Marsh Flow Model

Trace matter and energy through a salt marsh food chain

BIO.7 "Develop and use models to illustrate the flow of matter and energy between abiotic and biotic factors in ecosystems, including loss of heat, 10% rule, and the conservation of matter."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline movements of matter between living and nonliving parts of the marsh, circle energy transfers, and put a star beside each mention of heat loss. Use your marks to track what cycles and what flows away.

Where Does the Marsh Grass Go?

1. At the edge of a salt marsh, cordgrass grows in mud flooded by tides. Sunlight reaches its leaves, and the grass uses that energy to build sugars from carbon dioxide in the air and water carried through its roots. Minerals dissolved in the mud also enter the plant. A grasshopper eats the cordgrass, a spider catches the grasshopper, and a sparrow eats the spider. In this chain, carbon atoms can move from the air into grass and then into animals. The atoms change locations and become parts of different molecules, but none vanish.

2. An energy model can put numbers on this food chain. Suppose the cordgrass stores 10,000 kilojoules of chemical energy in new plant tissue. About 1,000 kilojoules might become new grasshopper tissue, about 100 new spider tissue, and about 10 new sparrow tissue. This illustrates the 10% rule: on average, roughly one tenth of the energy stored at one feeding level is stored as new biomass at the next. Organisms release energy as heat while living. Energy also remains in uneaten parts and waste, so the other nine tenths at each step do not all turn directly into heat.

3. Follow the grass after a grasshopper takes a bite. Pieces it does not digest leave its body as waste, while a fallen blade becomes dead plant material. Bacteria and fungi break down both, using some of the chemical energy and releasing heat. During respiration, the grasshopper, sparrow, and decomposers return carbon dioxide to the air. Decomposers also release minerals into the mud, where roots can take them up again. Matter cycles through living things, air, and mud; energy flows in from sunlight and eventually spreads into the surroundings as heat rather than cycling back into usable sunlight.

2 ANSWER WITH EVIDENCE

Use the passage

1. Trace one route carbon atoms could take from the air to the sparrow and back to the air. Name each living thing in the route.

2. Write an arrow chain showing the energy stored in new tissue at each feeding level. How does each number illustrate the 10% rule?

3. Your model shows 10,000 kilojoules in cordgrass but only 1,000 in new grasshopper tissue. Why would an arrow labeled “9,000 kilojoules of heat” be misleading?

4. Add decomposers to a model of the food chain. Describe one arrow for matter and one for energy that would connect decomposers to the rest of the marsh.

3 YOUR TURN

Your own words

Draw a labeled arrow model of a pond chain with one producer and two consumers. Start with 2,000 kJ in the producer, apply the 10% rule twice, and show sunlight, heat leaving two organisms, and matter cycling through water and decomposers. Label each arrow as matter or energy.

ANSWER KEY

Marsh Flow Model

PART 1 · READ AND MARK

Underline movements of matter between living and nonliving parts of the marsh, circle energy transfers, and put a star beside each mention of heat loss. Use your marks to track what cycles and what flows away. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Trace one route carbon atoms could take from the air to the sparrow and back to the air. Name each living thing in the route.	**Carbon dioxide in air → cordgrass → grasshopper → spider → sparrow → carbon dioxide in air through sparrow respiration.**
2	Write an arrow chain showing the energy stored in new tissue at each feeding level. How does each number illustrate the 10% rule?	**Cordgrass, 10,000 kJ → grasshopper, 1,000 kJ → spider, 100 kJ → sparrow, 10 kJ. Each level stores about one tenth as much energy in new tissue as the level before it.**
3	Your model shows 10,000 kilojoules in cordgrass but only 1,000 in new grasshopper tissue. Why would an arrow labeled "9,000 kilojoules of heat" be misleading?	**Not all the remaining energy turns directly into heat. Some stays in uneaten plant parts or waste, where decomposers can use it.**
4	Add decomposers to a model of the food chain. Describe one arrow for matter and one for energy that would connect decomposers to the rest of the marsh.	**A matter arrow can show decomposers releasing minerals into mud for cordgrass roots to take up. An energy arrow can show decomposers releasing heat to the surroundings.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Sunlight →(energy) algae (2,000 kJ) →(energy) zooplankton (200 kJ) →(energy) minnow (20 kJ). Algae →(energy as heat) surroundings; zooplankton →(energy as heat) surroundings. Dissolved CO_2 in water →(matter) algae →(matter) zooplankton →(matter) minnow →(matter after death) bacteria →(matter as dissolved CO_2 and minerals) water →(matter) algae.

Accept other plausible pond food chains and matter cycles. Energy values should decrease from 2,000 to about 200 to about 20 kJ; matter must cycle rather than disappear or turn into energy.