

## KEY CONCEPT

# 1.3

# Energy flows through ecosystems.

## BEFORE, you learned

- Matter cycles continuously through an ecosystem
- Living things are part of the water, carbon, and nitrogen cycles

## NOW, you will learn

- How living things move energy through an ecosystem
- How feeding relationships are important in ecosystems
- How the amount of energy changes as it flows through an ecosystem

## VOCABULARY

- producer p. 23
- consumer p. 24
- decomposer p. 25
- food chain p. 26
- food web p. 26
- energy pyramid p. 28

## EXPLORE Energy

### How can you observe energy changing form?

#### PROCEDURE

- 1 Mark and cut a spiral pattern in a square piece of paper.
- 2 Cut a 15-cm piece of thread and tape one end to the center of the spiral.
- 3 Adjust the lamp to shine straight at the ceiling. Turn the lamp on.
- 4 Hold the spiral by the thread and let it hang 10 cm above the light bulb.  
CAUTION: Don't let the paper touch the bulb!

#### MATERIALS

- paper
- marker
- scissors
- thread
- tape
- desk lamp



#### WHAT DO YOU THINK?

- What do you see happen to the spiral?
- In what sense has the energy changed form?

## Living things capture and release energy.

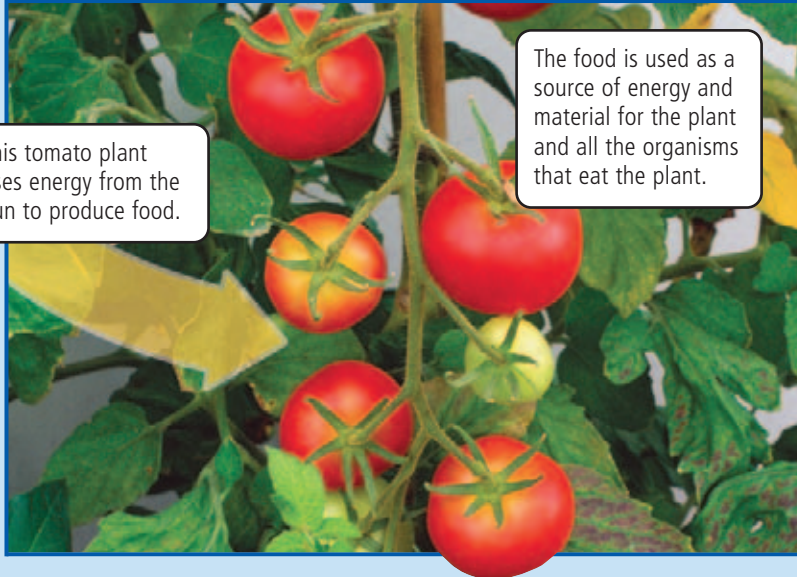
Everything you do—running, reading, and working—requires energy. The energy you use is chemical energy, which comes from the food you eat. When you go for a run, you use up energy. Some of that energy is released to the environment as heat, as you sweat. Eventually, you will need to replace the energy you've used.

Energy is vital to all living things. Most of that energy comes either directly or indirectly from the Sun. To use the Sun's energy, living things must first capture that energy and store it in some usable form. Because energy is continuously used by the activities of living things, it must be continuously replaced in the ecosystem.

## Producers

All of these producers capture energy from sunlight.

### Plants



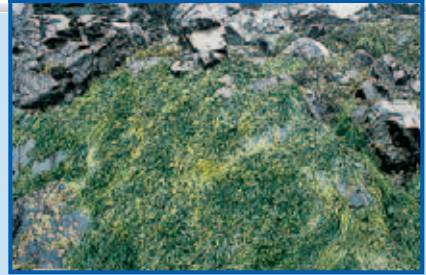
This tomato plant uses energy from the Sun to produce food.

The food is used as a source of energy and material for the plant and all the organisms that eat the plant.

#### READING VISUALS

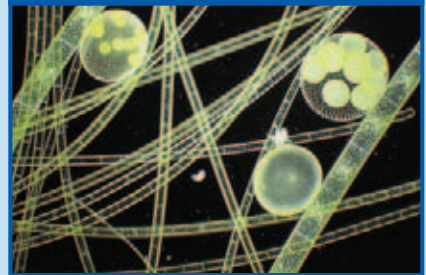
What process do all of these producers have in common?

### Seaweed



Seaweed is a producer found in Earth's oceans and coastal zones.

### Phytoplankton



The most numerous producers are tiny organisms that live in water called phytoplankton.

## Producers

A **producer** is an organism that captures energy and stores it in food as chemical energy. The producers of an ecosystem make energy available to all the other living parts of an ecosystem. Most energy enters ecosystems through photosynthesis. Plants, and other photosynthetic organisms, take water and carbon dioxide from their environment and use energy from the Sun to produce sugars. The chemical energy stored in sugars can be released when sugars are broken down.

#### CHECK YOUR READING

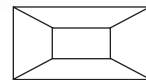
How does energy enter into the living parts of an ecosystem?

Plants are the most common producers found in land ecosystems. In water ecosystems, most food is produced by photosynthetic bacteria and algae. A few examples of producers that use photosynthesis are shown in the photographs above.

The Sun provides most of the energy that is stored in food. One exception is the unusual case of a type of bacteria that lives in the deep ocean, where there is no sunlight. These bacteria produce food using heated chemicals released from underwater vents. This process is called chemosynthesis. Whether producers use photosynthesis or chemosynthesis, they do just as their name suggests—they produce food for themselves and for the rest of the ecosystem.

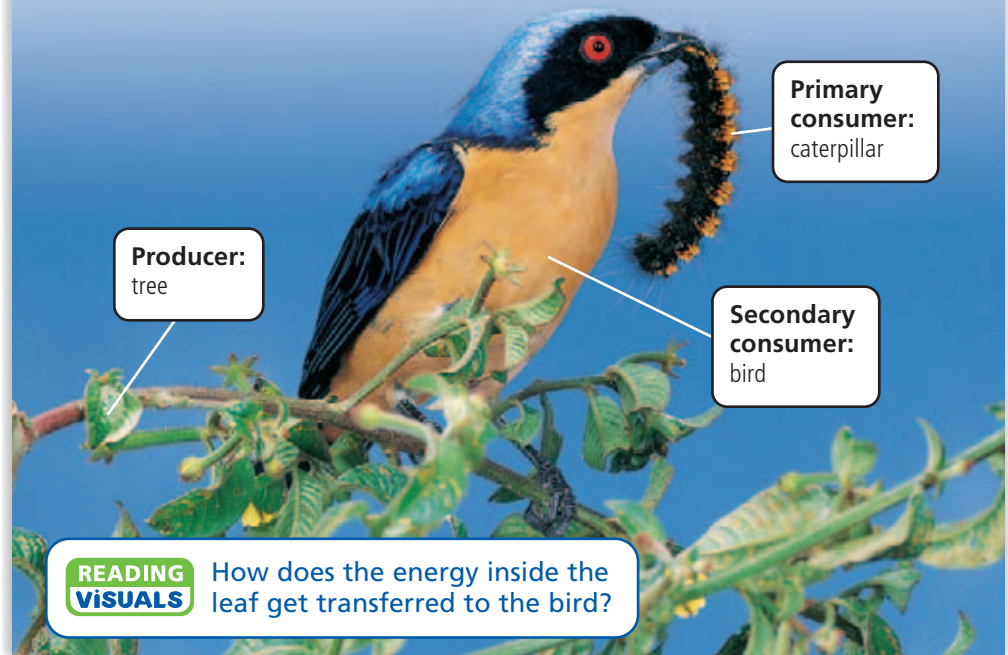
#### VOCABULARY

Remember to add a frame game for *producers* to your notebook.



## Consumers

A consumer is an organism that gets energy by eating producers or other consumers.



## Consumers

Organisms that cannot produce their own food must get their food from other sources. **Consumers** are organisms that get their energy by eating, or consuming, other organisms. To understand how energy flows through an ecosystem, you have to study feeding relationships. A feeding relationship starts with a producer, followed by one and often many more consumers.



**CHECK YOUR READING**

Describe the producer-consumer relationship in terms of energy.

### READING TIP

*Primary* is a word that means "first in order," *secondary* means "second in order," and *tertiary* means "third in order."

Consumers are classified by their position in a feeding relationship. In a meadow ecosystem, animals such as antelopes and grasshoppers feed on grasses. They are primary consumers because they are the first link between the producers and the rest of the consumers in an ecosystem. The wolves that eat the antelopes and the meadowlarks that eat the grasshoppers are secondary consumers. There are also tertiary consumers, like the prairie falcon that eats the meadowlark. Ecosystems also have special consumers called scavengers, like the vulture or earthworm, which are consumers that feed on dead animals.

In the photograph above, energy enters the ecosystem through the tree, which is the producer. The caterpillar that gets its energy by feeding on the leaves is the first, or primary, consumer. The bird that gets its energy by feeding on the caterpillar is a secondary consumer.



## Decomposers

If you've been for a hike through a forest, or a walk through a park, you have seen the interaction of producers and consumers. Tall trees and leafy shrubs are home to many insects and the birds that feed upon the insects. Also important to the maintenance of an ecosystem are decomposers, a group of organisms that often go unseen.

**Decomposers** are organisms that break down dead plant and animal matter into simpler compounds.

You can think of decomposers as the clean-up crew of an ecosystem. In a forest, consumers such as deer and insects eat a tiny fraction of the leaves on trees and shrubs. The leaves that are left on the forest floor, as well as dead roots and branches, are eventually digested by fungi and bacteria living in the soil. Decomposers also break down animal remains, including waste materials. A pinch of soil may contain almost half a million fungi and billions of bacteria.

The energy within an ecosystem gets used up as it flows from organism to organism. Decomposers are the organisms that release the last bit of energy from once-living matter. Decomposers also return matter to soil or water where it may be used again and again.



Fungi, such as these mushrooms, are decomposers.

## INVESTIGATE Decomposers

### Where do decomposers come from?

#### PROCEDURE

- 1 Carefully use scissors to cut an opening across the middle of the bottle.
- 2 Place a handful of stones in the bottom of the bottle for drainage, and add enough soil to make a layer 10 cm deep.
- 3 Place some leaves and fruit slices on top of the soil.
- 4 Seal the cut you made with tape. Mark the date on the tape.
- 5 Add water through the top of the bottle to moisten the soil, and put the cap on the bottle. Wash your hands.
- 6 Observe the fruit slices each day for two weeks. Record your observations. Keep the soil moist.

#### WHAT DO YOU THINK?

- What do you observe happening to the fruit slices?
- Where do the decomposers in your bottle come from?

**CHALLENGE** Predict what would happen if you used potting soil instead of soil from outside.

#### SKILL FOCUS Observing

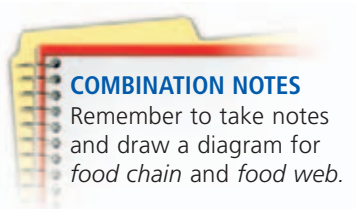


#### MATERIALS

- clear soda bottle with cap
- scissors
- stones
- garden soil
- leaves
- slices of fruit
- masking tape
- marker
- water

**TIME**  
30 minutes





### COMBINATION NOTES

Remember to take notes and draw a diagram for *food chain* and *food web*.

## Models help explain feeding relationships.

You have learned how energy is captured by producers and moved through ecosystems by consumers and decomposers. Scientists use two different models to show the feeding relationships that transfer energy from organism to organism. These models are food chains and food webs.

### Food Chain

A chain is made of links that are connected one by one. Scientists use the idea of links in a chain as a model for simple feeding relationships. A **food chain** describes the feeding relationship between a producer and a single chain of consumers in an ecosystem.

The illustration in the white box on page 27 shows a wetland food chain. The first link in the chain is a cattail, a primary producer that captures the Sun's energy and stores it in food. The second link is a caterpillar, a primary consumer of the cattail. The frog is the next link, a secondary consumer that eats the caterpillar. The final link is a heron, a tertiary consumer that eats the frog. Energy is captured and released at each link in the chain. The arrows represent the flow of energy from organism to organism. You can see that some of the energy captured by the cattail makes its way through a whole chain of other organisms in the ecosystem.

### Food Web

A **food web** is a model of the feeding relationships between many different consumers and producers in an ecosystem. A food web is more like a spiderweb, with many overlapping and interconnected food chains. It is a better model for the complex feeding relationships in an ecosystem, which usually has many different producers, with many primary and secondary consumers.

The illustration on page 27 also shows a wetland food web. You can see that the feeding relationships can go in several directions. For example, the food web shows that ruddy ducks eat bulrushes, which are producers. That makes ruddy ducks primary consumers. Ruddy ducks are also secondary consumers because they eat snails. A food web shows how one consumer can play several roles in an ecosystem.

#### READING TIP

Notice that the food chain described above is also a part of the food web described here. Follow the blue arrows in the diagram on page 27.



**CHECK YOUR READING** What is the difference between a food chain and a food web?

Both food chains and food webs show how different organisms receive their energy. They also show how different organisms depend on one another. If one organism is removed from the food web or food chain, it may affect many other organisms in the ecosystem.



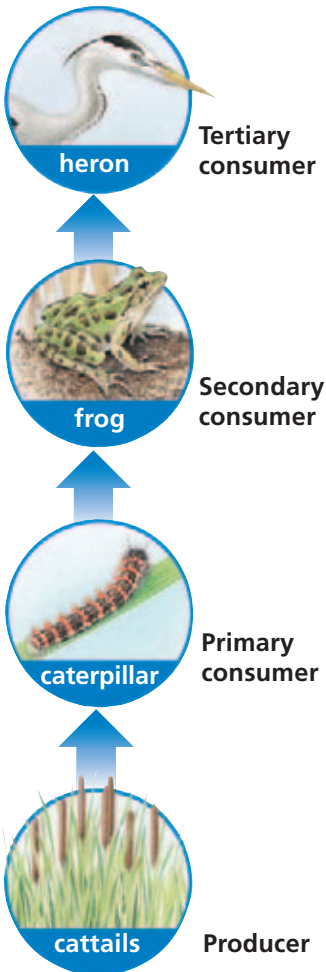
# Energy Flows Through Ecosystems

Energy is transferred from one organism to the next as organisms eat or are eaten.

## A Wetland Food Chain

### Flow of Energy

Energy flow starts at the bottom. Arrows represent energy moving from an organism that is eaten to the organism that eats it.



## A Wetland Food Web



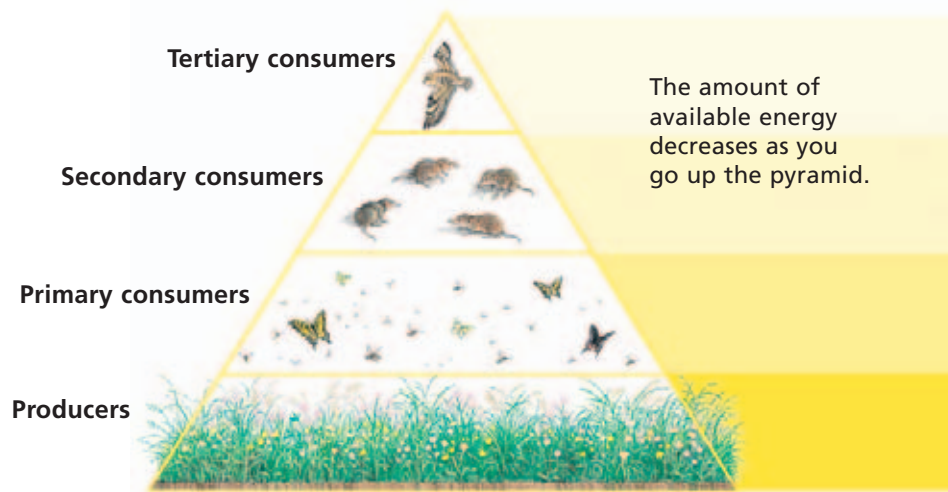
### Decomposers

These tiny organisms recycle dead and decayed material.



## Available energy decreases as it moves through an ecosystem.

Another way to picture the flow of energy in an ecosystem is to use an energy pyramid. An **energy pyramid** is a model that shows the amount of energy available at each feeding level of an ecosystem. The first level includes the producers, the second level the primary consumers, and so on. Because energy is lost as it moves from producers to consumers, the bottom level is the largest. The available energy gets smaller and smaller the farther up the pyramid you go.



### READING TIP

Refer to the diagram above as you read the text. It is because some energy is lost at each level that the diagram takes the shape of a pyramid.

In the pyramid shown here, plants are the producers. They capture energy from the Sun, use some of it, then store the rest as food. The plants are eaten by insects, which also use up some of the energy before being eaten by shrews. The shrews use up energy before being eaten by the owl. You can see that it takes a lot of sunlight to support the producers and consumers in a food web that feeds an owl.

## 1.3 Review

### KEY CONCEPTS

1. Describe the role of producers, consumers, and decomposers in an ecosystem.
2. Explain why a food web provides a better model of an ecosystem than a food chain does.
3. Explain how the amount of available energy changes as energy moves up a food chain.

### CRITICAL THINKING

4. **Apply** Draw a food chain and a food web for an ecosystem near your home.
5. **Predict** Imagine that muskrats are removed from a wetland ecosystem. Predict what would happen both to producers and to secondary consumers.

### CHALLENGE

6. **Synthesize** Explain how the carbon cycle is related to a food web. Describe how energy and matter move through the food web and the carbon cycle.