

## Section 2.2

# Nutrition and Energy Flow

**North Carolina Objectives** Objective 5.02 Analyze the flow of energy and the cycling of matter in the ecosystem: Relationship of the carbon cycle to photosynthesis and respiration; Trophic levels—direction and efficiency of energy transfer

## ► Before You Read

This section discusses how organisms interact with their environment to get the food and energy they need. On the lines below, explain how a pet's food might be different if it had to live in the wild and get its own food.

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## ► Read to Learn

### How Organisms Obtain Energy

One of the most important things about a species' niche is how the species gets its energy. Ecologists study the flow of energy through communities to discover nutritional relationships between organisms.

**Autotrophs** The ultimate source of energy for all life is the sun. Plants use the sun's energy to make food. This process is called photosynthesis (foh tuh SIN tuh suhs). This makes plants autotrophs. **Autotrophs** (AW tuh trohfs), or producers, are organisms that use light energy or energy stored in chemical compounds to make energy-rich compounds. Grass, trees, and other plants are the most familiar autotrophs, but some one-celled organisms, such as green algae, also make their own food.

**Heterotrophs** Some organisms cannot make their own food. They must eat other organisms to get their food and energy. These organisms are called consumers, or **heterotrophs** (HE tuh ruh trohfs). Some heterotrophs, such as rabbits, feed only on autotrophs. Other heterotrophs, such as lions, feed only on other heterotrophs. Still other heterotrophs, such as bears and humans, feed on both autotrophs and heterotrophs.

**Decomposers** There are other organisms called **decomposers**. They break down the complex compounds of dead and decaying plants and animals. They change these compounds into simpler forms that they can use for fuel. Some protozoans, many bacteria, and most fungi are decomposers. ♡

### STUDY COACH

**Make an Outline** Make an outline of the information you learn about in this section. Use the headings in the reading as a starting point. Include the boldface terms.

#### ✓ Reading Check

1. What do decomposers do?

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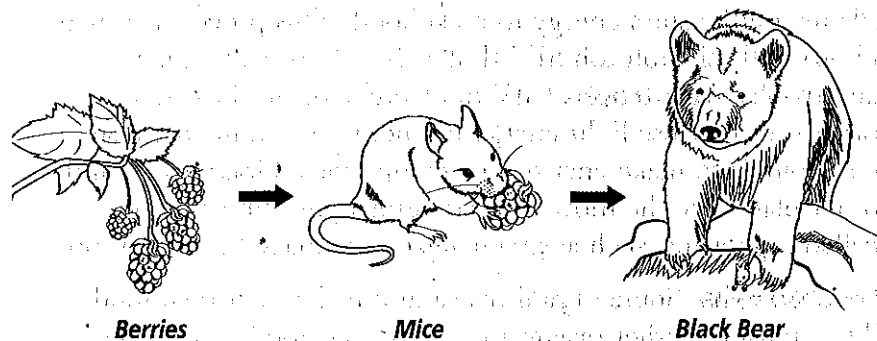
## Section

Nutrition and Energy Flow, *continued***Flow of Matter and Energy in Ecosystems**

When you eat food, such as an apple, you consume matter. Matter, in the form of carbon, nitrogen, and other elements, flows through the levels of an ecosystem from producers to consumers. Scientists call this flow of matter *cycling*. The apple is more than matter, though. It also contains some energy from sunlight. This energy was trapped in the apple as a result of photosynthesis. As you cycle the matter in the apple by eating it, some trapped energy is transferred from one level of the ecosystem to the next. At each level, a certain amount of energy is also transferred to the environment as heat.

**What are food chains?**

Ecologists study feeding relationships and symbiotic relationships to learn how matter and energy flow in ecosystems. These scientists sometimes use a simple model called a food chain. **Food chains** show how matter and energy move through an ecosystem. In a food chain, nutrients and energy move from autotrophs to heterotrophs to, in the end, decomposers. A food chain is drawn using arrows. The arrows show the direction in which energy is transferred. An example of a simple food chain in a forest ecosystem is shown below.



Most food chains are made up of two, three, or four transfers, or steps. Each organism in a food chain represents a feeding step, or **trophic** (TROH fihk) **level**, in the transfer of energy and matter. The amount of energy in the last transfer is only a small part of what was available at the first transfer. At each transfer, some of the energy is given off as heat.

**Think it Over**

**2. Interpret** When energy is transferred between trophic levels, what is always given off to the environment? (Circle your choice.)

- a. photosynthesis
- b. heat
- c. water

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Nutrition and Energy Flow, *continued***What is a food web?**

A food chain shows only one possible path for the transfer of matter and energy through an ecosystem. Many other paths may exist because many different species can be on each trophic level. For instance, in the food chain example on the previous page, there are many animals in the forest other than mice that eat berries. Also, many different kinds of organisms eat more than one type of food. This means that a single species may feed at several different trophic levels. The black bear, for instance, does not eat only mice. It also eats berries. There also are other animals in the forest that eat berries and mice. For these reasons, ecologists also use food webs. **Food webs** are models that show all possible feeding relationships at each trophic level in a community. A food web is a more realistic model than a food chain because most organisms depend on more than one type of organism for food.

**How does energy flow through an ecosystem?**

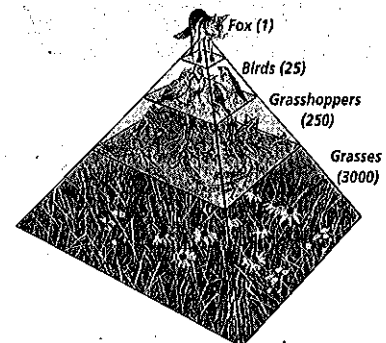
Food chains and food webs deal with both matter and energy. When ecologists want to focus only on energy, they use another type of model—an ecological pyramid. An ecological pyramid shows how energy flows through an ecosystem. There are different types of ecological pyramids. Each pyramid has the autotrophs, or first trophic layer, at the bottom. Higher trophic layers are then layered on top of one another.

The pyramid of energy shows that the amount of available energy becomes less from one trophic level to the next. The total energy transfer from one trophic level to the next is only about ten percent because organisms do not use all the food energy in the trophic level below them. An organism uses energy to do all the things necessary for life. Organisms use energy to move, to interact with their environment, and to digest their food. They also use energy to build body tissue. Some of this energy is given off as heat. The law of conservation of energy states that energy is neither lost nor gained. Even though some of the energy transferred at each trophic level enters the environment as heat, it is still energy. It is just in a different form.

A pyramid of numbers shows the number of organisms eaten by the level above it. In most cases, the number of organisms decreases at each higher trophic level.

**✓ Reading Check**

3. What type of organisms appear at the bottom of the ecological pyramid?



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**Nutrition and Energy Flow, *continued*****✓ Reading Check**

4. What is biomass?

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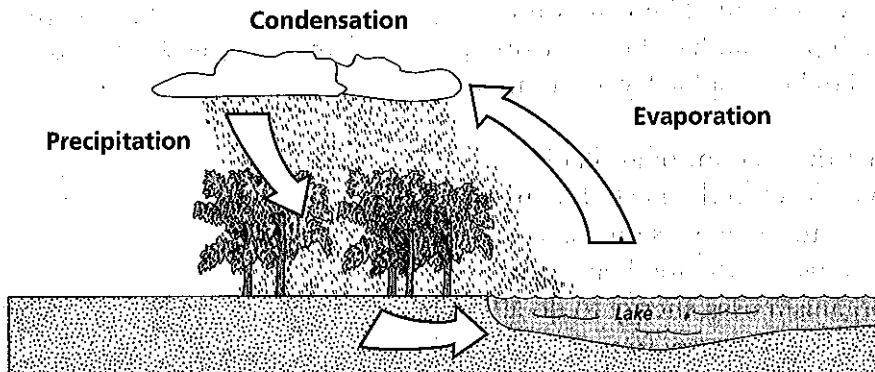
**Biomass** is the total weight of living matter at each trophic level. A pyramid of biomass shows the total dry weight of living material at each trophic level. ✓

**Cycles in Nature**

Matter, in the form of food, moves through every organism. In this way, matter is found at every trophic level. Matter is never made or destroyed. It just changes form as it cycles through the different trophic levels. There is the same amount of matter today as there was when life on Earth began.

**What is the water cycle?**

Water also cycles through different stages. It is always moving between the atmosphere and Earth. For instance, when you leave a glass of water out for a few days, some of it seems to disappear. It has evaporated or changed into water vapor in the air. Similarly, water from lakes and oceans evaporates. At some point, this water vapor condenses, or comes together, and makes clouds. After even more condensation, drops of water form. This water then falls back to Earth as rain, ice, or snow.



In the water cycle, water is constantly moving between the atmosphere and Earth.

Plants and animals need water to live. When the water falls to Earth, plants and animals use it. Plants pull water from the ground and lose water from their leaves. Losing water this way puts water vapor back into the air. This continues the water cycle. Animals also take in water. They breathe out water vapor in every breath. When animals urinate, they return water to the environment. This water then continues in the cycle.

**What is the carbon cycle?**

Carbon has its own cycle. All life on Earth is based on carbon, and all living organisms need carbon.

The carbon cycle starts with autotrophs. In photosynthesis, autotrophs use the sun's energy to change carbon dioxide gas into energy-rich forms of carbon.

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**Nutrition and Energy Flow, *continued***

Autotrophs use this carbon for growth and energy. Heterotrophs then feed on autotrophs or feed on other animals that have already fed on autotrophs. The heterotrophs then use the carbon for growth and energy. As autotrophs and heterotrophs use this carbon, they release carbon dioxide into the air. The carbon cycle continues very slowly. How rapidly it cycles depends upon whether the carbon is found in soil, leaves, roots, in oil or coal, in animal fossils, or in calcium carbonate reserves.

**What is the nitrogen cycle?**

Nitrogen is another element important to living things. Although 78 percent of air is nitrogen, plants cannot use this form well. There are bacteria, though, that change the nitrogen from air to a form plants can better use. This form is found in the soil. Plants use this nitrogen to make proteins. Animals eat the plants and change the plant proteins into animal proteins. These proteins are used in building muscle and blood cells. Urine is an animal waste that lets animals get rid of nitrogen they do not need. This urine returns nitrogen to the soil. When organisms die and decay, nitrogen returns to the soil. Plants then reuse this nitrogen. Soil bacteria also act on these dead organisms and put nitrogen back into the air. In this way, nitrogen is always cycling through the system. ♣

**What is the phosphorous cycle?**

Phosphorus also cycles through ecosystems. It is another element that all organisms need. It cycles in two ways. In the short-term cycle, plants get phosphorus from the soil. Animals get phosphorus from eating plants. When these animals die, their decaying bodies release phosphorus back into the soil to be used again.

In the long-term cycle, materials containing phosphorus are washed into rivers and oceans. As millions of years pass, the phosphorus becomes locked in rocks. Millions of years later, as the environment changes, some of the rock is no longer covered. As this rock wears away, the phosphorus is released back into the environment.

**✓ Reading Check**

5. What type of organisms change nitrogen in the air into a form plants can better use?

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Nutrition and Energy Flow, *continued*

## After You Read

### Mini Glossary

**autotrophs (AW tuh trohfs):** organisms that use energy from the sun or energy stored in chemical compounds to make their own nutrients

**biomass:** the total mass or weight of all living matter in a given area

**decomposers:** organisms, such as fungi and bacteria, which break down and absorb nutrients from dead organisms

**food chain:** a simple model that shows how matter and energy move through an ecosystem

**food web:** a model that shows all the possible feeding relationships at each trophic level in a community

**heterotrophs (HE tuh ruh trohfs):** organisms that cannot make their own food and must feed on other organisms for energy and nutrients

**trophic (TROH fihk) level:** an organism that represents a feeding step in the movement of energy and materials through an ecosystem

1. Review the terms and their definitions in the Mini Glossary above. Define **autotrophs** and **heterotrophs** in your own words. Give an example of an autotroph and a heterotroph.

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2. Use the table below to help you review what you have read. For each of the organisms shown in the food chain, choose three facts from the list below the table that are true. Then write the facts in the table under the correct organism.

Grass

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Rabbit

→

Wolf

Grass	Rabbit	Wolf

performs photosynthesis

heterotroph

eats other heterotrophs

on highest trophic level

provides energy for other heterotrophs

heterotroph

on lowest trophic level

autotroph

eats autotrophs

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**Nutrition and Energy Flow, *continued***

3. Next to each of the statements below, place a T if the statement is true or an F if the statement is false.

\_\_\_\_\_ a. Although 78 percent of air is nitrogen, plants cannot use this form well.

\_\_\_\_\_ b. Heterotrophs can get the energy they need directly from the sun.

\_\_\_\_\_ c. During part of its cycle, phosphorus falls back to Earth as rain, ice, or snow.

\_\_\_\_\_ d. All life on Earth is based on carbon.



Visit the Glencoe Science Web site at **science.glencoe.com** to find your biology book and learn more about nutrition and energy flow.