18 Energy for Ecosystems

6.2-C4

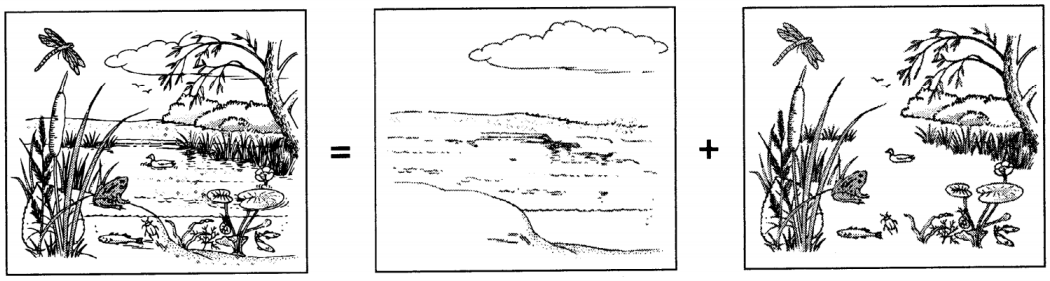
Getting the Idea

Key Words
ecosystem
biotic factor
abiotic factor
photosynthesis
pollutant

An **ecosystem** is made up of all the living things and nonliving things that interact with each other in a certain place. The living things in an ecosystem depend on each other. They also rely on the nonliving things around them. In fact, nonliving parts of an ecosystem are the source of food for all living things. When one part of an ecosystem is disturbed, all the living things can be affected.

Biotic and Abiotic Factors

The living, or once-living, parts of an ecosystem are called **biotic factors**. Biotic factors include plants, animals, bacteria, fungi, and other organisms. **Abiotic factors** are the nonliving parts of an ecosystem. These include light, temperature, weather, soil, water, air, and minerals.



Environment | Abiotic factors | Biotic factors

Energy cycles through ecosystems. It passes from one living thing to another. But the source of all that energy is an abiotic factor—sunlight. The sun is the main source of energy for almost all ecosystems on Earth. Plants, algae, and some bacteria use the energy of sunlight to make their own food. This food becomes the source of energy for all living things in the ecosystem.

Photosynthesis

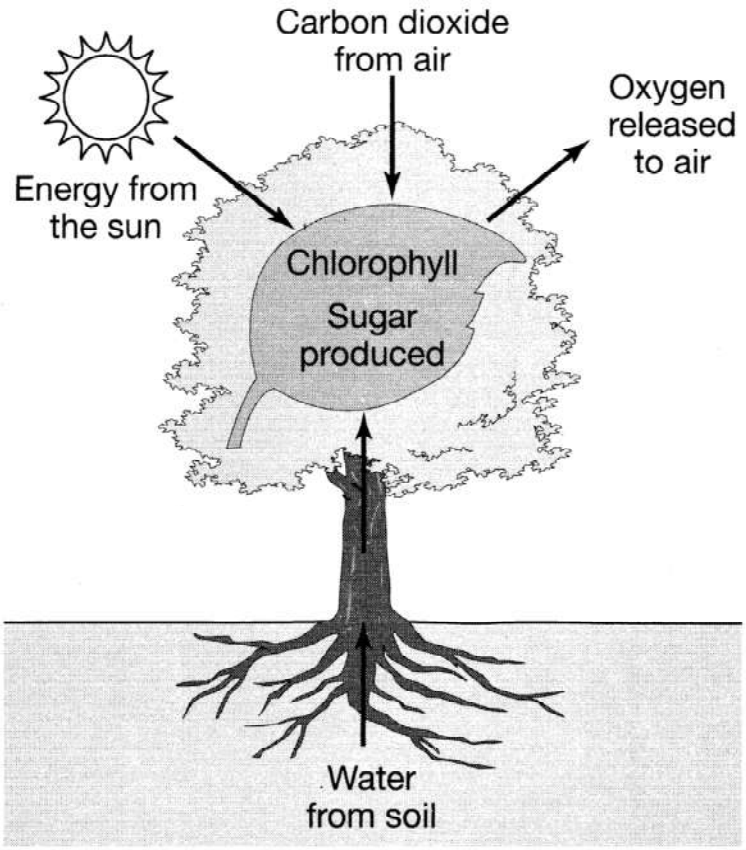
The process by which plants use the energy of sunlight to make their own food is called **photosynthesis**. In this process, carbon dioxide (CO_2) and water (H_2O) join chemically to produce oxygen and glucose. Glucose is an energy-rich sugar.

Photosynthesis

$$\text{Sunlight} + CO_2 + H_2O \rightarrow O_2 + \text{Glucose}$$

Photosynthesis happens in tiny structures called *chloroplasts*. In most plants, chloroplasts are found mainly in leaves. Chloroplasts contain a green pigment called *chlorophyll* that traps the energy of sunlight. It is this pigment that makes leaves and stems green. The trapped energy is used to change carbon dioxide and water into glucose and oxygen.

Carbon dioxide and water are abiotic factors that come from the ecosystem. Plants absorb water from the soil through their roots. Carbon dioxide is a gas in the air. Plants take in this gas through small openings in their leaves called *stomata*. Inside the leaves, water and carbon dioxide move to the chloroplasts. There, a series of chemical reactions produces glucose and oxygen. Plants use the glucose for food and release the oxygen into the air as waste.



19 The Flow of Energy in Ecosystems

6.2-C6

Getting the Idea

Key Words
producer
consumer
herbivore
carnivore
omnivore
decomposer
food chain
predator
prey
food web

As you learned in Lesson 18, plants make their own food. Some animals eat plants. Other animals eat those animals. In time, all living things become food for other organisms.

Producers, Consumers, and Decomposers

Recall from Lesson 18 that the main source of energy for living things is the sun. Some organisms use the energy of sunlight to make their own food through photosynthesis. In this process, carbon dioxide and water combine chemically to produce glucose and oxygen. Glucose is an energy-rich sugar.

An organism that makes its own food is called a **producer**. Producers include plants, most algae, and some bacteria. Organisms that cannot make their own food must get the energy they need from other organisms. An organism that gets energy by eating other organisms is a **consumer**. All animals are consumers.

Consumers are further classified by their food sources. An animal that eats mainly producers or their products is a **herbivore**. In Connecticut, common herbivores include white-tailed deer and woodchucks, or groundhogs. They eat a wide variety of plants, grasses, and sticks or bark. Another Connecticut herbivore is the beaver. It eats leaves, roots, bark, and water plants.

An animal that eats mainly other animals is a **carnivore**. One common carnivore in Connecticut is the redback salamander. It eats ants, beetles, caterpillars, earthworms, snails, and grasshoppers. Some birds are carnivores. Carnivorous birds in Connecticut include great horned owls and red-tailed hawks. These birds eat mice, squirrels, rabbits, and other small animals.

Did You Know?

Earthworms are both decomposers and consumers. Earthworms break down dead plant and animal matter. But they also eat live organisms in soil, such as bacteria and fungi.

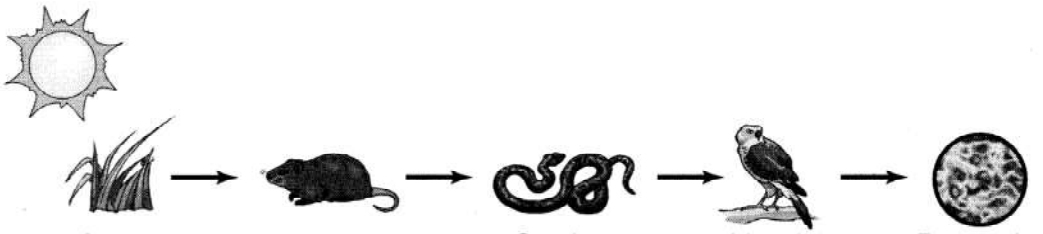
Other carnivores live in the waters of Long Island Sound. These carnivores include lobsters, long-finned squid, and frilled anemones. They eat other sea animals.

An animal that eats both producers and other animals is an **omnivore**. Humans are omnivores. Many other omnivores live in Connecticut. They include squirrels, black bears, painted turtles, skunks, frogs, coyotes, northern cardinals, and wild turkeys. All of these animals eat a wide variety of plants and animals.

A third group of organisms are called decomposers. A **decomposer** is an organism that gets its energy by breaking down the remains of dead organisms. Decomposers also break down the wastes of living things. Most fungi and many bacteria are decomposers. This group also includes earthworms and some insects. Decomposers are nature's recyclers. They return materials such as carbon and nitrogen to the air and soil. Then producers can use the materials again for photosynthesis and growth.

Food Chains and Food Webs

The flow of energy from one organism to the next can be shown in a **food chain**. Food chains show the flow of energy from producer to different consumers to decomposers. The food chain below shows one path for the flow of energy that you might find in a Connecticut ecosystem.

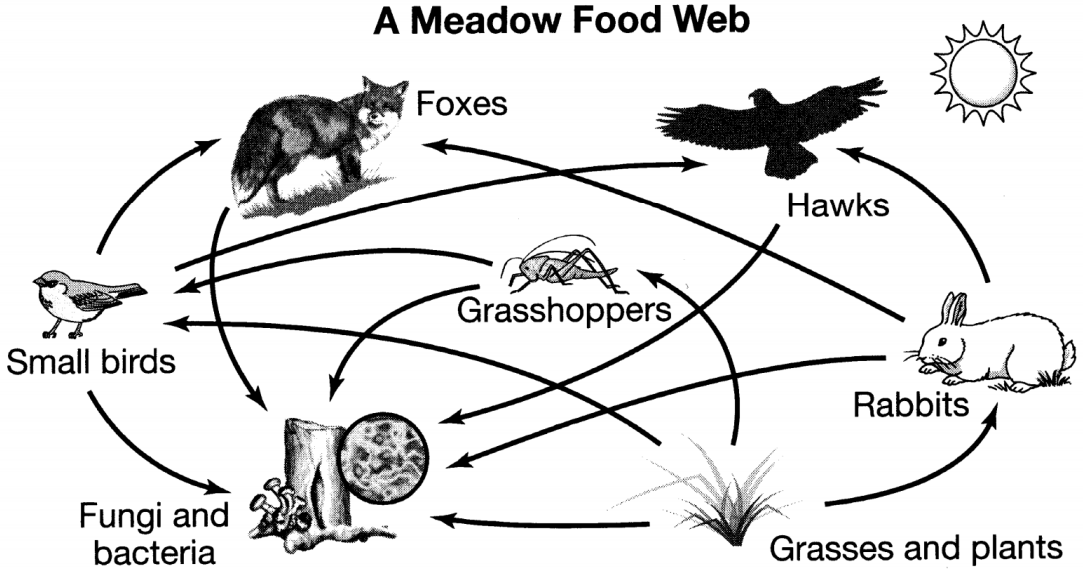


Animals that hunt other animals for food are called **predators**, and the hunted animals are **prey**. In the food chain shown above, both the hawk and the snake are predators. The snake is also prey for the hawk.

A food chain shows only one path for the flow of energy. In most ecosystems, feeding relationships are much more complicated than that. Each organism may be part of several food chains. A **food web** shows interconnected food chains in an ecosystem.

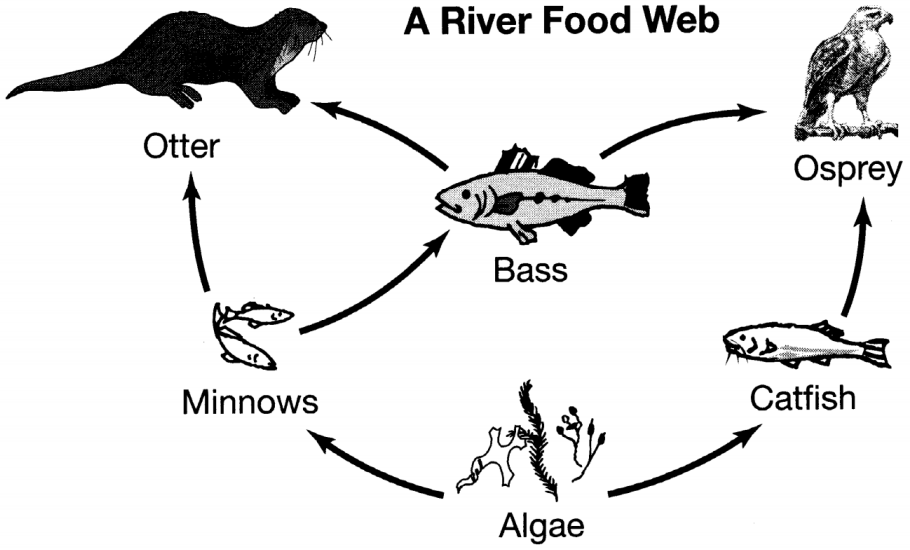
The food web below includes organisms you might find in a meadow in your state. The arrows show the direction of the flow of energy.

A Meadow Food Web



In water ecosystems, the main producers are algae. The diagram below shows a food web for a Connecticut river ecosystem.

A River Food Web



Many other kinds of ecosystems are found in Connecticut. There are several kinds of forests and woodlands. There are wetlands, such as marshes, swamps, and bogs. Freshwater ecosystems include lakes and ponds as well as rivers. And a saltwater ecosystem is found in the Long Island Sound. Different species of organisms live in each ecosystem. But in each ecosystem, the organisms are connected in food webs by the need for energy.

22 The Human Respiratory and Circulatory Systems

7.2-C16

Getting the Idea

Humans have invented devices such as scuba gear and space suits. These inventions allow people to breathe even in the most difficult environments. But why do people need to breathe? And how is the air you breathe brought to the cells of your body?

Key Words

respiratory system
lungs
alveoli
trachea
bronchi
diaphragm
circulatory system
heart
atrium
ventricle
artery
vein
capillary
plasma
red blood cell
white blood cell
platelet

Getting the Oxygen You Need

Breathing is how humans and other animals take in and release air. The air you take in is important because it provides the oxygen you need to release energy from your food. The air you breathe out contains carbon dioxide. Carbon dioxide is a waste product.

The **respiratory system** is the body system that takes in oxygen and releases carbon dioxide. It works closely with the circulatory system to carry oxygen to body cells and to carry carbon dioxide away from body cells as waste.

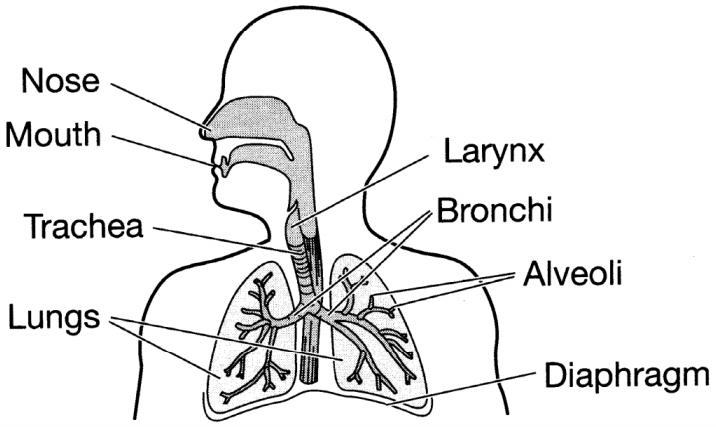
The Respiratory System

The main organs of the respiratory system are the lungs. The **lungs** are elastic, sponge-like organs in the chest. They are made up of tiny air sacs called **alveoli** (singular *alveolus*). Alveoli are very thin and are surrounded by tiny blood vessels. Oxygen enters the blood through the thin walls of the alveoli.

Did You Know?

Veins look blue because the blood is dark because it contains less oxygen. Arteries look red because the blood in arteries is bright red due to its high oxygen level.

As you can see on the diagram below, air enters the body through the mouth and nose. From there, it passes down the **trachea**, or windpipe. The trachea divides into two tubes called **bronchi**, which enter the lungs. The bronchi divide again and again. Each division ends in an alveolus.



The respiratory system itself cannot move air into and out of the lungs. Muscles in the chest expand and contract the chest, moving air into and out of the lungs.

When you breathe in, or inhale, the diaphragm contracts. The **diaphragm** is a dividing wall made of muscle and connective tissue. When the diaphragm contracts, it moves downward. This causes the chest cavity to expand and air to rush into the lungs.

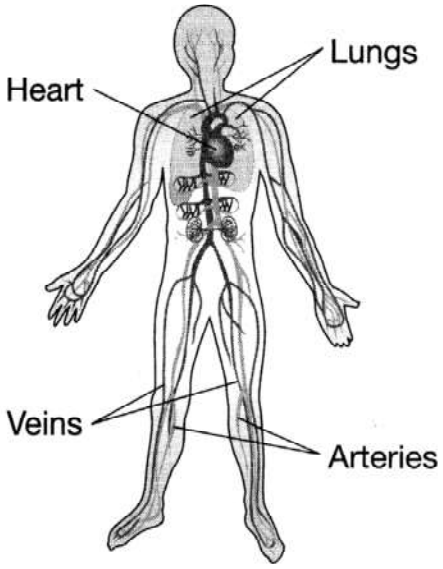
Oxygen in the air enters the blood vessels around the alveoli wher you breathe in. Carbon dioxide in the blood vessels enters the air space in the lungs.

When you exhale, the diaphragm relaxes and moves up. This pushes air out of the lungs. Muscles of the abdomen and the rib cage help push the air out. The air you exhale has a higher concentration of carbon dioxide and a lower concentration of oxygen than the air you inhaled.

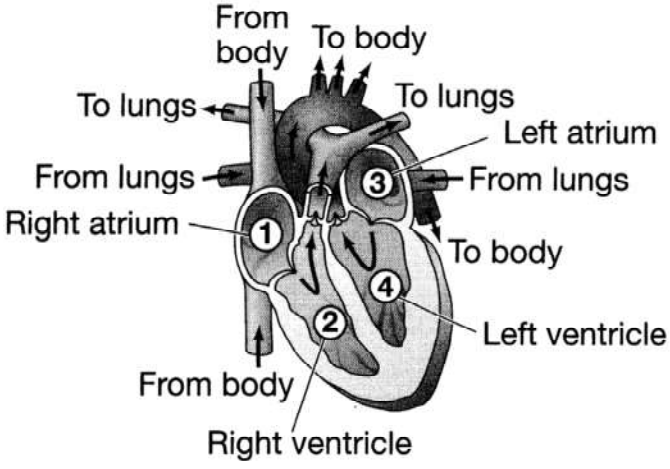
The Circulatory System

The **circulatory system** is a transport system that uses blood to carry nutrients and oxygen to the cells of the body. It also carries waste products like carbon dioxide away from the cells. The circulatory system transports chemical messages between cells in different parts of the body. It also carries substances that help fight disease. The circulatory system is made up of the heart, the blood vessels, and the blood.

Circulatory System



The **heart** is a muscular organ that consists of two pumps working side by side. When the heart muscles contract, they push the blood through the blood vessels. Each pump has two chambers. The upper chamber of each side is called the **atrium**, and the lower chamber is called the **ventricle**. The left side of the heart receives oxygen-rich blood from the lungs and pumps it to the rest of the body. The right side receives oxygen-poor blood from the rest of the body and pumps it to the lungs.

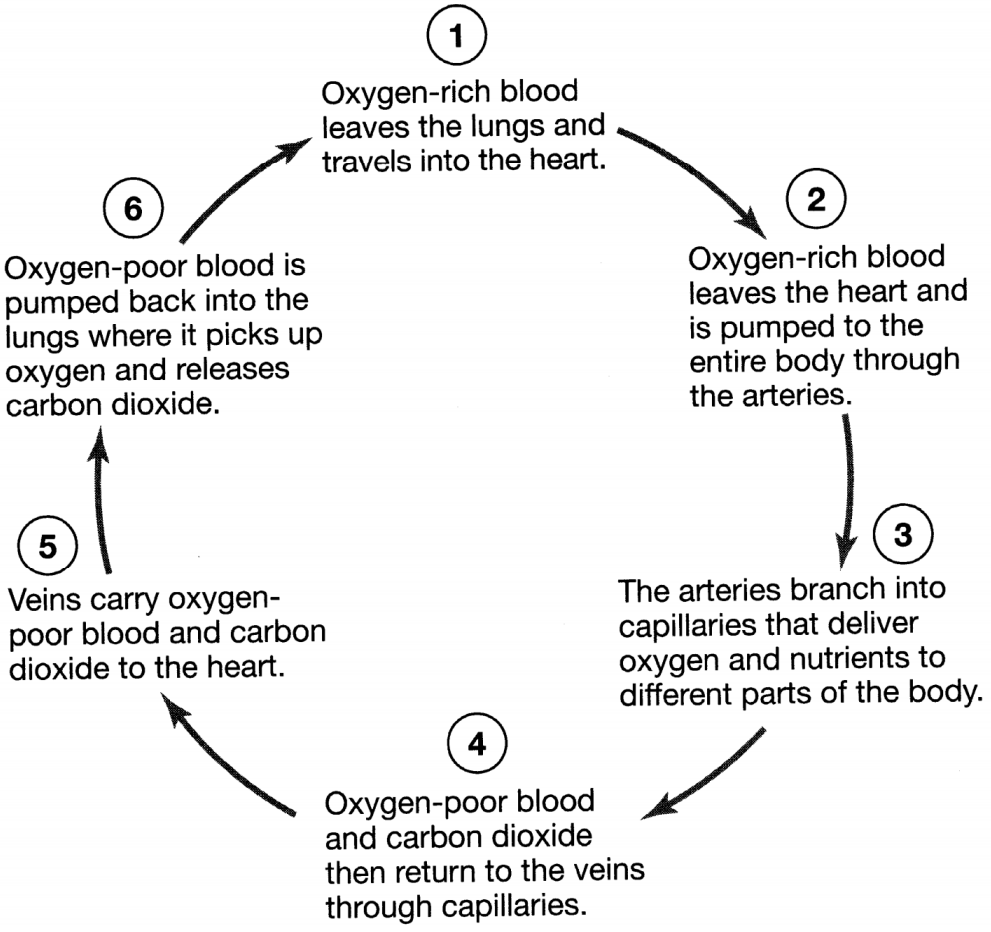


Blood vessels are the tube-like structures through which the blood flows. There are three types of blood vessels.

- **Arteries** carry blood away from the heart.
- **Veins** carry blood toward the heart.
- **Capillaries** are tiny vessels between arteries and veins. They exchange substances such as gases and nutrients between the blood and the body cells.

Blood is composed of two main parts: plasma and blood cells. **Plasma** is a yellowish fluid that is mostly water. It also contains dissolved nutrients, minerals, salts, and gases. The blood cells are solid and float in the plasma. There are three different types of blood cells. **Red blood cells** carry oxygen around the body. **White blood cells** fight disease by attacking invading microorganisms and by producing antibodies to fight infection. **Platelets** are fragments of cells that help form blood clots to stop bleeding.

The circulatory and respiratory systems work together to bring oxygen into the body and deliver it to cells. They also remove carbon dioxide from cells and release it from the body. This entire process is summarized below.



23 The Human Digestive System

7.2-C16

Getting the Idea

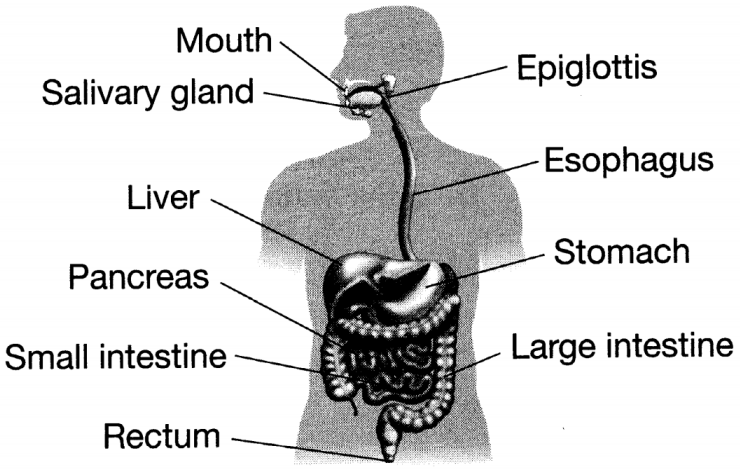
Key Words
digestive system
saliva
esophagus
epiglottis
peristalsis
stomach
small intestine
pancreas
liver
large intestine
rectum

Food serves as fuel and building material for all organisms. You take in food when you eat, but what happens after that? Your body has a system that breaks down food, changing it into forms that your body can use.

Digestive System

The **digestive system** breaks food down into smaller particles. The smaller pieces can then be used by your cells. Digestion takes place in two ways. *Mechanical digestion* is a physical process that breaks the food into smaller particles. *Chemical digestion* is a chemical process that results from the action of enzymes on the food particles. Together, these processes change food from bite-sized pieces to small molecules. Refer to the diagram of the digestive system below as you read about the organs that make up the digestive system.

Digestive System



Did You Know?

Your small intestine is about 4.75 meters (about 15.5 feet) long. It is longer than the large intestine. However, the small intestine is narrower than the large intestine.

Digestion starts in the mouth. Chewing is a form of mechanical digestion. As food is chewed, the tongue works to move the food around and mix it with saliva. **Saliva** is a liquid that contains an enzyme that is important for breaking down starches and sugars. This is the first step in chemical digestion.

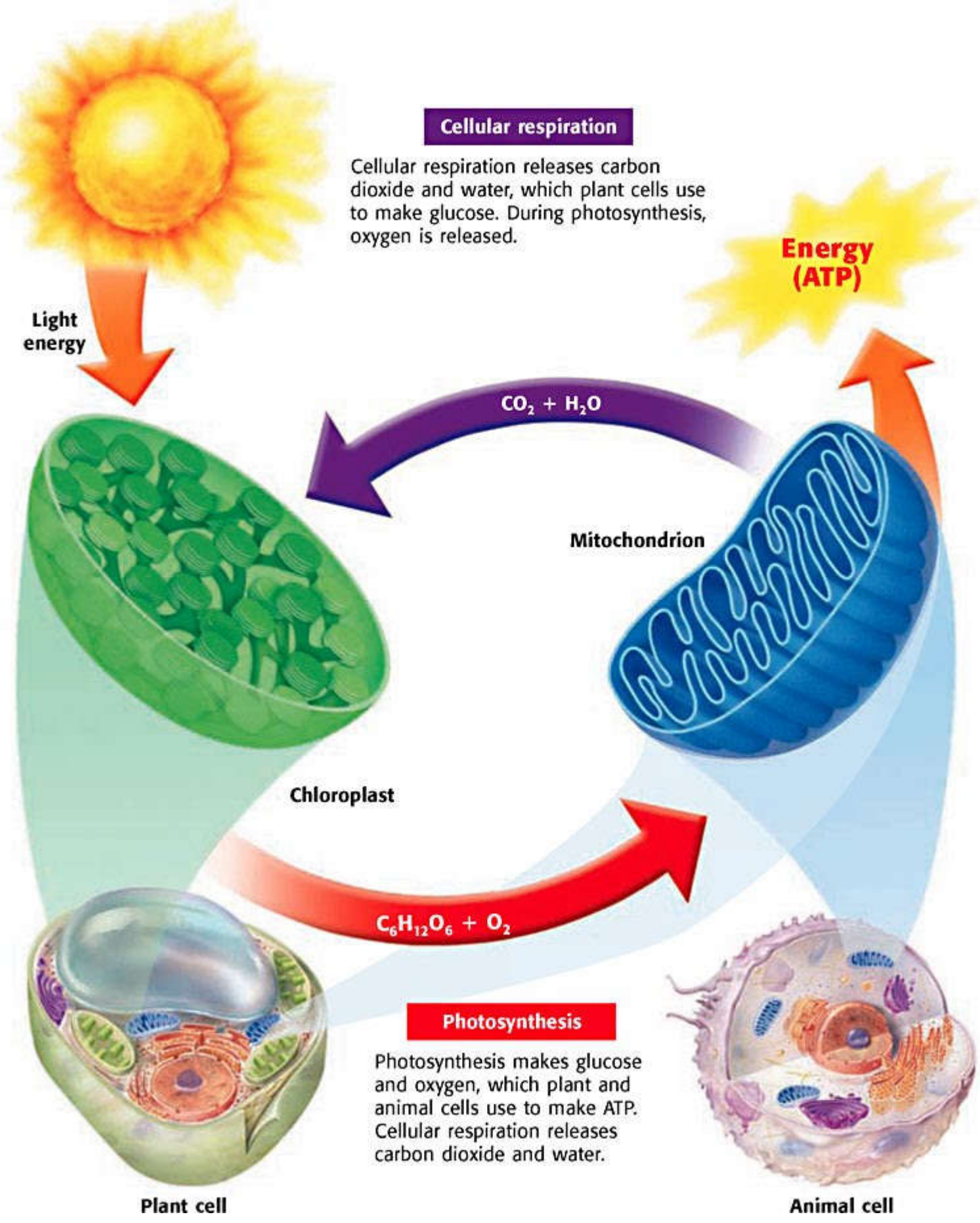
After food is swallowed, it enters the **esophagus**, a muscular tube that is connected to the stomach. A small flap of tissue called the **epiglottis** covers the opening of the trachea during swallowing to keep food out. This keeps you from breathing in small pieces of food and choking. The walls of the esophagus contain layers of muscles that squeeze to push the food along. This wave of muscle contractions is called **peristalsis**.

After traveling through the esophagus, food reaches the **stomach**, a muscular, expandable organ. As the muscles in the wall of the stomach contract, mechanical digestion continues as the food inside the stomach is mixed. Enzymes and strong digestive juices such as hydrochloric acid continue the process of chemical digestion.

Eventually the food is changed into a liquid that moves into the **small intestine**. Chemical digestion continues in the small intestine. Secretions from the **pancreas** and **liver** are mixed with the carbohydrates, fats, and proteins from the food you eat. Peristalsis moves the mixture along the small intestine.

Most nutrients are absorbed in the small intestine. The walls of the small intestine have many folds. This increases the surface area, so there are more places for digested food to be absorbed. Nutrients move into the capillaries in the lining of the small intestine. The blood then transports the nutrients to cells throughout the body. Peristalsis moves the undigested material into the **large intestine**. Excess water is absorbed from the undigested material, leaving a semi-solid mass.

From the large intestine, the material moves to the **rectum**. The undigested material is held in the rectum until it is eliminated from the body.


Cellular respiration
Cellular respiration releases carbon dioxide and water, which plant cells use to make glucose. During photosynthesis, oxygen is released.
Energy (ATP)
Light energy
$CO_2 + H_2O$
Mitochondrion
Chloroplast
$C_6H_{12}O_6 + O_2$
Photosynthesis
Photosynthesis makes glucose and oxygen, which plant and animal cells use to make ATP. Cellular respiration releases carbon dioxide and water.
Plant cell
Animal cell