ESSENTIAL QUESTION

How does energy flow through an ecosystem?

By the end of this lesson, you should be able to relate the roles of organisms to the transfer of energy in food chains, food webs, and food pyramids.

Energy is transferred from the sun to producers, such as kelp. It flows through the rest of the ecosystem.

This fish also needs energy to live. How do you think it gets this energy? From the sun like kelp do?
Engage Your Brain

1 Describe Most organisms on Earth get energy from the sun. How is energy flowing through the ecosystem pictured on the opposite page?

2 Predict List two of your favorite foods. Then, explain how the sun's energy helped make those foods available to you.

Active Reading

3 Synthesize You can often define an unknown word if you know the meaning of its word parts. Use the word parts and sentences below to make an educated guess about the meaning of the words herbivore and carnivore.

<table>
<thead>
<tr>
<th>Word part</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>-vore</td>
<td>to eat</td>
</tr>
<tr>
<td>herbi-*</td>
<td>plant</td>
</tr>
<tr>
<td>carn-*</td>
<td>meat</td>
</tr>
</tbody>
</table>

Example sentence
A koala bear is an herbivore that eats eucalyptus leaves.

herbivore:

Example sentence
A great white shark is a carnivore that eats fish and other marine animals.

carnivore:

Vocabulary Terms
- producer
- decomposer
- consumer
- herbivore
- carnivore
- omnivore
- food chain
- food web
- energy pyramid

4 Apply As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.
How do organisms get energy?

Energy is all around you. Chemical energy is stored in the bonds of molecules and holds molecules together. The energy from food is chemical energy in the bonds of food molecules. All living things need a source of chemical energy to survive.

Active Reading 6 Identify As you read, underline examples of producers, decomposers, and consumers.

Producers Convert Energy Into Food

A producer, also called an autotroph, uses energy to make food. Most producers use sunlight to make food in a process called photosynthesis. The sun powers most life on Earth. In photosynthesis, producers use light energy to make food from water, carbon dioxide, and nutrients found in water and soil. The food contains chemical energy and can be used immediately or stored for later use. All green plants, such as grasses and trees, are producers. Algae and some bacteria are also producers. The food that these producers make supplies the energy for other living things in an ecosystem.

Decomposers Break Down Matter

An organism that gets energy and nutrients by breaking down the remains of other organisms is a decomposer. Fungi, such as the mushrooms on this log, and some bacteria are decomposers. Decomposers are nature's recyclers. By converting dead organisms and animal and plant waste into materials such as water and nutrients, decomposers help move matter through ecosystems. Decomposers make these simple materials available to other organisms.

Think Outside the Book

5 Apply Record what you eat at your next meal. Where do you think these items come from, before they reach the market?
Consumers Eat Other Organisms

A **consumer** is an organism that eats other organisms. Consumers use the energy and nutrients stored in other living organisms because they cannot make their own food. A consumer that eats only plants, such as a grasshopper or bison, is called an **herbivore**. A **carnivore**, such as a badger or this wolf, eats other animals. An **omnivore** eats both plants and animals. A **scavenger** is a specialized consumer that feeds on dead organisms. Scavengers, such as the turkey vulture, eat the leftovers of the meals of other animals or eat dead animals.

** Consumers

**Visualize It!**

7 **List** Beside each image, place a check mark next to the word that matches the type of consumer the animal is.

<table>
<thead>
<tr>
<th>Name</th>
<th>What I eat</th>
<th>What am I?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hedgehog</td>
<td>leaves, earthworms, insects</td>
<td>herbivore</td>
</tr>
<tr>
<td>Komodo dragon</td>
<td>insects, birds, mammals</td>
<td>carnivore</td>
</tr>
<tr>
<td>Moose</td>
<td>grasses, fruits</td>
<td>herbivore</td>
</tr>
</tbody>
</table>

** Infer** Explain how carnivores might be affected if the main plant species in a community were to disappear.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
How is energy transferred among organisms?

Organisms change energy from the environment or from their food into other types of energy. Some of this energy is used for the organism’s activities, such as breathing or moving. Some of the energy is saved within the organism to use later. If an organism is eaten or decomposes, the consumer or decomposer takes in the energy stored in the original organism. Only chemical energy that an organism has stored in its tissues is available to consumers. In this way, energy is transferred from organism to organism.

Active Reading 9 Infer When a grasshopper eats grass, only some of the energy from the grass is stored in the grasshopper’s body. How does the grasshopper use the rest of the energy?

10 Identify By what process does this tree get its energy?

This tree gets its energy from the sun.

This ant eats plants like the mesquite tree, and other insects.

11 Apply What type of energy is this ant consuming?
Energy Flows Through a Food Chain

A **food chain** is the path of energy transfer from producers to consumers. Energy moves from one organism to the next in one direction. The arrows in a food chain represent the transfer of energy, as one organism is eaten by another. Arrows represent the flow of energy from the body of the consumed organism to the body of the consumer of that organism.

Producers form the base of food chains. Producers transfer energy to the first, or primary, consumer in the food chain. The next, or secondary, consumer in the food chain consumes the primary consumer. A tertiary consumer eats the secondary consumer. Finally, decomposers recycle matter back to the soil.

12 **Apply** What does the arrow between the ant and the lizard represent?

13 **Predict** If nothing ever eats this hawk, what might eventually happen to the energy that is stored in its body?
How do food webs show energy connections?

Few organisms eat just one kind of food. So, the energy and nutrient connections in nature are more complicated than a simple food chain. A food web is the feeding relationships among organisms in an ecosystem. Food webs are made up of many food chains.

The next page shows a coastal food web. Most of the organisms in this food web live in the water. The web also includes some birds that live on land and eat fish. Tiny algae called phytoplankton form the base of this food web. Like plants on land, phytoplankton are producers. Tiny consumers called zooplankton eat phytoplankton. Larger animals, such as fish and squid, eat zooplankton. At the top of each chain are top predators, animals that eat other animals but are rarely eaten. In this food web, the killer whale is a top predator. Notice how many different energy paths lead from phytoplankton to the killer whale.

**Active Reading**

14 Identify Underline the type of organism that typically forms the base of the food web.

**Visualize It!**

15 Apply Complete the statements to the right with the correct organism names from the food web.

Energy flows up the food web when __________________ eat puffins.

Puffins are connected to many organisms in the food web.

Puffins get energy by eating

__________________________,

__________________________,

and ________________________.
The top predator is shown at the top of the food web. What is the top predator in this food web?

Consumers can eat producers and other consumers.

Producers, such as these phytoplankton, form the base of the food web.
How does energy move through an ecosystem?

Another way to visualize the transfer of energy between organisms is with an energy pyramid. The shape of a pyramid represents the decreasing amount of energy at each level of an ecosystem’s food chain. The base of the pyramid represents the producer level of an ecosystem—organisms that utilize energy most efficiently. The second level represents primary consumers, and the third level represents secondary consumers. More levels can be added to represent tertiary consumers. At each level, energy is lost to the environment.

There is a direct relationship between the energy available to organisms at each level of a pyramid and population size. Secondary and tertiary consumers have smaller populations because there is less energy available to them.

16 Analyze Describe how energy flows in the ecosystem represented by this food pyramid. How would you translate the pyramid into words?

The amount of energy available and population size decrease as you go up the energy pyramid.
How many levels can an energy pyramid have?

Ecosystems are more like pyramids than skyscrapers. There are limits to the number of levels they can have. Most ecosystems can only sustain tertiary consumers, not fourth- or fifth-level consumers. There is only so much energy in an ecosystem, and organisms lose energy at each level.

Organisms do not retain all of the energy they consume. Every action—even the act of consuming—requires energy. Organisms lose about 90% of all energy they consume in the form of heat. This heat is released into the environment. This phenomenon is known as the “10% rule.” At each level of an ecosystem, only about 10% of energy is passed along.

Think Outside the Book Inquiry

17 Apply With a classmate, think of a local ecosystem and fill in the energy pyramid with producers and consumers. Label the percentages of energy retained at each level. Circle the organism with the highest population and explain your choice.

The 10% rule says that at each level of the energy pyramid, consumers only retain about 10% of the energy they consume.
How are organisms connected by food webs?

An energy pyramid simplifies an ecosystem into levels to make it easier to visualize the flow of energy. However, all living organisms are connected by global food webs. Global food webs include webs that begin on land and webs that begin in the water. Many organisms have feeding relationships that connect land- and water-based food webs. For example, algae might be eaten by a fish, which might then be eaten by a bird.

Food webs that start on land may also move into the water. Many insects that eat plants on land lay their eggs in the water. Some fish eat these eggs and the insect larvae that hatch from them. Because the global food webs are connected, removing even one organism can affect many organisms in other ecosystems.

Imagine how these organisms would be affected if herring disappeared from the food web. Answer the questions starting at the bottom of the page.

**18 Identify** Put a check mark next to the organisms that eat herring.

**19 Predict** With no herring to eat, how might the eating habits of cod change?

**20 Infer** Gulls don’t eat herring but they are still connected by the food web. How might gull populations be affected?
Sometimes species are introduced into a new area. These invasive species often compete with native species for energy resources, such as sunlight and food.

**Full Coverage**
The kudzu plant was introduced to stop soil erosion, but in the process it outgrew all the native plants, preventing them from getting sunlight. Sometimes it completely covers houses or cars!

**Destructive Zebras**
The zebra mussel is one of the most destructive invasive species in the United States. They eat by filtering tiny organisms out of the water, often leaving nothing for the native mussel species.

**Across the Grass**
The walking catfish can actually move across land to get from one pond to another! As a result, sometimes the catfish competes with native species for food.

**Extend**

21 **Relate** Describe how the competition between invasive and native species might affect a food web.

22 **Describe** Give an example of competition for a food resource that may occur in an ecosystem near you.

23 **Illustrate** Provide an illustration of your example of competition in a sketch or a short story. Be sure to include the important aspects of food webs that you learned in the lesson.
Organisms get energy in different ways.
- Producers make their own food.
- Consumers eat other living organisms.
- Decomposers break down dead organisms.

24 Herbivores, carnivores, and omnivores are three types of producers / consumers / decomposers.

Food chains, food webs, and energy pyramids describe the flow of energy in an ecosystem.

25 All food chains start with producers / consumers / decomposers.

26 Predict Describe the effects on global food webs if the sun’s energy could no longer reach Earth.
Lesson Review

Vocabulary

Fill in the blanks with the term that best completes the following sentences.

1. ____________ is the primary source of energy for most ecosystems.

2. A _______________ eats mostly dead matter.

3. A _______________ contains many food chains.

4. ____________ is the process by which light energy from the sun is converted to food.

Key Concepts

5. Describe What are the roles of producers, consumers, and decomposers in an ecosystem?

6. Apply What types of organisms typically make up the base, middle, and top of a food web?

7. Describe Identify the two types of global food webs and describe how they are connected.

8. Apply Describe the flow of energy in this food chain. Be sure to use the names of the organisms and what role they serve in the food chain (producer, consumer, or decomposer). If an organism is a consumer, identify whether it is an herbivore, carnivore, or omnivore.

9. Apply If the above illustration were converted to an energy pyramid, which organism would be placed at each level?

Critical Thinking

10. Predict Give an example of a decomposer, and explain what would happen if decomposers were absent from a forest ecosystem.

11. Predict How would a food web be affected if a species disappeared from an ecosystem?