

Food Webs and Trophic Pyramids: Mastery Check

Learning target: I can read a food web, calculate with the 10 percent model, explain how matter cycles and energy flows through an ecosystem, and predict direct and indirect effects of a change.

Retrieval and mastery check

About 35 min

Individual

MS-LS2-3 · assesses

MS-LS2-4 · practice

independent practice

writing

Standards connections

MS-LS2-3 (assesses, describing the cycling of matter and the flow of energy among living and nonliving parts, including a drawn pyramid model): Items ask students to describe where matter and energy go, to draw and label a pyramid model, and to include nonliving parts and the system's energy input; the synthesis item is a compact version of the PE's model. No item requires chemical reactions.

MS-LS2-4 (practice): Two items ask students to predict population changes from a stated food web; they practice the reasoning behind arguments about changes to ecosystems without analyzing empirical data.

Purpose: assess · **Time:** about 35 minutes · **Format:** individual

Answers with reasoning

Part A: Retrieval (items 1-11)

1. In a meadow food web, an arrow runs from *grasshopper* to *meadowlark*. What does the arrow mean? 2 pts

Answer: B. The meadowlark eats the grasshopper, and matter and energy move from the grasshopper to the meadowlark.

Why: Arrows point from food to eater and represent the transfer of matter and energy. Option A reverses the arrow; C and D misread the symbol.

Also acceptable: None.

2. Which organism is a producer? 2 pts

Answer: C. Phytoplankton drifting in a lake.

Why: Phytoplankton make their own food by photosynthesis. Mushrooms are decomposers, zooplankton are consumers, and earthworms feed on dead material.

Also acceptable: None.

3. What do decomposers do with dead remains and wastes, and why do producers depend on them even though no feeding arrow runs from decomposers to producers? 3 pts

Answer: Decomposers feed on dead remains and wastes, using the matter and energy in them, and release carbon dioxide and nutrients into the air, water or soil. Producers take those materials in from the nonliving surroundings to build new matter. The link runs through the environment, not through eating, so there is no feeding arrow.

Why: Full credit needs both what decomposers release and the fact that producers absorb it from the surroundings.

Also acceptable: Accept 'they recycle the matter so plants can use it again' with the environment named.

- Decomposers break down remains and wastes
- They release carbon dioxide and nutrients (to the nonliving environment)
- Producers take those materials in rather than eating decomposers

4. The producers in a marsh store 40,000 energy units in a year. Using the 10 percent model, how many energy units are stored at the **third** trophic level (the second-stage consumers)? Show each step. 3 pts

Answer: Level 1 (producers): 40,000 units. Level 2: $40,000 \times 0.10 = 4,000$ units. Level 3: $4,000 \times 0.10 = 400$ energy units.

Why: Two 10 percent steps from the producers reach the third level. A common error is applying only one step (4,000) or three steps (40).

Also acceptable: Accept $40,000 \div 100 = 400$ with the levels named.

5. Which statement about an ecosystem is true? 2 pts

Answer: C. Matter cycles between living and nonliving parts, while energy flows through and leaves as heat.

Why: A says energy is recycled (false), B says matter is destroyed (false), D reverses the pyramid.

Also acceptable: None.

6. True or false: 'The matter a deer eats but does not turn into body mass is destroyed.' Circle your answer and explain where that matter actually goes. 3 pts

Answer: False. The matter leaves the deer as droppings and urine, and as carbon dioxide and water released by cellular respiration; it goes to decomposers and to the air, water and soil, where producers can use it again. No matter is destroyed.

Why: Students must mark false and name at least two destinations for the matter.

Also acceptable: Accept 'poop and breath' in plain words.

- False
- Names waste and carbon dioxide (or respiration) as where the matter goes
- States that it is not destroyed or is reused

7. A kelp-forest web has these arrows: kelp → sea urchins, sea urchins → sea otters, kelp → snails, snails → sheephead fish. If the sea otter population increases, name one **direct effect** and one **indirect effect**, and say which population sits in between for the indirect one. 3 pts

Answer: Direct effect: sea urchins decrease, because otters eat them (the two populations share an arrow). Indirect effect: kelp increases, because fewer urchins eat kelp; the sea urchin population sits in between. (Snails and sheephead are not affected by otters in this web except, possibly, through more kelp for snails, which would be a second indirect effect.)

Why: Direct means the populations share an arrow; indirect means a population lies between them.

Also acceptable: Accept 'snails increase through more kelp' as the indirect effect if urchins and kelp are both named in the path.

- Direct effect: urchins decrease
- Indirect effect: kelp increases
- Urchins named as the population in between

8. Draw a trophic pyramid for this chain: grass → grasshoppers → lizards → hawks. The grass stores 6,000 energy units. Using the 10 percent model, label each level with its name and its energy units, and add one arrow showing where most of the energy goes at each step. 3 pts

Answer: A four-level pyramid, widest at the bottom: grass 6,000 units; grasshoppers 600 units; lizards 60 units; hawks 6 units. An arrow out of each level labeled 'heat' (or 'used for living and lost as heat'), and optionally a second arrow to decomposers.

Why: $6,000 \times 0.1 = 600$; $600 \times 0.1 = 60$; $60 \times 0.1 = 6$. The heat arrow shows where most of the energy goes at each step.

Also acceptable: Accept the arrow drawn once with a note that it applies to every level.

- Four levels in the correct order, widest at the bottom
- Correct energy values 6,000, 600, 60, 6
- At least one arrow labeled heat (or 'to decomposers and heat') leaving a level

9. Why are top predators such as mountain lions rare compared with the plant eaters they hunt? 2 pts

Answer: B. Only a small fraction of the energy stored at each level reaches the next, so very little is left for the top level.

Why: The energy pyramid explains the scarcity of top predators; A, C and D are not reasons.

Also acceptable: None.

10. In a stream, the producers store 500 energy units per square meter each year and the first-stage consumers store 75. What percent of the producers' energy was passed on? Show the calculation. 2 pts

Answer: $75 \div 500 = 0.15$; $0.15 \times 100 = 15$ percent.

Why: This stream passes on more than the 10 percent average, reinforcing that 10 percent is a rough figure.

Also acceptable: Accept 15% with the division shown.

11. Explain why an ecosystem needs sunlight every day but does not need a daily supply of new carbon atoms. 2 pts

Answer: Energy leaves the ecosystem as heat at every level and cannot be gathered up again by producers, so new energy must arrive as sunlight constantly. Carbon atoms are never used up: the carbon dioxide released by respiration and decomposition stays in the air and water, and producers take it in again, so the same atoms cycle around the ecosystem.

Why: This is the matter-cycles, energy-flows idea stated as a contrast.

Also acceptable: Accept 'heat cannot be turned back into food' as the energy half.

- Energy leaves as heat and is not recaptured
- Carbon is recycled through carbon dioxide and producers

Part B: Synthesis (item 12)

12. Choose any ecosystem (a pond, a desert, a kelp forest, a creek). In one paragraph, describe how matter and energy move through it. Your paragraph must name a producer, a consumer and a decomposer, must include a nonliving part of the ecosystem, must say where the energy comes from and where it ends up, and must use the words *cycle* and *flow* correctly. 3 pts

Answer: Model paragraph (pond): Sunlight is the pond's energy source. Algae, the producers, capture it and build sugar from carbon dioxide and water taken from the pond water, a nonliving part of the ecosystem. Water fleas, consumers, eat the algae, and bluegill eat the water fleas; at each step most of the energy is used for living and flows out of the pond as heat, so only a small share is stored in the next level. When organisms release wastes or die, bacteria and fungi in the mud, the decomposers, break the remains down and release carbon dioxide and nutrients into the water and mud, where the algae take them in again. Matter cycles around the pond through living and nonliving parts, while energy flows through it once and must be replaced by the sun every day.

Why: Grade against the required elements, not the example. The paragraph must show the loop for matter (through a nonliving part) and the one-way path for energy ending in heat.

Also acceptable: Any ecosystem is acceptable; a paragraph that uses 'cycle' for energy loses the language point but may keep the others.

- Names a producer, a consumer and a decomposer
- Includes a nonliving part (air, water, soil, mud, sunlight)
- States the energy source (sunlight) and where energy ends up (heat)
- Uses cycle for matter and flow for energy correctly

Teacher notes

Points: q1 2, q2 2, q3 3, q4 3, q5 2, q6 3, q7 3, q8 3, q9 2, q10 2, q11 2, q12 3; total 30. Items q5, q6 and q11 directly test the chapter's two accuracy corrections (energy is not recycled; matter is not lost), so weight them in reteaching decisions. The 10 percent model is used in q4 and q8 as a stated condition, while q10 gives 15 percent so students see that real values differ from the model. The kelp web in q7 is stated in full so no outside knowledge is needed. Expect q4 errors from counting levels: the third trophic level is two steps above producers. For q8, a labeled stack of boxes is enough; proportional widths are not required.

Scaffold offered to students: Two rules to remember

Rule 1: an arrow in a food web points from the food to the eater, and it shows matter and energy moving to the eater. Rule 2: matter cycles (atoms leave an organism as wastes, carbon dioxide and remains, are recycled by decomposers and taken in again by producers), but energy flows one way (it enters as sunlight and leaves as heat at every level). When you are unsure about an item, ask which rule it is testing.

Extension: Write the thirteenth item

Write one new multiple-choice item for this quiz that tests the difference between a pyramid of energy and a pyramid of numbers of individuals. Include four options, one correct answer, and a one-sentence explanation of why each wrong option is tempting. Then explain, using an oak tree and its caterpillars, when a pyramid of numbers can be upside down even though the pyramid of stored energy never is.