

Exercise walk-through

Energy Flow and the 10% Rule ■ 1.10

eXercise

You must be able to

- apply the **10% rule** 十分之一定律
- calculate energy at each trophic level
- explain why energy is lost between levels

Method — The 10% rule

Only about **10%** of the energy at one trophic level is passed to the next. The other ~90% is lost as **heat** and used for the organism's own life processes (movement, respiration).

Method — Calculating up the levels

Multiply by 0.1 at each step. Producers with 10 000 units $\rightarrow$ primary consumers 1000 $\rightarrow$ secondary 100 $\rightarrow$ tertiary 10.

Method — Why energy is lost

Energy is used for respiration, movement, and heat, and not all of an organism is eaten or digested — so most energy never reaches the next level.

Method — A worked calculation

If producers store 50 000 kcal, the secondary consumers receive
 $50\,000 \times 0.1 \times 0.1 = 500$ kcal.

Practice 2.1 ■ 1 mark

What percentage of energy passes to the next trophic level?

Solution 2.1

Method: The 10% rule

Worked steps

About 10% **B1**.

Practice 2.2 ■ 1 mark

Producers have 8000 kcal. How much reaches the primary consumers?

Solution 2.2

Worked steps

800 kcal **B1**.

Practice 2.3 ■ 1 mark

Where does the “lost” energy go?

Solution 2.3

Worked steps

Lost as heat and used in life processes (respiration, movement) **B1**.

Exam-style 3.1 ■ 1 mark

By the 10% rule, energy passed from producers to primary consumers is

A 1%

B 10%

C 90%

D 100%

Solution 3.1

A 1%

B 10% 

C 90%

D 100%

Worked steps

B — 10%.

Exam-style 3.2 ■ 3 marks

Producers in an ecosystem store $30\,000 \text{ kcal/m}^2/\text{yr}$.

- (a) Calculate the energy reaching the tertiary consumers.
- (b) Explain why so little reaches this level.

Solution 3.2

Method: A worked calculation

Worked steps

(a) primary = 3000; secondary = 300; tertiary = 30 kcal/m²/yr **M1** **M1** **A1**. (b)
About 90% of the energy is lost at each of the three transfers **B1**.

Exam-style 3.3 ■ 2 marks

Explain why energy flow limits the number of trophic levels an ecosystem can support.

Solution 3.3

Method: The 10% rule

Worked steps

Because ~90% of energy is lost at each level, after a few levels there is too little energy left to support another, limiting the number of levels **M1** **A1**.