



AMBITION INSTITUTE

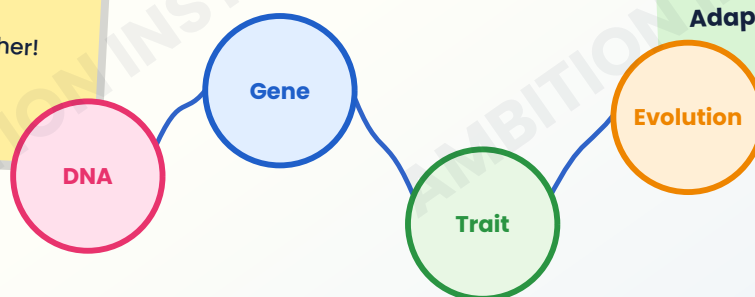
CLASS 10TH

CHAPTER 8

HEREDITY AND EVOLUTION

Let's Inherit, Vary and Evolve – The Story of Life!

Every trait has a story... Let's trace it from parents to species together!



Inherit · Vary · Select · Adapt · Evolve!

**Genes → Traits → Variation
Selection → Evolution**

Observe · Compare · Infer · Understand



HEREDITY & VARIATION



IN SHORT

- Offspring look like their parents – passing of traits from parents to offspring = **Heredity**.
- Differences between individuals of a species (and between parent and child) = **Variation**.
- A distinguishing feature (height, eye colour) = **Trait**.
- The unit of heredity – a segment of DNA that codes for a protein = **Gene**.

Note

- Heredity and variation are two sides of one coin: DNA copying is **mostly accurate** (heredity) but with **small errors** (variation).
- Variation is the **raw material of evolution** – no variation, no evolution.
- Science Class – 10 😊

PATH OF INHERITANCE



Gametes carry **half** the chromosomes (n). At fertilisation the full set (2n) is restored, so a child receives **equal genetic material from both parents** – that is why it resembles both, yet is not identical to either.

TERMS TO KNOW

Term	Meaning	Term	Meaning
Trait	A feature of an organism (height, colour)	Gene	DNA segment that controls one trait
Allele	Alternative form of a gene (T or t)	Genotype	Genetic make-up (TT, Tt, tt)
Phenotype	Visible look (tall / dwarf)	Dominant	Trait that shows in the F1 hybrid (T)
Recessive	Trait hidden in F1, back in F2 (t)	Homozygous	Same alleles (TT or tt)
Heterozygous	Different alleles (Tt) – a hybrid	F1 / F2	1st / 2nd filial generation

WHY IS VARIATION IMPORTANT?

- Helps a species **survive** a changing environment (e.g. heat-resistant bacteria survive a heat wave).
- Gives **raw material** for natural selection.
- Ensures not **all** individuals die in a disaster.
- Sexual reproduction creates **more variation** than asexual.

ASEXUAL VS SEXUAL

Asexual	Sexual
One parent	Two parents
Tiny variation (copying errors)	More variation (crossing over + gamete mixing)
Near-identical clones	Offspring differ from parents
Amoeba, Bryophyllum	Humans, flowering plants

Tip!

Heredity = similarity. Variation = difference. Both come from **DNA**. Say it in order: **Gene → Protein → Trait → Variation → Selection**.

EXAMPLES OF VARIATION

- Free vs attached earlobes
- Tall vs dwarf pea plants
- Skin, hair and eye colour in humans
- Red and green beetles in a population



MENDEL'S EXPERIMENTS



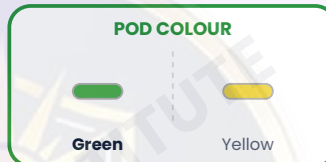
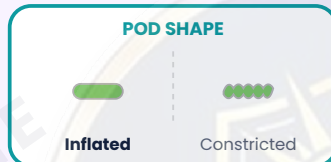
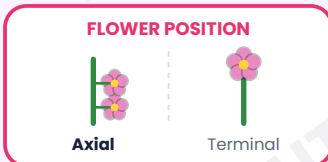
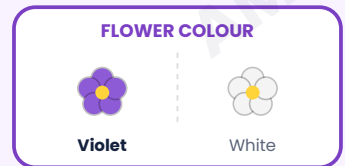
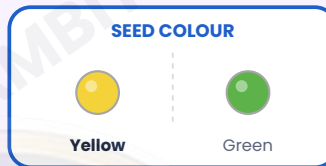
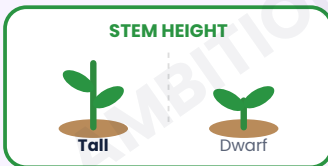
WHO WAS MENDEL?

- **Gregor Johann Mendel** (1822–1884) – Austrian monk, the **Father of Genetics**.
- Experimented on **garden pea** (*Pisum sativum*) from **1856 to 1863**.
- Studied **one or two traits at a time** and counted offspring; work **rediscovered in 1900**.

WHY THE PEA PLANT?

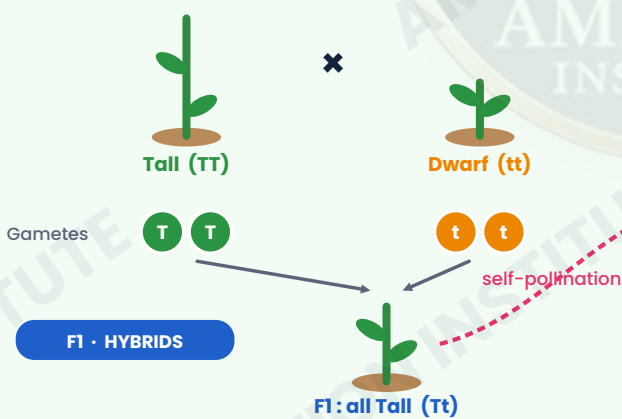
- Many **contrasting traits** (tall/dwarf, round/wrinkled).
- **Self-pollinating** – gives pure (true-breeding) lines.
- Easy to **cross-pollinate** by hand.
- **Short life cycle** and many seeds per plant.

7 PAIRS OF CONTRASTING TRAITS



MONOHYBRID CROSS (ONE TRAIT): TALL × DWARF

P · PARENTS (pure)



F2 · Tt × Tt

	T	t
T	TT	Tt
t	Tt	tt

F1 gametes (top & side)

3 TALL
TT, Tt, Tt

1 DWARF
tt

Phenotype
3 : 1
Genotype
1 TT : 2 Tt : 1 tt

LAW OF DOMINANCE

In a hybrid (Tt) only the **dominant** allele shows; the recessive is masked.

LAW OF SEGREGATION

The two alleles of a pair **separate** in gametes; each gamete gets **one** allele.

INDEPENDENT ASSORTMENT

Alleles of **different traits** are inherited **independently** (9:3:3:1).

Tip!

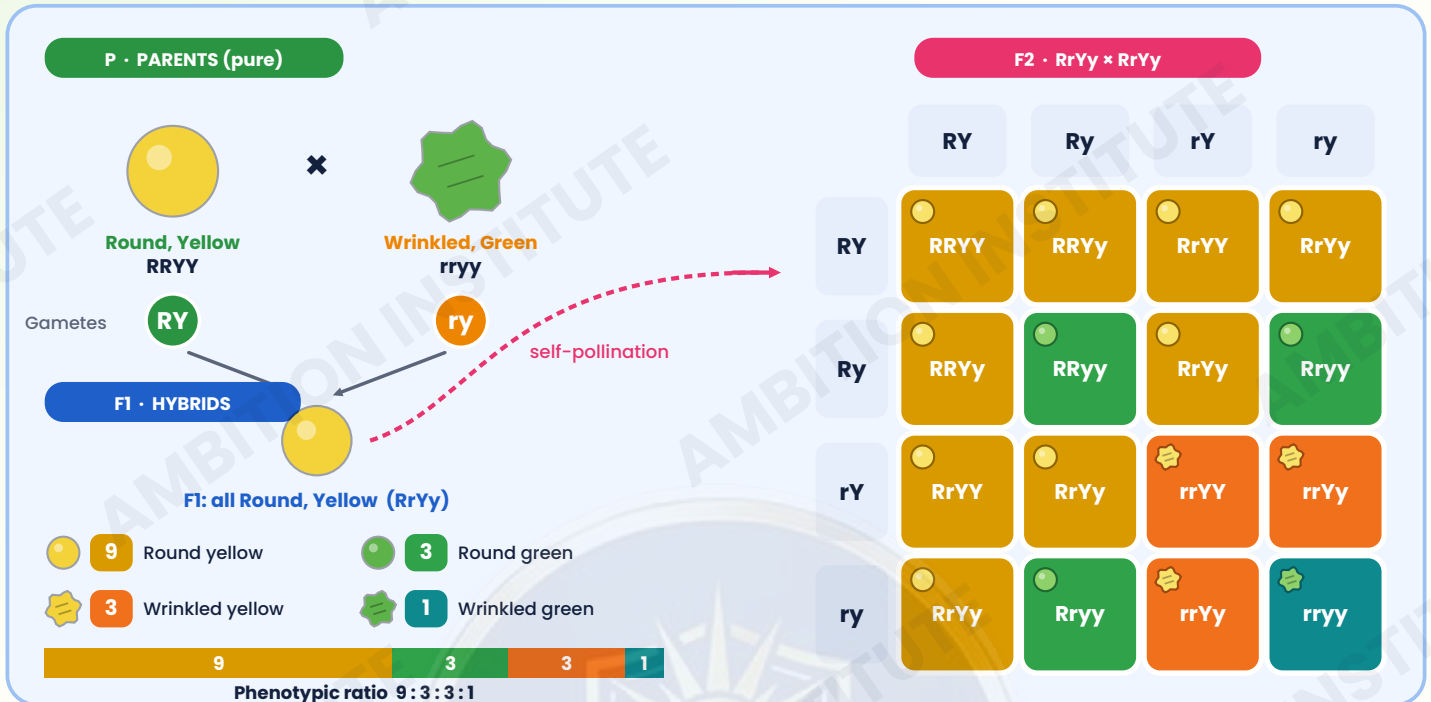
F1 shows **only** the dominant trait; the recessive trait **reappears in F2** in the ratio **3:1**. Mendel's F2 count: 787 tall : 277 dwarf (≈ 3 : 1).

GOOD TO KNOW

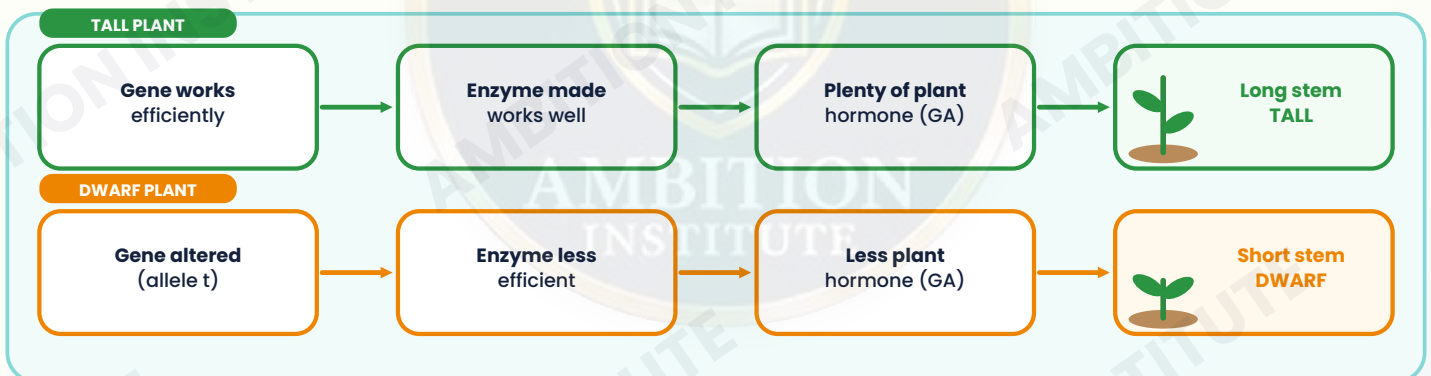
- Capital letter = dominant, small = recessive.
- Pure line = homozygous (TT or tt).



DIHYBRID CROSS (TWO TRAITS): ROUND-YELLOW × WRINKLED-GREEN



HOW ARE TRAITS EXPRESSED? FROM GENE TO TRAIT



MONOHYBRID
Phenotype 3 : 1
Genotype 1 : 2 : 1

DIHYBRID
Phenotype 9 : 3 : 3 : 1
16 boxes in the square

TEST
Count the boxes!
Tall = TT , Tt , Tt (3 of 4)

DOMINANT VS RECESSIVE

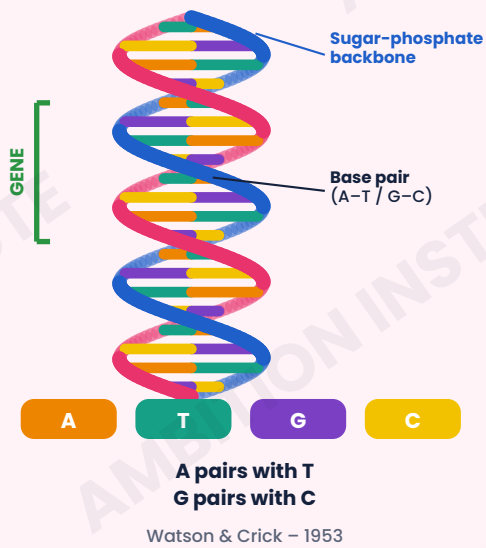
	Dominant	Recessive
Shows in	F1 hybrid (Tt)	Hidden in F1, back in F2
Symbol	Capital letter (T)	Small letter (t)
Copies needed	One (TT or Tt)	Two (tt)
Pea examples	Tall, round, yellow, violet	Dwarf, wrinkled, green, white
Human example	Free earlobe	Attached earlobe

Tip!

Both parents give **one allele each**. A recessive trait appears **only** when the child gets **two recessive alleles** (tt).

Genes do not make traits directly – they make **proteins** (enzymes, hormones) that build traits.

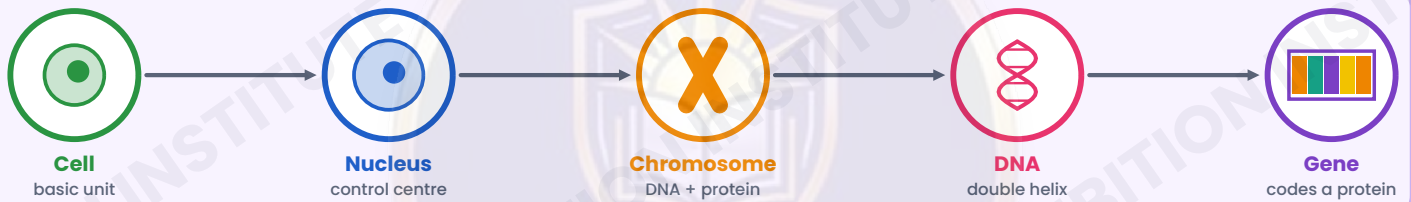
DNA – DOUBLE HELIX



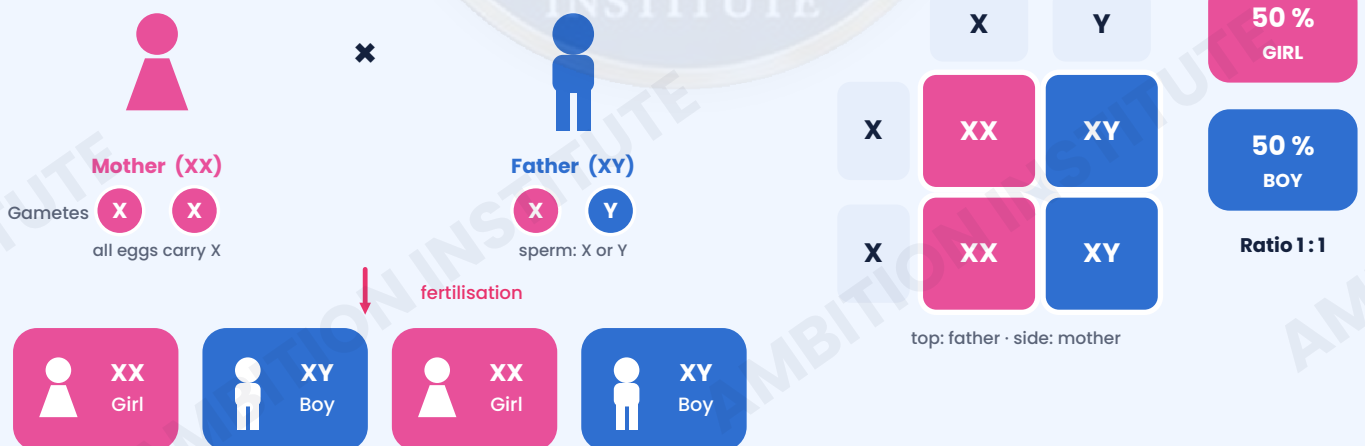
WHAT DOES DNA DO?

- **DNA** = Deoxyribonucleic Acid – the **hereditary material** found in the nucleus.
- A **gene** is a section of DNA that codes for a **protein**; proteins control traits.
- DNA copies itself during cell division; **small errors** give variation.
- Genes are carried on **chromosomes** (thread-like, made of DNA + protein).

CHROMOSOMES IN HUMANS: 46 = 23 PAIRS



SEX DETERMINATION IN HUMANS



SEX DETERMINATION – FACTS

- **Father decides** the sex – his sperm carries X or Y; every egg carries X.
- In some animals (turtles, some lizards) **temperature** of incubation decides sex.
- In snails an individual can **change sex**.

Tip!

X from sperm + X from egg = **girl**.
Y from sperm + X from egg = **boy**.

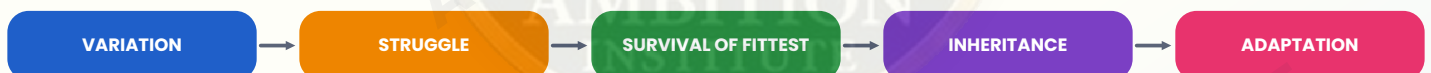
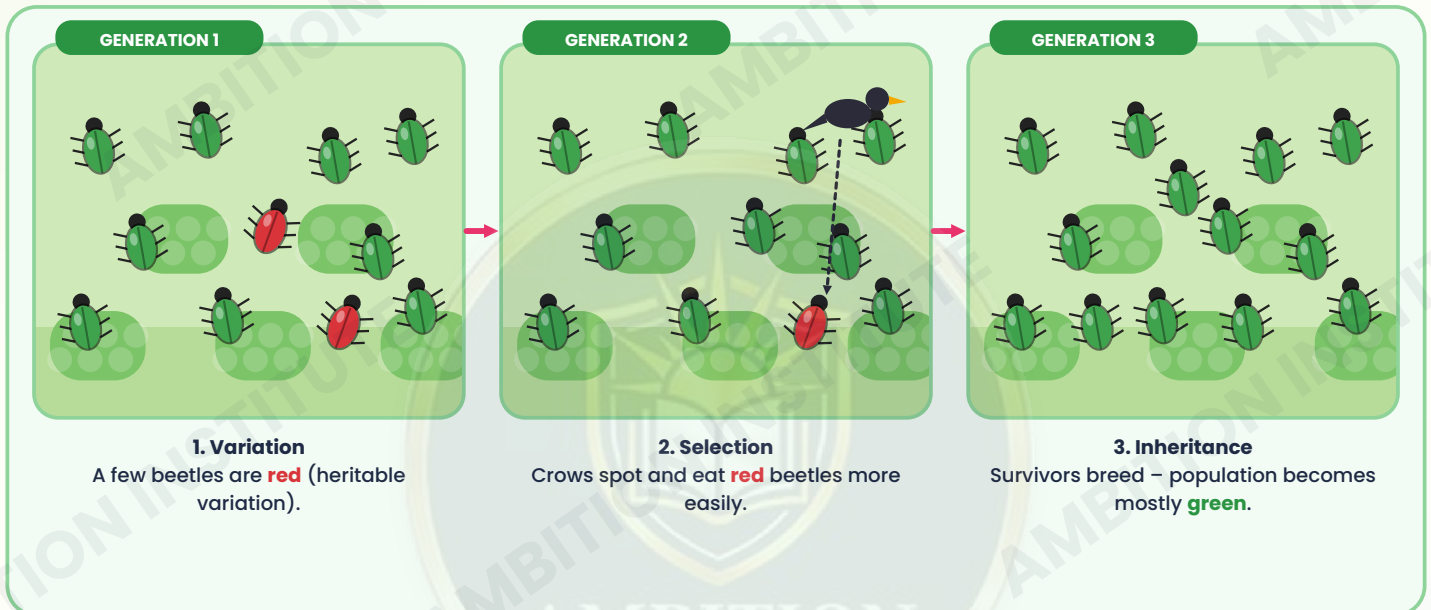
WHAT IS EVOLUTION?

- **Evolution** = gradual change in the characteristics of a species over many generations.
- **Charles Darwin** (1859, *On the Origin of Species*) proposed **natural selection**.
- Evolution is a slow, branching process – not a march to a “better” form.

SOURCES OF VARIATION

- **Errors in DNA copying** (mutations).
- **Crossing over** and random mixing of genes in sexual reproduction.
- **Random fertilisation** – any sperm may fuse with any egg.
- Variations **accumulate** over generations.

NATURAL SELECTION – THE BEETLE STORY



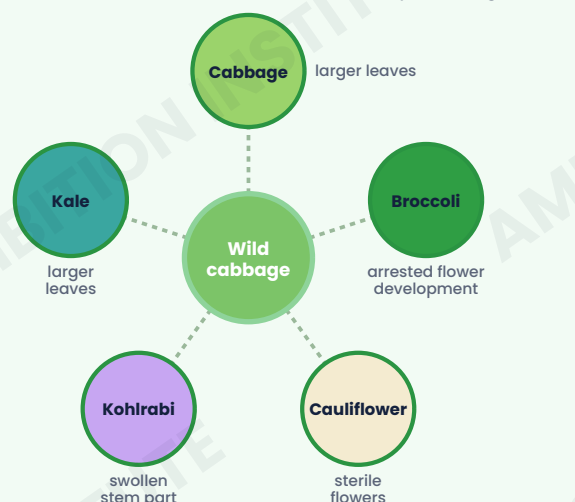
ACQUIRED VS INHERITED TRAITS

Acquired	Inherited
Gained in a lifetime	Come from parents
Change body cells only	Change germ-cell DNA
Not passed on	Passed on
Bodybuilding, a cut tail, learned skills	Eye colour, earlobe type, height

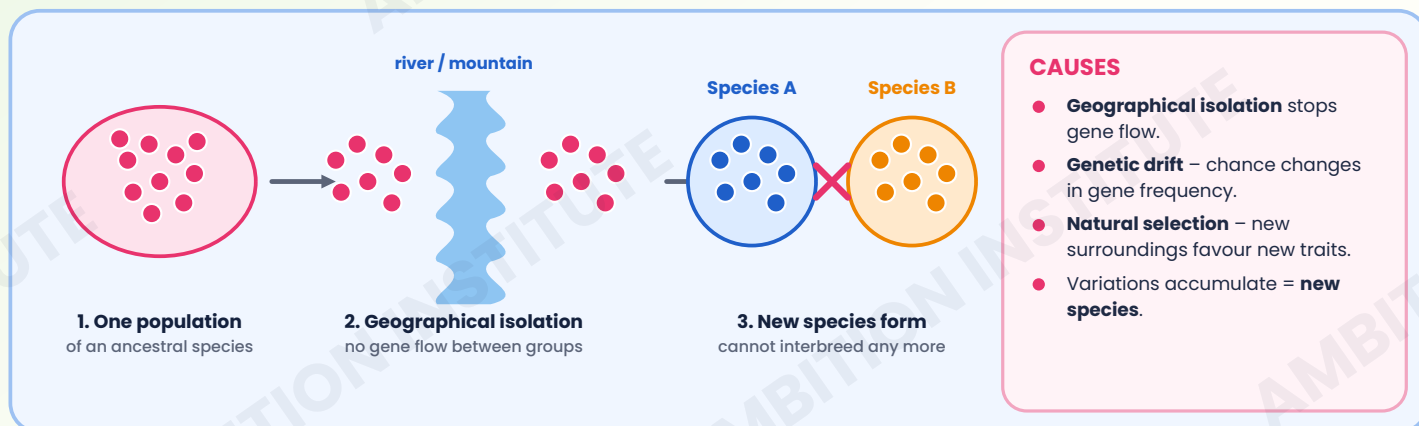
Remember!

Cutting the tails of mice for generations does **not** produce tail-less mice – body-cell changes never reach the **germ cells**.

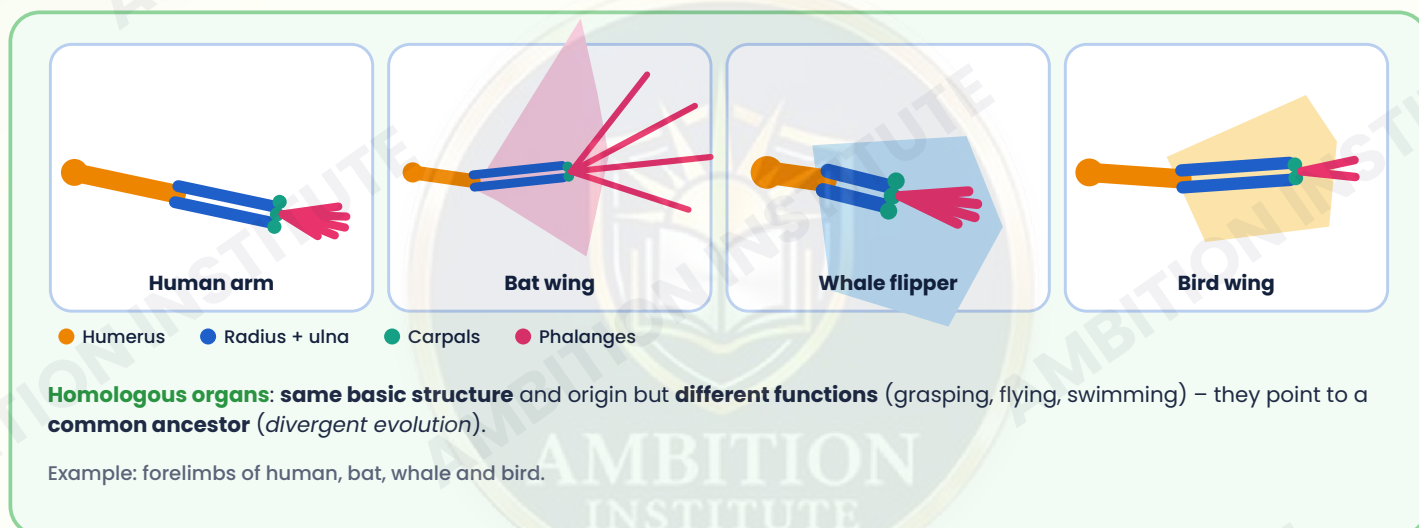
ARTIFICIAL SELECTION



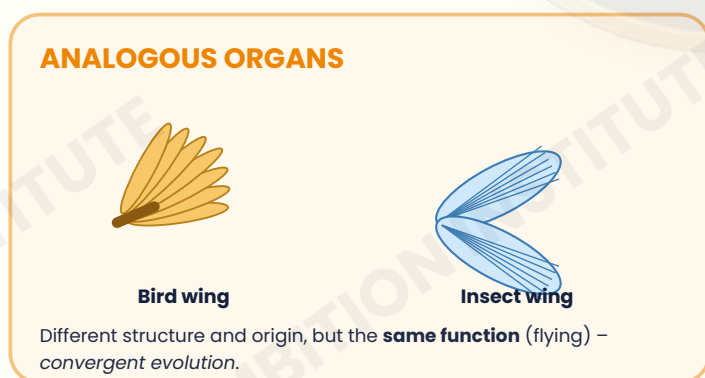
SPECIATION – FORMATION OF NEW SPECIES



EVIDENCE: HOMOLOGOUS ORGANS



ANALOGOUS ORGANS



VESTIGIAL ORGANS

- Human appendix** – large in herbivore ancestors, now almost useless.
- Wisdom teeth** and **tail bone** (coccyx).
- Pelvic bones** in whales; **wings** of the kiwi.
- Reduced or **non-functional** – proof of ancestry.

MOLECULAR EVIDENCE

- Compare **DNA** of species – more similar DNA = closer relatives.
- Gives the same family tree that fossils and anatomy suggest.

Tip!

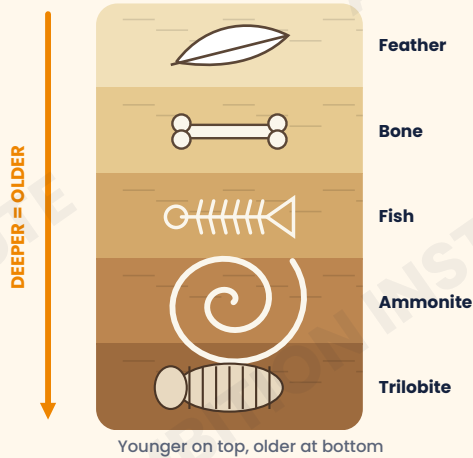
Homologous = same origin.
Analogous = same function.



FOSSILS & HUMAN EVOLUTION



FOSSIL LAYERS



WHAT ARE FOSSILS?

- **Fossils** = preserved remains or impressions of organisms that lived long ago.
- Mostly found in **sedimentary rock** layers.
- **Relative dating**: deeper layer = older fossil.
- **Radiometric dating**: ratio of isotopes (e.g. **Carbon-14**, half-life 5730 years) gives the age.
- Fossils show how forms **changed over time** and reveal **connecting links**.

ARCHAEOPTERYX – A CONNECTING LINK

REPTILE

Teeth in jaws
Claws on wings
Long bony tail

ARCHAEOPTERYX

≈ 150 million
years ago
reptile + bird

BIRD

Feathers
Wings
Flight ability

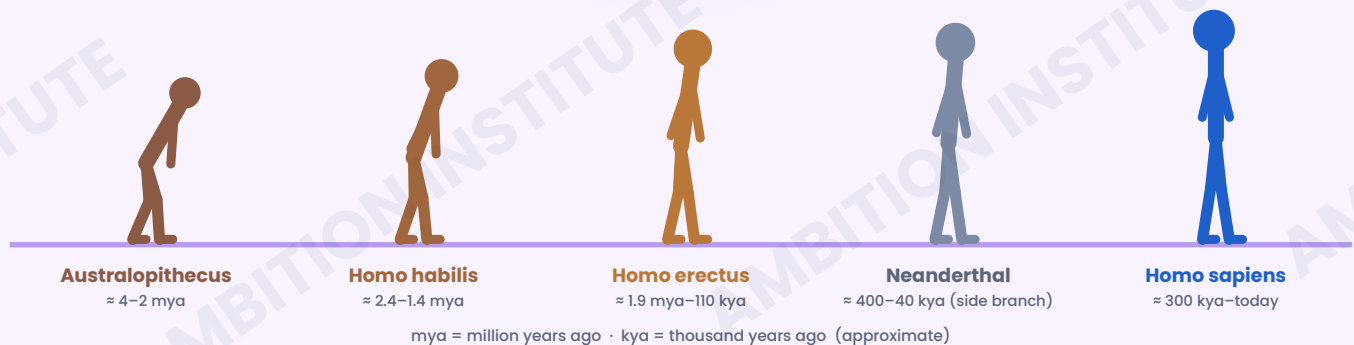
Some **dinosaurs** had feathers for **warmth**; birds later used them for **flight** – a trait can change its use during evolution.

CLASSIFICATION

- Classification reflects **evolutionary relationship**.
- More shared characters = **closer relatives**.
- Tools: homologous organs, fossils, **DNA** comparison.

HUMAN EVOLUTION – FROM AFRICA TO THE WORLD

upright posture · bigger brain · tools & language



HOW WE TRACE IT

- **Excavation** of fossils
- **Time-dating** of finds
- **Fossil study**
- **DNA analysis**

OUT OF AFRICA

- *Homo sapiens* arose in **Africa**.
- Spread to Asia, Europe and beyond.
- All humans = **one species**.

Not progress!

Evolution is a **branching tree**, not a ladder. No species is “higher” or “lower”.





QUICK REVISION



KEY POINTS IN ONE GLANCE

- Heredity = passing of traits; variation = differences. Both arise from **DNA**.
- Mendel (pea plant): **monohybrid 3 : 1** (genotype 1 : 2 : 1); **dihybrid 9 : 3 : 3 : 1**.
- Gene → protein → trait. Dominant shows in F₁; recessive reappears in F₂.
- Humans: **46 chromosomes** (23 pairs). Female **XX**, male **XY**; the **father's sperm** decides sex.
- Natural selection: variation → survival of the fittest → inheritance → adaptation.
- Evidence: **homologous** (same origin), **analogous** (same function), **vestigial** organs, **fossils**, DNA.
- Only changes in **germ-cell DNA** are inherited; acquired traits are not.

COMMON MISTAKES TO AVOID

- Writing 9 : 3 : 3 : 1 for a monohybrid cross – it is **3 : 1**.
- Mixing **genotype** (TT, Tt) with **phenotype** (tall).
- Saying acquired traits are inherited.

- Confusing **homologous** (origin) with **analogous** (function) organs.
- Saying the **mother** decides the sex of the child.
- Calling evolution “progress”; forgetting labels on Punnett squares.

PRACTICE QUESTIONS

1 MARK (MCQ / VSA)

1. Who is known as the father of genetics?
2. What is the F₂ phenotypic ratio of a monohybrid cross?
3. Name the sex chromosomes of a human male.
4. What are organs with the same origin but different functions called?
5. What is the chemical name of the hereditary material?
6. Which isotope is used to date fossils?

2–3 MARKS

1. Differentiate between dominant and recessive traits.
2. How do Mendel's experiments show traits are inherited independently? Draw the Punnett square.
3. How is the sex of a child determined? Draw a flow chart.
4. Differentiate between acquired and inherited traits with examples.
5. What are fossils? How are they dated?
6. Explain homologous and analogous organs with examples.

ANSWERS (1 MARK)

1. Gregor Johann Mendel

2. 3 : 1

3. XY

4. Homologous organs

5. DNA

6. Carbon-14

SELF-CHECK

- Can I draw and explain the monohybrid and dihybrid Punnett squares?
- Can I state 3 : 1 and 9 : 3 : 3 : 1?
- Can I show how sex is determined?
- Can I tell homologous, analogous and vestigial organs apart?

Exam tip!

Diagrams carry marks: Punnett square, sex-determination chart and homologous organs are frequent. Label with a pencil and ruled arrows.