# Flow of Energy

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# CHAPTER 1 Flow of Energy

## Lesson Objectives

- Explain how living things are classified based on the way they obtain energy.
- Show how food chains and food webs model the flow of energy through ecosystems.
- Identify trophic levels, and state how they are related to energy and biomass.

## Lesson Vocabulary

- biomass
- chemoautotroph
- chemosynthesis
- consumer
- decomposer
- detritivore
- food chain
- food web
- photoautotroph
- producer
- saprotroph
- scavenger
- trophic level

## Introduction

Energy is the ability to change or move matter. All living things need energy. They need energy for everything they do, whether it is to move long distances or simply to carry out basic biochemical processes inside cells. Energy enters most ecosystems in the form of sunlight. In a few ecosystems, energy enters in the form of chemical compounds. All ecosystems need a constant input of energy in one of these two forms.

## Types of Organisms and Energy

Living things can be classified based on how they obtain energy. Some use the energy in sunlight or chemical compounds directly to make food. Some get energy indirectly by consuming other organisms, either living or dead.

### Producers

Producers are living things that produce food for themselves and other organisms. They use energy and simple inorganic molecules to make organic compounds. Producers are vital to all ecosystems because all organisms need

organic compounds for energy.

Producers are also called autotrophs. There are two basic types of autotrophs: photoautotrophs and chemoautotrophs.

- Photoautotrophs use energy in sunlight to make organic compounds by photosynthesis. They include plants, algae, and some bacteria (see **Figure** 1.1).
- Chemoautotrophs use energy in chemical compounds to make organic compounds. This process is called chemosynthesis. Chemoautotrophs include certain bacteria and archaea.

FIGURE 1.1

The green streaks in this brilliant blue Guatemalan lake are billions of photosynthetic bacteria.

## Consumers

Consumers are organisms that depend on other living things for food. They take in organic compounds by eating or absorbing other living things. Consumers include all animals and fungi. They also include some bacteria and protists.

Consumers are also called heterotrophs. There are several different types of heterotrophs depending on exactly what they consume. They may be herbivores, carnivores, or omnivores.

- Herbivores are heterotrophs that consume producers such as plants or algae. Examples include rabbits and snails.
- Carnivores are heterotrophs that consume animals. Examples include lions and frogs.
- Omnivores are heterotrophs that consume both plants and animals. They include crows and human beings. The grizzly bears pictured in **Figure** 1.2 are also omnivores.

## Decomposers

Decomposers are heterotrophs that break down the wastes of other organisms or the remains of dead organisms. When they do, they release simple inorganic molecules back into the environment. Producers can then use the inorganic molecules to make new organic compounds. For this reason, decomposers are essential to every ecosystem. Imagine what would happen if there were no decomposers. Organic wastes and dead organisms would pile up everywhere, and their nutrients would no longer be recycled.

Decomposers are classified by the type of organic matter they break down. They may be scavengers, detritivores, or saprotrophs.

FIGURE 1.2
Grizzly bears eat both plant and animal foods, including grasses, berries, fish, and clams.

- Scavengers are decomposers that consume the soft tissues of dead animals. Examples of scavengers include hyenas and cockroaches.
- Detritivores are decomposers that consume dead leaves, animal feces, and other organic debris that collects on the ground or at the bottom of a body of water. Examples of detritivores include earthworms and catfish. You can see another example in **Figure** 1.3.
- Saprotrophs are decomposers that feed on any remaining organic matter that is left after other decomposers do their work. Examples of saprotrophs include fungi and protozoa.

FIGURE 1.3
These dung beetles are detritivores. They are feasting on a pile of horse dung (feces).

## Modeling the Flow of Energy

Energy flows through ecosystems from producers, to consumers, to decomposers. Food chains and food webs are diagrams that model this flow of energy. They represent feeding relationships by showing who eats whom.

### Food Chains

A food chain is a diagram that represents a single pathway through which energy flows through an ecosystem. Food chains are generally simpler than what really happens in nature. That's because most organisms consume and are consumed by more than one species. You can see examples of terrestrial and aquatic food chains in **Figure** 1.4. See if you can construct a food chain of each type by playing the animation at this link: http://www.ecokids.ca/pub/eco_info/topics/frogs/chain_reaction/play_chainreaction.cfm

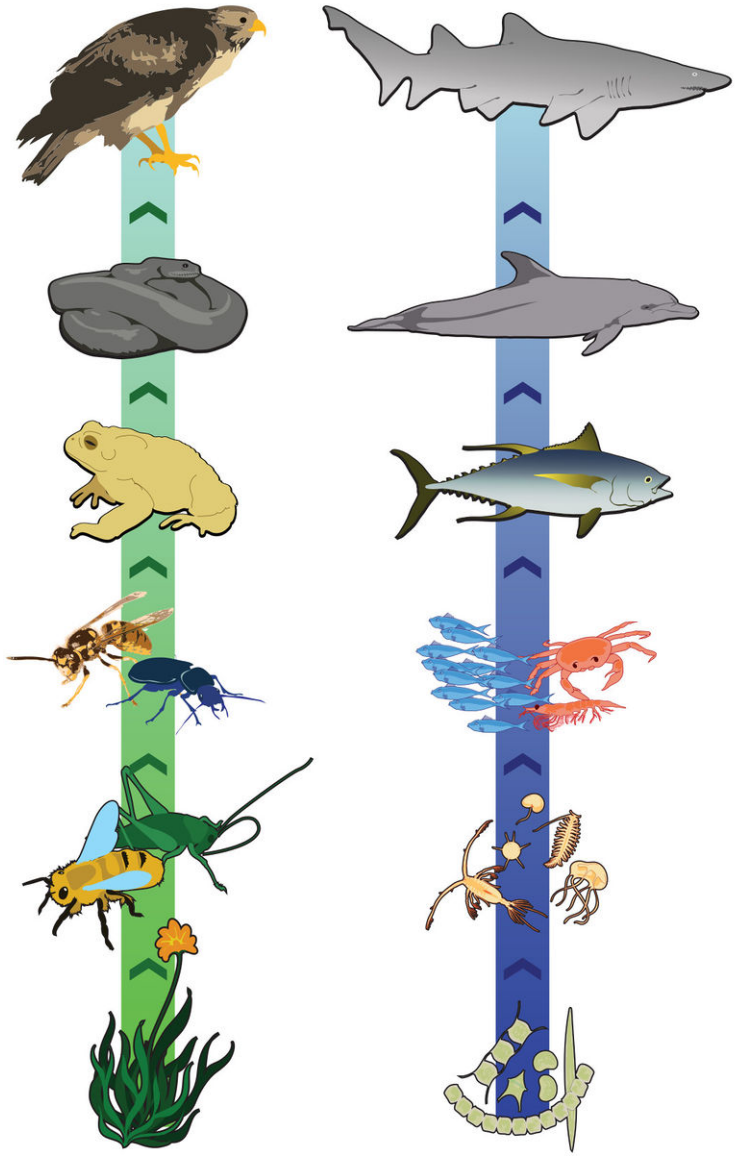


FIGURE 1.4
Terrestrial (left) and aquatic (right) food chains

### Food Webs

A food web is a diagram that represents many pathways through which energy flows through an ecosystem. It includes a number of intersecting food chains. Food webs are generally more similar to what really happens in nature. They show that most organisms consume and are consumed by multiple species. You can see an example of a food web in **Figure** 1.5.

## Trophic Levels

Each food chain or food web has organisms at different trophic levels. A trophic level is a feeding position in a food chain or web. The trophic levels are identified in the food web in **Figure** 1.5. All food chains and webs have at least two or three trophic levels, but they rarely have more than four trophic levels. The trophic levels are:

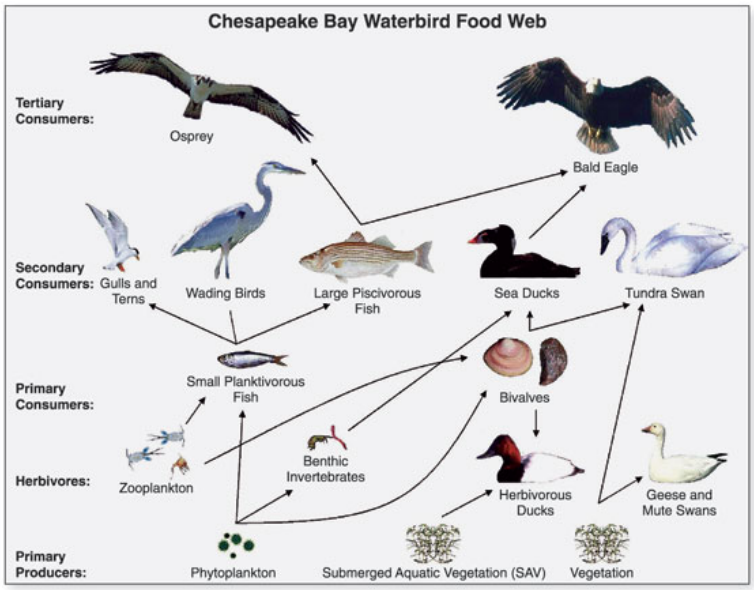



FIGURE 1.5
Food web showing trophic levels

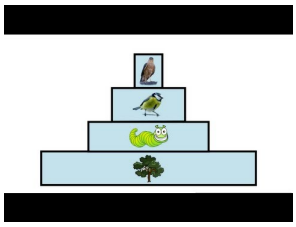
1. Trophic level 1 = producers that make their own food
2. Trophic level 2 = primary consumers that eat producers
3. Trophic level 3 = secondary consumers that eat primary consumers
4. Trophic level 4 = tertiary consumers that eat secondary consumers

Many consumers feed at more than one trophic level. For example, the bivalves in **Figure** 1.5 eat both producers and primary consumers. Therefore, they feed at trophic levels 2 and 3.

## Trophic Levels and Energy

Energy is passed up a food chain or web from lower to higher trophic levels. However, only about 10 percent of the energy at one level is passed up the next level. This is represented by the ecological pyramid in **Figure** 1.6. The other 90 percent of energy at each trophic level is used for metabolic processes or given off to the environment as heat. This loss of energy explains why there are rarely more than four trophic levels in a food chain or web. There isn't enough energy left to support additional levels. It also explains why ecosystems need a constant input of energy.

You can learn more about ecological pyramids in this video: http://www.youtube.com/watch?v=wGfOoRrICto .



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## Trophic Levels and Biomass

Biomass is the total mass of organisms at a trophic level. With less energy at higher trophic levels, there are usually fewer organisms as well. This is also represented in the pyramid in **Figure** 1.6. Organisms tend to be larger in size

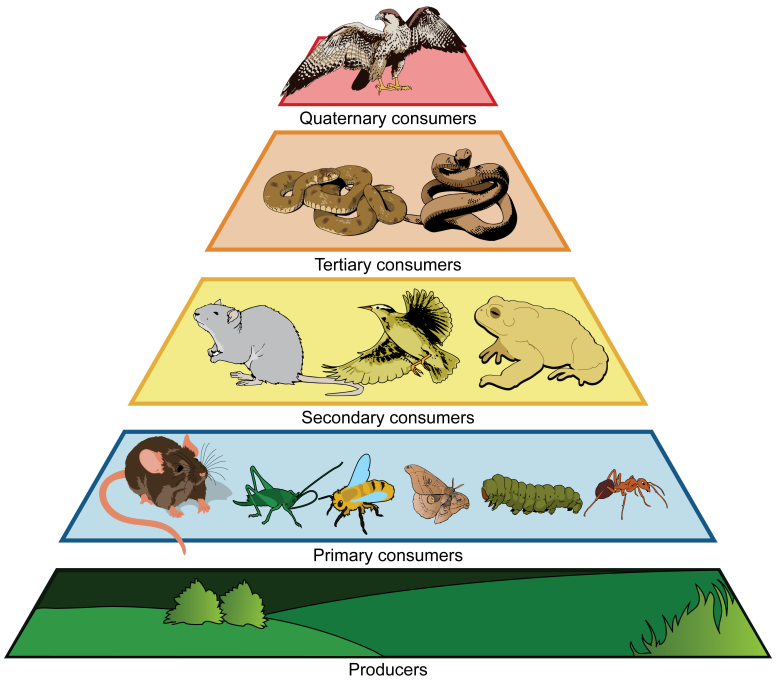


FIGURE 1.6
This ecological pyramid shows how energy and biomass decrease from lower to higher trophic levels.

at higher trophic levels. However, their smaller numbers result in less biomass.

## Lesson Summary

- All ecosystems need a constant input of energy in the form of sunlight or chemical compounds. Living things can be classified based on how they obtain energy as producers, consumers, or decomposers.
- Food chains and food webs are diagrams that model the flow of energy through ecosystems. They show who eats whom.
- A trophic level is a feeding position in a food chain or food web. Most food chains and webs have a maximum of four trophic levels. There is less energy and biomass at higher trophic levels.

## Lesson Review Questions

### Recall

1. Identify three major categories of living things based on how they obtain energy.
2. What is a food chain? Why are food chains simpler than actual feeding relationships in nature?
3. Define trophic level. How does an organism at trophic level 2 obtain energy?

4. At which trophic levels are you consuming when you eat a cheeseburger and French fries?

### Think Critically

5. Compare and contrast three types of decomposers.
6. Explain why food chains and webs rarely have more than four trophic levels.

## Points to Consider

Energy must constantly be added to an ecosystem for use by organisms. Matter, on the other hand, is continuously recycled through ecosystems.

1. Give an example of a cycle of matter.
2. What role do living things play in this cycle?

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