

Introduction to Genetics: Traits, DNA, and Inheritance



- Discover how genetics shapes your daily life



- Explore the link between traits, DNA, and inheritance



- Learn to define traits and DNA's role



- Understand genotype vs. phenotype differences



- Journey from visible traits to molecular blueprint



What Are Traits, Really?

- A trait is any observable characteristic: eye color, earlobe shape, hair curliness
- Physiological traits include lactose tolerance and blood type
- Behavioral traits cover tendencies like risk-taking or sociability
- Trait variation within groups largely has a genetic basis

EXAMPLES OF HUMAN TRAITS



Eye Color



Earlobe Shape



Hair Curliness



Tongue Rolling

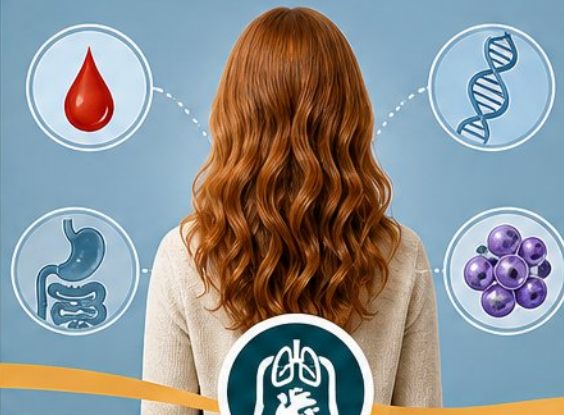
Traits in Daily Life: More Than Meets the Eye

Morphological Traits



- **Morphological traits:** eye color, height, earlobe shape — directly visible features.

Physiological Traits



- **Physiological traits:** blood type, lactose tolerance, metabolism rate — internal functions.

Behavioral Traits



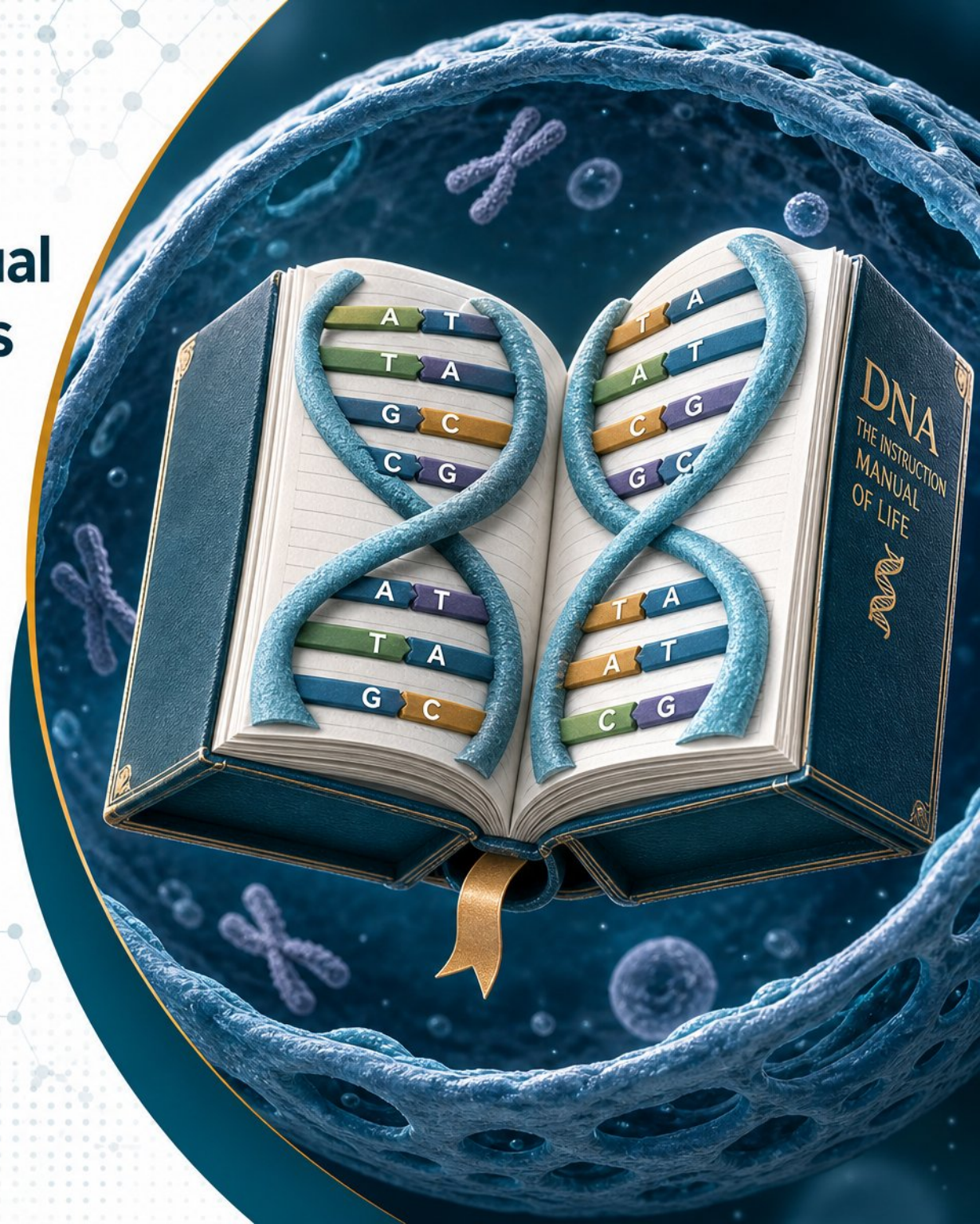
- **Behavioral traits:** risk-taking, sleep patterns, social tendencies — actions and responses.

- **Not all important traits are visible;** many affect health or agriculture.
- **Genes, environment,** and their interaction shape every trait.

DNA:

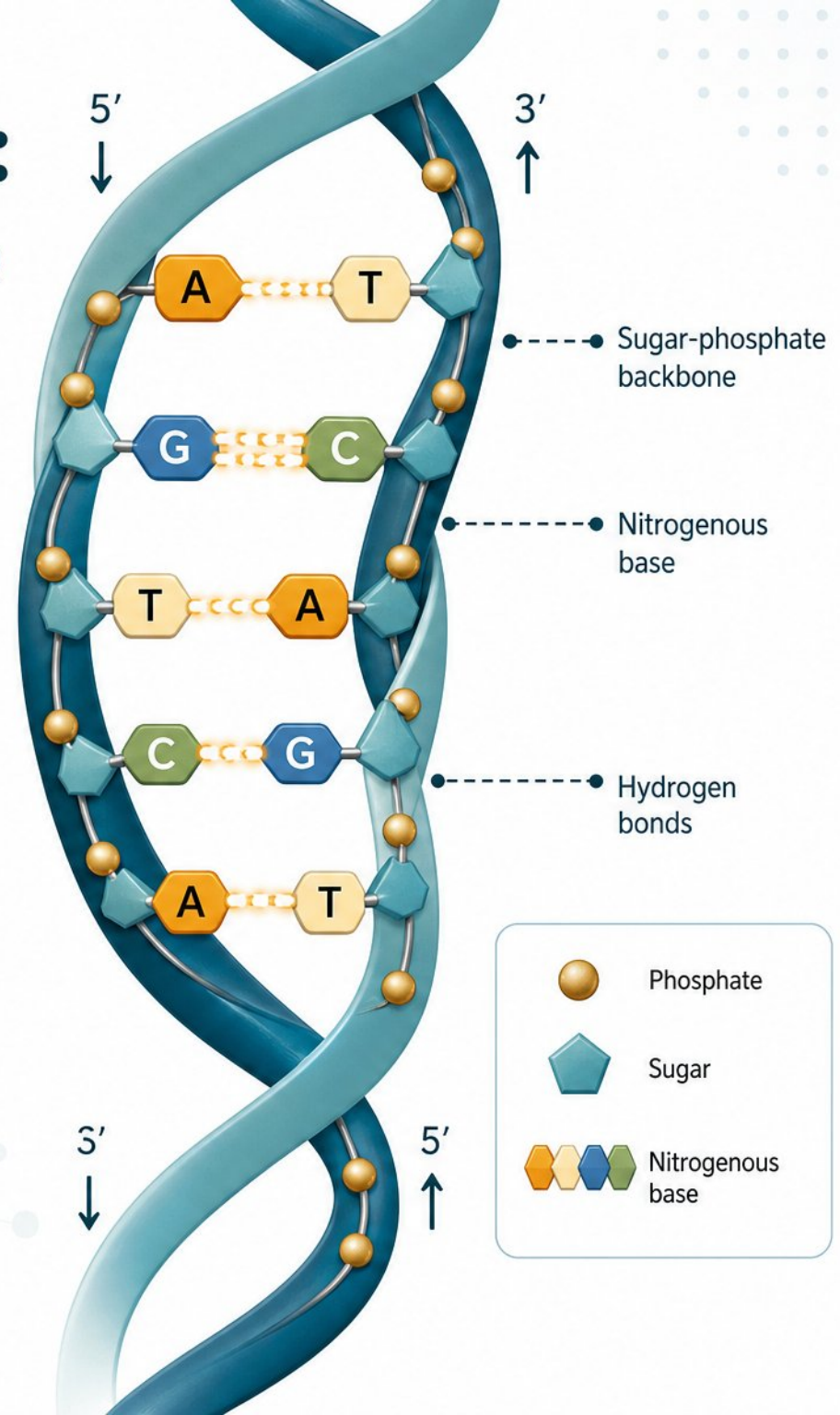
The Instruction Manual Deep Inside Your Cells

- DNA holds all genetic information for an organism
- Found in the cell nucleus, packaged into chromosomes
- Double helix structure with paired bases (A-T, G-C)
- Acts like a recipe book for building the body



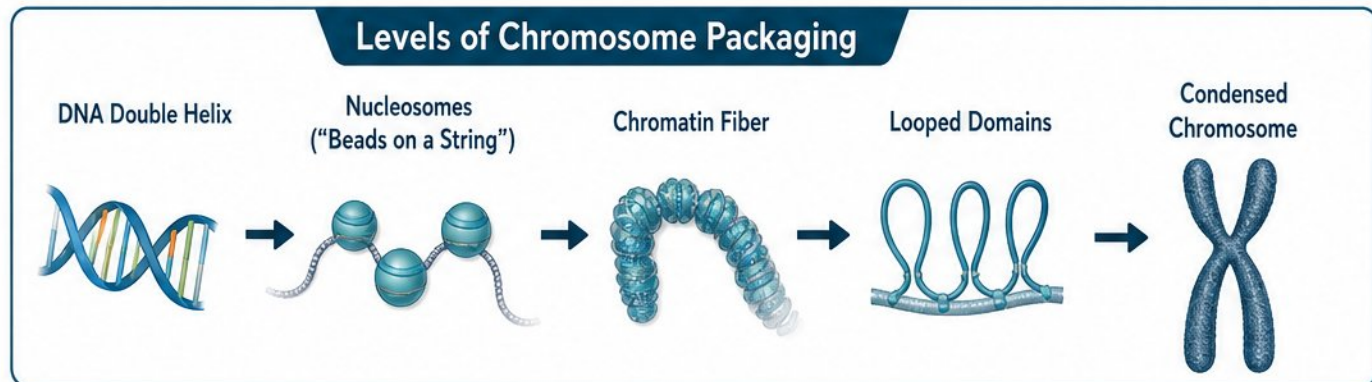
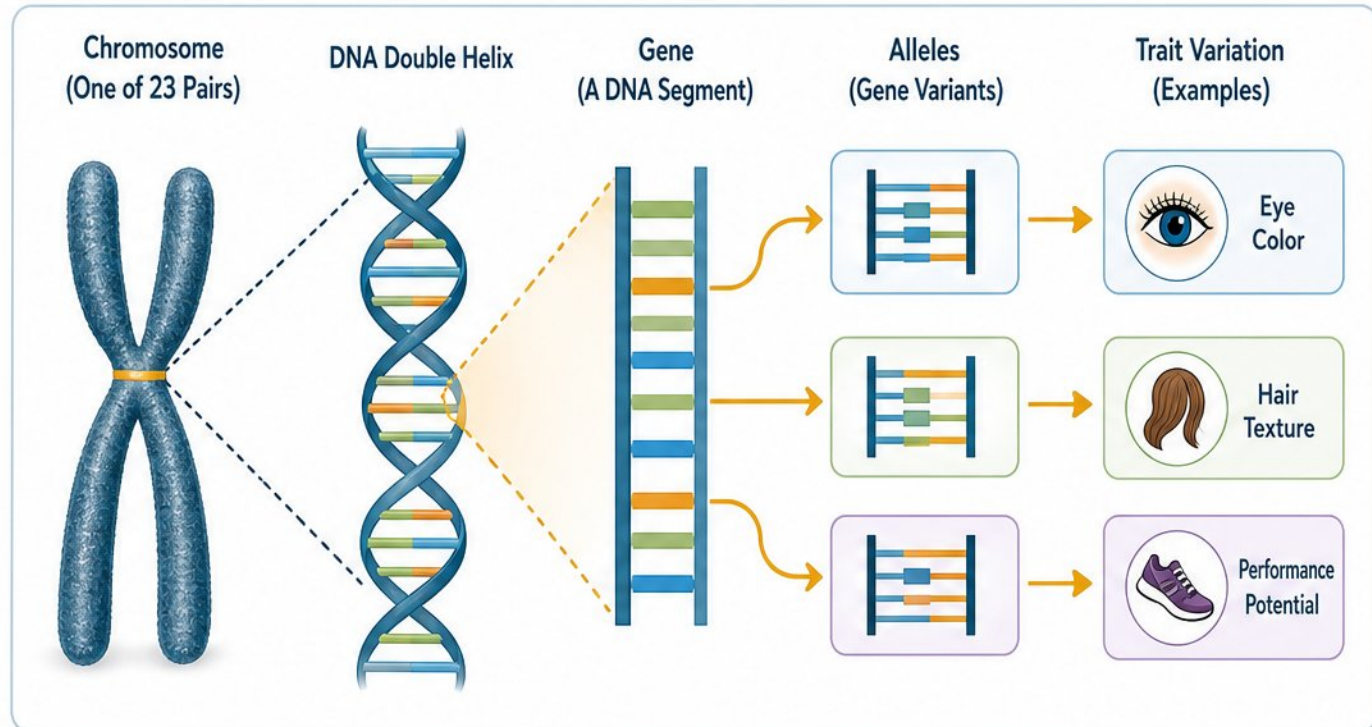
The Double Helix: Cracking the Code

- Nucleotide building blocks: phosphate, sugar, and nitrogen base
- Complementary base pairing: A with T, G with C
- Anti-parallel strands running in opposite directions
- Twisted ladder structure held together by hydrogen bonds



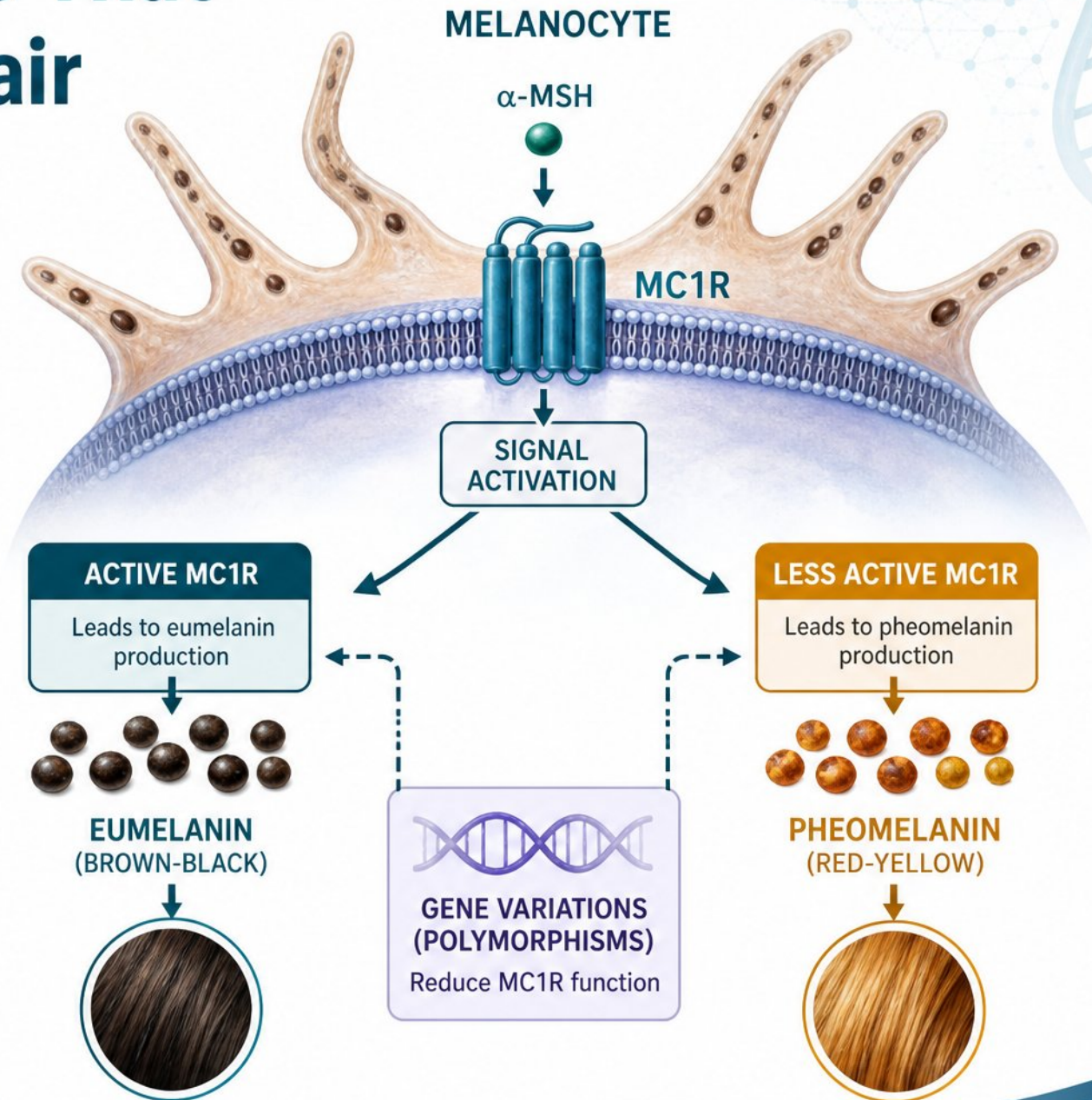
From DNA to Genes: Segments That Mean Business

- A gene is a DNA segment encoding a protein or functional RNA
- Genes are the units of heredity passed from parents to offspring
- Humans possess roughly 20,000–25,000 genes on 23 chromosome pairs
- Alleles, or gene variants, drive the trait variation we observe



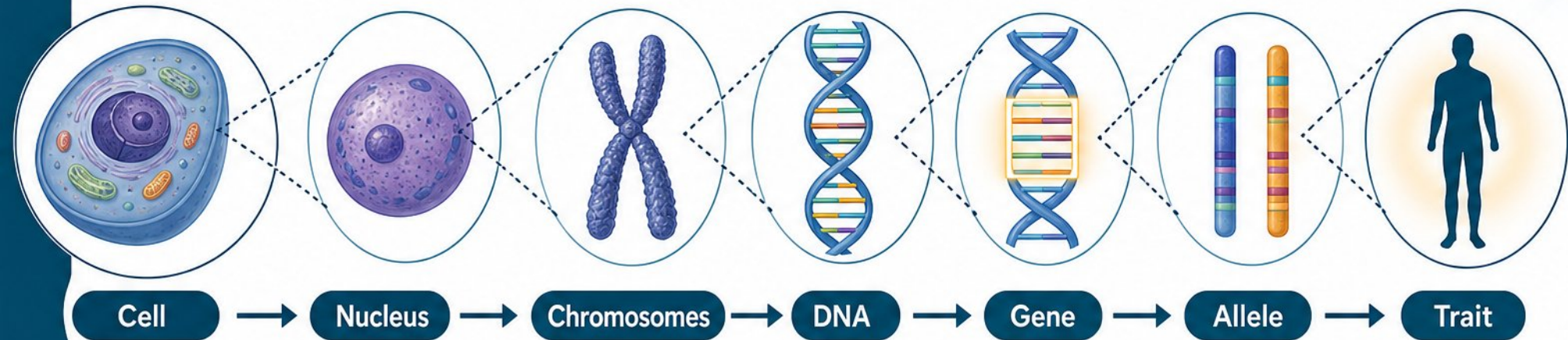
MC1R: A Gene That Paints Your Hair

- MC1R gene codes for the melanocortin 1 receptor protein on melanocytes
- Active MC1R produces brown-black eumelanin pigment
- Less active MC1R shifts output to red-yellow pheomelanin
- Gene variations (polymorphisms) reduce function, resulting in red or blond hair
- A single gene clearly linking DNA difference to visible trait



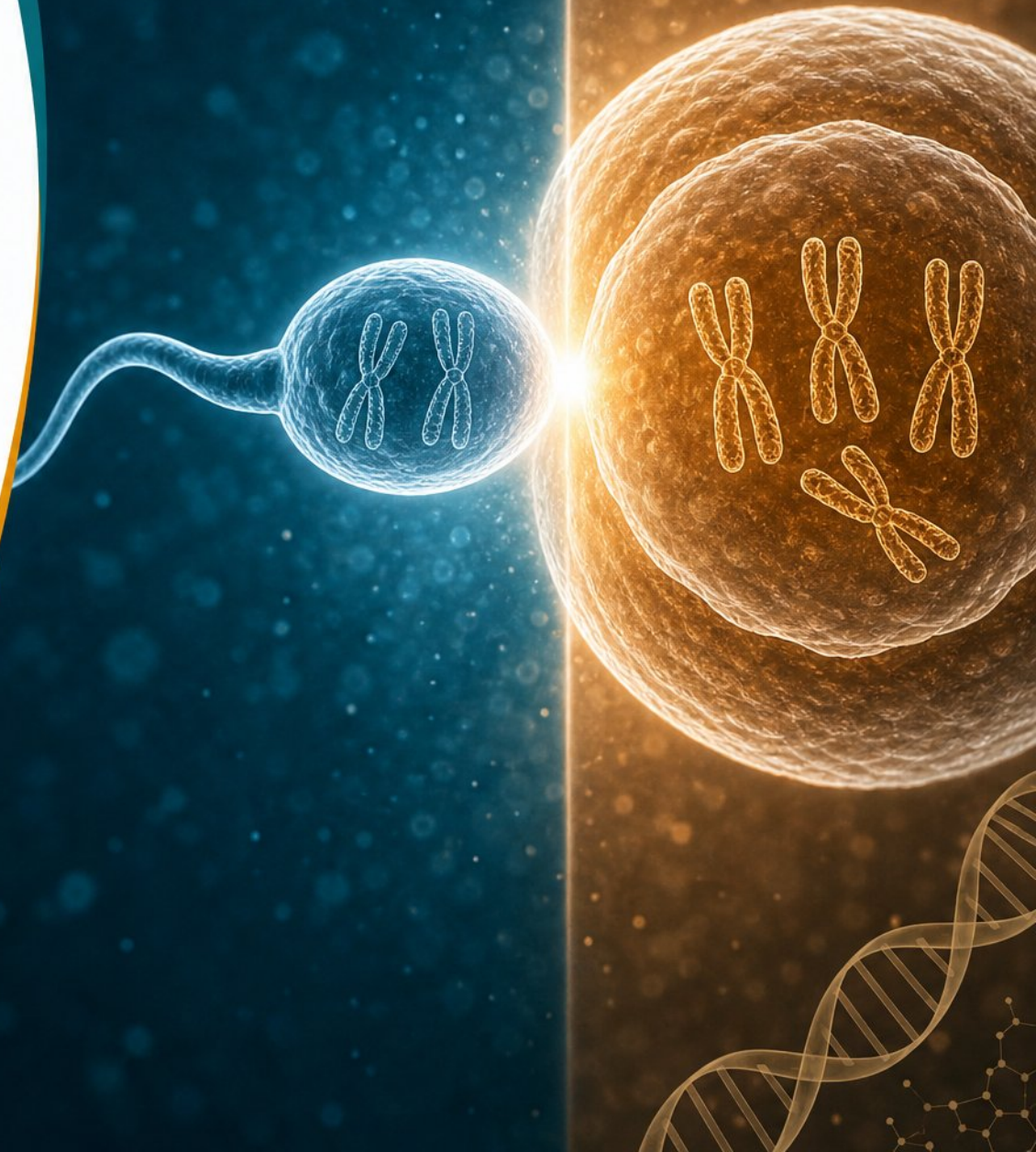
Chromosomes, Genes, and You: The Big Picture

- DNA wraps around proteins, forming chromatin that condenses into chromosomes.
- A chromosome holds many genes in order; each gene sits at a specific locus.
- Humans inherit 23 chromosomes from each parent, giving two gene copies.
- Relationship map: cell → nucleus → chromosomes → DNA → gene → allele → trait.



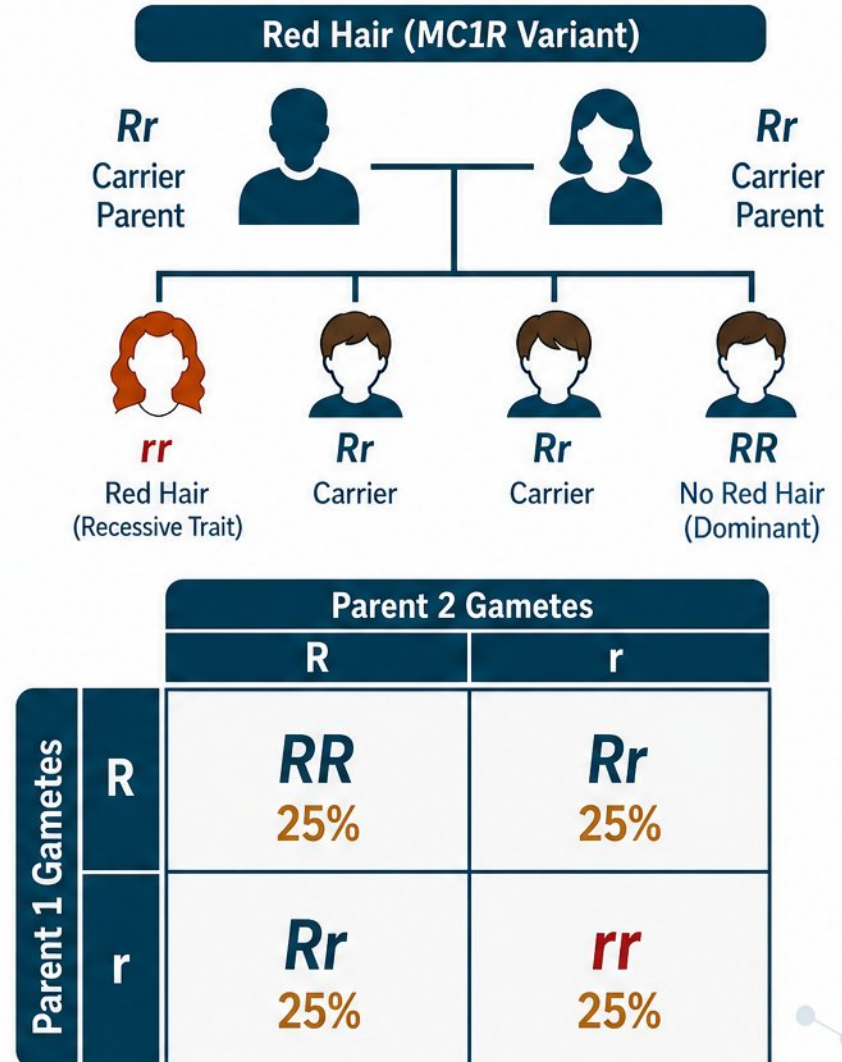
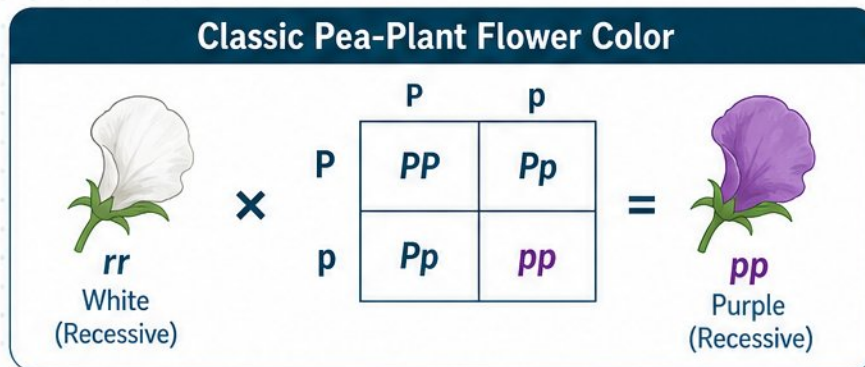
How Traits Travel Through Generations

- Parents pass genes via sperm and egg cells
- Each gamete carries one set of chromosomes
- Unique allele combinations explain family resemblance and variation
- Simple inheritance patterns set the stage for Mendelian rules
- Alleles are gene versions; their combination shapes the outcome



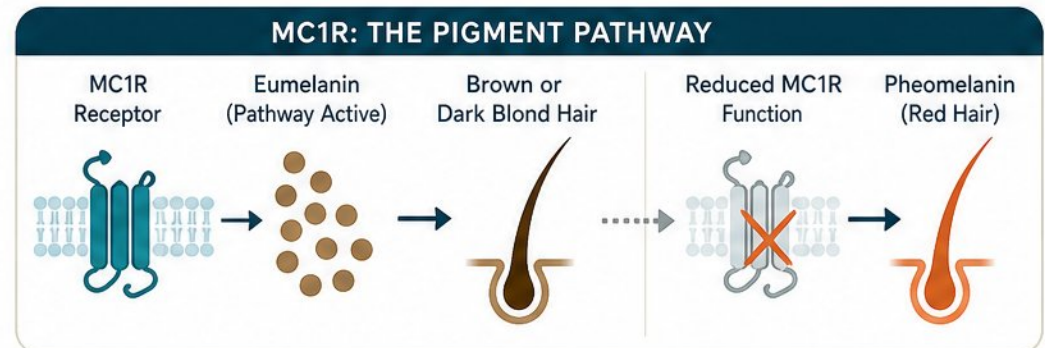
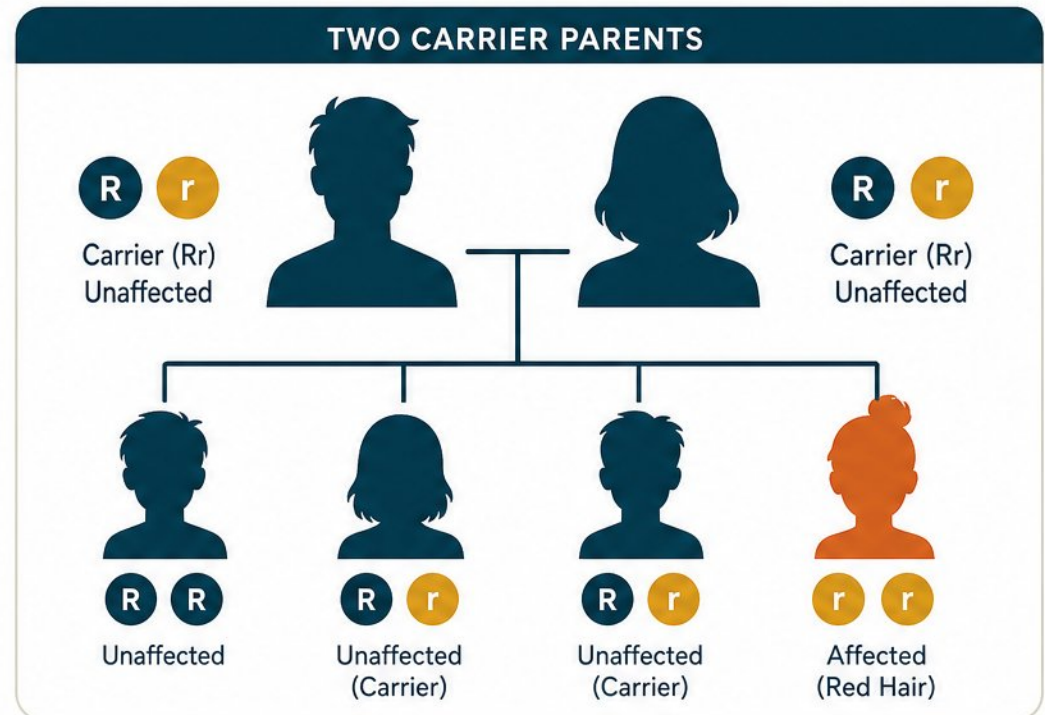
Dominant, Recessive, and the Mighty Punnett Square

- Dominant alleles mask recessive ones; recessive traits need two copies
- Red hair (*MC1R* variant) is recessive: need two variant alleles
- Punnett squares predict offspring allele combinations
- Two carrier parents ($Rr \times Rr$): 25% *rr*, 50% *Rr*, 25% *RR*
- Classic pea-plant flower color shows the same pattern



Why Red Hair Can Hide: Carriers Explained

- A carrier has one recessive allele but doesn't show the trait
- Carriers pass the recessive allele to children without showing it themselves
- Two carrier parents can have an affected child even if both look unaffected
- MC1R example: Rr individuals have brown or dark blond hair, not red
- This explains how traits can seemingly skip generations



R R = Dominant allele
(normal MC1R function)

r r = Recessive allele
(reduced MC1R function)

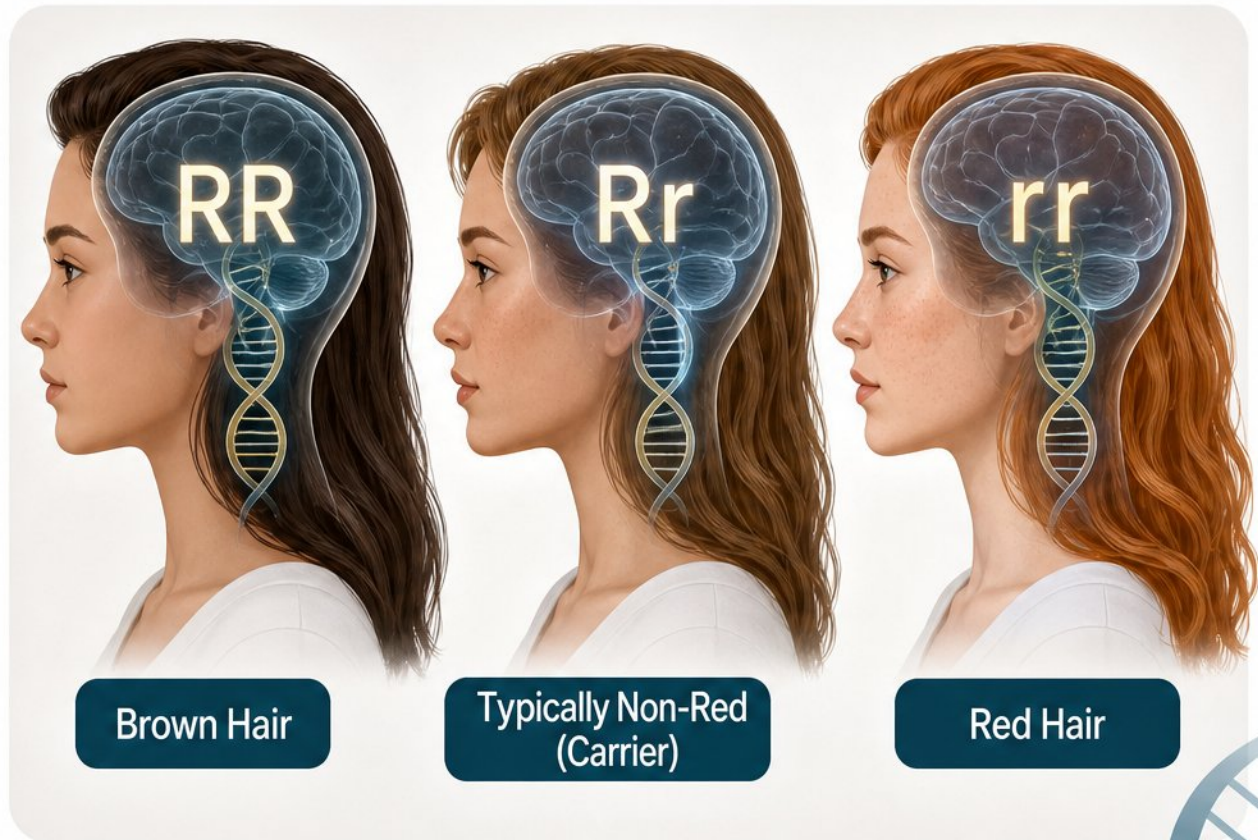
 Unaffected
(not red hair)

 Affected
(red hair)

Genotype vs. Phenotype:

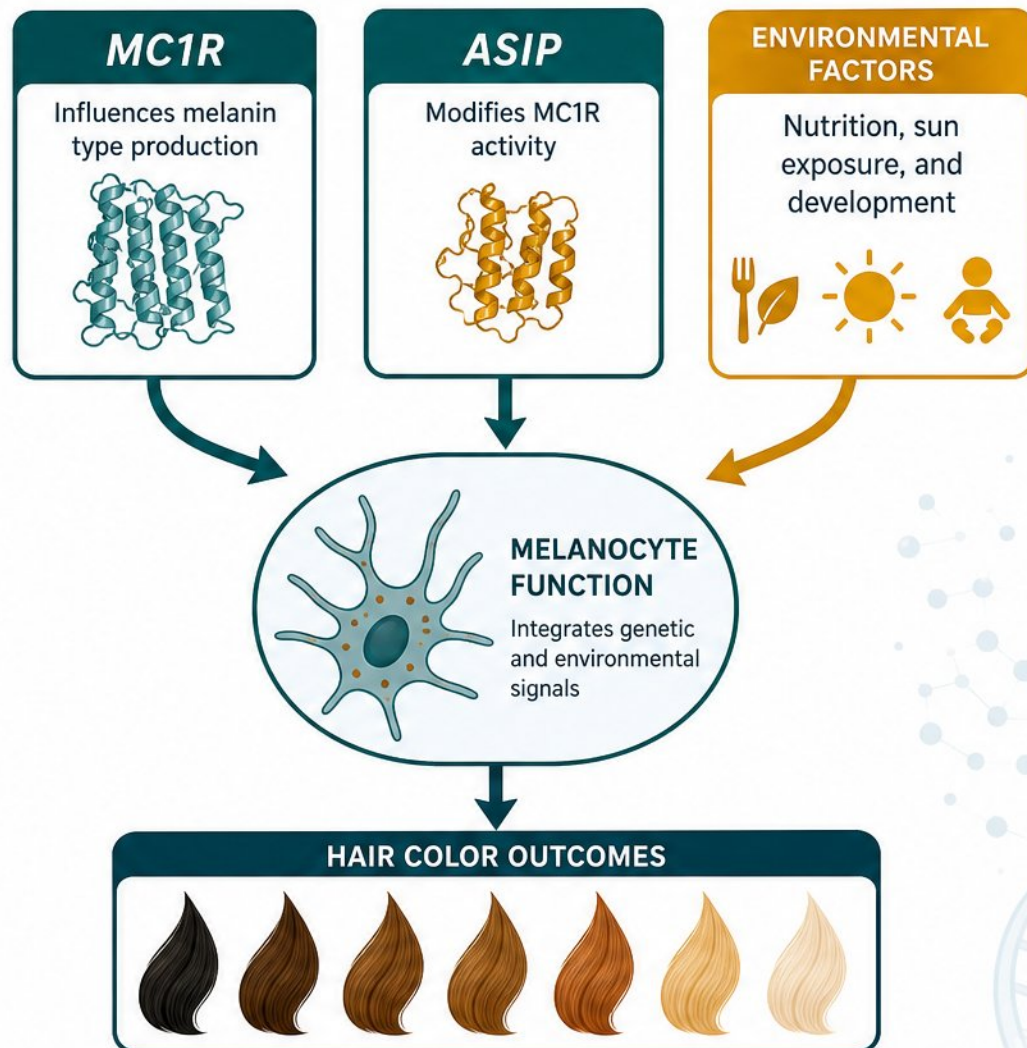
What You See and What You Don't

- **Genotype:** the genetic makeup you carry (e.g., RR, Rr, or rr at MC1R)
- **Phenotype:** the observable trait that appears (e.g., brown hair, red hair)
- **Same phenotype** can hide different genotypes: brown hair may be RR or Rr
- **Same genotype** can show variable phenotypes due to environment or other genes
- **MC1R example:** rr → red hair; Rr → typically non-red but carrier

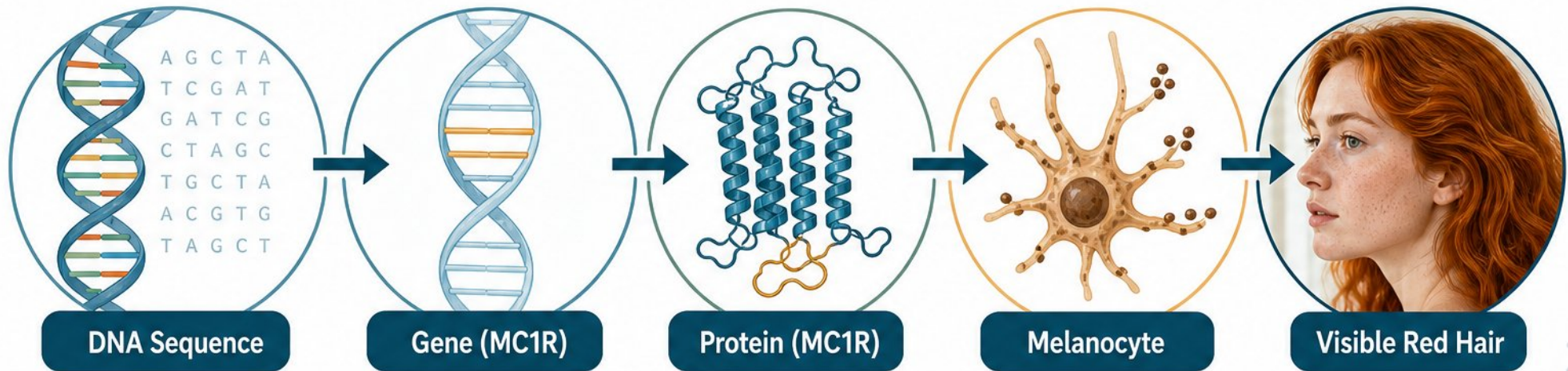


It's (Almost Always) More Complicated: Beyond Simple Inheritance

- Most traits are polygenic — influenced by many genes, not just one.
- Other genes like ASIP modify MC1R effects, complicating predictions.
- Epistasis occurs when one gene masks or overrides another gene.
- Nutrition, sun exposure, and development also shape final traits.



Putting It All Together: From DNA to the Mirror



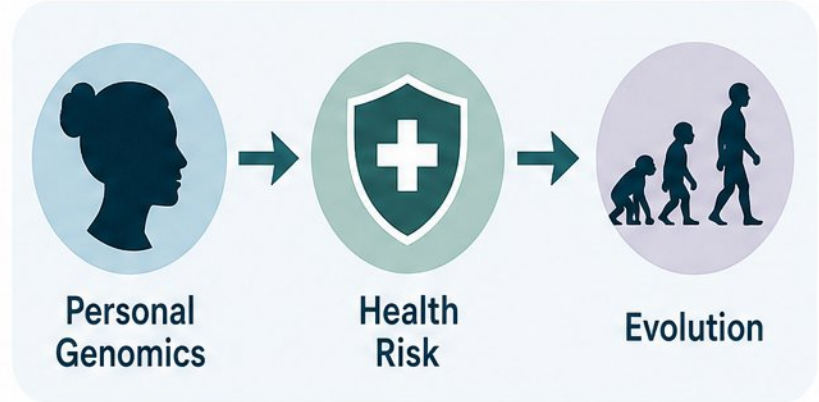
- Traits arise from DNA sequences → genes → proteins → visible outcomes
- Mendelian patterns provide a toolkit; real genetics is more interactive
- Genotype holds potential; phenotype is the realized expression shaped by many factors
- The MC1R story captures the full journey from molecule to trait variation

Summary & What's Next

- - Traits: any observable feature — visible, physiological, or behavioral
- DNA: the double-helix instruction manual in every cell nucleus
- Genes: functional DNA segments that code for proteins like MC1R
- Inheritance: how alleles pass from parents to offspring
- Genotype (hidden code) vs. Phenotype (visible outcome)
- Next: complex traits, genetic testing, and gene-editing tools



BEFORE



AFTER



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