*This is the **Foundation Combined** version — Higher Tier and Separate-only content removed.*

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).

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.