D.4.1 · Natural selection · supported focus

International Baccalaureate · IB Diploma · Biology · HL

Scope and prerequisites

Supported HL/SL core focus. First assessment 2025; current subject brief acquired; full Biology guide not acquired. Remaining guide, assessment and practical requirements retain their recorded holds.

Prerequisites: variation and inheritance from D.1 and evolution evidence from A.4.1. Each lesson develops its own method before independent transfer.

These are original or explicitly fictional teaching examples, not actual measurements or completed assessed learner investigations.

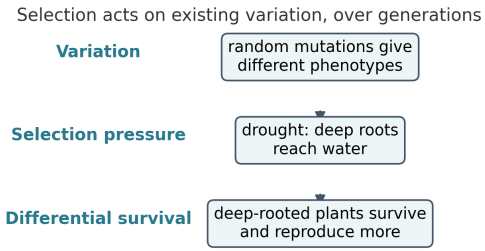
Natural selection

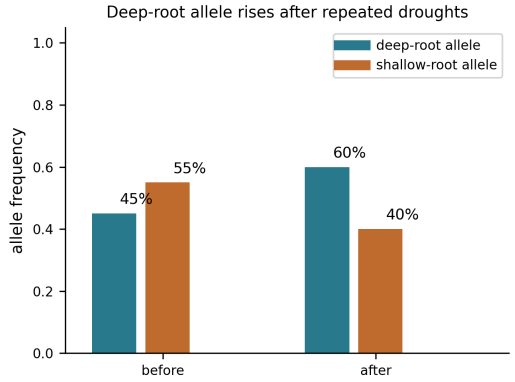
■ What would explain this observation?

- After several dry summers, most plants in a population have deeper roots than their grandparents' generation did. Nobody chose this – how did the population change?
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- **Natural selection** needs three ingredients: inherited **variation** exists in the population; a **selection pressure** makes some variants survive and reproduce better than others; and the successful variants' alleles become commoner in the next generation. Over generations the population's traits shift.
- Selection does not create mutations and no individual evolves: random mutation supplies the variation BEFORE the pressure acts, and it is the population's **allele frequency** that changes, not any one organism.
- natural selection: The process by which heritable variants that fit the environment leave more offspring, changing allele frequencies over generations; variation: Inherited differences among individuals of a population; selection pressure: An environmental factor that affects survival or reproduction; allele frequency: The proportion of one allele among all copies of that gene in a population.





■ Choose evidence that can test it

- The model predicts the direction of change: after repeated droughts, measure the deep-root allele's frequency in stored seed collections or dated samples – it should rise. If it does not, the explanation fails.
- A fair test compares the SAME population across time or matched populations across a boundary, so that migration or sampling differences cannot fake the shift.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: before the droughts, 200 gene copies include 90 copies of the deep-root allele; after several generations, 120 of 200. Allele frequency = copies of the allele / total copies. Before: 90/200 = 45%. After: 120/200 = 60%. The frequency rose by 15 percentage points – evidence of selection acting on the population.

Example:

In a new generation, 140 of 200 copies carry the deep-root allele. Find the frequency and the change from the previous generation using the same sequence: known quantities → model → relation → substitution → unit and interpretation. (Answer: 140/200 = 70%; change = 70% − 60% = +10 percentage points. Frequencies of two alleles at one gene sum to 100%.)

■ Check the conclusion and its limits

- A frequency shift shows association between the trait and survival; proving the mechanism needs the variation to be heritable and the survival difference measured. Genetic drift in small populations can shift frequencies with no selection at all.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

An organism develops a useful adaptation during its lifetime because it needs one. This claim is false: mutation is random with respect to need – the deep-root alleles existed before the drought. Selection only changes which variants leave more offspring; individuals do not evolve.

Key:

Natural selection: inherited variation + a selection pressure + differential reproduction shifts allele frequencies over generations. Track the shift with allele counts divided by total copies, and remember that the population evolves – never the individual.