

What is Energy Flow in Ecosystems?

Worksheet

Energy flows one-way through an ecosystem, entering as sunlight captured by producers and passing through trophic levels; on average only about 10% of the energy at one trophic level is transferred to the next (the 10% rule, or Lindeman's Rule).

$$\text{Efficiency} = \frac{\text{Energy}_n}{\text{Energy}_{n-1}}$$

Questions

1. According to the 10% rule, if producers have 5,000 kcal/m/yr, how much energy is available to primary consumers?

- A) 500 kcal/m/yr
- B) 5,000 kcal/m/yr
- C) 50 kcal/m/yr
- D) 50,000 kcal/m/yr

2. What happens to the ~90% of energy not passed to the next trophic level?

- A) It disappears completely
- B) It is stored underground
- C) It is lost mainly as heat through respiration
- D) It converts into new nutrients

3. How does energy flow differ from nutrient cycling in an ecosystem?

- A) Energy cycles, nutrients flow one way
- B) Both cycle repeatedly
- C) Energy flows one way, nutrients cycle
- D) There is no difference

4. Why do food chains typically have only 4-5 trophic levels?

- A) Predators refuse to evolve further
- B) Energy loss at each level leaves too little to support more levels
- C) There is a fixed rule in nature limiting exactly 5 levels
- D) Producers can only support 5 species

5. Producers in a grassland fix 10,000 kcal/m/yr. How much energy is available to primary consumers?

6. Primary consumers have 500 kcal/m/yr available. How much energy reaches secondary consumers?

7. A producer level has 50,000 kcal/m/yr. Calculate the energy available at the tertiary consumer level (3 transfers away).

8. Define: What is energy flow?

9. Define: What is the 10% rule?

10. Define: Does energy cycle like nutrients?

Answer Key

1. A) $500 \text{ kcal/m/yr} - 5,000 \cdot 0.10 = 500 \text{ kcal/m/yr}$.
2. C) It is lost mainly as heat through respiration - Most energy is used for metabolism and lost as heat during cellular respiration.
3. C) Energy flows one way, nutrients cycle - Energy passes through an ecosystem once and is lost as heat; nutrients are reused (recycled).
4. B) Energy loss at each level leaves too little to support more levels - Because roughly 90% of energy is lost at each transfer, higher levels cannot get enough energy to sustain a population.
5. Using the 10% rule: $E_1 = E_0 \cdot 0.10$ $E_1 = 10,000 \cdot 0.10 = 1,000 \text{ kcal/m/yr}$
6. $E_2 = E_1 \cdot 0.10$ $E_2 = 500 \cdot 0.10 = 50 \text{ kcal/m/yr}$
7. $E_3 = E_0 \cdot 0.10$ $E_3 = 50,000 \cdot 0.001 = 50 \text{ kcal/m/yr}$
8. The one-way movement of energy through an ecosystem, from producers through each trophic level of consumers.
9. On average, only about 10% of energy at one trophic level is transferred to the next; the rest is lost mainly as heat via respiration.
10. No - energy flows in one direction and is not recycled; nutrients cycle, energy does not.

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