

2.3 Track energy transfer and matter cycling in an ecosystem

Name: _____ Class: _____ Date: _____

Total: 24 marks**KEY WORDS** ecosystem 生态系统 • producer 生产者 • decomposer 分解者

Objective

Track energy transfer and matter cycling in an ecosystem. This is original GAC023-aligned practice, not an official assessment. All supplied case data and review records are fictional; explicitly cited background is factual. The case data are invented for learning; they are not findings about a real school, country or population. Use the supplied evidence and do not invent missing observations.

1 Key knowledge and worked examples

■ Key knowledge: energy transfer and nutrient cycling are different processes

An **ecosystem** 生态系统 includes organisms and nonliving conditions in an area. A **producer** 生产者 makes organic material using an energy source; a consumer obtains organic material from other organisms. A **decomposer** 分解者 breaks down dead material and waste, helping return nutrients to available forms. Food-chain arrows point from food to consumer, showing transfer. Energy enters, transfers and is dissipated; matter can cycle. Transfer efficiencies vary rather than following a universal fixed percentage.

■ Source A: text or task brief

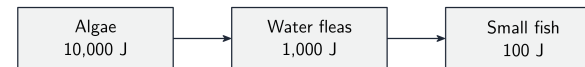
Fictional simplified meadow energy budget for one stated period: grass has 5,000 J available in the defined producer level; grasshoppers receive 600 J from that level; frogs receive 60 J from grasshoppers. For this task, efficiency is energy received at the next level divided by energy available at the previous level, times 100%. The record supplies no other transfers, population counts or long-term trend.

The meadow also contains soil microbes that break down dead leaves, plus nonliving water, mineral nutrients and light conditions. In a separate illustrative worked example, algae have 10,000 J, water fleas receive 1,000 J and small fish receive 100 J. This example is not the meadow's measured budget.

■ Source B: response or review record

Student explanation: "The arrows should point from the frog to the grasshopper because the frog eats it. Exactly 90% of energy disappears in every ecosystem transfer. Microbes return energy to the grass so it cycles forever. If grasshoppers decline, the frog population must drop by exactly the same percentage next week. We can compare biodiversity by counting only the total number of grasshoppers."

■ Worked example: calculate an efficiency for the defined levels



Known: algae level 10,000 J and water fleas 1,000 J. Why use a ratio? The question asks what fraction reaches the next defined level.

$$\eta = \frac{E_{next}}{E_{previous}} \times 100\%$$

$$\eta = \frac{1000}{10000} \times 100\% = 10\%$$

That is the efficiency of this supplied example. It does not make 10% a law for every ecosystem. Some energy is dissipated through respiration and other pathways; not all material is eaten or assimilated.

2 Practice

2.1 Name ONE biotic and ONE abiotic component supplied in the meadow case. [2]

2.2 Calculate the grass-to-grasshopper transfer efficiency. [2]

2.3 Calculate the grasshopper-to-frog efficiency and state why the record does not support a universal 10% rule. [3]

2.4 Explain the direction of a food-chain arrow and distinguish matter cycling from energy transfer. [3]

3 Exam-style questions

3.1 Evaluate the population and biodiversity claims using six points. [6]

3.2 Write an 80–110-word ecosystem explanation correcting the energy and population claims. [8]

Solutions

2.1

: grass, grasshoppers, frogs or soil microbes as living component.: water, mineral nutrients or light as nonliving component.

2.2

: $\text{efficiency} = \text{next energy} / \text{previous energy} \times 100\%$.: $600/5000 \times 100\% = 12\%$.

2.3

: $\text{efficiency} = \text{next energy} / \text{previous energy} \times 100\%$.: $60/600 \times 100\% = 10\%$.: the first transfer is 12%, and these defined period values do not establish every ecosystem's transfers.

2.4

: food-to-consumer, grass $\rightarrow$ grasshopper $\rightarrow$ frog.: decomposers help make nutrients available again and matter can cycle.: energy is transferred and dissipated rather than recycled indefinitely back to the producer.

3.1

each: energy budget contains no population counts; change in prey may affect consumers but other foods/conditions matter; no exact matched percentage or next-week timing is supplied; one species' total count does not measure all biodiversity; examine variety of organisms and the chosen diversity measure; obtain comparable repeated observations before claiming a trend.

3.2

Local analytic rubric, 8 $\times$: give correct chain direction; identify producer/consumer relation; state 12% first transfer; state 10% second transfer; reject universal percentage; distinguish matter from energy; avoid exact population prediction; explain need for broader biodiversity evidence; coherent truthful 80–110 word response. Example: "Energy transfers from grass to grasshoppers and then frogs, so the arrows point from food to consumer. The supplied meadow values give twelve percent efficiency for the first transfer and ten percent for the second. These numbers concern defined levels and one period; they do not establish a universal percentage. Decomposers help return nutrients to available forms, but energy is dissipated rather than recycled indefinitely. The record does not provide population trends, so it cannot predict an exact frog decline next week. A grasshopper count alone also cannot describe the variety of organisms needed for a broader biodiversity assessment."