B.4.1 · Adaptation to environment · 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: transpiration from B.2.3 onwards and natural selection from D.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.

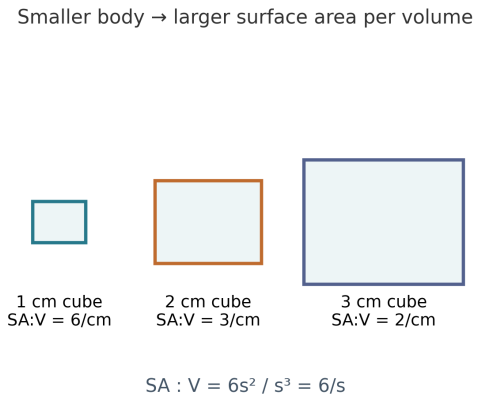
Adaptation to environment

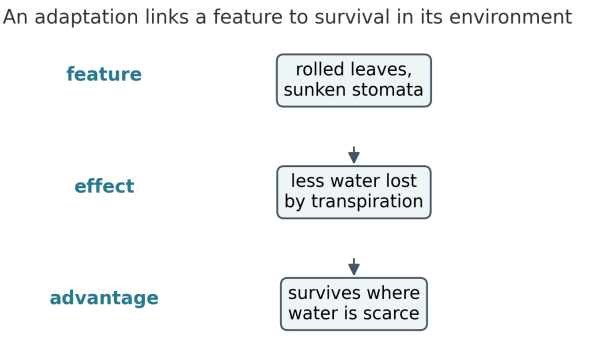
■ What would explain this observation?

- A cactus survives months without rain while a water lily lives with its leaves flat on the water surface. Both are plants, yet their bodies are nearly opposite. Why?
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- An **adaptation** is an inherited feature that improves survival or reproduction in a particular environment. Adaptations are structural (rolled leaves, sunken stomata in a **xerophyte**), physiological (concentrated urine in a desert mammal) or behavioural (a lizard basking to warm up).
- A useful adaptation explanation links feature → effect → advantage: rolled leaves trap moist air, so less water is lost by transpiration, so the plant survives drought. **Surface area to volume ratio** (SA:V) explains many adaptations: a smaller body has a larger SA:V and loses heat or water faster.
- adaptation: An inherited feature improving survival or reproduction in a given environment; xerophyte: A plant adapted to dry conditions; surface area to volume ratio: Surface area divided by volume, controlling exchange rates.





Choose evidence that can test it

- Compare water loss from a xerophyte leaf and a mesophyte leaf under the same warm, dry, moving air: the adaptation model predicts less loss from the xerophyte. Keep leaf size, temperature and humidity constant, or the comparison proves nothing.
- Measure the SA:V of model cubes or of organisms and compare with their habitats; a claim about surface area must come from measured dimensions, not from looking at the picture.

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: cube side s = 3 cm. Surface area = $6s^2 = 6 \times 9 = 54$ cm^2; volume = s^3 = 27 cm^3. SA:V = 54/27 = 2 per cm. For a 1 cm cube: SA:V = 6/1 = 6 per cm. Tripling the side cut the ratio to one third – larger bodies have less surface per unit volume, so they lose less heat per unit of tissue.

Example:

A desert mammal model has body surface 400 cm^2 and volume 2,000 cm^3. Find its SA:V and compare it with a small desert mouse at 2 per cm, using the same sequence: known quantities → model → relation → substitution → unit and interpretation. (Answer: SA:V = 400/2,000 = 0.2 per cm – one tenth of the mouse's, so the larger animal loses proportionally less water and heat through its surface.)

■ Check the conclusion and its limits

- A plausible story about a feature's use is a hypothesis until evidence supports it; some features are side effects of other traits, not adaptations. The cube model assumes a uniform shape – real organisms extend surface where exchange is needed (lungs, gills, root hairs), breaking the simple scaling.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A desert plant adapts during one hot summer by growing thicker cuticle because it needs to. This claim is false: adaptations are INHERITED features shaped by selection over generations; an individual's one-season response is acclimatization, not adaptation, and need never directs the change.

Key:

Adaptation to environment: inherited features link to survival through a feature → effect → advantage chain, testable by controlled comparison. SA:V = 6/s for a cube, and it falls as size rises – exchange surfaces and body plans follow from it.