

Transfer of energy and matter · supported focus

International Baccalaureate · IB Diploma · Biology · HL

Scope and prerequisites

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

Prerequisites: read the stated quantities and units, use arithmetic and the model conditions below. 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.

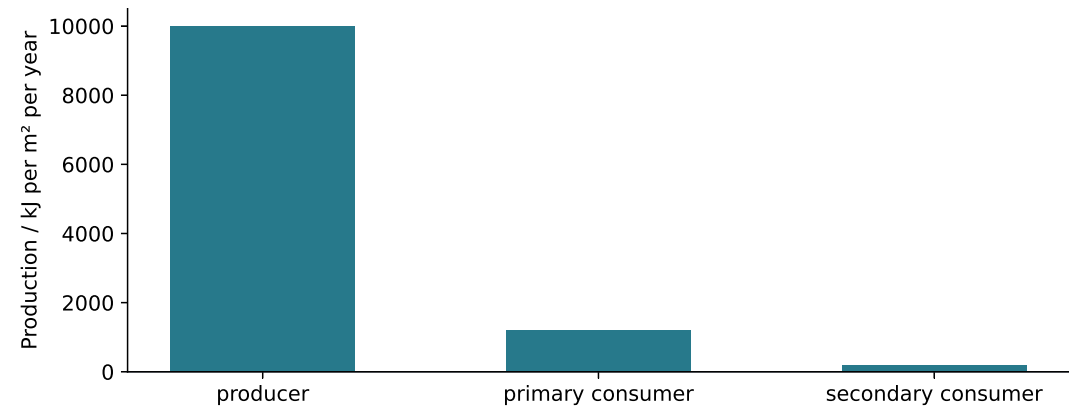
Energy transfer: use production and a stated boundary

■ What would explain this observation?

- Energy available as new biomass usually decreases along a food chain. Energy is conserved overall, but some transferred energy leaves the next-level production pathway.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Producers convert an energy input into chemical energy in organic material. Consumers obtain material by feeding. **Trophic transfer efficiency** compares production available at one level with production at the preceding level over a common area and time. Energy can enter detrital pathways, remain in uneaten material, leave in egested waste or be transferred as heat through respiration.
- trophic transfer efficiency: Production at one trophic level divided by production at the preceding level over a common interval; **assimilation** : Uptake of digested material into an organism's usable internal pool.



■ Choose evidence that can test it

- Use the same energy units and period in numerator and denominator. Distinguish ingestion, assimilation and production: consumed energy is not all assimilated, and assimilated energy is not all stored as new biomass. An energy pyramid records a flow per area per time; a standing biomass snapshot is a different quantity.
- Analyse attributed or fictional ecosystem budget data. Draw a boundary and arrows for feeding, detritus and heat transfer. Identify which values are measured and which inferred, and check whether the budget includes decomposers. Avoid treating a fixed 10% rule as a universal measurement for every ecosystem.

■ 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: producer production is 10,000 kJ/m²/year and primary-consumer production is 1,200 kJ/m²/year. Transfer efficiency is $1,200/10,000 \times 100 = 12\%$. Secondary-consumer production of 180 kJ/m²/year gives $180/1,200 \times 100 = 15\%$ for that step. These different values show why a universal 10% assumption would misrepresent this dataset.

Example:

Producer production is 8,000 and primary-consumer production is 800 kJ/m²/year. Calculate transfer efficiency. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ Check the conclusion and its limits

- Energy is not destroyed when respiration transfers it as heat. Material can cycle through an ecosystem, while usable energy flow depends on continuing input. A count pyramid or biomass snapshot cannot automatically be substituted into an energy-efficiency calculation.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Respiration destroys energy instead of transferring it to other forms. This claim is false: Energy is not destroyed when respiration transfers it as heat. Material can cycle through an ecosystem, while usable energy flow depends on continuing input. A count pyramid or biomass snapshot cannot automatically be substituted into an energy-efficiency calculation.

Key:

Energy transfer: use production and a stated boundary: Use the same energy units and period in numerator and denominator. Distinguish ingestion, assimilation and production: consumed energy is not all assimilated, and assimilated energy is not all stored as new biomass. An energy pyramid records a flow per area per time; a standing biomass snapshot is a different quantity.