

This is the **Higher Combined** version — includes Higher Tier content. Some Separate-only details are omitted.

Variation between individuals arises from differences in genes and the environment. Mutations are changes to the DNA sequence and are the ultimate source of all genetic variation.

- Genetic variation: differences in the alleles inherited from parents. Caused by mutations and the random mixing during meiosis and fertilisation.
- Environmental variation: caused by conditions during development (e.g. nutrition, sunlight, exercise).
- Most characteristics are influenced by BOTH genes and environment (e.g. height is genetically influenced but also affected by diet).
- Continuous variation: a range of values between extremes (e.g. height, weight, skin tone). Controlled by many genes + environment. Forms a normal distribution (bell curve).
- Discontinuous variation: distinct categories with no intermediates (e.g. ABO blood group, tongue rolling). Usually controlled by one gene.
- A mutation is a change in the DNA base sequence. Can be caused by: radiation (UV, X-rays, gamma rays), chemicals (mutagens) or errors in DNA replication.
- Most mutations are neutral (no effect on protein). Some are harmful (change protein function). A few are beneficial (new advantageous trait).

★ **HT** Mutations are the only way NEW alleles arise — they are the raw material for evolution by natural selection.

Key Terms

Mutation	A change in the DNA base sequence — the ultimate source of new alleles and genetic variation
Continuous variation	Variation showing a range of values (normal distribution) — controlled by many genes + environment
Discontinuous variation	Variation producing distinct categories — usually controlled by one gene
Mutagen	An agent that increases the rate of mutation — e.g. UV radiation, X-rays, certain chemicals

■ **Exam Tip:** Mutations are RANDOM and do not occur in a directed way to help the organism. They just happen — and if they improve survival, they spread through natural selection. This is crucial: mutations are not "designed" to help organisms adapt.