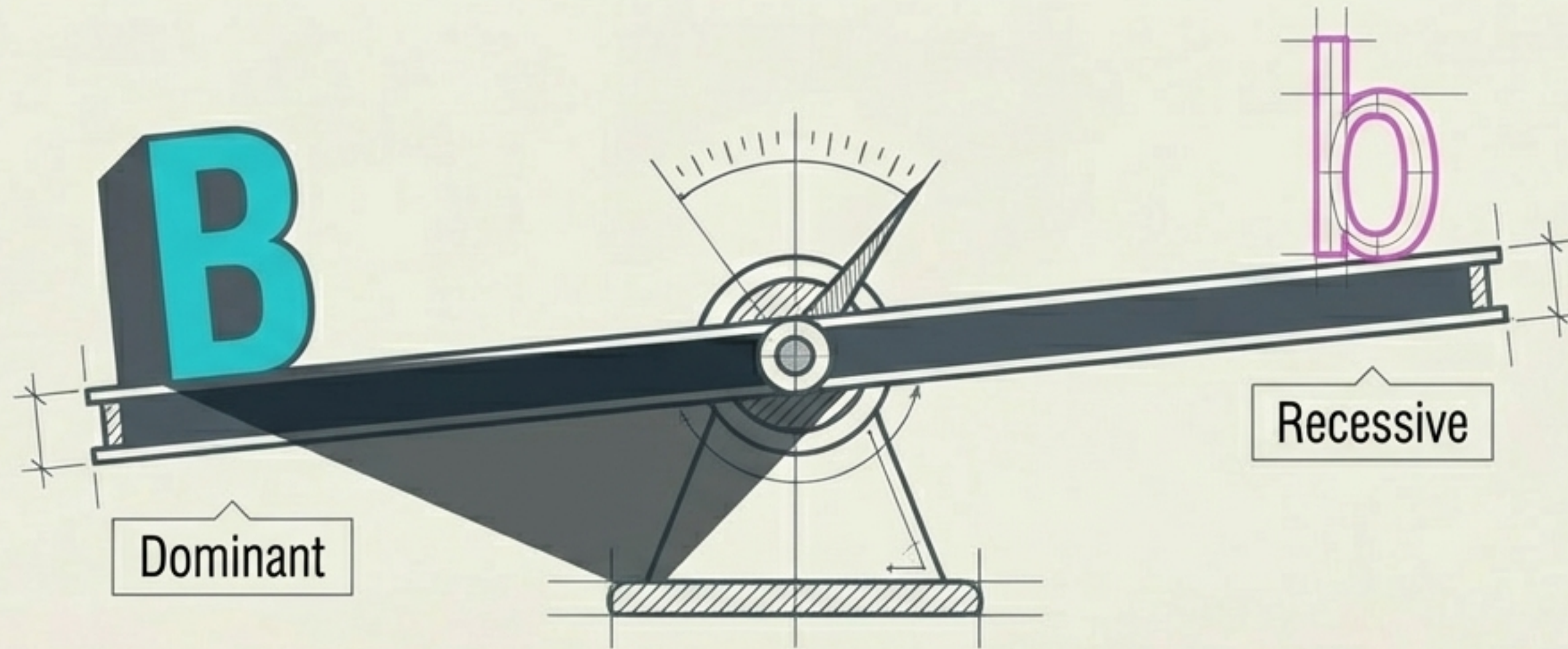
## PHENOTYPE



The observable physical characteristics.  
The live performance.

**AN ORGANISM'S PHENOTYPE IS THE PHYSICAL MANIFESTATION OF ITS UNDERLYING GENOTYPE.**

# THE RULES OF EXPRESSION: DOMINANT VS. RECESSIVE



## DOMINANT ALLELE (B)

Only needs ONE copy to be expressed in the phenotype.  
It masks the presence of a recessive allele.

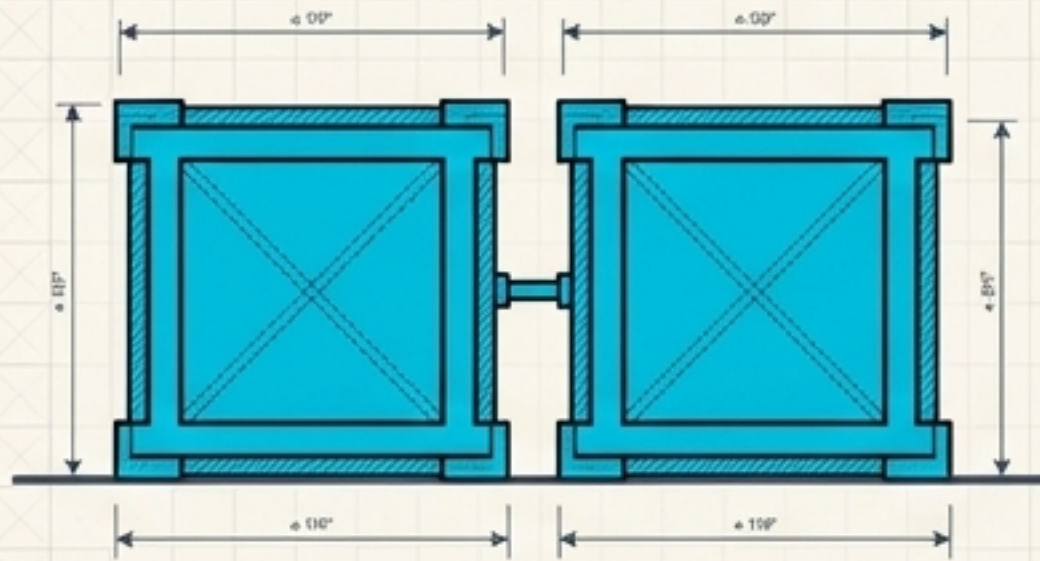
## RECESSIVE ALLELE (b)

Needs TWO copies to be expressed in the phenotype.  
It remains hidden if a dominant allele is present.

**YOUR TRAITS ARE DETERMINED BY HOW THESE PAIRED ALLELES INTERACT WITH ONE ANOTHER.**

# DEFINING ALLELE PAIRINGS

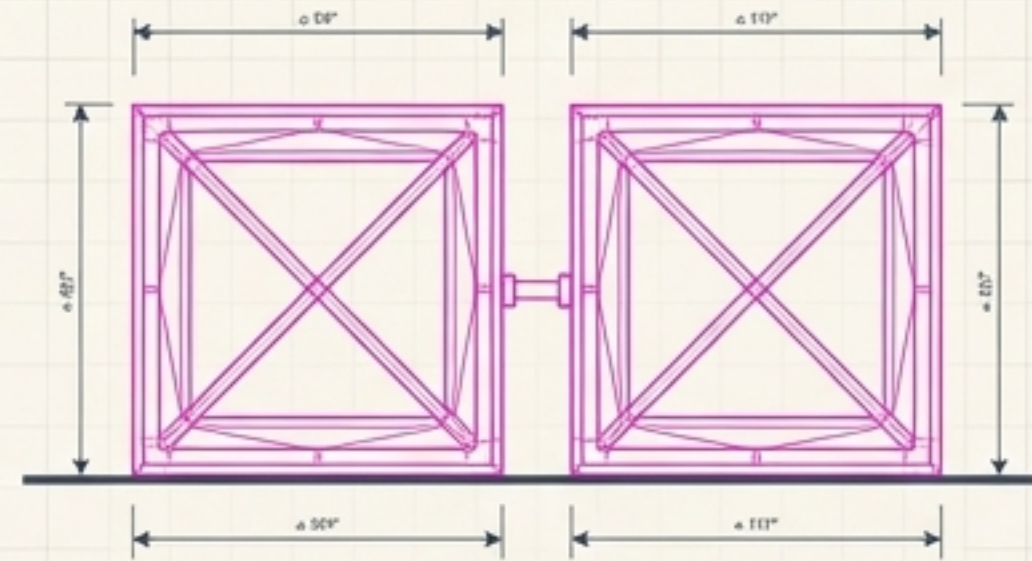
## BB



Homozygous Dominant

Result: Dominant Phenotype

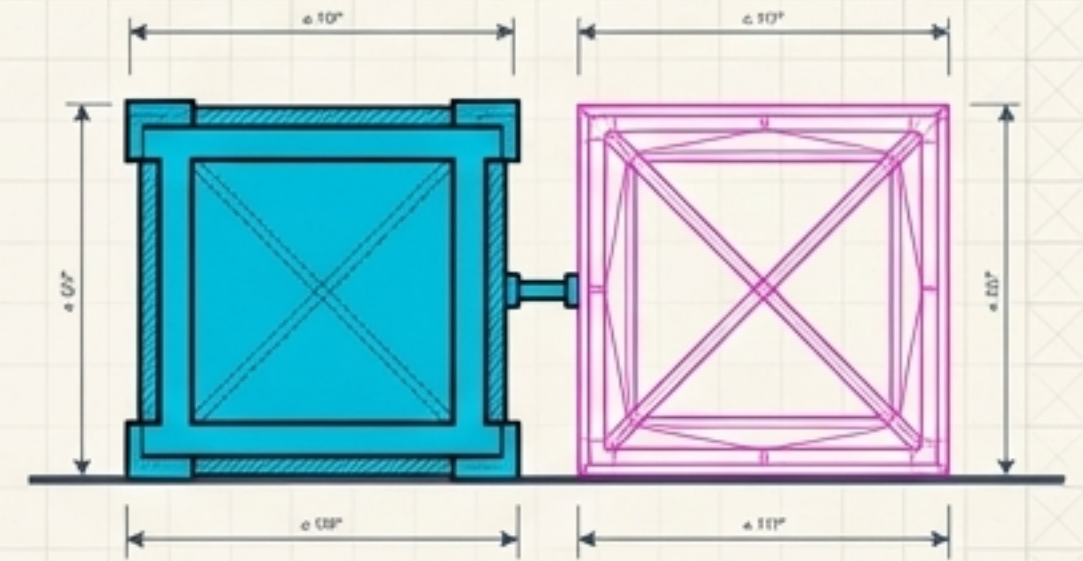
## bb



Homozygous Recessive

Result: Recessive Phenotype

## Bb

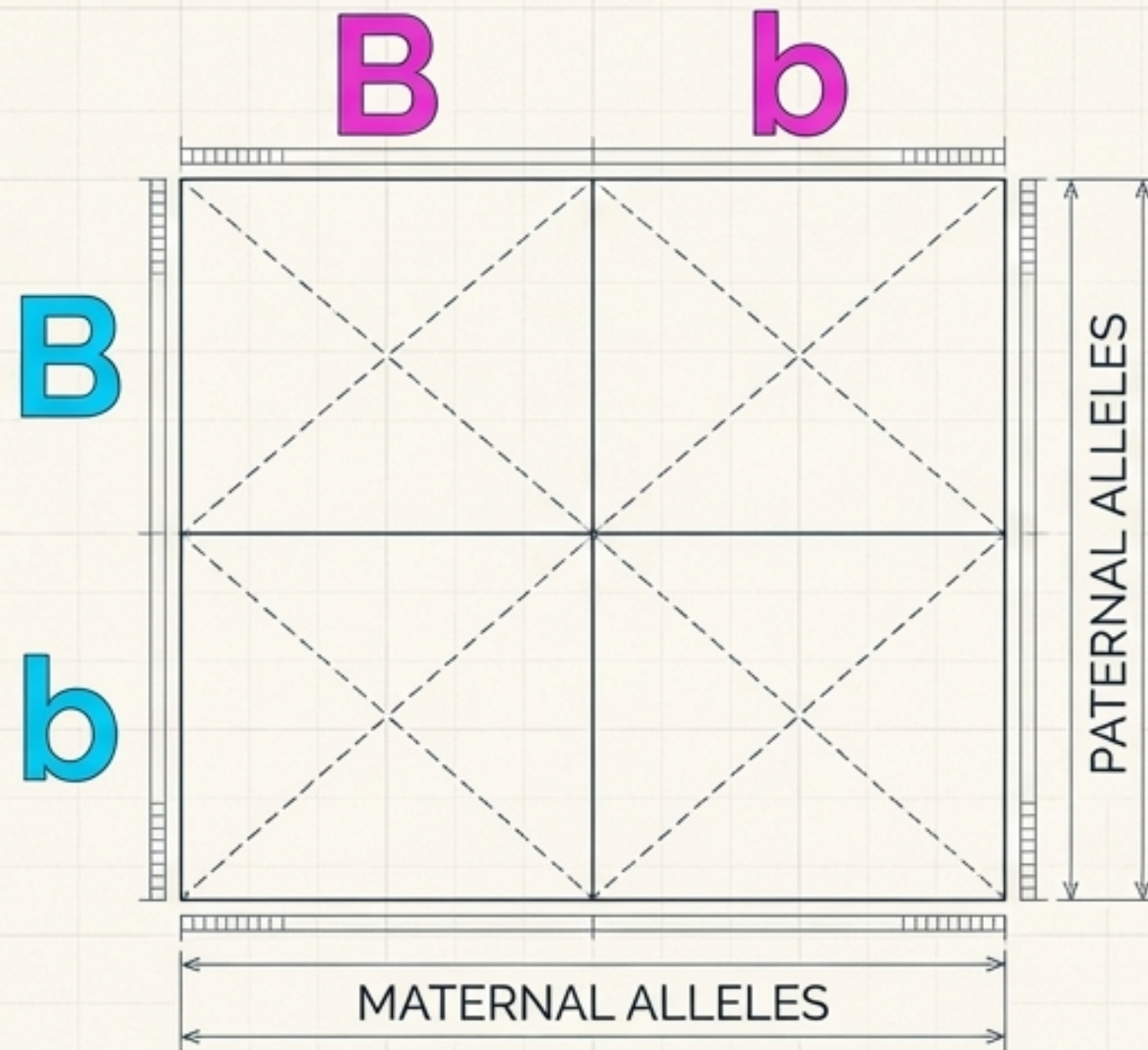


Heterozygous

Result: Dominant Phenotype

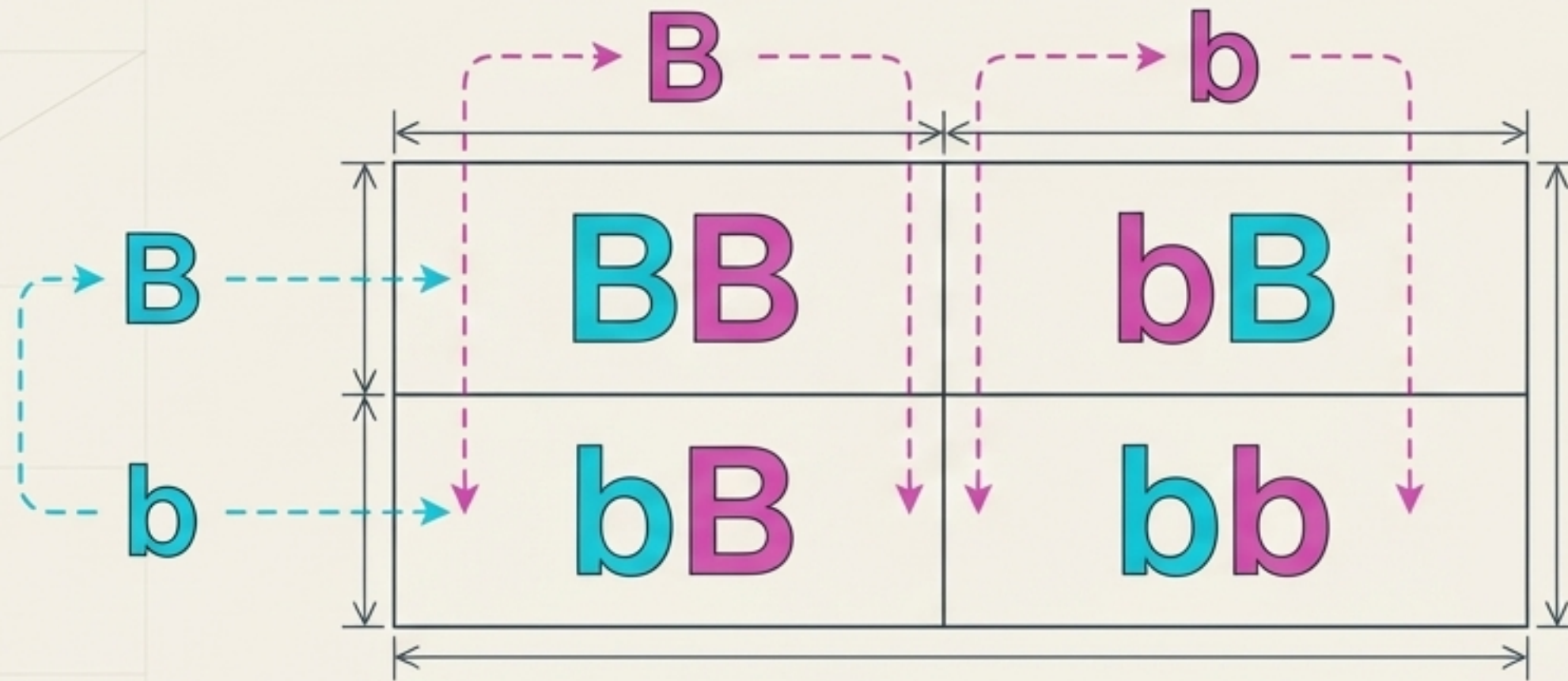
INSIGHT: HETEROZYGOUS INDIVIDUALS ARE "CARRIERS" OF THE RECESSIVE TRAIT. THEY HOLD THE CODE, BUT IT IS INVISIBLE IN THEIR PHENOTYPE.

# PREDICTIVE GENETICS: THE PUNNETT SQUARE



THE PUNNETT SQUARE IS A VISUAL ALGORITHM. IT CALCULATES THE EXACT MATHEMATICAL PROBABILITY OF A SINGLE OFFSPRING'S GENOTYPE BASED ON RANDOM FERTILISATION.

# THE MONOHYBRID CROSS IN ACTION



**Genotype Ratio**

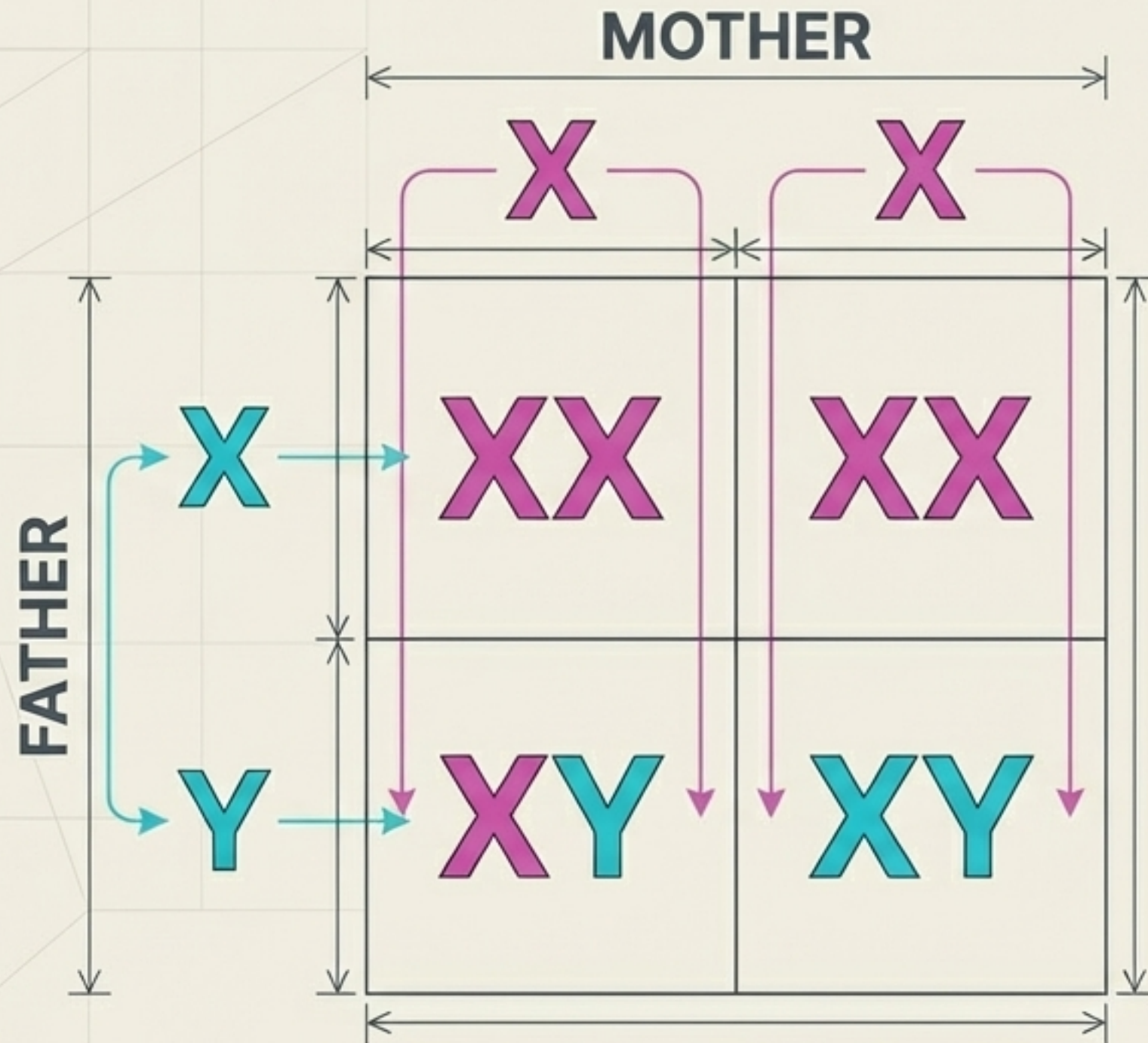
1 BB : 2 Bb : 1 bb

**Phenotype Ratio**

75% Dominant Trait : 25% Recessive Trait (3:1)

**KEY INSIGHT:** Every single offspring has a fresh, independent 25% chance of expressing the recessive phenotype.

# SEX DETERMINATION IN HUMANS



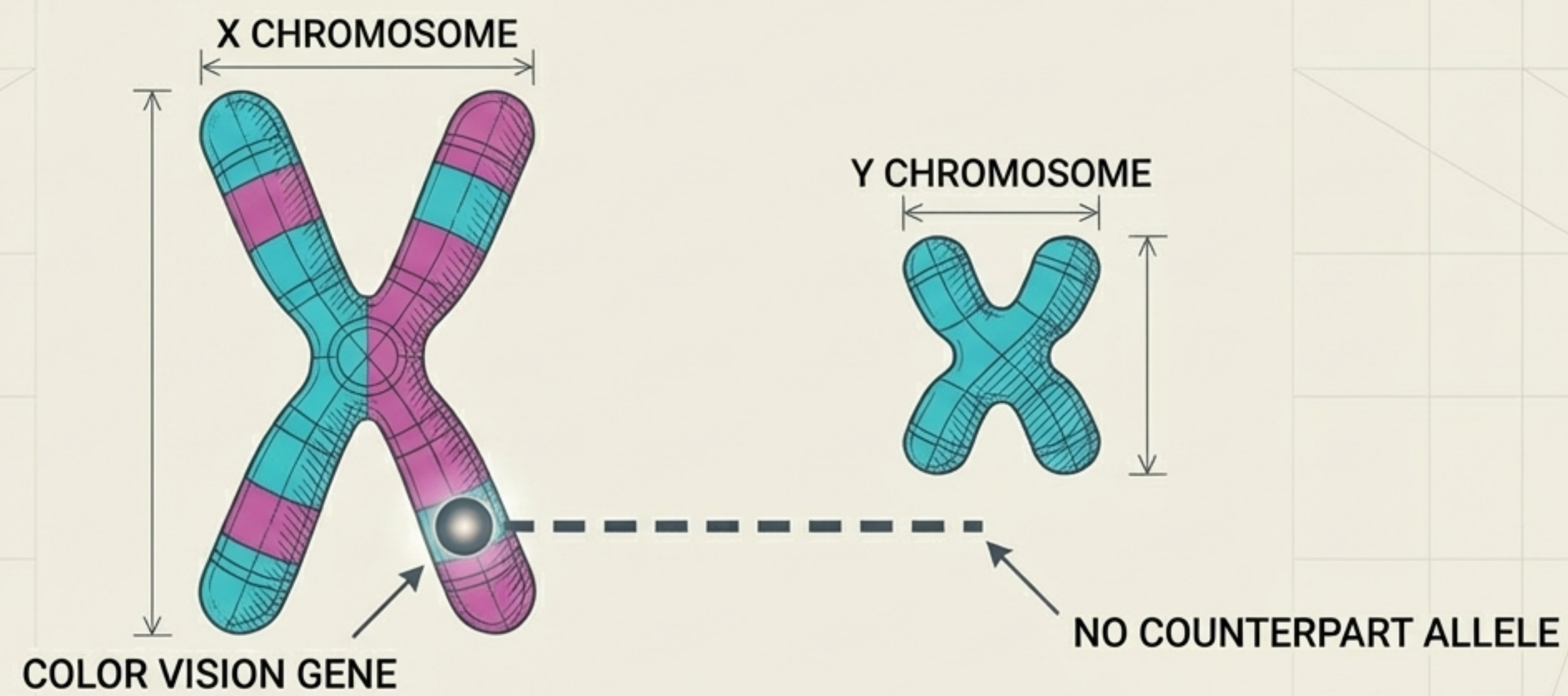
## CHROMOSOMES 23

The 23rd pair of chromosomes determines biological sex. Females carry XX; males carry XY.

## GENETIC DETERMINATION

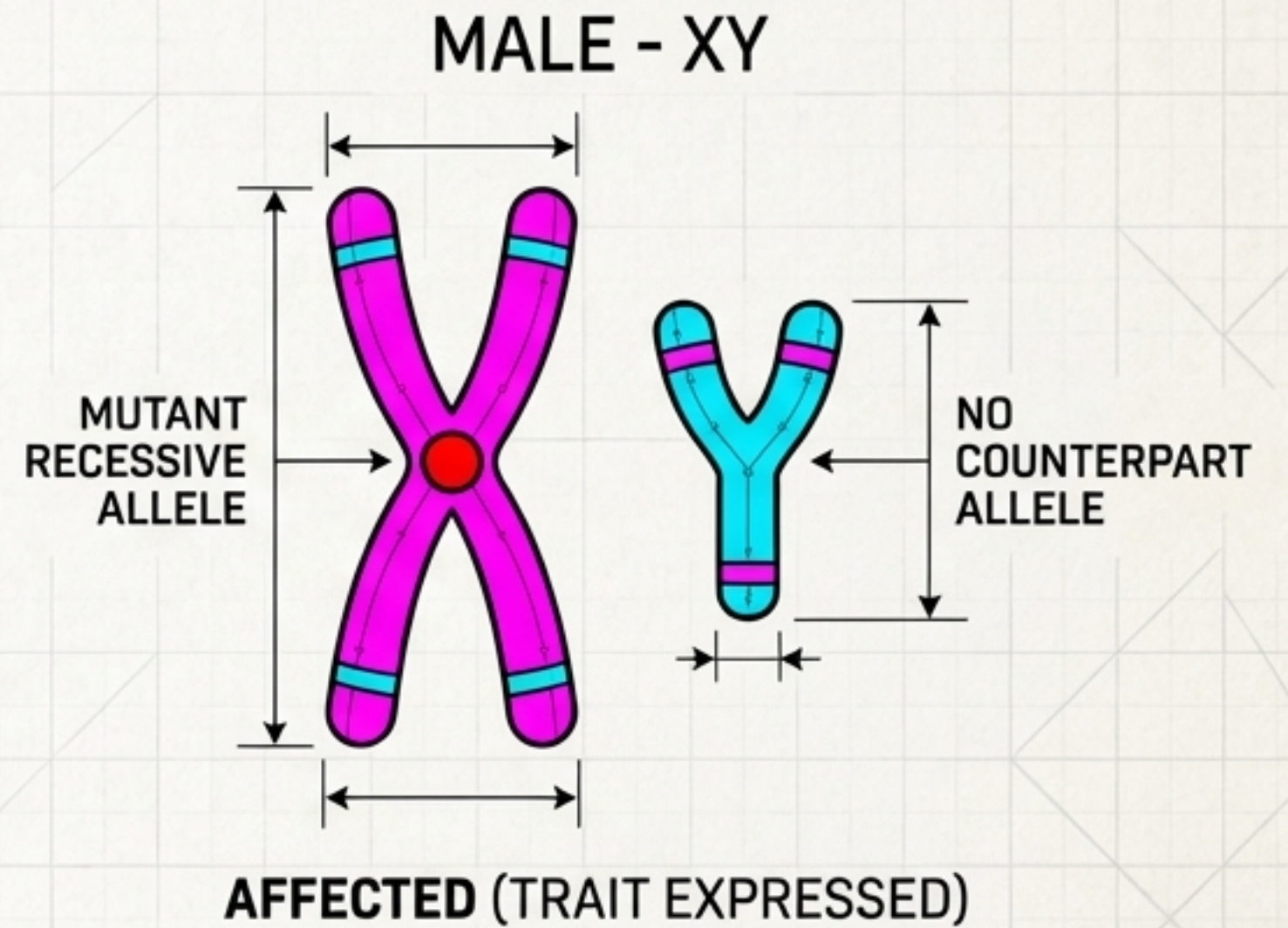
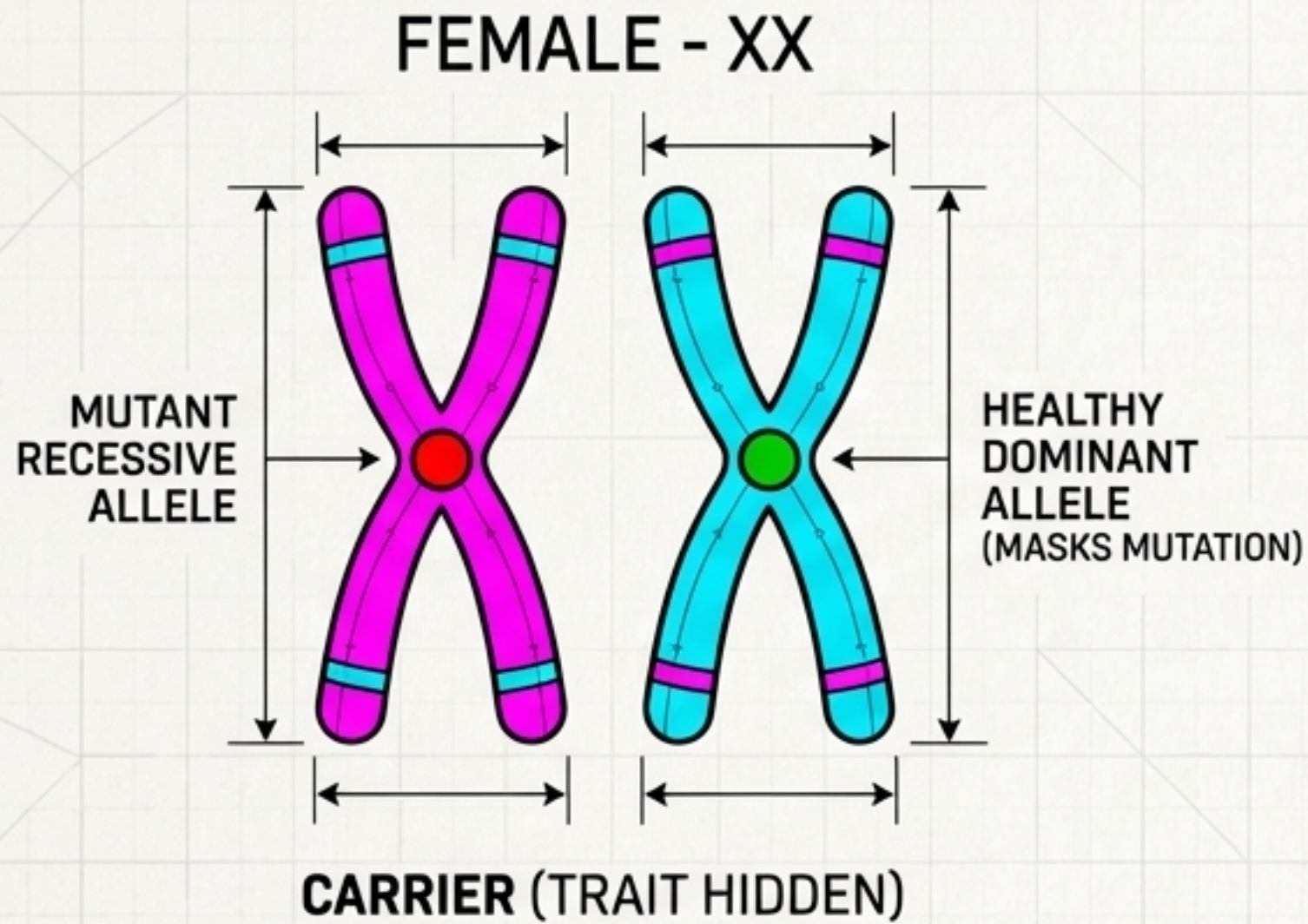
The genetic sex of the offspring is entirely determined by whether the fertilising sperm carries an X or a Y chromosome. The probability is always exactly 50%.

# THE COMPLEXITY OF SEX-LINKED INHERITANCE



Genes located on the sex chromosomes exhibit unique inheritance patterns. Because the Y chromosome is significantly smaller, it lacks counterpart alleles for many genes found on the X chromosome.

# WHY X-LINKED TRAITS AFFECT MALES DIFFERENTLY



## SYNTHESIS INSIGHT

Males are statistically far more likely to express X-linked recessive disorders (like color blindness) because they lack a “backup” X chromosome to mask the mutation. Whatever is on their single X chromosome is automatically expressed.