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.

Topic 4 Natural Selection — Understanding Darwin's Great Insight

Charles Darwin spent 20 years refining his theory before publishing On the Origin of Species in 1859, knowing it would be controversial. Alfred Russel Wallace independently arrived at the same idea, prompting Darwin to finally publish. Their insight was that life's diversity could be explained without supernatural intervention — through a purely natural process.

The Mechanism in Detail

The key insight is that reproduction produces variation (through mutation and genetic mixing), resources are limited (so not all offspring can survive), and the environment "selects" which variants are better at surviving and reproducing. Better-adapted variants leave more offspring, so their genes become more common over generations.

■ **Why does this happen?** Why did it take so long for evolution to be accepted? Darwin could not explain how variation was inherited — the mechanism of genetics was not known until Mendel's work was rediscovered in 1900, decades after Darwin. Without a mechanism for inheritance, some scientists were sceptical. Once genetics was combined with natural selection in the "Modern Synthesis" (1930s-1940s), the theory became overwhelming.

■ **Real-life example:** The beak shape of Galapagos finches varies between islands depending on available food. During a drought in 1977, researchers watched natural selection in real time: only large seeds were available, and birds with larger beaks survived better. The average beak size in the population measurably increased within one generation — evolution documented as it happened.

Speciation — When Populations Diverge

Speciation occurs when a population is divided (by a geographic barrier like a mountain range or sea) into two groups that cannot interbreed. Each population evolves independently under different environmental pressures. Eventually, genetic differences accumulate until the two groups can no longer reproduce successfully even if brought back together — they are now different species.

Natural selection	Process by which better-adapted individuals survive and pass on their genes
Variation	Differences between individuals in a population — the raw material for natural selection
Adaptation	An inherited characteristic that increases an organism's chance of survival and reproduction
Speciation	Formation of a new species through reproductive isolation and independent evolution
Selective breeding	Artificial selection — humans choosing which individuals to breed for desired traits

Genetic engineering	Inserting a gene from one organism into another using restriction enzymes and ligase