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. Original classroom practice for IB SL; not an official IB paper.

1 Key knowledge and worked examples

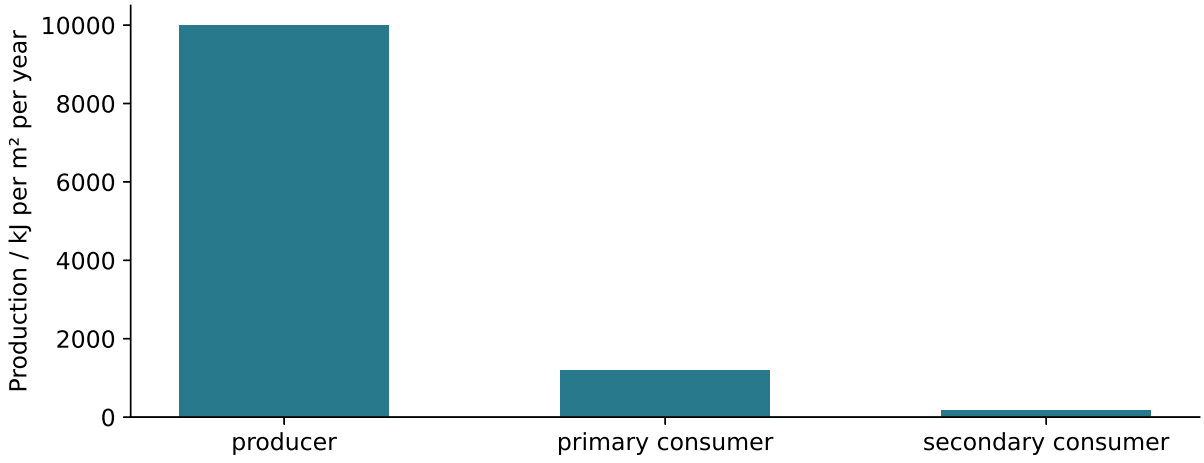
What would explain this observation?

- 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.

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.

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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.

In the lab: 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

- Known: producer production is 10,000 kJ/m^2/year and primary-consumer production is 1,200 kJ/m^2/year.
- Transfer efficiency is 1,200/10,000×100=12%.
- Secondary-consumer production of 180 kJ/m^2/year gives 180/1,200×100=15% for that step.
- These different values show why a universal 10% assumption would misrepresent this dataset.

Your turn: Producer production is 8,000 and primary-consumer production is 800 kJ/m^2/year. Calculate transfer efficiency.

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.

Not true: Respiration destroys energy instead of transferring it to other forms. Respiration transfers energy to the surroundings as heat - the energy still exists. “Loss” between trophic levels means energy leaves the food chain’s usable flow; conservation is never violated.

Key:

- Producers convert an energy input into chemical energy in organic material.
- Use the same energy units and period in numerator and denominator.
- Watch for: energy is not destroyed when respiration transfers it as heat.

■ **Write from a transfer efficiency of 15 percent**

- Producer production is 6,000 and primary-consumer production is 900 kJ per square metre per year.
- Find the transfer efficiency. Respiration transfers energy. It does not destroy it.

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** Standing biomass divided by an unrelated yearly energy total
- **C** Animal count divided by plant biomass [1]

2.2 Producer production is 8,000 and primary-consumer production is 800 kJ/m^2/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/(m^2 year) at successive levels. Find both transfer efficiencies and explain why a universal 10% assumption fails. [4]

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Solutions

2.1 A Transfer efficiency is a ratio of productions, so both values must be production in the same area, time and energy units. Mixing counts, standing biomass or unmatched units produces a meaningless number.

2.2 efficiency=800/8,000×100=10%.

2.3 False. Respiration transfers energy to the surroundings as heat - the energy still exists. "Loss" between trophic levels means energy leaves the food chain's usable flow; conservation is never violated.

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.