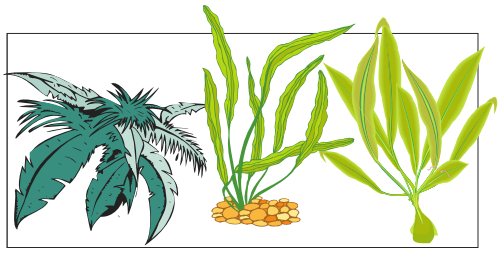
Introduction

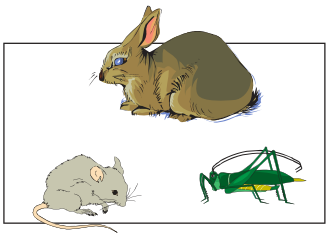
In Unit 18 we examined protecting our **environment** and natural resources that provide us with energy. In Units 3, 5, 9, and 11 we learned how there is conservation of mass and energy when matter is transformed. Now in this unit we will look at how living things need energy in order to live. Living systems obey all the physical laws of science. That is, that matter and energy are neither created nor destroyed.

Environment—Where Organisms Interact

An *environment* includes all the living and nonliving things with which an **organism**, or a living thing, interacts. All the living and nonliving things in an environment are interdependent. That is, they depend on each other. All living things need energy in order to live. They use energy to carry on all the basic life functions. *Organisms* can be classified into three main groups based on how they obtain energy: **producers**, **consumers**, and **decomposers**. Organisms that can make their own food are called *producers*. Producers use light energy to make food by the process of **photosynthesis**. Photosynthetic organisms like plants, phytoplankton, and green algae are producers. *Consumers* are classified according to the type of food they eat. The **herbivores** are the plant eaters. They eat the producers. Organisms such as mice, insects, and rabbits are *herbivores.* The **carnivores** are consumers who eat animals (consumers). Snakes, frogs, and eagles are *carnivores*.



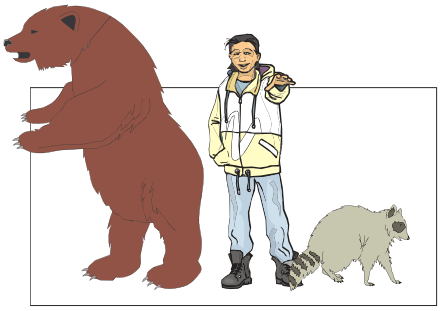
Producers *use light energy to make food by the process of photosynthesis.*



The herbivores are consumers *who eat plants (producers).*

The carnivores are consumers *who eat animals (consumers).*

The consumers that eat both producers and other consumers, or plants and animals, are **omnivores**. Bears, people, and raccoons are examples of *omnivores*. **Scavengers** are consumers who feed on organisms who have recently died. Vultures, crayfish, and snails clean up by eating dead organisms. After plants and animals die, organisms called *decomposers* break down the dead matter into simpler substances. Bacteria and fungi work as decomposers. Plants, to make food, then use these substances. This cycle is repeated over and over in the same **ecosystem**. The matter is cycled within the *ecosystem*, which is a distinct, self-supporting unit of interacting organisms and their environment.



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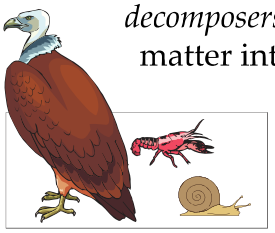
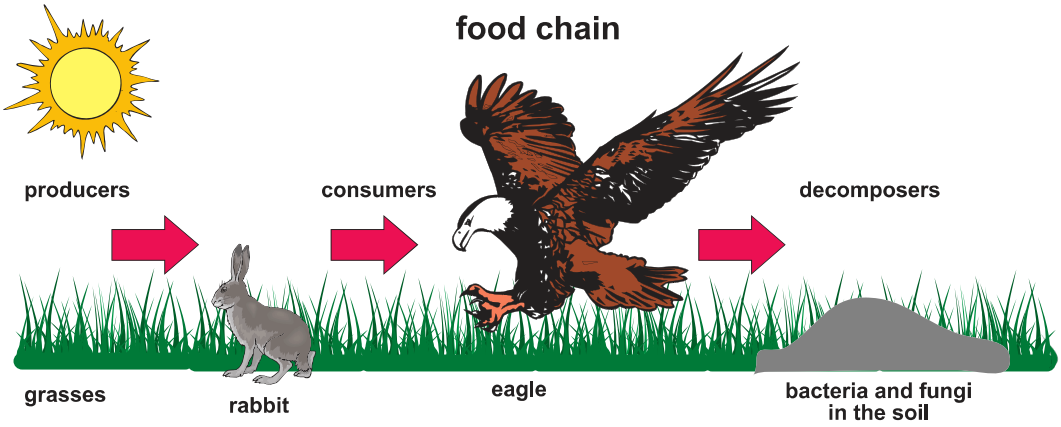


Scavengers *are consumers who feed on organisms who have recently died.*

Food Chain

We can see how every organism on Earth is involved in a **food chain**. All energy for life comes from the sun, and all life relies on energy. All the energy used by plants and animals comes directly or indirectly from the sun. A *food chain* is a way to show the transfer of energy from the sun, to producers, and onto consumers.

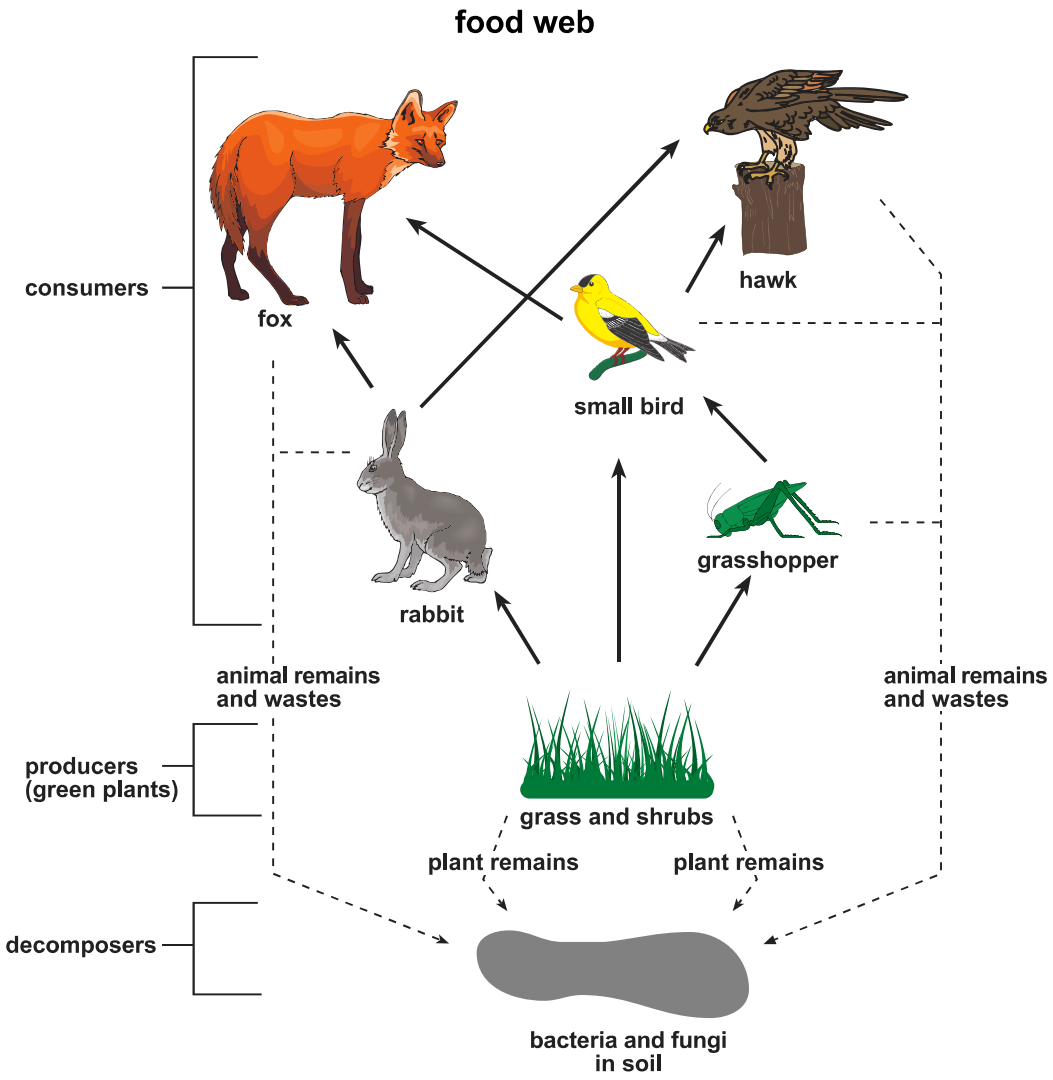


In this food chain, grasses are eaten by the rabbit.

The eagle eats the rabbit.

The dead and decaying remains of all are decomposed and recycled by decomposers.

But interactions among organisms often are more complex because most animals eat more than one type of food. A **food web** includes all the food chains in an ecosystem that are interconnected.



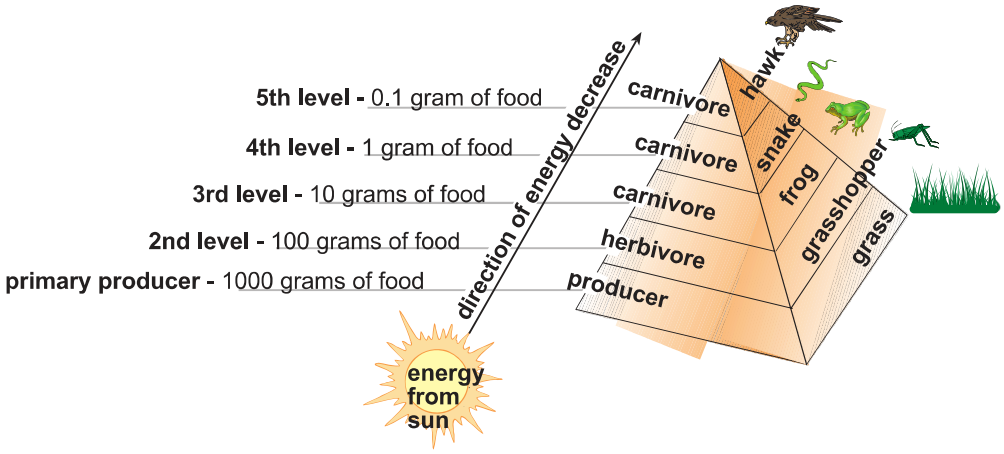
The food chain shows the interconnected feeding relationships in a food chain in a particular place and time

Energy Flows through an Ecosystem

A feeding level is the location of a plant or an animal along a food chain. Each feeding level is basically a "link" in the food chain. Because the plants are producers they form the first feeding level. The consumers that eat plants form the second feeding level. The consumers that eat animals

form a third feeding level. Each organism at a particular feeding level uses up some of the energy in the food to carry out its life activities. At each feeding level, however, much of the energy in the food is lost. A large amount of the energy is used up as it is transferred from one feeding level to another. There is less energy available to the organisms at the higher feeding level. Although the food chain models show how energy moves and is recycled, they do not show how some energy becomes heat. This loss of energy can be shown in an energy pyramid below. There is a decreasing amount of energy available at each feeding level. When producers transform energy into chemical energy, most of it is converted into heat energy lost to the environment. And when we look at the amount of energy available from one level to another, there is only about 10 percent of total energy left from the step below.

For example, if a primary producer makes 1000 grams of food, only 100 grams reach the second level of the food chain. The third level of the food c[illegible]
doesn't support a large organism. At the fourth feeding level only 1 gram of food passed up the food chain remains, and the fifth step has 0.1 gram. No more steps in a food chain are possible, since there is so little energy left.



This energy pyramid shows the energy flow and losses of energy at each feeding level.

Diversity in the Food Chain

An organism has a greater chance of survival if there is more diversity in its food chain, because there are

- more kinds of producers at the bottom.
- more kinds of herbivores at the second level.
- many different kinds of omnivores and carnivores at the third level.

different kinds of herbivores at the second level

Because there are more connections between the different levels, a diverse *food web* is not as likely to break down. Food webs can help us understand how energy is used by living systems. Through it you get a better idea of how energy moves to different organism. The web describes a system.

different kinds of omnivores at the third level

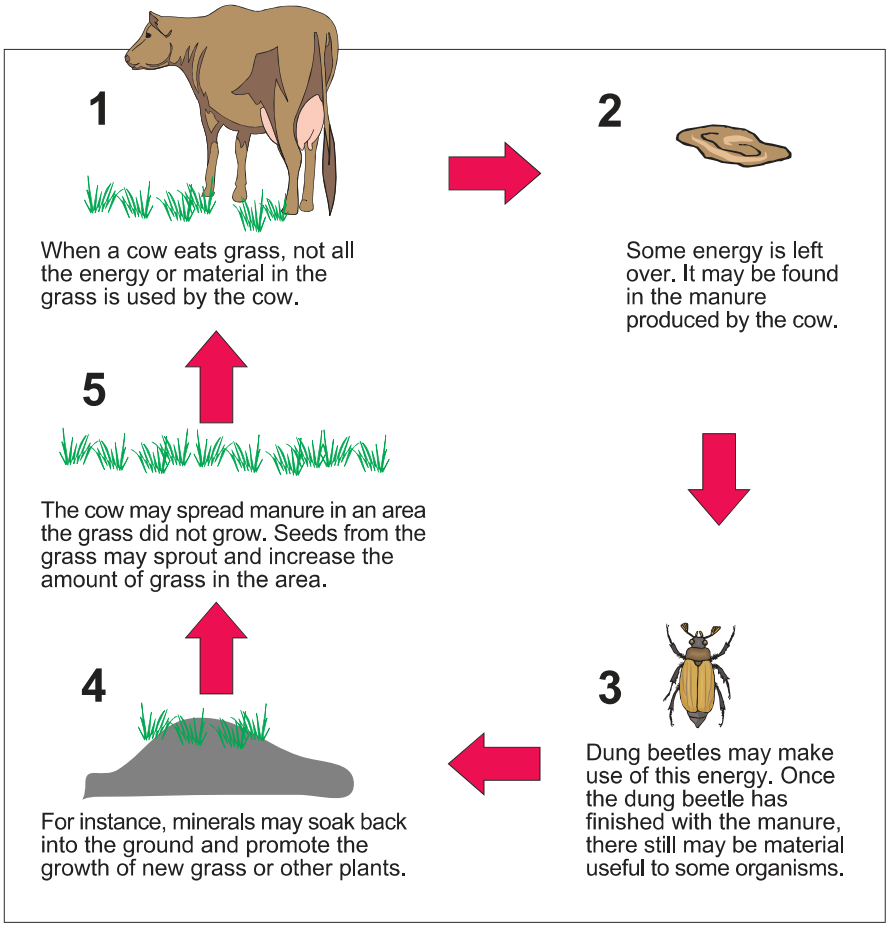
It is important to understand what scientists mean by *system*. A system is a group of interrelated objects and energy. It can be large or small. On the large scale, scientists view the entire universe as a system with energy and objects (matter). The universe is a complex system, so the rules that describe it range from simple to complex. Science, through careful study, tries to find these rules. A food web can be one way of describing rules for a smaller system.

Let's look at an example of a system. A producer that is fairly common is grass. Grass takes a small part of the sun's light energy and makes sugars. The sugars are then consumed by any number of organisms. If a cow happens to be the consumer, the cow will only make use of a small part of the

different kinds of carnivores at the third level

energy. Again, the rest of the energy will become heat. With so much energy being lost as heat, interesting results occur.

One result is that organisms are very good at finding unused or seldom used sources of energy. This results in a high number of different organisms living together. Consider the example of cows and grass. In reality, many organisms besides the cow and the grass live together. When a cow eats grass, not all the energy or material in the grass is used by the cow. Some energy is left over. It may be found in the manure produced by the cow. In this case, dung beetles may make use of this energy. Once the dung beetle has finished with the manure, there still may be material useful to some organisms. For instance, minerals may soak back into the ground and promote the growth of new grass or other plants. Alternatively, the cow may spread manure in an area the grass did not grow. Seeds from the grass may sprout and increase the amount of grass in the area.



It's easy to see how the cow relies on the grass in its area, but now we see more. We see that the grass relies on the cow, the dung beetle, and other organisms in order to survive and spread. Such connections are known as *interdependence*. The interdependence is based on the need for energy, and the result is a high variety of organisms.

Interconnectedness and Biodiversity

A **habitat** is the place in an ecosystem where an organism normally lives. Within an ecosystem there is interaction by all of the organisms that choose to live in that environment. All the interacting organisms of different **species** living in the same area are referred to as a **community**. An ecosystem is a finely balanced environment in which living things successfully interact in order to survive. It is the **biodiversity**, or the variety of *species* of organisms of ecosystems, that makes them healthy. The study of how the *habitat* and the *community* affect each other, and how the ecosystem works is called **ecology**.

A disturbance in the balance in one part of the ecosystem can cause problems in another part of the ecosystem. Such disturbances can be the result of nature or of human interference. In many ways, an ecosystem itself functions like a huge creature: it has its own special and recognizable character traits that make it different from other ecosystems. All of its parts must function together to support it. If its supply of energy or water suddenly changes, it can go into shock. If its internal systems are badly injured, an ecosystem can die. As with any living being, though, changes to systems are usually met by efforts to avoid death. Changes can cause unpredictable results. *Biodiversity* helps make it possible for the ecosystem to return to its original condition.

Summary

On Earth there is great diversity and interconnectedness of life. These result from the flow of energy from producers to consumers and to decomposers. Energy and matter are not destroyed in these changes, but energy is lost as unusable heat. Knowledge of the flow of energy is essential to all sciences. Changes in an ecosystem can destroy it or have unpredicted results. Although changes may occur, ecosystems tend to return to their original condition.