

Energy Flow

As You Read

What You'll Learn

- **Explain** how organisms produce energy-rich compounds.
- **Describe** how energy flows through ecosystems.
- **Recognize** how much energy is available at different levels in a food chain.

Vocabulary

chemosynthesis energy pyramid
food web

Why It's Important

All living things, including people, need a constant supply of energy.

Figure 14

A Chemicals in the water that flows from hydrothermal vents provide bacteria with a source of energy. **B** The bacterial producers use this energy to make nutrients through the process of chemosynthesis. Consumers, such as tubeworms, feed on the bacteria.

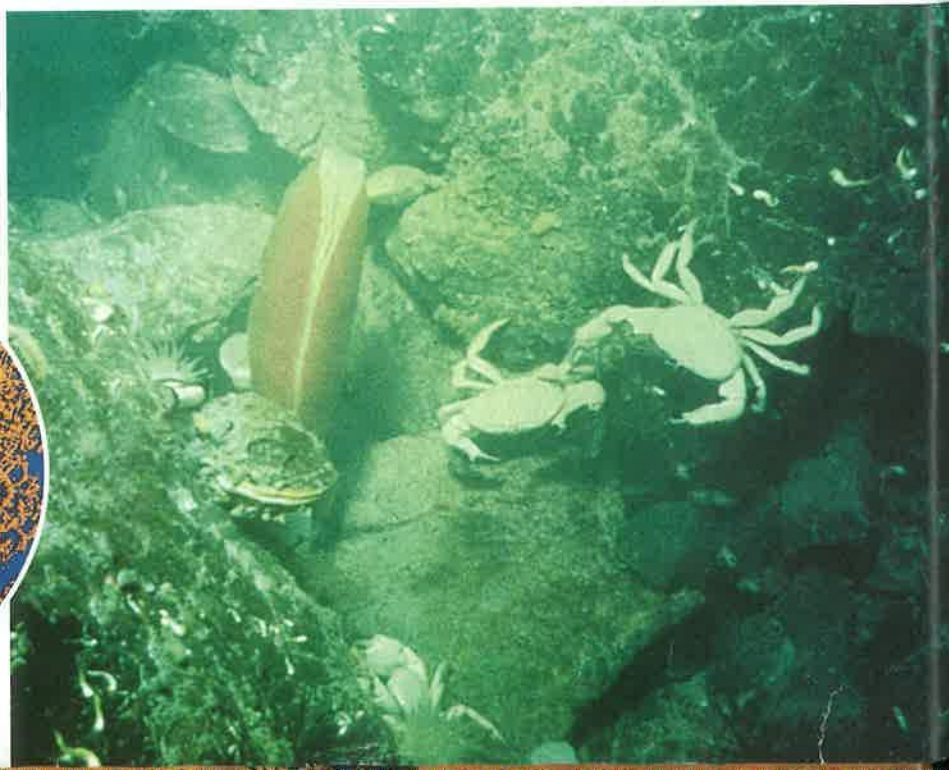


Converting Energy

All living things are made of matter, and all living things need energy. Matter and energy move through the natural world in different ways. Matter can be recycled over and over again. The recycling of matter requires energy. Energy is not recycled, but it is converted from one form to another. The conversion of energy is important to all life on Earth.

Photosynthesis During photosynthesis, producers convert light energy into the chemical energy in sugar molecules. Some of these sugar molecules are broken down as energy is needed. Others are used to build complex carbohydrate molecules that become part of the producer's body. Fats and proteins also contain stored energy.

Chemosynthesis Not all producers rely on light for energy. During the 1970s, scientists exploring the ocean floor were amazed to find communities teeming with life. These communities were at a depth of almost 3.2 km and living in total darkness. They were found near powerful hydrothermal vents like the one shown in **Figure 14**.



Hydrothermal Vents A hydrothermal vent is a deep crack in the ocean floor through which the heat of molten magma can escape. The water from hydrothermal vents is extremely hot from contact with molten rock that lies deep in Earth's crust.

Because no sunlight reaches these deep ocean regions, plants or algae cannot grow there. How do the organisms living in this community obtain energy? Scientists learned that the hot water contains nutrients such as sulfur molecules that bacteria use to produce their own food. The production of energy-rich nutrient molecules from chemicals is called **chemosynthesis** (kee moh SIN tuh sus). Consumers living in the hydrothermal vent communities rely on chemosynthetic bacteria for nutrients and energy. Chemosynthesis and photosynthesis allow producers to make their own energy-rich molecules.

 **Reading Check** What is chemosynthesis?

Energy Transfer

Energy can be converted from one form to another. It also can be transferred from one organism to another. Consumers cannot make their own food. Instead, they obtain energy by eating producers or other consumers. This way, energy stored in the molecules of one organism is transferred to another organism. At the same time, the matter that makes up those molecules is transferred from one organism to another. Throughout nature, energy and matter move from organism to organism when one organism becomes food for another organism.

Food Chains A food chain is a way of showing how matter and energy pass from one organism to another. Producers—plants, algae, and other organisms that are capable of photosynthesis or chemosynthesis—are always the first step in a food chain. Animals that consume producers such as herbivores are the second step. Carnivores and omnivores—animals that eat other consumers—are the third and higher steps of food chains. One example of a food chain is shown in **Figure 15**.



Earth Science INTEGRATION

The first hydrothermal vent community discovered was found along the Galápagos rift zone. A rift zone forms where two plates of Earth's crust are spreading apart. In your Science Journal, describe the energy source that heats the water in the hydrothermal vents of the Galápagos rift zone.

Figure 15

In this food chain, grasses are producers, marmots are herbivores that eat the grasses, and grizzly bears are consumers that eat marmots. The arrows show the direction in which matter and energy flow.

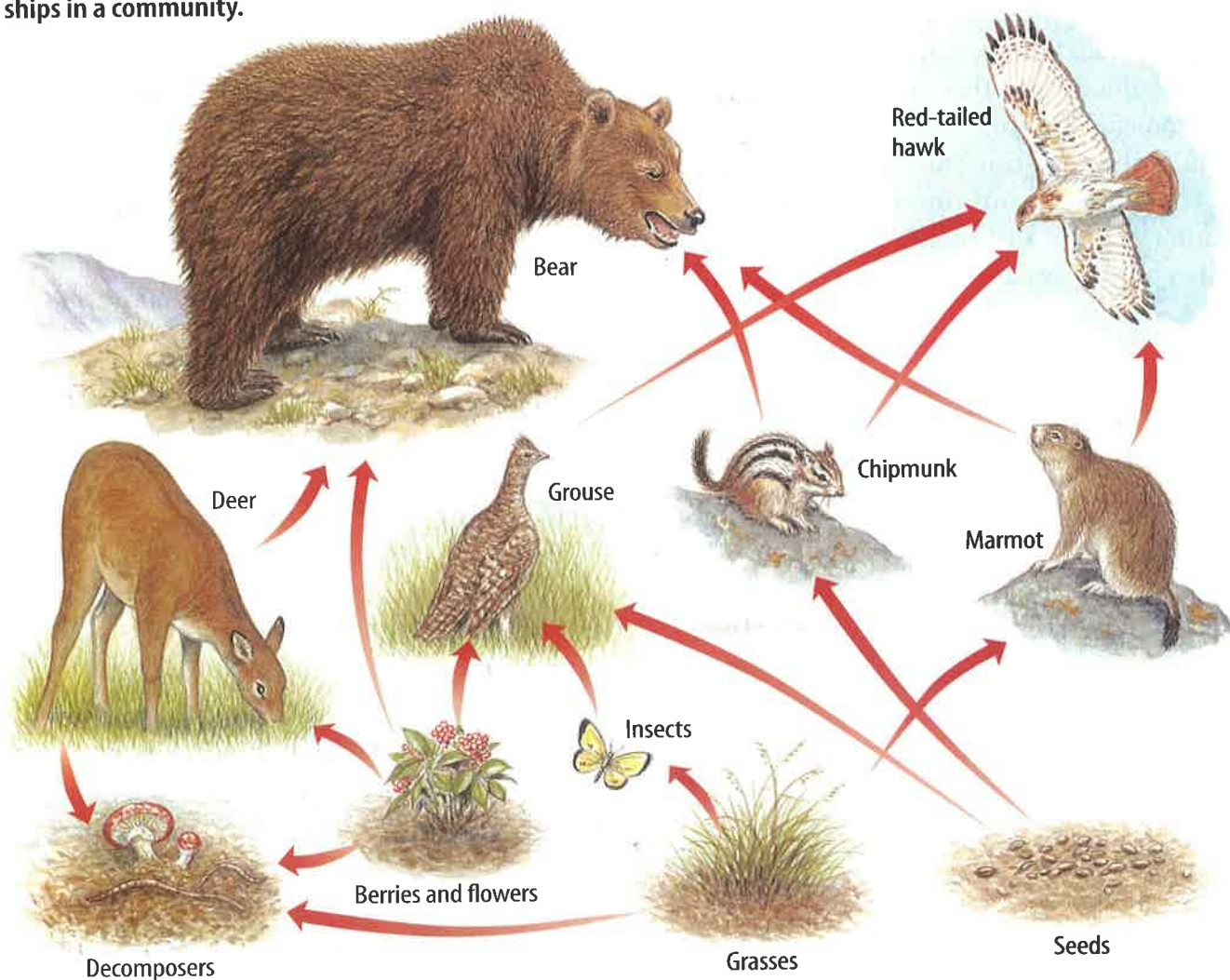
Food Webs A forest community includes many feeding relationships. These relationships can be too complex to show with a food chain. For example, grizzly bears eat many different organisms, including berries, insects, chipmunks, and fish. Berries are eaten by bears, birds, insects, and other animals. A bear carcass might be eaten by wolves, birds, or insects. A **food web** is a model that shows all the possible feeding relationships among the organisms in a community. A food web is made up of many different food chains, as shown in **Figure 16**.

Energy Pyramids

Food chains usually have at least three links, but rarely more than five. This limit exists because the amount of available energy is reduced as you move from one level to the next in a food chain. Imagine a grass plant that absorbs energy from the Sun. The plant uses some of this energy to grow and produce seeds. Some of the energy is stored in the seeds.

Figure 16

Compared to a food chain, a food web provides a more complete model of the feeding relationships in a community.



Available Energy When a mouse eats grass seeds, energy stored in the seeds is transferred to the mouse. However, most of the energy the plant absorbed from the Sun was used for the plant's growth. Much less energy is stored in the seeds eaten by the mouse. The mouse uses much of the energy remaining in the seeds for its own life processes, including respiration, digestion, and growth. A hawk that eats the mouse obtains even less energy.

The same thing happens at every feeding level of a food chain. The amount of available energy is reduced from one feeding level to another. An **energy pyramid**, like the one in **Figure 17**, shows the amount of energy available at each feeding level in an ecosystem. The bottom layer of the pyramid, which represents all of the producers, is the first feeding level. It is the largest level because it contains the most energy and the largest number of organisms. As you move up the pyramid, each level becomes smaller. Only about ten percent of the energy available at each feeding level of an energy pyramid is transferred to the next higher level.

 **Reading Check**

Why does the first feeding level of an energy pyramid contain the most energy?

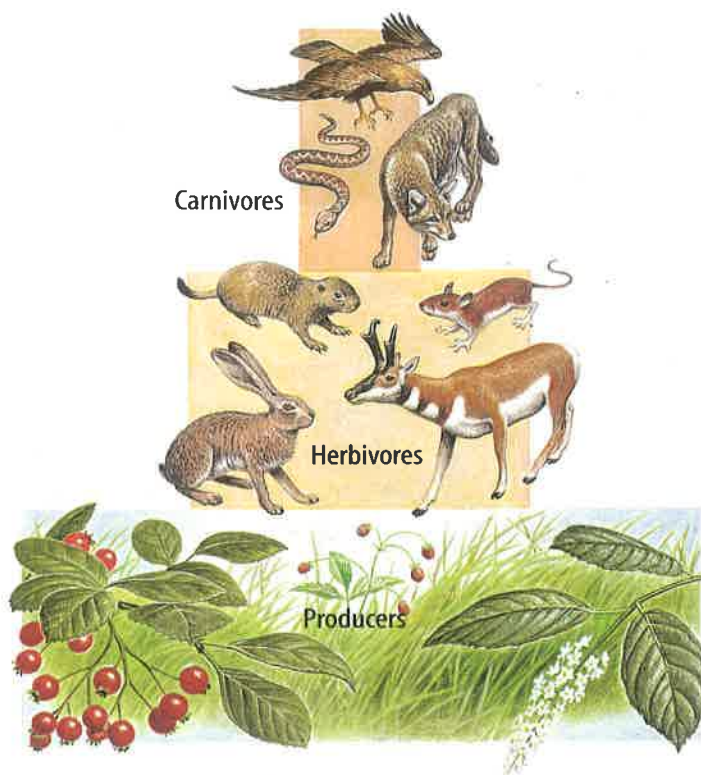


Figure 17

This energy pyramid shows that each feeding level contains less energy than the level below it. What would happen if the hawks and snakes outnumbered the rabbits and mice in this ecosystem?

Section 3 Assessment

1. Compare and contrast photosynthesis and chemosynthesis.
2. Explain how your three favorite foods provide you with energy from the Sun.
3. What is the difference between a food web and an energy pyramid?
4. Why is there a limit to the number of links in a food chain?
5. **Think Critically** Use your knowledge of food chains and the energy pyramid to explain why the number of mice in a grassland ecosystem is greater than the number of hawks.

Skill Builder Activities

6. **Classifying** Classify each species as photosynthetic or chemosynthetic: *Red hattus* uses red light to make its food; *Selen dion* makes food if the element selenium is present. **For more help, refer to the Science Skill Handbook.**
7. **Solving One-Step Equations** A forest has 24,055,000 kilocalories (kcal) of producers, 2,515,000 kcal of herbivores, and 235,000 kcal of carnivores. How much energy is lost between producers and herbivores? Between herbivores and carnivores? **For more help, refer to the Math Skill Handbook.**