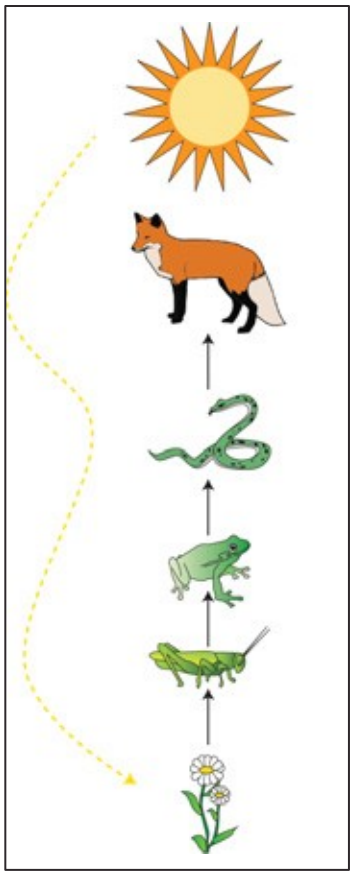
Transfer of Energy in Ecosystems

Reflect

Have you ever looked outside a window at the people passing by? Have you noticed all the different types of trees and plants from your window view? Just in your own front yard, there is a great variety of organisms; imagine the diversity in a whole ecosystem. Then, imagine multiple ecosystems! So many traits and variations make every organism unique, but even with all their differences, they all require energy to survive. Where does this energy come from? Where does this energy go?



Energy Flow Through an Ecosystem

All living things need energy to survive. Where does this energy come from? Almost all organisms on Earth get their energy from the Sun, either directly or indirectly. Organisms that are able to generate their own food, such as plants, are called **autotrophs**. **Auto**- means "self" and -**troph** means "to feed" or "to nourish." Through photosynthesis, autotrophs combine sunlight, water, and carbon dioxide to make glucose (a type of sugar) and oxygen. The glucose is used by the autotroph either for energy or to build cellular structures. Organisms that are not able to make their own food are called **heterotrophs**. **Hetero**- means "other." Heterotrophs must feed on other organisms to get energy.

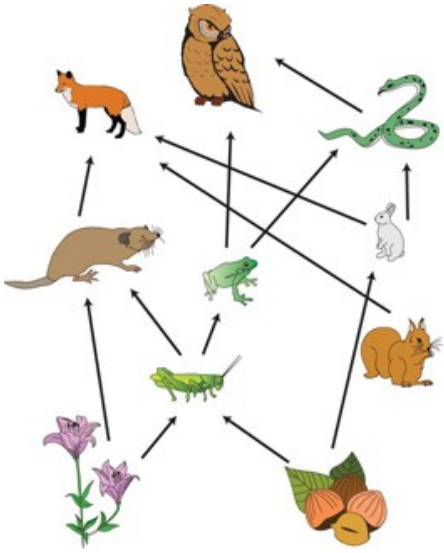
Energy moves through an ecosystem in a single direction. First, it flows from the Sun to autotrophs, or **producers**. Then, it flows from producers to heterotrophs, or **consumers**. Energy never flows backward from consumers to producers. For example, a plant cannot consume and get energy directly from a mouse. But, when a mouse dies, decomposers break down its body and return the nutrients to the ecosystem.
Nutrients from the dead mouse may indirectly return to the plant through the soil.

Transfer of Energy in Ecosystems

Reflect

Food chains and food webs are used to show the movement of energy through an ecosystem.
A **food chain** shows the step-by-step transfer of energy between producers and consumers. Arrows indicate the movement of energy as each organism is eaten.

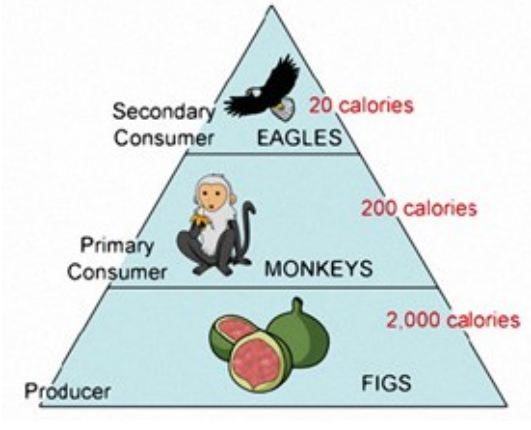
A **food web** paints a more complex picture of the ecosystem. It shows all of the interrelating food chains within an ecosystem. For example, a food web may show that a certain plant is a source of energy for two or three consumers, who are themselves the source of energy for several other consumers.



Look Out!

Autotrophs that get energy from the Sun are called photoautotrophs. Plants, algae, plankton, and certain bacteria are photoautotrophs. However, not all autotrophs get their energy from the Sun. Some autotrophs are able to make their own food from chemicals. These organisms are called chemoautotrophs. Many species of bacteria are chemoautotrophs, as they derive energy from sources such as iron, methane, sulfur, ammonia, and hydrogen.

Trophic Levels and Energy Loss
The steps of a food chain are called **trophic levels**. Producers occupy the bottom trophic level, and consumers occupy the higher trophic levels. Pyramids can be used to illustrate the amount of energy and biomass at each trophic level. An energy pyramid shows the upward flow of energy through a food chain. It also shows the relative amount of energy available at each trophic level. Though the Sun supplies producers with massive amounts of energy, only about 10% of this energy is available to the consumers at the next trophic level. Where does 90% of the energy go? Some of it is used to fuel body processes such as growth, repair, and reproduction. Most of
it is lost to the atmosphere as heat. The more levels there are in a pyramid, the less energy is available to the organism at the top. Biomass pyramids show the total mass of organisms at each trophic level. Scientists usually measure biomass in grams or kilograms of mass in a given area.



Look Out!

Looking to the Future: Biomass in Peril

Trees with diameters greater than three feet only make up 1% of the trees in Yosemite National Park. But, these massive trees make up almost 50% of the biomass in the park! White firs, sugar pines, and incense cedars dominate the first level of the biomass pyramid in this ecosystem. This small population of trees performs a very important job: During photosynthesis, they trap carbon dioxide from the air, helping to maintain a healthy balance of gases in Earth's atmosphere. These trees also release huge amounts of oxygen, which most organisms on Earth depend on for life processes. However, the trees are under threat.

This particular tree population in Yosemite has declined over the last 80 years, and scientists are struggling to figure out the cause. Dr. James Lutz, one of the scientists studying the decline, explained that losing 1% of these trees could mean losing half of the biomass in the park. The organisms at the upper levels of the biomass pyramid depend on the organisms at the base. If the trees die out, it's possible that the rest of the Yosemite ecosystem will collapse.

Biotic and Abiotic Factors

An ecosystem is made up of living and nonliving factors. The living things in an ecosystem are called **biotic factors**. Biotic factors include organisms that are alive and organisms that used to be alive (such as rotting tree stumps). **Abiotic factors** are the nonliving things in an ecosystem. Sunlight, water, wind, temperature, and soil are examples of abiotic factors.

An organism interacts with and depends on the abiotic and biotic factors in its environment. For example, a prairie dog makes its home in the soil, which is an abiotic factor. It also eats plants, which are biotic factors. The prairie dog relies on the soil for shelter and the plants for food. A change in the balance of biotic and abiotic factors can affect the stability of an ecosystem. Suppose a drought occurs in the prairie ecosystem and the plants begin to die out. The soil that was once anchored by the plant roots may start to blow away. The prairie dogs will lose their habitat and source of food. Any predator that relied on prairie dogs as a source of prey will begin to die out, too.

An ecosystem typically houses a wide variety of organisms that need access to resources like space, shelter, food, and water. However, resources in an ecosystem are usually limited. When more than one organism is trying to get access to a limited resource, competition occurs. Prairie dogs share the prairie ecosystem with many other organisms. They compete with other grass-eating animals for food, with other burrow-dwelling organisms for living space and shelter, and with all the other living things in the prairie for water.

Look Out!

Prairie dogs also compete with each other for these resources. If a prairie dog cannot get adequate resources, it will die. Space, shelter, food, and water are known as limiting resources. Their availability limits the amount of organisms that can survive in an ecosystem.

Try Now

What Do You Know?

Use what you know about environmental interactions and effects to fill out the table below. First, decide if you agree or disagree with the statement in the left column. Then, provide an explanation for your decision in the column on the right. Use complete sentences.

Agree/Disagree?	Explanation
A biomass pyramid represents the relative amount of energy that is available at each trophic level. _____ Agree _____ Disagree	
Producing toxins is a physiological adaptation. _____ Agree _____ Disagree	
Approximately 90% of energy is available to the next trophic level in an energy pyramid. _____ Agree _____ Disagree	
Abiotic factors include sunlight, soil, algae, birds, and wind. _____ Agree _____ Disagree	

Connecting With Your Child

Changes in an Ecosystem
To help your child learn more about the ways in which abiotic and biotic factors affect the stability of an ecosystem, work together to conduct an investigation of an ecosystem that has experienced a major change or event. Research how this change or event affected the ecosystem, and develop a digital slideshow presentation about this change or event. If you do not have access to digital resources or appropriate software, your child can create a trifold poster display.

Begin by conducting research to find an ecosystem that was affected by a dramatic change or event. This change could be abiotic or biotic. Some examples of changes in abiotic factors could include flooding, drought, hurricanes, wildfires, or volcanic eruptions. Some examples of changes in biotic factors could be overfishing, cattle grazing, introduction of invasive species, or extinction of keystone organisms.

Next, find information about the structure of the ecosystem before the change by addressing the following questions:

- What kinds of abiotic and biotic factors did it contain?
- How were these factors interconnected?
- What organisms made up the ecosystem's food web?

Then, describe how the change affected the abiotic and biotic factors in the ecosystem. For example, overfishing may have caused a collapse of organisms that depended on the fish for food and an increase in the organisms that were once preyed upon by the fish.

Work together to find information from a variety of sources and media, such as:

- photographs
- sound recordings
- video clips (for example, newscasts on a natural disaster)
- scientific data (graphs or tables)
- eyewitness accounts

Here are some questions to discuss with your child:

- How did the change in the ecosystem affect the abiotic and biotic factors?
- How did the change in the ecosystem affect competition among the organisms that lived there?
- Were any organisms well adapted to the ecosystem after it changed?
- Did any new organisms enter the ecosystem?