43
FLOW OF ENERGY AND MATTER IN THE BIOSPHERE

One of the requirements of life is a constant flow of energy. Life involves activity, and activity requires energy. If the supply of energy stops, life stops. A constant flow of matter is also necessary, since matter is intimately involved in trapping energy and transporting it from one place to another within the living organism or from one organism to another. The food we eat, for example, consists of matter organized as carbohydrates, proteins, and lipids. These molecules contain usable energy, but when the same atoms are combined as carbon dioxide and water, they contain virtually no usable energy.

Color titles A through I, including the headings Carbon Dioxide and Water, and the corresponding parts of the plate. Choose a light color for C. Leave the oxygen and carbon dioxide next to the rabbit uncolored for now.

All the life processes on earth obtain their energy directly or indirectly from the *sun. Plants* absorb *light energy* and convert it into chemical energy in the process of photosynthesis. Plants conduct photosynthesis by combining carbon dioxide from the air with water and minerals taken up from the soil to make *carbohydrates, proteins,* and *lipids.* In the daytime, when the plant is photosynthesizing, the *oxygen* of the water molecules is a waste product as far as the plant is concerned, so it releases that oxygen into the atmosphere. The identical process goes on in plants and algae that live in lakes, streams, and oceans, except that they are immersed in water and don't have to depend on soil for it. (At night, photosynthetic organisms use oxygen just as animals do.)

Color title J, the animal, the oxygen it consumes, and the carbon dioxide it releases.

Although *animals* cannot carry out photosynthesis to obtain energy from light directly, they obtain it indirectly by eating plants or eating animals that eat plants (or eating animals that eat animals that eat plants, etc.). To extract the energy from the food they eat, animals must combine the food molecules with oxygen. This process is called oxidation and results in the production of carbon dioxide and water, which are released into the atmosphere when the animal exhales (although some of the water may be excreted in liquid or semisolid form). Plants carry on oxidation also, both to grow and to maintain themselves during the hours of darkness.

Color titles K and K^1 and the arrows representing heat energy gained and lost.

Anyone who has ever been out in the sun knows that the sun radiates *heat* as well as light, and that heat keeps the earth warm enough for living things to survive. What is not so obvious is that even light energy is sooner or later converted to heat. No chemical process is 100 percent efficient, and the reactions of photosynthesis lose a little of the trapped light energy as heat. Much more heat is produced by the oxidation of the products of photosynthesis as a plant grows or as an animal converts them into energy for its own life processes.

Eventually the heat energy received by the earth is radiated away into outer space. If you find this hard to believe, take notice in the winter how much colder it is on a morning following a night of clear skies than it is following a night with a heavy overcast to reflect radiating heat back to the earth. Energy, then, flows through the biosphere—the thin layer of our planet's surface that supports life—and back out into space. Matter, on the other hand, flows in constant cycles, and no significant amount of matter is added to the earth or lost from it. The cyclic flow of carbon from plants to animals and back to plants again is commonly called the "carbon cycle." Many other kinds of matter also flow in cycles, such as water, nitrogen, oxygen, and sulfur.

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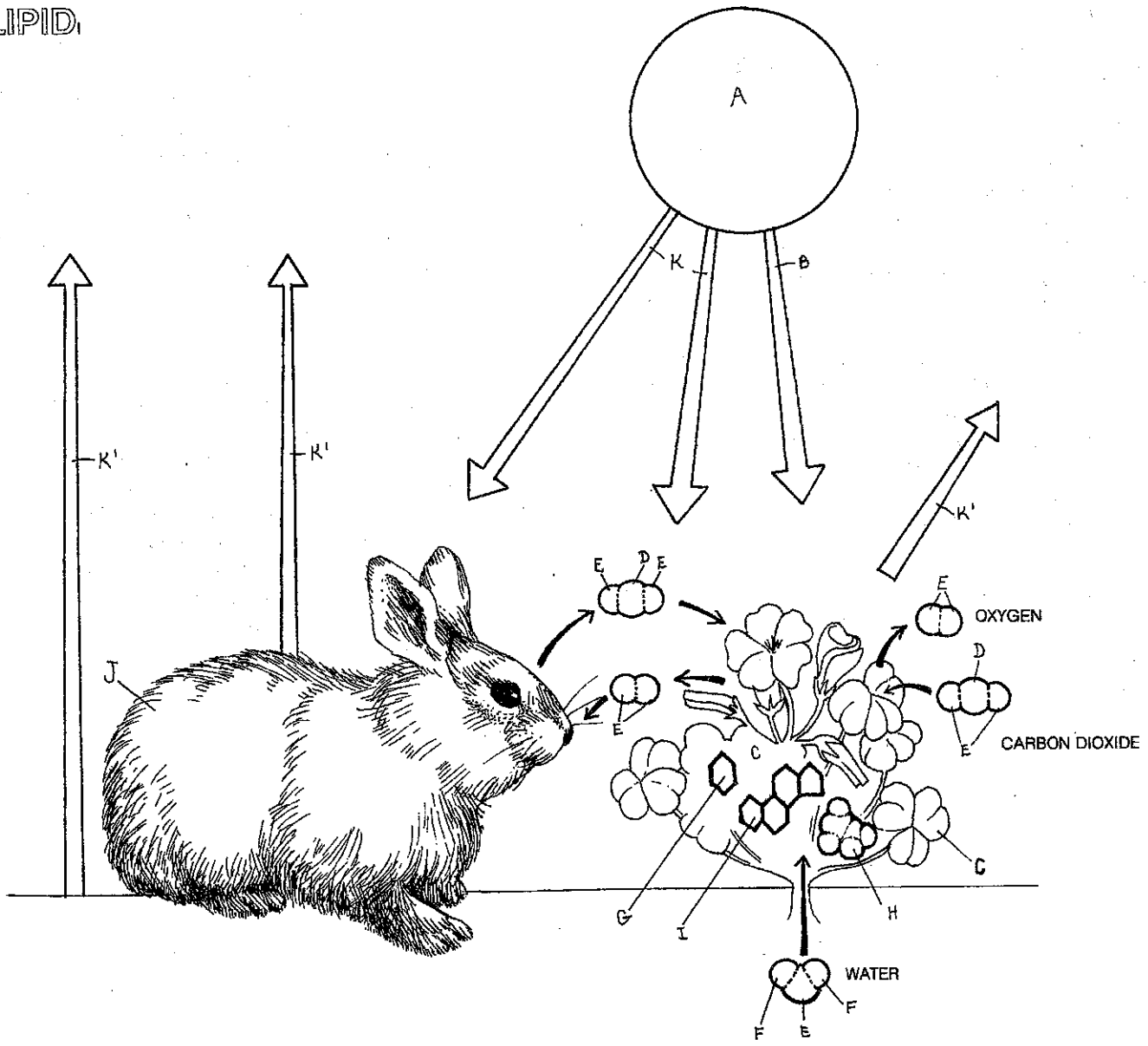
SUN$_A$
LIGHT ENERGY$_B$
PLANT$_C$
CARBON DIOXIDE (CO_2)★
CARBON ATOM$_D$
OXYGEN ATOM$_E$
WATER (H_2O)★
HYDROGEN ATOM$_F$
CARBOHYDRATE$_G$
PROTEIN$_H$
LIPID$_I$
ANIMAL$_J$
HEAT ENERGY GAINED$_K$
HEAT ENERGY LOST$_{K'}$



Name _____

Cycles worksheet

*Please answer the following **using the words in the text box.***

Carbon Cycle

Coal	Oil	Natural Gas	burning of fossil fuels		volcanoes
Photosynthesis	Respiration	ocean	sugar	Greenhouse	decayed

1. Plants use CO_2 in the process of _____ to make _____ and oxygen.
2. Animals use oxygen in the process of _____ and make more CO_2.
3. The _____ is the main regulator of CO_2 in the atmosphere because CO_2 dissolves easily in it.
4. In the past, huge deposits of carbon were stored as dead plants and animals _____.
5. Today these deposits are burned as fossil fuels, which include _____, _____, and _____.
6. More CO_2 is released in the atmosphere today than in the past because of _____ _____ .
7. Another natural source for CO_2 is _____.
8. Too much CO_2 in the atmosphere may be responsible for the _____ effect.
9. Write the equation for **photosynthesis.**

10. Draw a **simple diagram** of the Carbon Cycle using the words in the text box above.

Oxygen Cycle

Photosynthesis	Ozone	Waste	Crust	Oceans	Respiration

1. Plants release 430-470 billion tons of oxygen during process of _____.
2. Atmospheric oxygen in the form of _____ provides protection from harmful ultraviolet rays.
3. Oxygen is found everywhere on Earth, from Earth's _____ (rocks) to the _____ where it is dissolved.
4. Oxygen is vital for _____ by animals, a process which produces CO_2.and water.
5. Oxygen is also necessary for the decomposition of _____ into other elements necessary for life.
6. Write the equation for **respiration**.

7. Draw a **diagram** of the Oxygen Cycle using the words in the text box.

Nitrogen Cycle

Atmosphere	78%	ammonia	proteins	denitrificating	
Nitrate	nitrogen-fixing	plants	animals	waste	plants

1. Our atmosphere is _____ nitrogen gas.
2. Animals and plants cannot directly use all the nitrogen found in our _____.
3. Only special bacteria can directly use nitrogen in our atmosphere and "fix" it so other organisms can benefit. These bacteria are called _____-_____ bacteria.
4. Higher organisms use nitrogen to make their _____.
5. Animal waste decay by the action of bacteria which create _____and _____ products rich in nitrogen, and useful for plants to use again.
6. _____ bacteria in the soil can break down the ammonia into the gaseous form of nitrogen, which is not available for use by plants or animals.
7. In another part of the cycle, animals eat _____ containing nitrogen, which is again returned to the soil by animal _____ or decaying _____ and _____.
8. Draw a **diagram** of the Nitrogen cycle using the words in the text box.

Phosphorus Cycle

Pollution	basins	rocks and minerals	waste	DNA	overgrowth	plants

1. Phosphorus in NOT found in the free state in Nature, but is contained mostly in _____ and _____.
2. It is an essential nutrient for life, as it makes up important chemicals such as _____.
3. In the Phosphorus Cycle, phosphorus moves between the soil and _____, which are eaten by animals. The animals use phosphorus, and then their _____ products help return the Sulfur for the next generation of phosphorus in the soil.
4. Some of the phosphorus in soils can be washed away into water _____.
5. Another source of phosphorus in water comes from man-made _____.
6. Too much phosphorus in water leads to plant _____, strangling all other life forms in the water.
7. Why is the use of too much phosphorus-rich fertilizers bad for the environment?