

These notes explain the **why** behind every concept, not just the what. They include **analogies**, **real-life examples**, and explanations of **common mistakes**. Use these alongside your revision notes for full understanding.

B5 Genetics — The Instructions That Build You

Your DNA is a set of instructions 3 billion base pairs long, packed into a nucleus just 6 micrometres across. If stretched out, the DNA from one human cell would be about 2 metres long. It contains approximately 20,000 genes, each coding for a specific protein.

Why Sexual Reproduction Generates Such Variation

Two processes during meiosis ensure that every gamete is unique. First, crossing over: sections of DNA are exchanged between homologous chromosomes during meiosis I. Second, independent assortment: the way chromosomes line up before dividing is random — with 23 pairs of chromosomes, there are 2^{23} (about 8 million) possible chromosome combinations in each gamete. Combine two gametes and the number of possible offspring genotypes is enormous.

■ **Think of it like this:** *Your genome is like a recipe book with 23 chapters (chromosomes). During meiosis, pages are swapped between the two copies of each chapter (crossing over), then one copy of each chapter is randomly selected (independent assortment). The resulting recipe book is unique.*

Evolution — Not a Theory in the Everyday Sense

In everyday language, "theory" means a guess. In science, a theory is a well-tested, evidence-supported explanation for a wide range of observations. Evolution by natural selection is one of the best-supported theories in all of science, backed by evidence from genetics, palaeontology, comparative anatomy, direct observation, and more.

■ **Real-life example:** We can observe evolution happening in real time with bacteria. A population of bacteria can evolve antibiotic resistance within days. MRSA evolved from normal *Staphylococcus aureus* through natural selection driven by antibiotic use in hospitals — a perfect, rapid demonstration of Darwin's mechanism.

Crossing over	Exchange of genetic material between homologous chromosomes during meiosis — generates variation
Natural selection	Mechanism of evolution — better-adapted individuals survive and pass on their genes
Speciation	Formation of a new species when populations become reproductively isolated
Mutation	Change in DNA base sequence — the ultimate source of all new genetic variation