

**Reflect**

Your muscles use **energy** to help you move, and your nervous system uses energy to help you understand the world around you. But how does your body obtain and use this energy? Animals, including humans, get their energy by eating other organisms. For example, you may have eaten an apple at breakfast that provided your body with energy later in the day. Where did the energy stored in the apple come from? We know that energy cannot be created or destroyed, so where does the source of energy in living systems begin, and how does it move through these systems?

**energy:** the ability to do work or cause change

**Energy flows through food chains and food webs.**

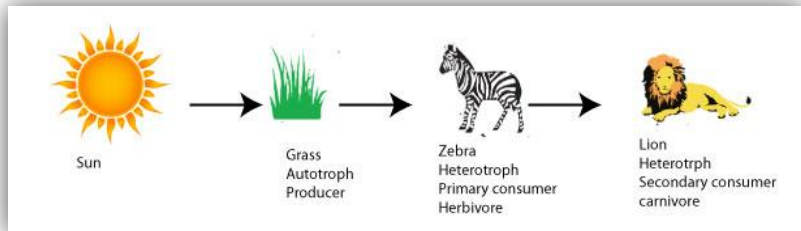
Maintaining life on Earth requires a continual input of energy from the Sun. Energy from the Sun travels through a number of different organisms in a **food chain**.

**food chain:** the path of food energy from the Sun to producers and then to consumers

Plants, algae, and some bacteria can convert light energy from the Sun into usable, **chemical energy**. This process is called *photosynthesis*. These types of organisms are called *primary producers*. Primary producers are also called *autotrophs* because they produce their own food. “Auto-” refers to self, and “troph-” refers to feeding, so autotrophs are self-feeders.

**chemical energy:** energy stored in the chemical bonds of molecules

*Consumers*, also called *heterotrophs*, are organisms that obtain their energy by eating other organisms. Different types of heterotrophs are classified according to what they eat. *Herbivores* eat producers; the root “herb-” refers to plants. Herbivores are *primary consumers* because they are the first consumer level in a food chain. Examples of common primary consumers include rabbits, squirrels, and cows.



A food chain shows the path of food energy in an ecosystem.

The next level of consumers, called *secondary consumers*, eats the primary consumers. Secondary consumers are also called *carnivores* because they eat other animals. The root “carn-” refers to meat. Some common secondary consumers include wolves, eagles, and lions.

A consumer that eats secondary consumers is a *tertiary*, or third level, consumer. Snakes and hawks are often the tertiary consumers in a food chain.

*Omnivores* are a unique group of consumers because they eat both producers and other organisms. So, omnivores can be classified as primary or secondary consumers, depending on what they choose to eat in a particular situation. Raccoons, brown bears, and many humans are omnivores.

Organisms called *decomposers* fill the last link in a food chain. These organisms break down the remains and wastes of other organisms. Decomposers are important because they help return important nutrients to the environment. Certain bacteria and fungi act as decomposers.

### Look Out!

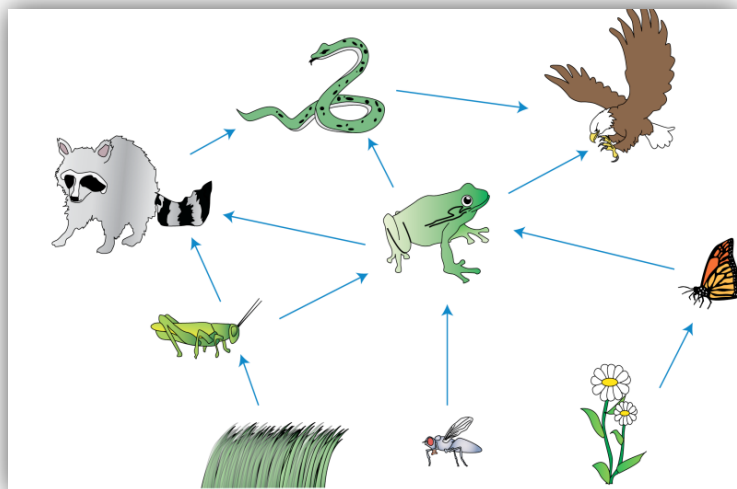
The consumer level of an animal can vary, depending on the path of energy in a particular food chain. For example, suppose a mouse eats grass and is the primary consumer. If a snake eats the mouse, the snake is a secondary consumer. On the other hand, suppose an insect eats grass and is the primary consumer. If a mouse eats the insect and the snake eats the mouse, the snake is a tertiary consumer. The important thing to remember is that food chains end with a top-level consumer that does not have any natural enemies. Alligators, hawks, and polar bears are examples of top-level consumers.

### In terrestrial ecosystems, food webs involve organisms that live on land.

A food chain is useful for tracing energy flow, but it only tells part of the story. A *food web* shows the complexity of interactions between the different **trophic levels**. The food web shown at right illustrates food relationships in a terrestrial ecosystem. *Terrestrial* refers to land, so a *terrestrial ecosystem* is located on land rather than in the water.

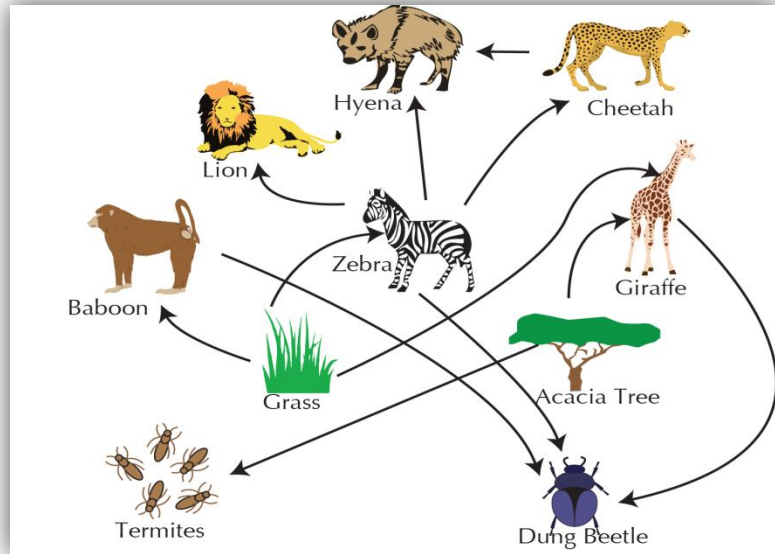
**trophic levels:**  
groups of organisms whose energy source is the same number of steps away from the Sun

You can see how several food chains overlap in this diagram. The primary producers are plants. Insects like grasshoppers and butterflies are primary consumers that eat the plants. Frogs and raccoons are secondary consumers that eat the insects, and snakes and eagles are tertiary consumers (also carnivores) that eat the secondary consumers. The flies are a food source and also eat dead plant and animal matter.



**What Do You Think?**

Take a look at the terrestrial food web at right. Identify each organism as a producer (autotroph), primary consumer (heterotroph), secondary consumer (heterotroph), or tertiary consumer (heterotroph). Which organisms do you think do the job of eating dead plant and animal matter? Keep in mind that a single organism may fall into more than one heterotroph category.

**Look Out!**

Autotrophs are called primary producers, but they do not produce energy. Energy cannot be produced or destroyed; it is only converted from one form to another. Producers convert **light energy** into chemical energy. Other organisms can then use this chemical energy.

**light energy:** a type of energy that humans can see, such as light energy from the Sun

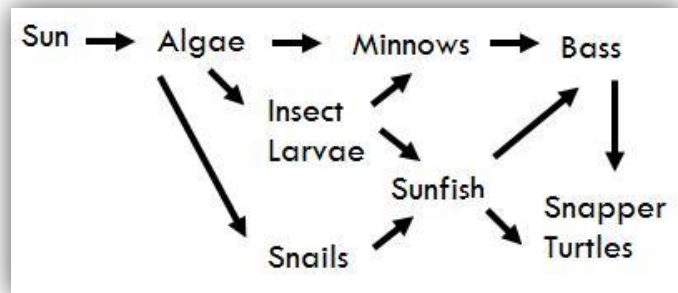
**In aquatic ecosystems, food webs involve organisms that live in water.**

Terrestrial ecosystems may be more familiar to us, but aquatic ecosystems make up the largest part of our **biosphere**. *Aquatic ecosystems* include marine and freshwater ecosystems. *Marine ecosystems* are saltwater environments like oceans, coral reefs, and salt marshes. *Freshwater ecosystems* are water environments with a very low salt content and include rivers, streams, and ponds. Like all ecosystems, aquatic ecosystems consist of food webs with producers and consumers.

**biosphere:** the part of Earth that is able to support life

Tiny aquatic plants called *phytoplankton* are the main producers in aquatic ecosystems. Algae are a common type of phytoplankton. Tiny aquatic animals called *zooplankton* and small animals without backbones called *invertebrates* are primary consumers that feed on phytoplankton. Fish and larger aquatic life eat these primary consumers and make up the higher consumer levels of the food chain.

In the marine food web shown here, algae are the primary producers. Minnows, insect larvae, and snails are secondary consumers. Bass and sunfish are tertiary consumers. This food chain has a fourth consumer level, called a quaternary level. Snapper turtles eat the tertiary consumers, so they belong to this group



Algae are common producers in aquatic food webs.

### Looking to the Future: Protecting Food Webs

What would happen to a food web if one group of organisms were removed? Every organism in a food web plays an important role. For example, in some terrestrial ecosystems, frogs are a food source for organisms like eagles and snakes. If frogs were not available, eagles and snakes would have less food and would decrease in number. Frogs are also regulators of the populations below them on the food chain. Frogs are secondary consumers. They eat insects, spiders, and small fish. If there were not enough secondary consumers to eat the primary consumers, the number of primary consumers would increase. If there were too many primary consumers, they could completely consume and destroy the plant populations.

Removing one link in a food web has ripple effects. This is an important consideration because as humans take up more of Earth's landscape, we often displace wild animals and plants. This can have dramatic effects on an ecosystem. As we consider conservation strategies, it is important to think about entire ecosystems. Efforts to save eagle habitats are not enough if we don't consider the habitats of the eagle's food sources.

### Food webs in ecosystems reveal predator/prey relationships and parasite/host relationships.

Different **species** in an ecosystem interact with one another and form relationships within a food web. These relationships can be divided into three main categories: competition, predation, and symbiosis.

**species:** a group of organisms that can mate and produce fertile offspring

*Competition* occurs when more than one group of organisms tries to use the same resource such as food, water, or living space. The organisms that get the needed resources will survive, while other organisms may not.

*Predation* is a type of feeding relationship in which one animal hunts and eats another animal. The carnivores we've discussed so far, including lions, eagles, and turtles, are *predators* because they hunt for food. The animals eaten by the predators are the *prey*. In an aquatic food web, a shark is a predator, and a seal is the prey.

*Symbiosis* describes a close, long-term relationship between two species. *Mutualism* is a type of symbiosis in which both species benefit. For example, certain bacteria live in the guts of animals. The bacteria have access to food and provide the animals with essential vitamins. Both the bacteria and the animals benefit by the relationship. *Commensalism* is a symbiotic relationship in which one species benefits and the other is not obviously affected. Marine animals called barnacles live on gray whales. The barnacles obtain food while riding on the whales, but the whales seem to be unaffected. *Parasitism* is a form of symbiosis in which an organism called a *parasite* feeds on another organism called a *host*. Parasites are generally much smaller than the host. In this relationship, the parasite benefits by receiving food and the host is usually weakened but not killed. An example of parasitism is a tick (parasite) feeding on the blood of a human (host).







The spider is a predator, and the fly is the prey in this relationship.



A tick is a parasite that feeds on a human host.

**What Do You Know?**

Study the images below. Identify the trophic levels shown in each image; write “producer,” “primary consumer,” “secondary consumer,” or “tertiary consumer” next to the correct image in the right column of the table. Also identify any predator/prey relationships by writing “predation” across from the image in the right column.

Image	Trophic level
	Squirrel:  Nut:
	Bear:  Fish:
	Caterpillars:  Leaf:
	Bird:  Insect:

**Connecting With Your Child: Food Relationships Close to Home**

To help your child learn more about relationships in food webs, go on a nature walk around your neighborhood or school. First, ask your child to list the different trophic levels found in food webs. Then have your child identify and record the trophic level(s) of each organism you observe on the walk. Some common examples include trees and grasses (producers), insects and rabbits (primary consumers), smaller birds (secondary consumers), and snakes (tertiary consumers). You might also ask your child to look for decomposers by searching for mushrooms and even lifting up rocks and logs. Many insects that live under rocks and logs break down dead leaves and tree limbs and return some of the nutrients from these plant parts back to the soil. However, remind your child that the unaided eye cannot see many decomposers like bacteria.

If your child is not sure about the organisms' trophic levels, suggest recording the names and drawing sketches or taking photographs of the organisms. During the trip, encourage your child to gather as much information about each trophic level as possible. After returning home, your child can conduct additional research on the trophic levels (if necessary) and feeding options for each organism. Once all of the information has been gathered and recorded, have your child draw a food web for the organisms you observed. If possible, take your child on a trip to a zoo or nature park and repeat the activity.

Here are some questions to discuss with your child:

- Which trophic level is the most common in your food web? Why do you think this is so? (Higher trophic levels are generally less common because of the energy required to maintain these organisms).
- What examples of predation did you observe? Is there any competition in your food web? Explain.
- You were probably not able to directly observe parasitism. Why do you think this is so?