Name _____ Date _____ Period _____

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Matter and Energy in Ecosystems Study Guide

Biology

Show your work with units. Use complete sentences when a question asks you to explain.

Key relationships	**Percent** = part ÷ whole × 100	**Rate of change** = change in amount ÷ change in time	**Times greater** = larger value ÷ smaller value	**Up one trophic level**: about 10% of the energy (× 0.10)

Part 1. Properties of Water

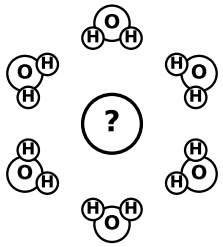
1. The model shows water molecules around a dissolved ion.

(a) Is the ion positive or negative? Explain using the partial charges (δ+ and δ−) on water.

(b) Blood plasma is mostly water. Use the model to explain how blood can carry dissolved ions, such as calcium ions, to cells.

(c) Name the property of water behind each observation: (1) a steel paper clip floats on water; (2) raindrops cling to a spider web; (3) dyed water climbs the narrow tubes of a celery stalk; (4) ice forms on top of a pond, and fish live in the water below.

(d) What attraction holds water molecules to each other?



2. Sample data for three places on the same sunny summer day:

Place	Daily high (°C)	Daily low (°C)	Daily range, high − low (°C)
Surface water of a lake	25	22	
Moist soil beside the lake	31	16	
Dry sand 10 km away	47	14	

(a) Complete the table. How many times greater is the daily range of the dry sand than that of the lake water?

(b) Write a claim about how water affects temperature change. Support it with evidence from the table, and use specific heat and hydrogen bonds in your reasoning.

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Part 2. The Water Cycle

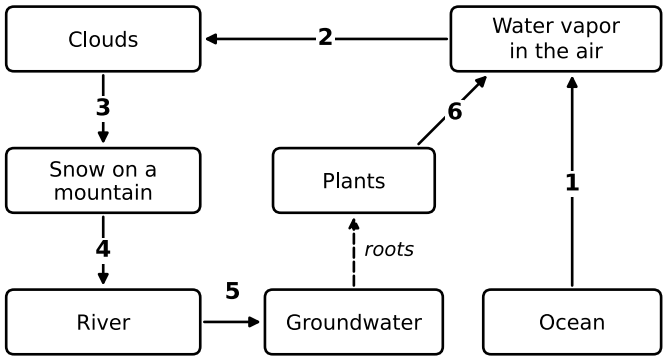
3. The model shows how water moves between places on Earth.

(a) Name the process at each numbered arrow, 1 to 6.

(b) At which arrow does water absorb energy from the Sun? At which is energy released to the air? Name one arrow powered by gravity.

(c) The model leaves out animals. Name two ways your body returns water to the environment.

(d) Earth's water is 2.5% fresh water. If all of Earth's water filled a 1,000 L tank, how many liters would be fresh? Where is most fresh water stored?



4. Two potted plants are wrapped in plastic around the pot, so water leaves only through the plant. Plant B has petroleum jelly on the underside of every leaf, where most of its stomata are. Assume all mass lost is water.

Time (h)	0	8	16	24
Plant A, no jelly (g)	650	628	614	596
Plant B, jelly on leaves (g)	650	646	644	641

(a) Calculate the mass of water each plant lost in 24 hours.

(b) Write a claim about where most transpiration happens. Support it with evidence and reasoning.

5. Students measure what happens to 50 mm of rain from one storm in a forest before and after it is logged (trees cut down).

Where the rain went	Before logging (mm)	After logging (mm)
Runoff	6	24
Infiltration	29	19
Evapotranspiration	15	7

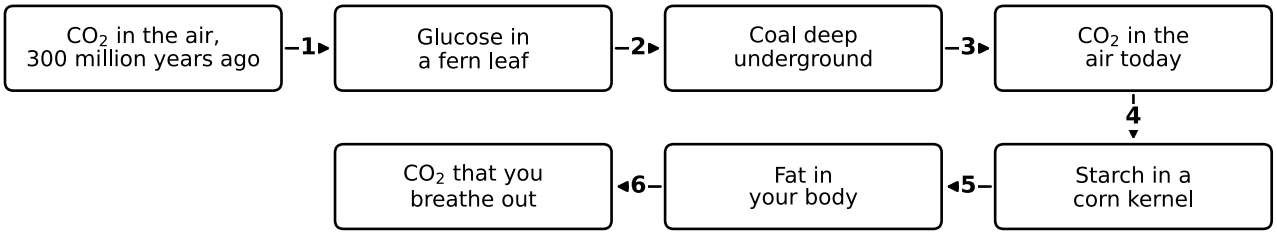
(a) What percent of the rain became runoff before logging? After logging?

(b) Predict how logging will change flooding in nearby streams and the amount of groundwater. Use data to support each prediction. Then explain why evapotranspiration dropped.

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Part 3. The Carbon Cycle

6. The model traces one carbon atom over 300 million years.



(a) Name the process or event at each numbered arrow, 1 to 6.

(b) Between arrows 2 and 3, which reservoir holds the atom: atmosphere, biosphere, ocean, or geosphere?

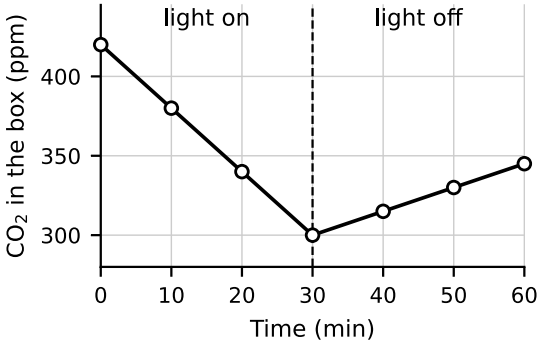
(c) Starch and fat are two of the four kinds of large biological molecules. Name the other two, and the element that forms the backbone of all four.

7. A potted plant is sealed in a clear box with a CO_2 sensor. A lamp shines on it for 30 minutes and is then turned off for 30 minutes.

(a) Calculate the rate of change in CO_2, in ppm per minute, while the light is on and while it is off.

(b) Explain the pattern in the graph using photosynthesis and cellular respiration.

(c) In the Northern Hemisphere, is CO_2 in the air lower at the end of summer or at the end of winter? Use your answer to (b) to explain.



8. The table uses yearly flows from the lesson's carbon cycle model (rounded values).

Where the carbon released by people goes	**GtC per year**
Released by burning fossil fuels and clearing forests	11
Taken up by the ocean (80 absorbed − 77 released)	3
Taken up by land (120 photosynthesis − 117 respiration and decomposition)	3
Stays in the air	

(a) Complete the table. What percent of the carbon released by people stays in the air? Round to the nearest whole percent.

(b) Describe one effect of the extra CO_2 in the air and one effect of the extra CO_2 in the ocean.

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Part 4. The Nitrogen Cycle

9. (a) Name two kinds of molecules in your body that contain nitrogen. Which of them also contain phosphorus?

(b) Air is about 78% nitrogen gas (N_2). Explain why plants and animals cannot use it directly.

(c) Complete the table of steps in the nitrogen cycle.

Starting form	Process	Organisms that do it	Ending form
N_2 gas in the air			Ammonium (NH_4^+)
Ammonium (NH_4^+)			Nitrate (NO_3^-)
Nitrate (NO_3^-) in soil			Amino acids, proteins
Protein in a dead leaf			Ammonium (NH_4^+)
Nitrate in wet, low-oxygen soil			N_2 gas in the air

10. Three fields grew different crops last summer, with no fertilizer. In spring, students measure the nitrate in each field's soil (sample data).

Crop grown last summer	Soil nitrate in spring (mg/kg)
Clover (a legume)	26
Wheat	8
Nothing (bare soil)	11

(a) Write a claim about how growing clover affects the nitrogen in soil. Support it with evidence and reasoning.

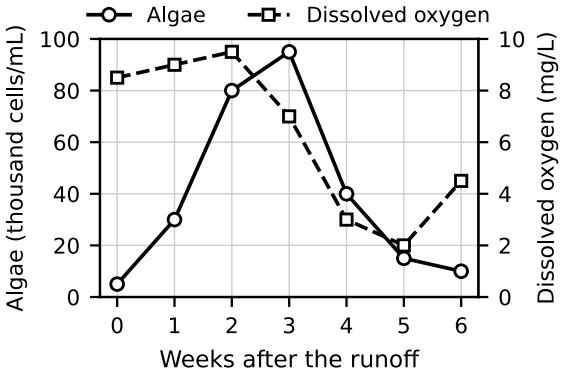
(b) The bacteria in clover root nodules get something from the clover. What is it, and what does the clover get in return?

11. Fertilizer that crops do not take up washes from nearby farms into a lake after a heavy rain.

(a) In which week were algae highest? In which week was dissolved oxygen lowest?

(b) Explain why oxygen was lowest two weeks after the algae peak, not during it.

(c) Many fish need at least about 5 mg/L of dissolved oxygen. In which weeks were fish at risk?



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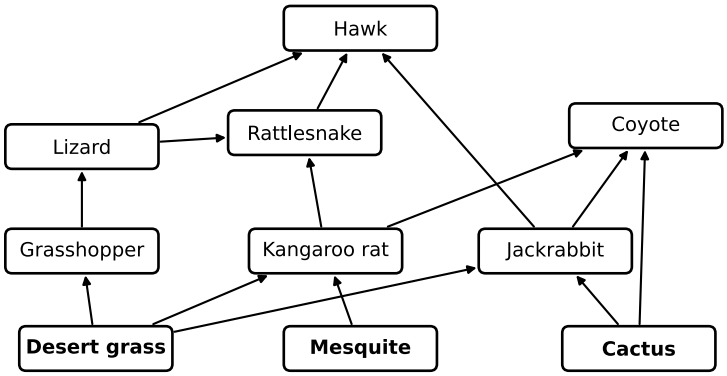
Part 5. Producers, Consumers, and Food Webs

12. Use the desert food web. Producers are in bold.

(a) Write a food chain with five organisms from this web. Use arrows that point the way energy moves.

(b) The coyote eats cactus fruit, kangaroo rats, and jackrabbits. Is it a herbivore, carnivore, or omnivore? At which two trophic levels does it feed?

(c) A long drought kills most of the desert grass. Predict how the grasshoppers and the lizards will change. Why might the jackrabbits be hurt less than the grasshoppers?



13. Classify each organism.

Organism	Producer, herbivore, carnivore, omnivore, or decomposer	Autotroph or heterotroph
(a) Kelp in the ocean, which makes food by photosynthesis		
(b) Mold growing on an old orange		
(c) An orca that eats seals and fish		
(d) Cave bacteria that make food using energy from chemicals in the water		

(e) The mold returns matter from the orange to the soil. Explain why it does not return energy that plants can use again.

14. Sea otters eat sea urchins, and sea urchins eat kelp. The table shows sample data for one stretch of coast.

	Sea otters (per km of coast)	Sea urchins (per m^2)	Kelp (percent of seafloor covered)
Year 1	18	4	65%
Year 4	9	15	40%
Year 8	3	36	12%

(a) Write a claim that explains the change in the kelp. Support it with evidence and reasoning.

(b) Predict what would happen to the kelp if sea otters returned to this coast. Explain.

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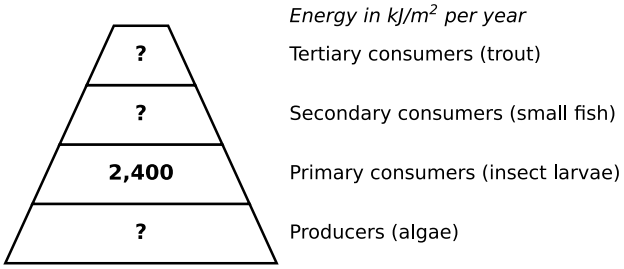
Part 6. Energy Pyramids

15. The energy pyramid shows a lake. Only the primary consumers' energy is given.

(a) Use the 10 percent rule to find the energy at each level marked ?.

(b) Ospreys eat trout. Calculate the energy available to the ospreys. Then explain why a sixth level, a predator that eats ospreys, is unlikely.

(c) In a backyard, 4 maple trees feed 24,000 aphids. Is the pyramid of numbers for these two levels widest at the bottom? Is the energy pyramid? Explain.



16. The table shows where the energy goes when two animals each eat 1,000 kJ of food.

Animal	Energy eaten (kJ)	Lost in feces (kJ)	Used in cellular respiration (kJ)	Stored in new growth (kJ)	Percent stored
Lizard (cold-blooded)	1,000	350	500		
Mouse (warm-blooded)	1,000	220	750		

(a) Complete the table.

(b) Explain why the mouse stores a much smaller percent of its energy than the lizard.

(c) A field of soybeans holds 80,000 kcal of food energy. Use the 10 percent rule to find how much food energy reaches people if they eat the soybeans, and if the soybeans are fed to chickens and people eat the chickens. Which feeds more people?

17. A pesticide that is not easily broken down gets into a pond. The table shows sample data.

Trophic level	Organisms	Energy (kJ/m^2/yr)	Pesticide in tissue (ppm)
Producers	Pond plants	20,000	0.05
Primary consumers	Crayfish	2,000	0.4
Secondary consumers	Bullfrogs	200	2.5
Tertiary consumers	Herons	20	15

(a) How many times greater is the pesticide concentration in herons than in pond plants?

(b) Energy goes down but the pesticide goes up at each higher level. Write a claim that explains both trends. Support it with data from both columns.

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