

23.1 Energy transfer: use production and a stated boundary

Name: _____ Class: _____ Date: _____ Total: 10 marks

KEY WORDS trophic transfer efficiency • assimilation

Objective

Energy transfer: use production and a stated boundary. Supported SL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

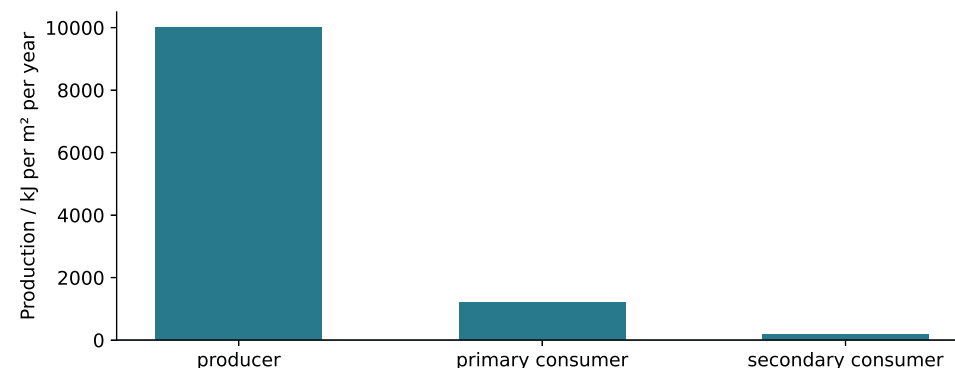
1 Key knowledge and worked examples

■ 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.

2 Practice

2.1 Which pair can be used for the stated transfer-efficiency calculation? Choose one answer.

- **A** Two production values with common area, time and energy units
- **B** Animal count divided by plant biomass
- **C** Standing biomass divided by an unrelated yearly energy total

[1]

2.2 Producer production is 8,000 and primary-consumer production is 800 kJ/m²/year. Calculate transfer efficiency. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: Respiration destroys energy instead of transferring it to other forms.

[2]

2.4 Production at one trophic level divided by production at the preceding level over a common interval: write the technical term.

[1]

3 Exam-style questions

3.1 Fictional production values are 12,000, 1,800 and 180 kJ/(m² year) at successive levels. Find both transfer efficiencies and explain why a universal 10% assumption fails.

[4]

Solutions

2.1 A 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.

2.2 $\text{efficiency} = 800 / 8,000 \times 100 = 10\%$.

2.3 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.

2.4 trophic transfer efficiency. trophic transfer efficiency means Production at one trophic level divided by production at the preceding level over a common interval.

3.1 15% then 10%. Use adjacent levels with the same area/time basis; losses and unconsumed material vary. The dataset gives two different fractions.