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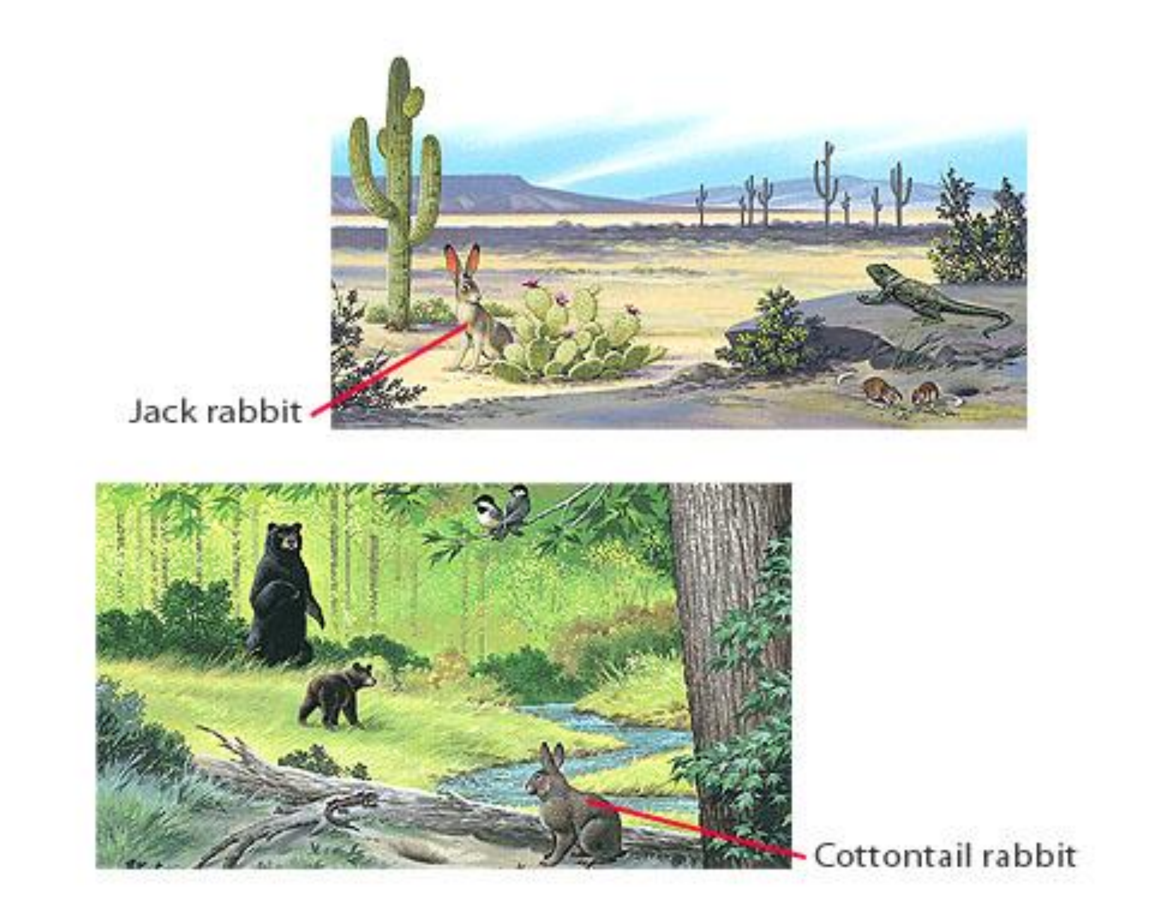
Objectives

- **Distinguish** an ecosystem from a community.
- **Describe** the diversity of a representative ecosystem.
- **Sequence** the process of succession.

Interactions of Organisms and Their Environment

- **Ecology** is the study of the interactions of living organisms with one another and with their physical environment (soil, water, climate, and so on).
- The place where a particular population of a species lives is its **habitat.**
- The many different species that live together in a habitat are called a **community.**

Habitat



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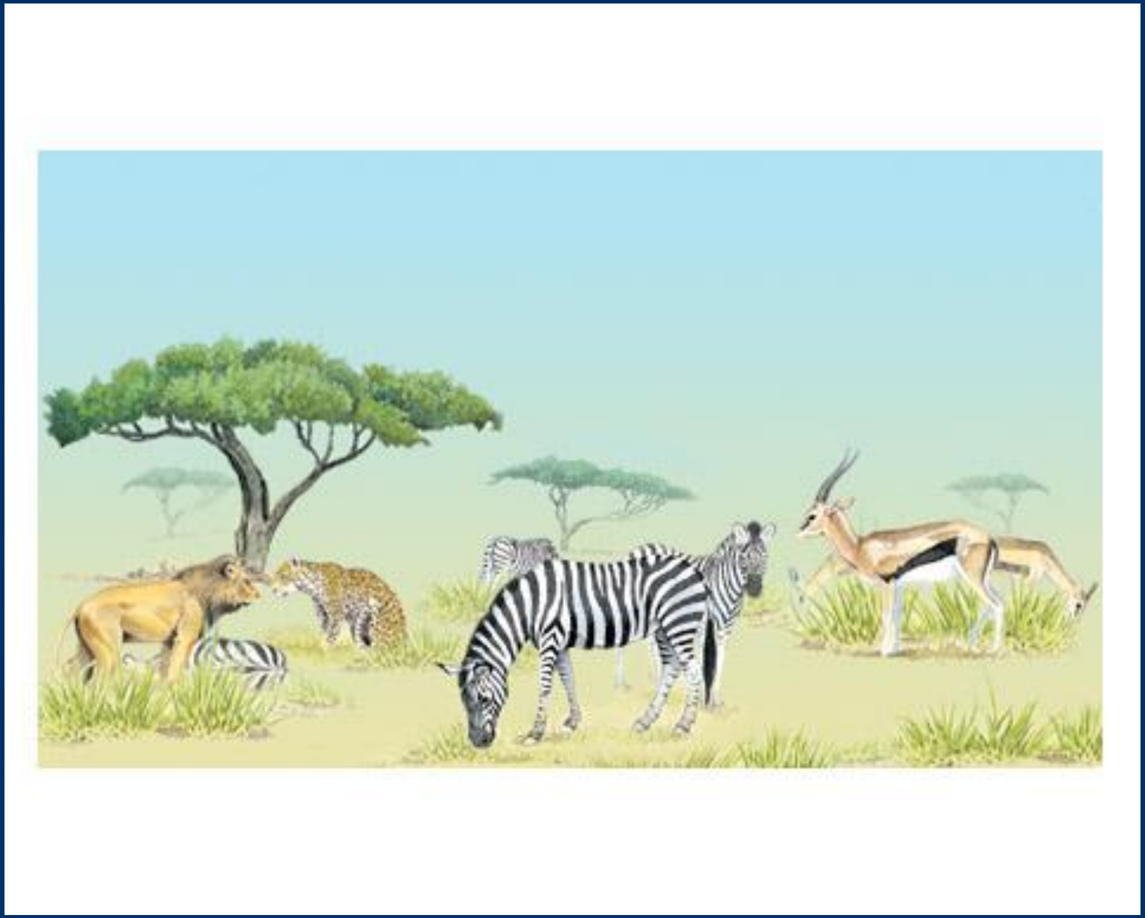
Community



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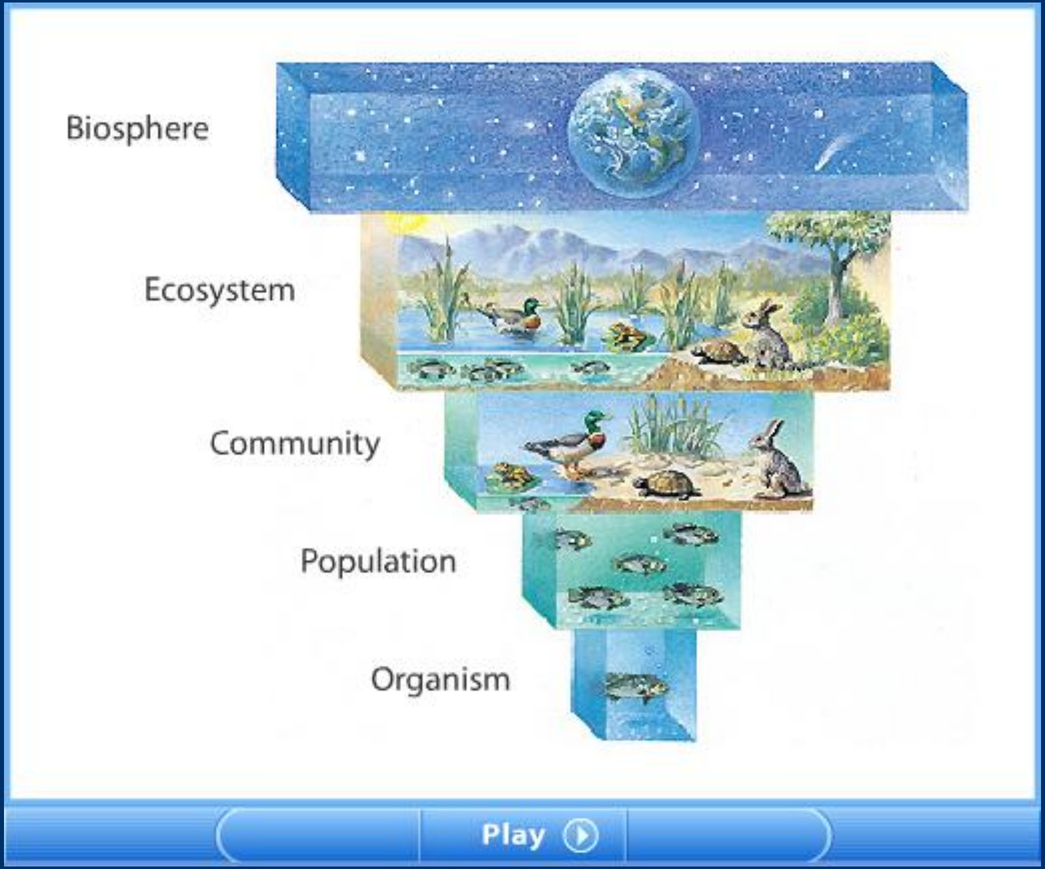
Interactions of Organisms and Their Environment, *continued*

- An **ecosystem,** or ecological system, consists of a community and all the physical aspects of its habitat, such as the soil, water, and weather.
- The physical aspects of a habitat are called **abiotic factors.**
- The organisms in a habitat are called **biotic factors.**

Levels of Ecology



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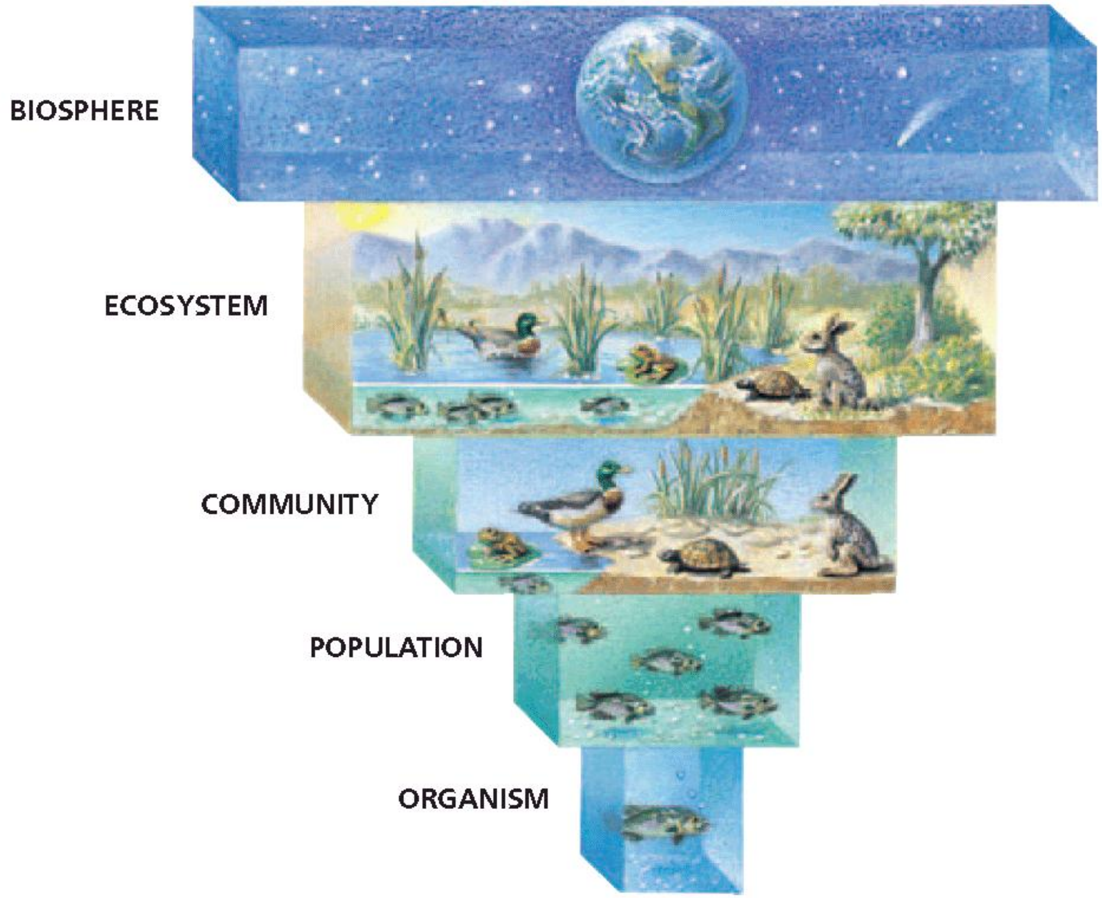
Levels of Organization



Ecosystem

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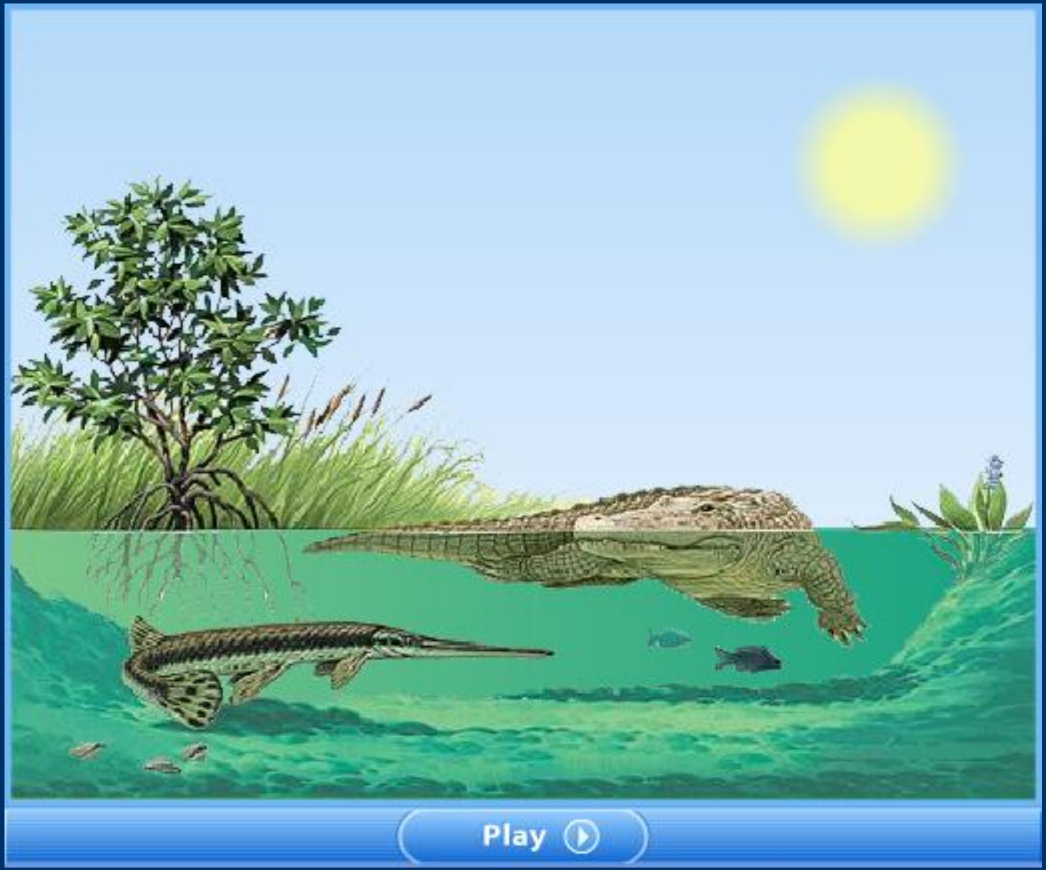
Comparing Biotic and Abiotic Factors



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Diverse Communities in Ecosystems

- The number of species living within an ecosystem is a measure of its **biodiversity.**
- The more biodiversity a community has, the more stable the community is.

Biodiversity

Diverse Communities in Ecosystems, *continued*

Ecosystem Inhabitants

- Most ecosystems contain a few large animals and some smaller animals.
- Ecosystems tend to contain more plants than animal life.
- The most plentiful organisms in an ecosystem are usually microscopic bacteria and protists.

End Of Slide

Diverse Communities in Ecosystems, *continued*

Ecosystem Boundaries

- The physical boundaries of an ecosystem are not always obvious, and they depend on how the ecosystem is being studied.
- Often individual fields, forests, or lakes are studied as isolated ecosystems.
- Of course, no location is ever totally isolated. Even oceanic islands get occasional migrant visitors, such as birds blown off course.

Change of Ecosystems over Time

- When a volcano forms a new island, a glacier recedes and exposes bare rock, or a fire burns all of the vegetation in an area, a new habitat is created.
- This change sets off a process of colonization and ecosystem development.
- The first organisms to live in a new habitat are small, fast-growing plants, called **pioneer species.**

Pioneer Species

Change of Ecosystems over Time, *continued*

Succession

- A somewhat regular progression of species replacement is called **succession.**
- Succession that occurs where plants have not grown before is called **primary succession.**
- Succession that occurs in areas where there has been previous growth, such as in abandoned fields or forest clearings, is called **secondary succession.**

Ecological Succession

End Of Slide

Change of Ecosystems over Time, *continued*

Glacier Bay: an Example of Succession

- A good example of primary succession is a receding glacier because land is continually being exposed as the face of the glacier moves back.
- The seeds and spores of pioneer species are carried in by the wind. Alders, grasses, and shrubs later take over from pioneer plants.
- As the amount of soil increases, spruce and hemlock trees become plentiful.

Ecological Succession at Glacier Bay

At first, land exposed by the receding glacier is lifeless because it lacks nutrients. An early "pioneer" of this land is the rockrose *Dryas, above left.* After several decades trees such as alder and shrubs grow large enough to shade and kill off the low-growing mat of *Dryas, above center.* After several more decades, these trees and shrubs are replaced by spruce and hemlock, *above right.*

Objectives

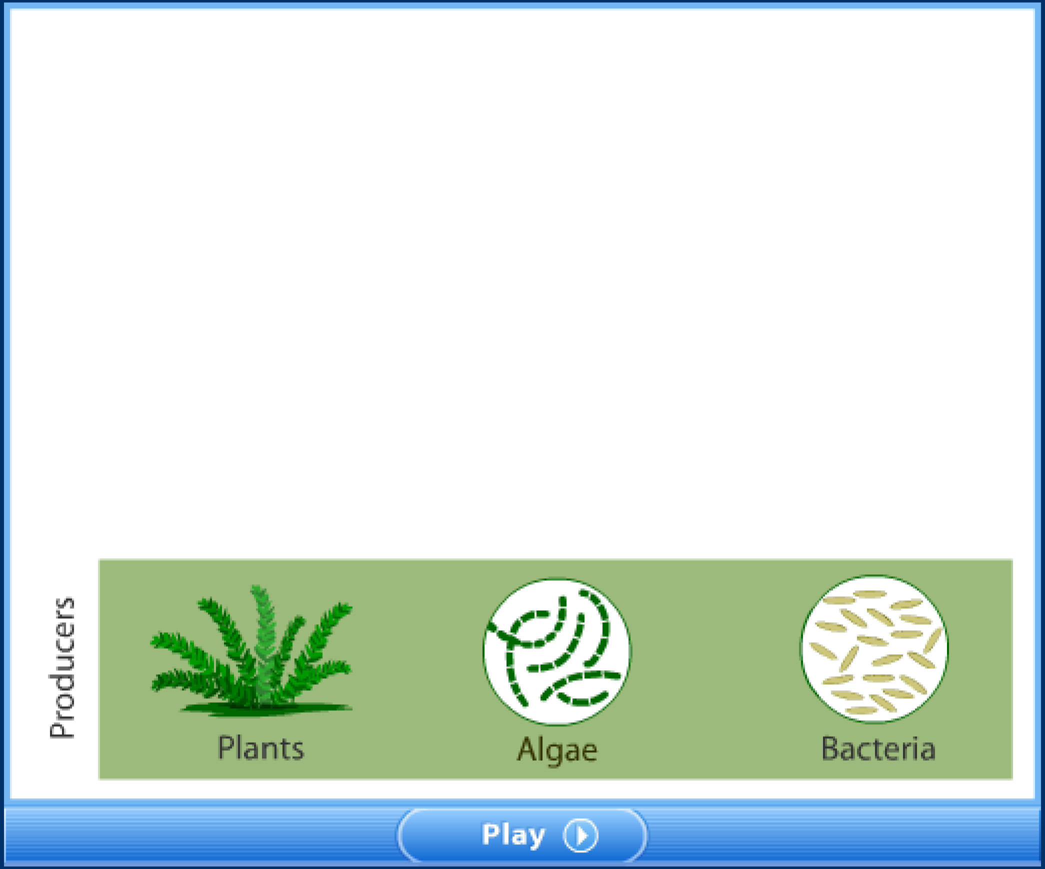
- **Distinguish** between producers and consumers.
- **Compare** food webs with food chains.
- **Describe** why food chains are rarely longer than three or four links.

Movement of Energy Through Ecosystems

Primary Energy Source

- The rate at which organic material is produced by photosynthetic organisms in an ecosystem is called **primary productivity.**
- Organisms that first capture solar energy, the **producers,** include plants, some kinds of bacteria, and algae.
- **Consumers** are those organisms that consume plants or other organisms to obtain the energy necessary to build their molecules.

Comparing Consumers and Producers

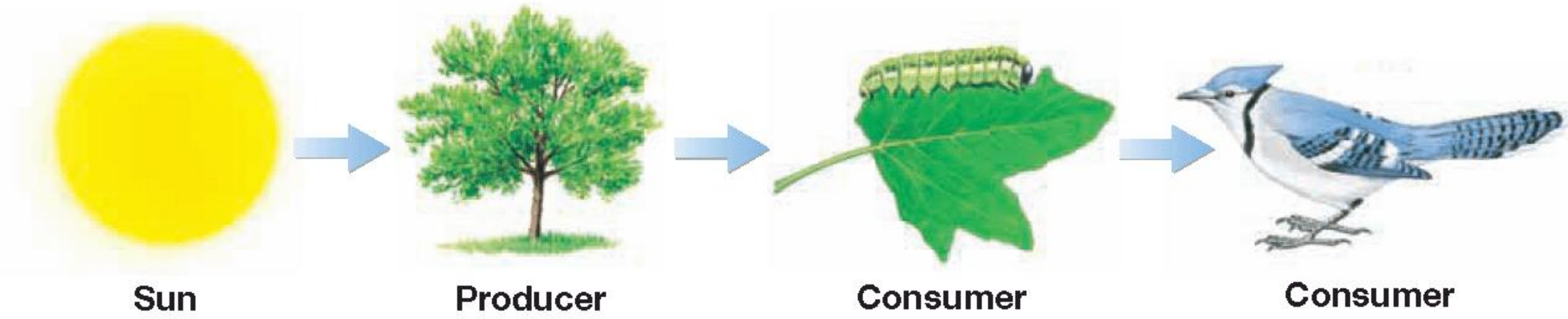


Movement of Energy Through Ecosystems

Trophic Levels

- Ecologists study how energy moves through an ecosystem by assigning organisms in that ecosystem to a specific level, called a **trophic level,** in a graphic organizer based on the organism's source of energy.
- Energy moves from one **trophic level** to another.

Trophic Levels

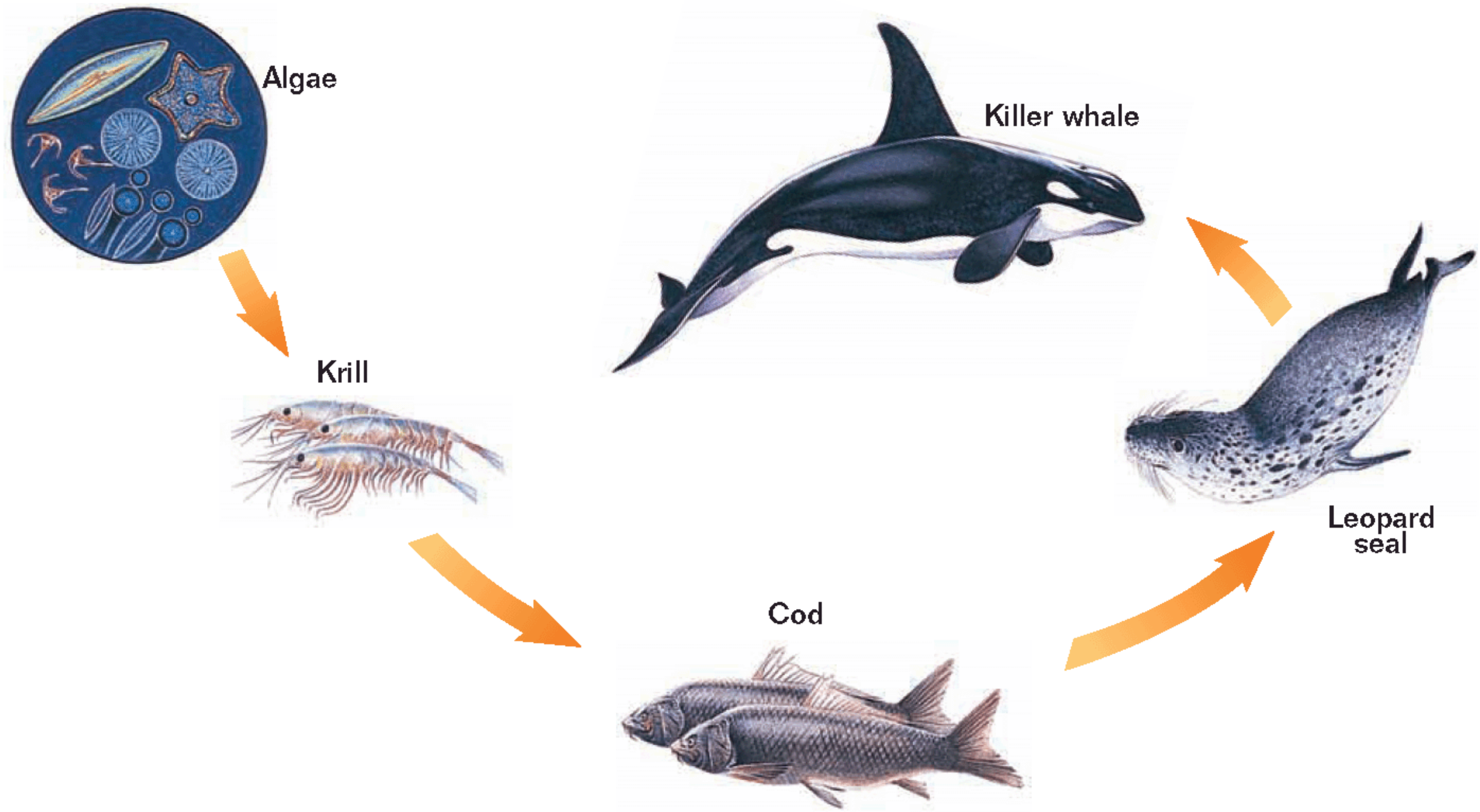


Movement of Energy Through Ecosystems, *continued*

Trophic Levels: First Level

- The path of energy through the trophic levels of an ecosystem is called a **food chain.**
- The lowest trophic level of any ecosystem is occupied by the producers, such as plants, algae, and bacteria.
- Producers use the energy of the sun to build energy-rich carbohydrates.

Food Chain in an Antarctic Ecosystem



Movement of Energy Through Ecosystems, *continued*

Trophic Levels: Second Level

- At the second trophic level are **herbivores,** animals that eat plants or other primary producers. They are the primary consumers.
- A herbivore must be able to break down a plant's molecules into usable compounds.
- Most herbivores rely on microorganisms, such as bacteria and protists, in their gut to help digest cellulose.

Movement of Energy Through Ecosystems, *continued*

Trophic Levels: Third Level

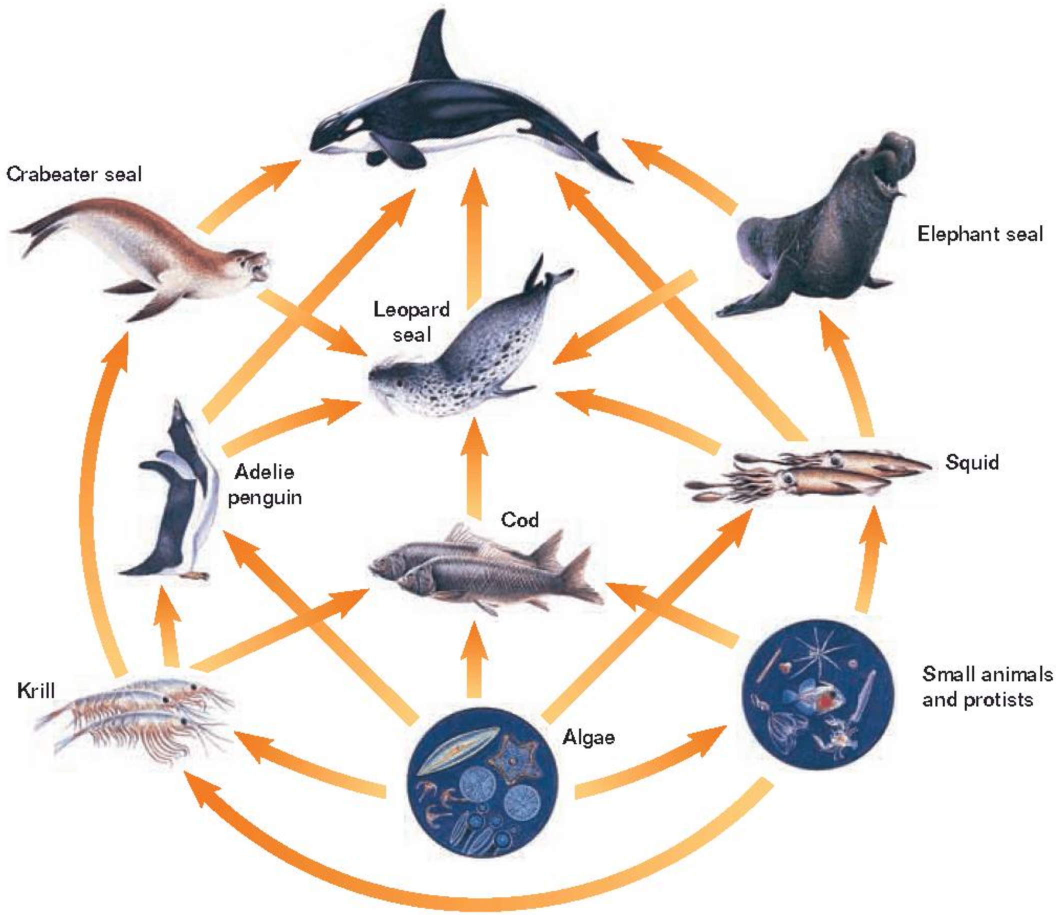
- At the third trophic level are secondary consumers, animals that eat herbivores. These animals are called **carnivores.**
- Some animals, such as bears, are both herbivores and carnivores; they are called **omnivores.**
- **Dentrivores** are organisms that obtain their energy from the organic wastes and dead bodies that are produced at all trophic levels.

Movement of Energy Through Ecosystems, *continued*

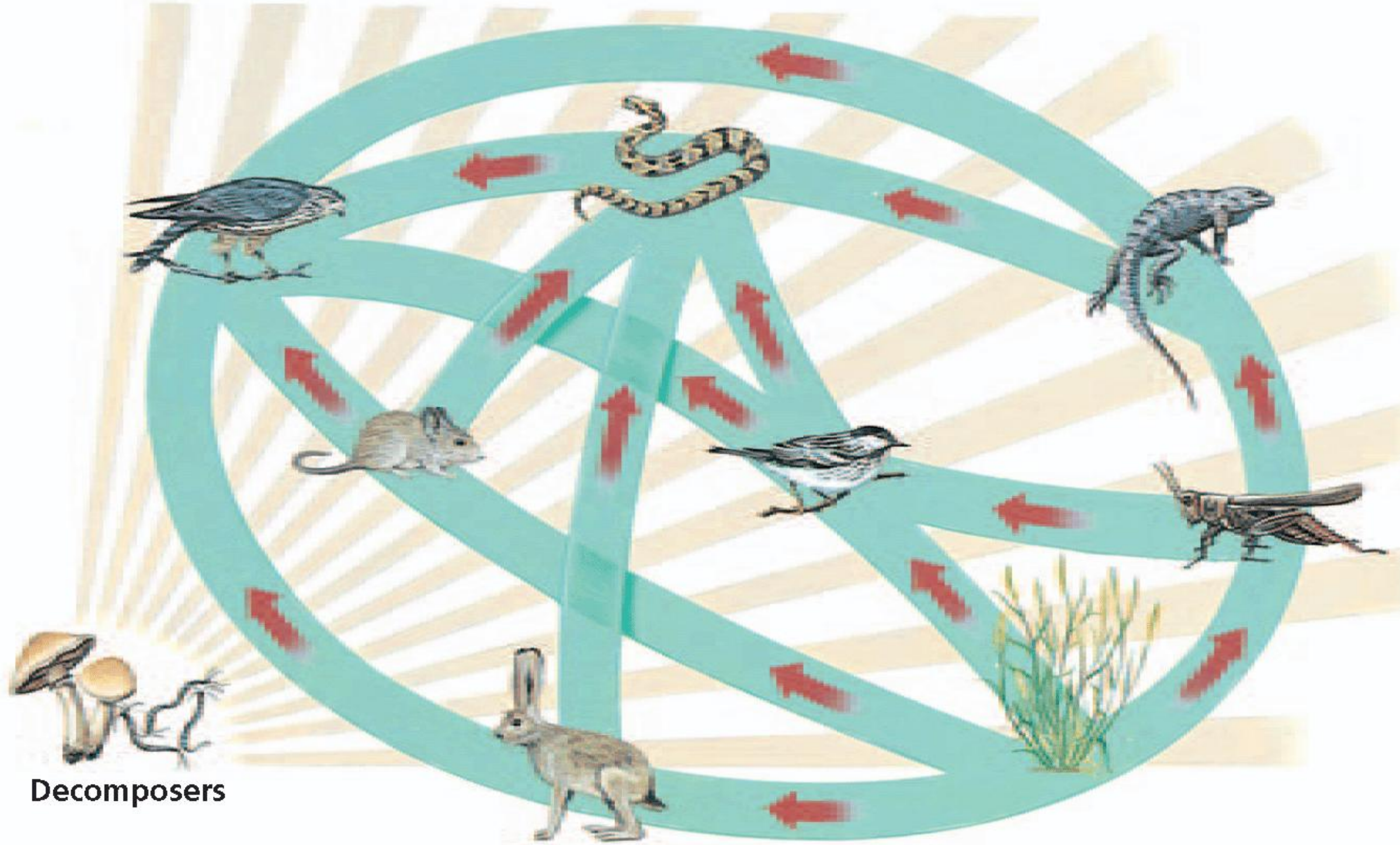
Trophic Levels: Third Level

- Bacteria and fungi are known as **decomposers** because they cause decay.
- Decomposition of bodies and wastes releases nutrients back into the environment to be recycled by other organisms.
- In most ecosystems, energy does not follow simple straight paths because animals often feed at several trophic levels. This creates an interconnected group of food chains called a **food web.**

Food Web in an Antarctic Ecosystem

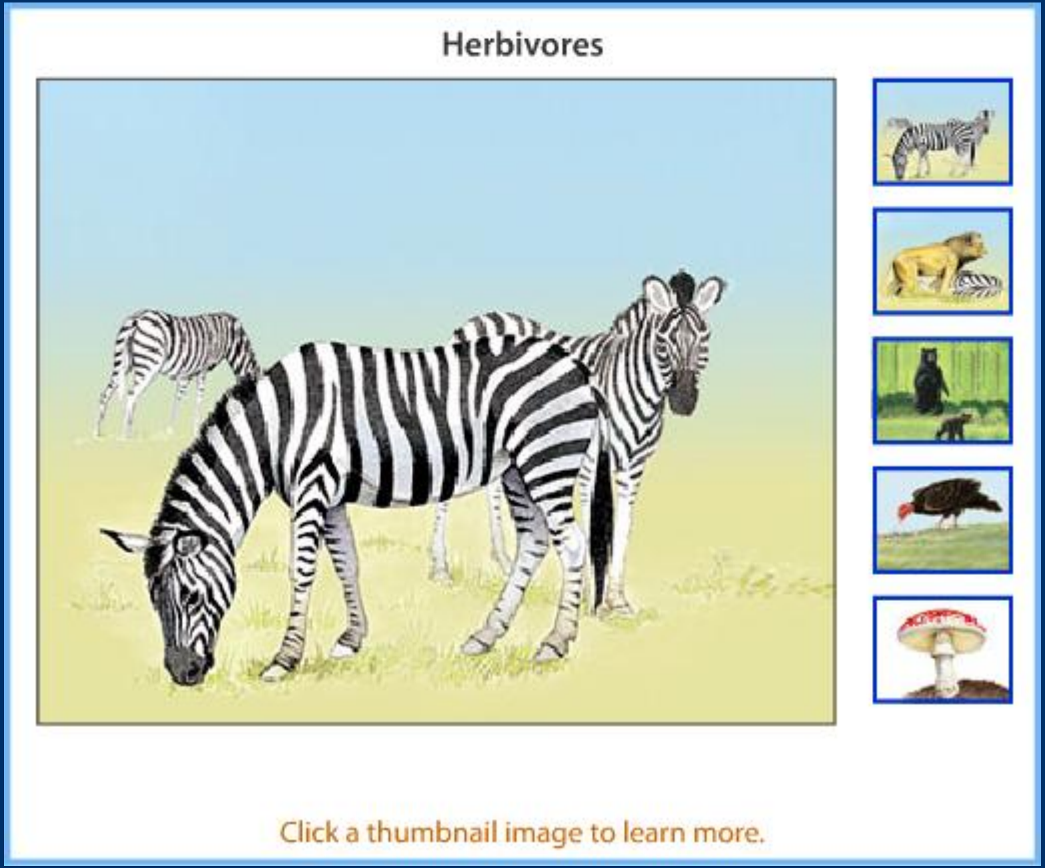


Grassland Food Web



Food Chains and Food Webs

Types of Consumers

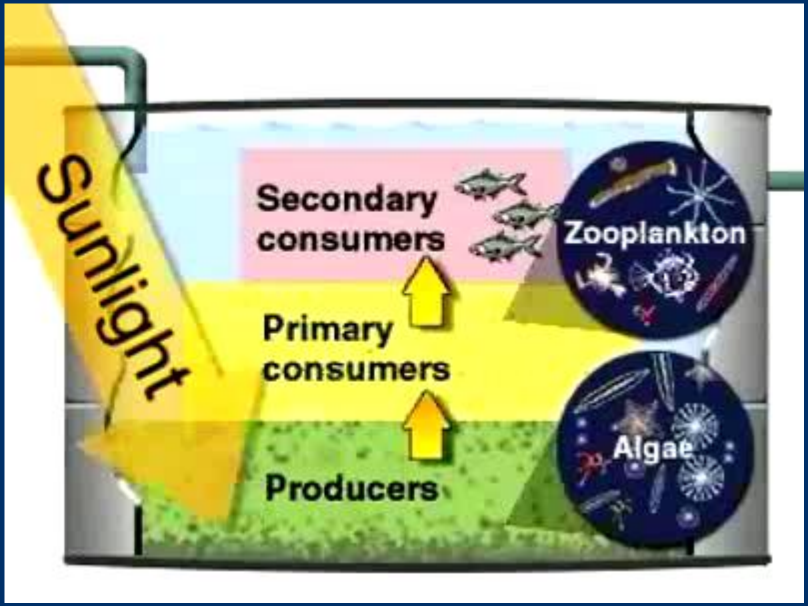


Loss of Energy in a Food Chain

Energy Transfer

- During every transfer of energy within an ecosystem, energy is lost as heat.
- Thus, the amount of useful energy available to do work decreases as energy passes through an ecosystem.
- The loss of useful energy limits the number of trophic levels an ecosystem can support.

Food Chains and Energy Transfer

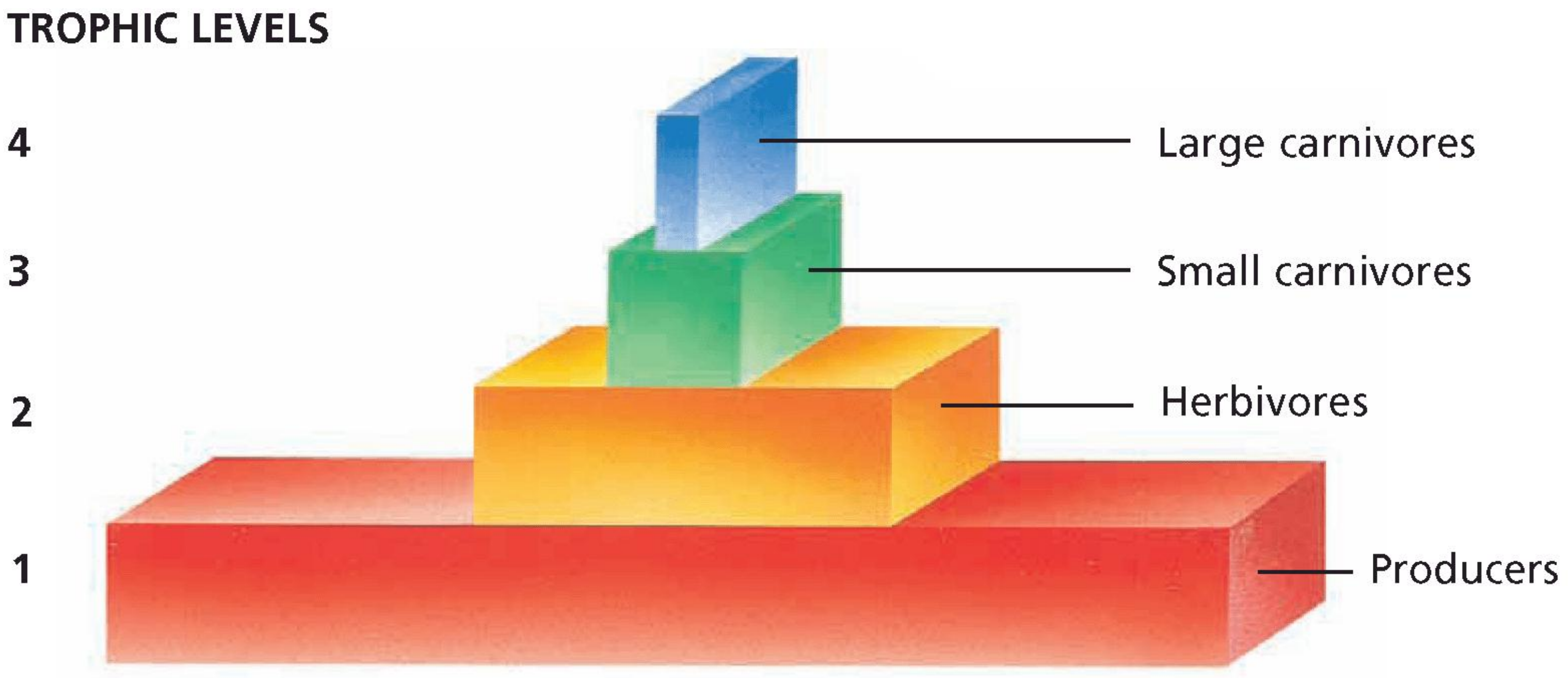


Loss of Energy in a Food Chain, *continued*

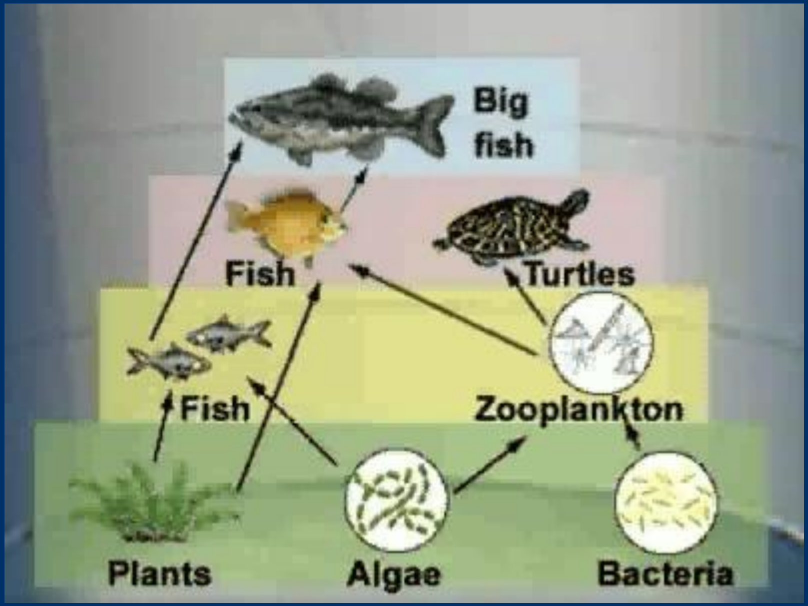
The Pyramid of Energy

- An **energy pyramid** is a diagram in which each trophic level is represented by a block, and the blocks are stacked on top of one another, with the lowest trophic level on the bottom.
- The width of each block is determined by the amount of energy stored in the organisms at that trophic level.
- Because the energy stored by the organisms at each trophic level is about one-tenth the energy stored by the organisms in the level below, the diagram takes the shape of a pyramid.

Energy Transfer Through Trophic Levels



Energy Pyramid



Loss of Energy in a Food Chain, *continued*

Limitations of Trophic Levels

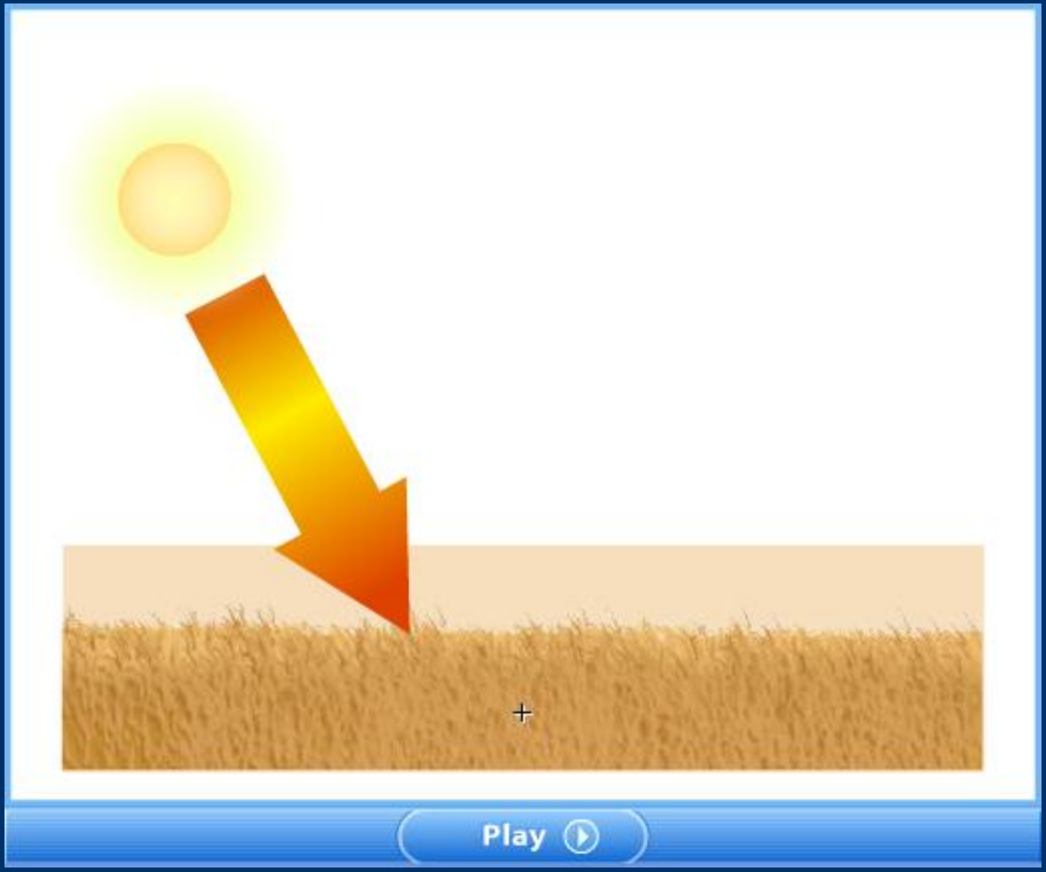
- Most terrestrial ecosystems involve only three or, on rare instances, four trophic levels. Too much energy is lost at each level to allow more levels.
- The number of individuals in a trophic level may not be an accurate indicator of the amount of energy in that level. Some organisms are much bigger than others and therefore use more energy.
- Because of this, the number of organisms often does not form a pyramid when one compares different trophic levels.

Loss of Energy in a Food Chain, *continued*

Limitations of Trophic Levels

- To better determine the amount of energy present in trophic levels, ecologists measure biomass.
- **Biomass** is the dry weight of tissue and other organic matter found in a specific ecosystem.
- Each higher level on the pyramid contains only 10 percent of the biomass found in the trophic level below it.

Biomass



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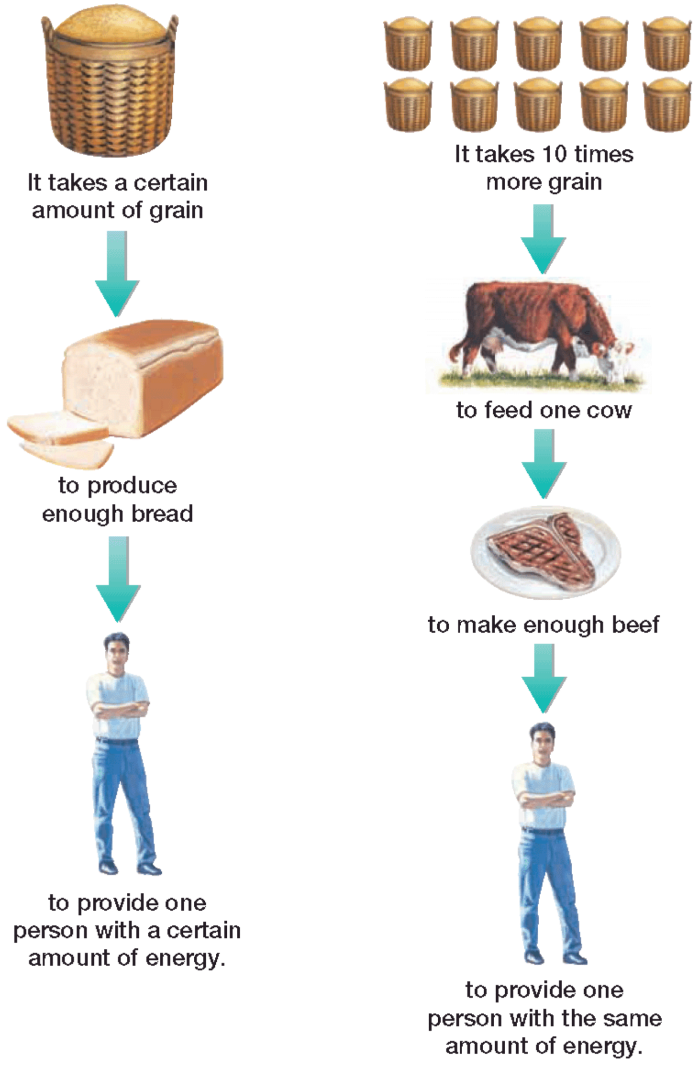
Energy Efficiency in Food Consumption



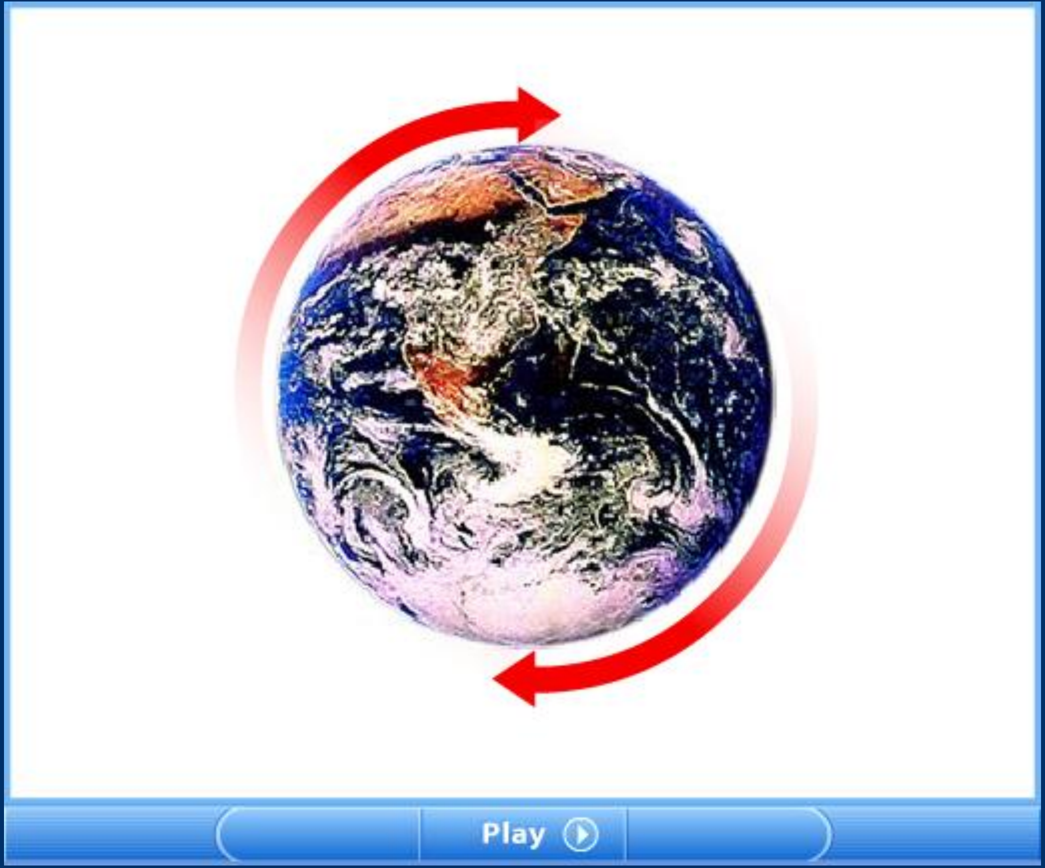
Objectives

- **Summarize** the role of plants in the water cycle.
- **Analyze** the flow of energy through the carbon cycle.
- **Identify** the role of bacteria in the nitrogen cycle.

Biogeochemical Cycles

- The physical parts of the ecosystems cycle constantly.
- The paths of water, carbon, nitrogen, and phosphorus pass from the nonliving environment to living organisms, and then back to the nonliving environment. These paths form closed circles, or cycles, called biogeochemical cycles.
- In each **biogeochemical cycle,** a pathway forms when a substance enters living organisms such as trees from the atmosphere, water, or soil; stays for a time in the living organism; then returns to the nonliving environment.

Biogeochemical Cycle



The Water Cycle

- In the nonliving portion of the water cycle, water vapor in the atmosphere condenses and falls to the Earth's surface as rain or snow.
- Some of this water seeps into the soil and becomes part of the **groundwater,** which is water retained beneath the surface of the Earth.
- Most of the remaining water that falls to the Earth does not remain at the surface. Instead, heated by the sun, it reenters the atmosphere by evaporation.

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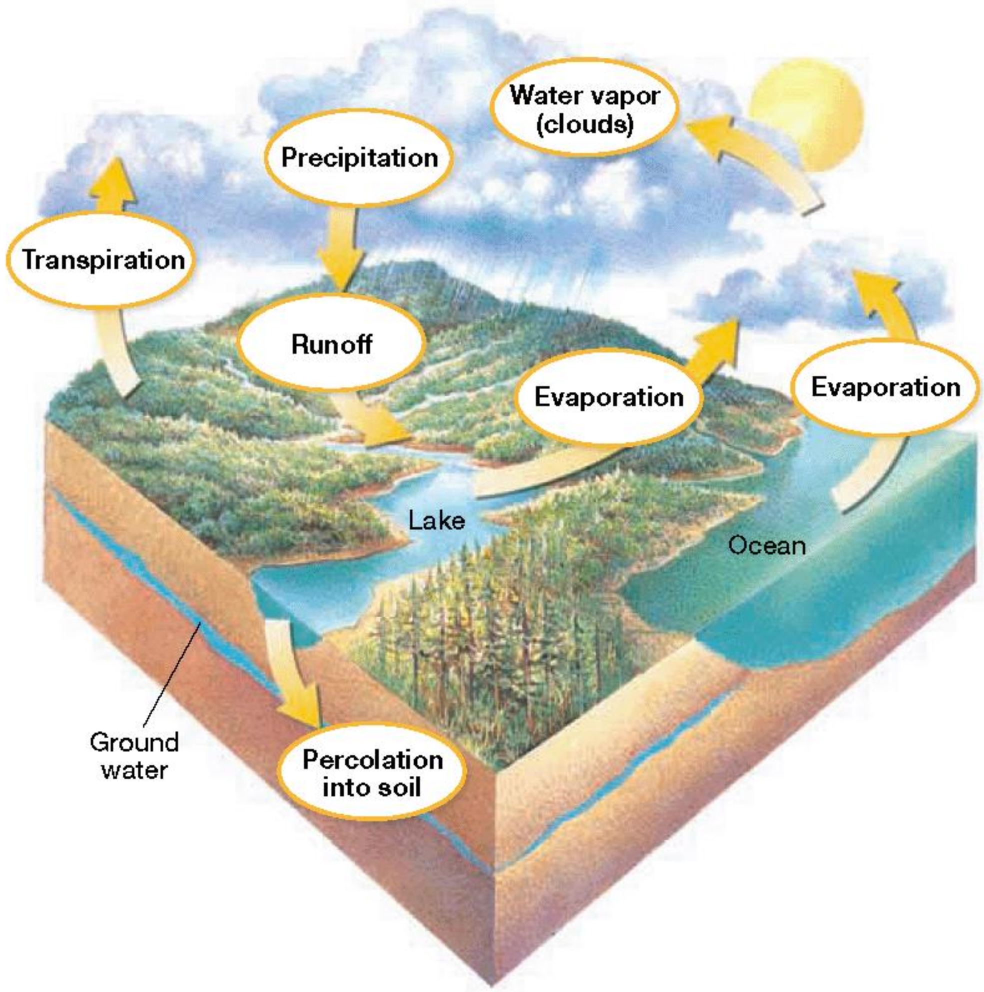
Chapter menu

Resources

The Water Cycle, *continued*

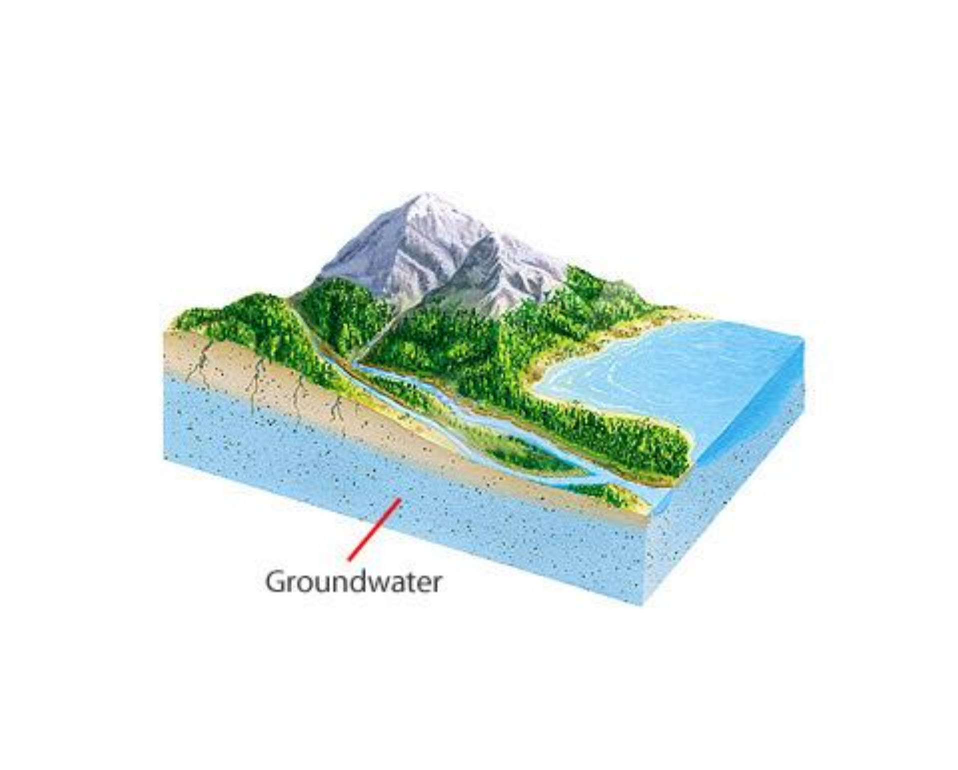
- In the living portion of the water cycle, much water is taken up by the roots of plants.
- After passing through a plant, the water moves into the atmosphere by evaporating from the leaves, a process called **transpiration.**
- Transpiration is also a sun-driven process. The sun heats the Earth’s atmosphere, creating wind currents that draw moisture from the tiny openings in the leaves of plants.

Water Cycle

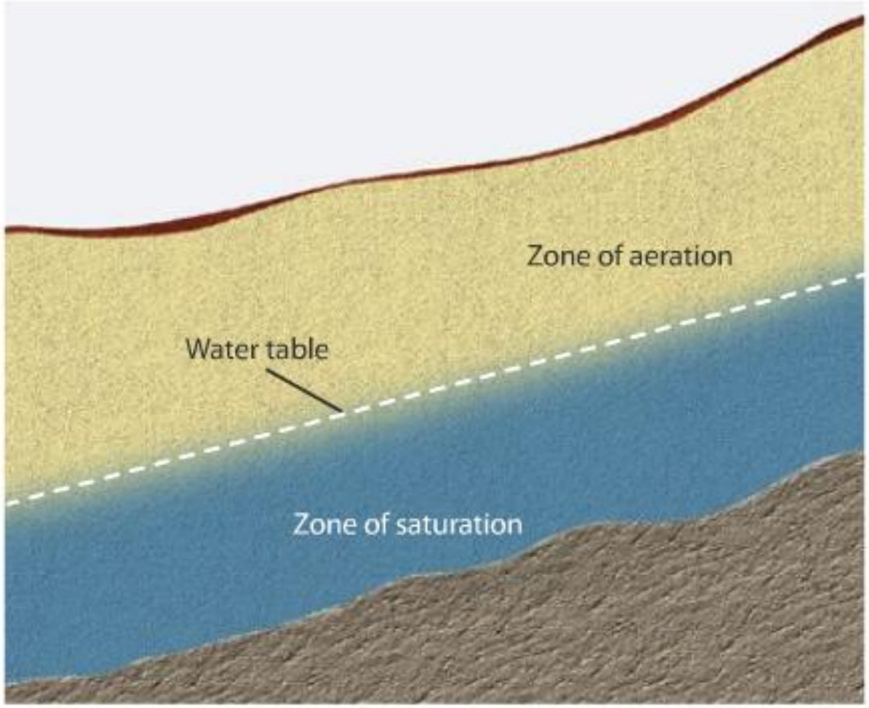

Water vapor (clouds)
Precipitation
Transpiration
Runoff
Evaporation
Evaporation
Lake
Ocean
Ground water
Percolation into soil

Water Cycle

Groundwater



Water Table



The Carbon Cycle

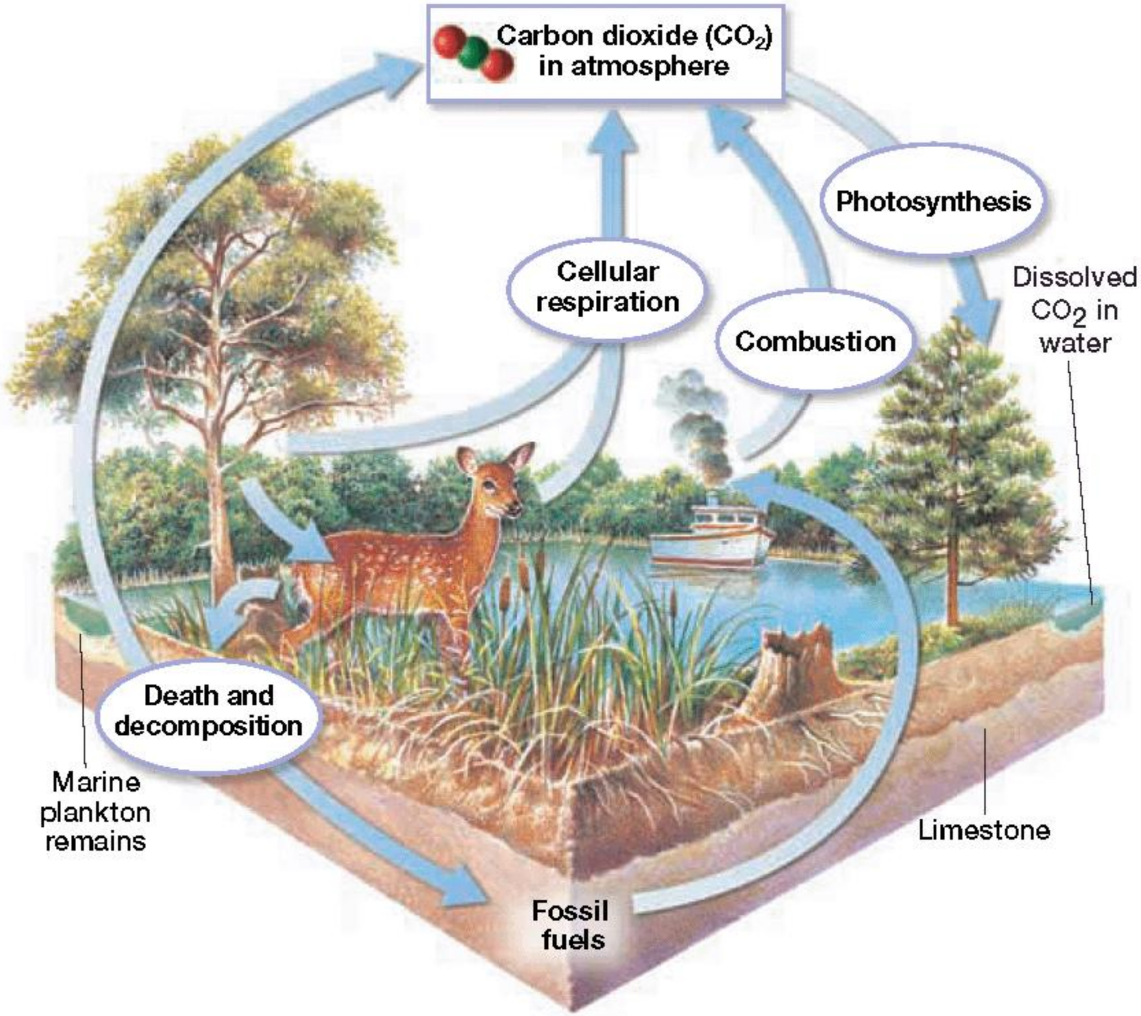
- In the carbon cycle, carbon atoms may return to the pool of carbon dioxide in the air and water in three ways:

1. Respiration Carbon dioxide is a byproduct of cellular respiration.

2. Combustion Carbon also returns to the atmosphere through combustion, or burning.

3. Erosion As the limestone becomes exposed and erodes, the carbon in it becomes available to other organisms.

Carbon Cycle



Carbon Cycle

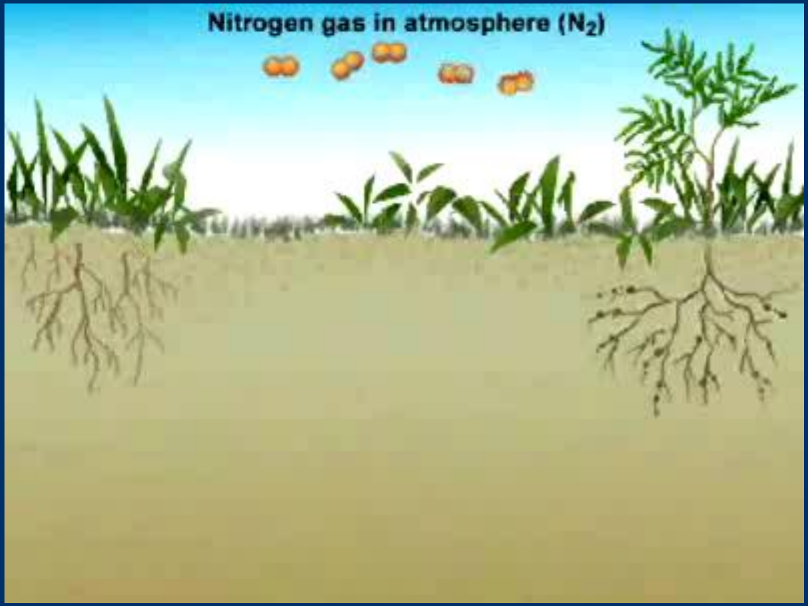
The Phosphorus and Nitrogen Cycle

- Organisms need nitrogen and phosphorus to build proteins and nucleic acids.
- Phosphorus is an essential part of both ATP and DNA.
- Phosphorus is usually present in soil and rock as calcium phosphate, which dissolves in water to form phosphate ions.

The Phosphorus and Nitrogen Cycle, *continued*

- The atmosphere is 79 percent nitrogen gas, N_2.
- The two nitrogen atoms in a molecule of nitrogen gas are connected by a strong triple covalent bond that is very difficult to break. However, a few bacteria have enzymes that can break it, and they bind nitrogen atoms to hydrogen to form ammonia.
- The process of combining nitrogen with hydrogen to form ammonia is called **nitrogen fixation.**

Nitrogen Fixation



The Phosphorus and Nitrogen Cycle, *continued*

- The nitrogen cycle is a complex process with four important stages:

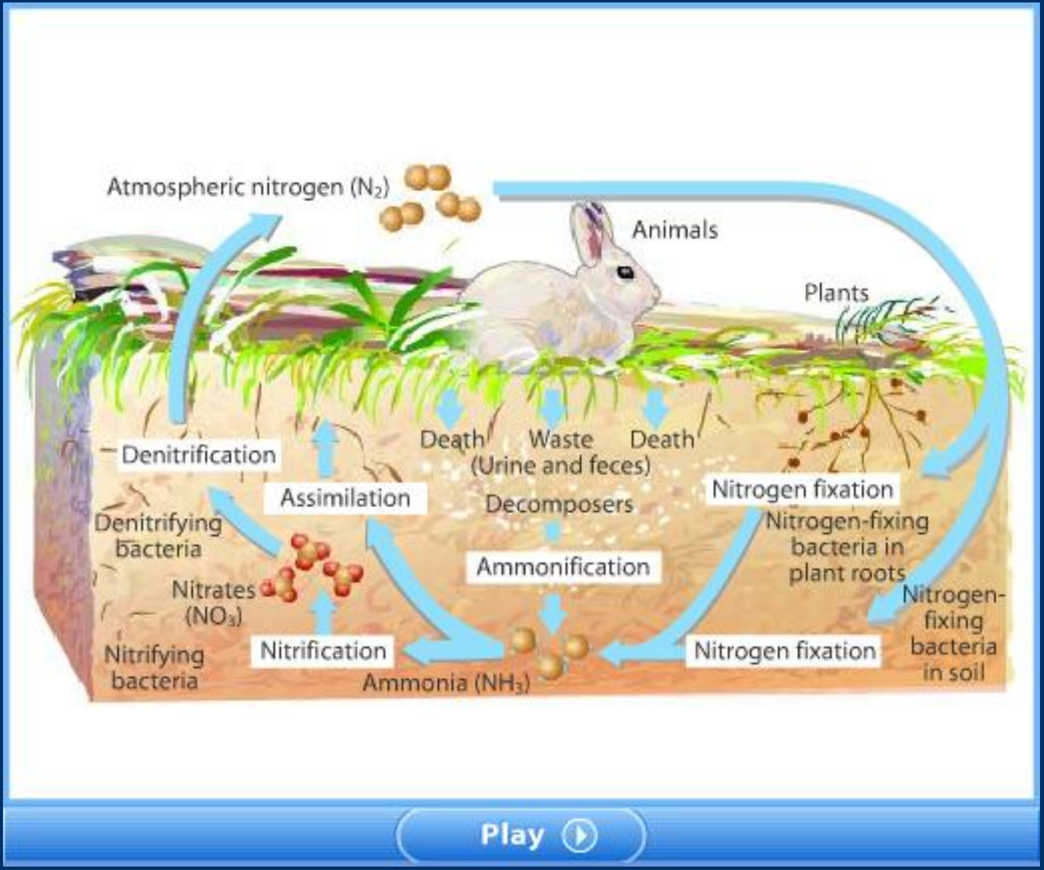
  1. Assimilation is the absorption and incorporation of nitrogen into plant and animal compounds.

  2. Ammonification is the production of ammonia by bacteria during the decay of nitrogen-containing urea.

  3. Nitrification is the production of nitrate from ammonia.

  4. Denitrification is the conversion of nitrate to nitrogen gas.

Ammonification



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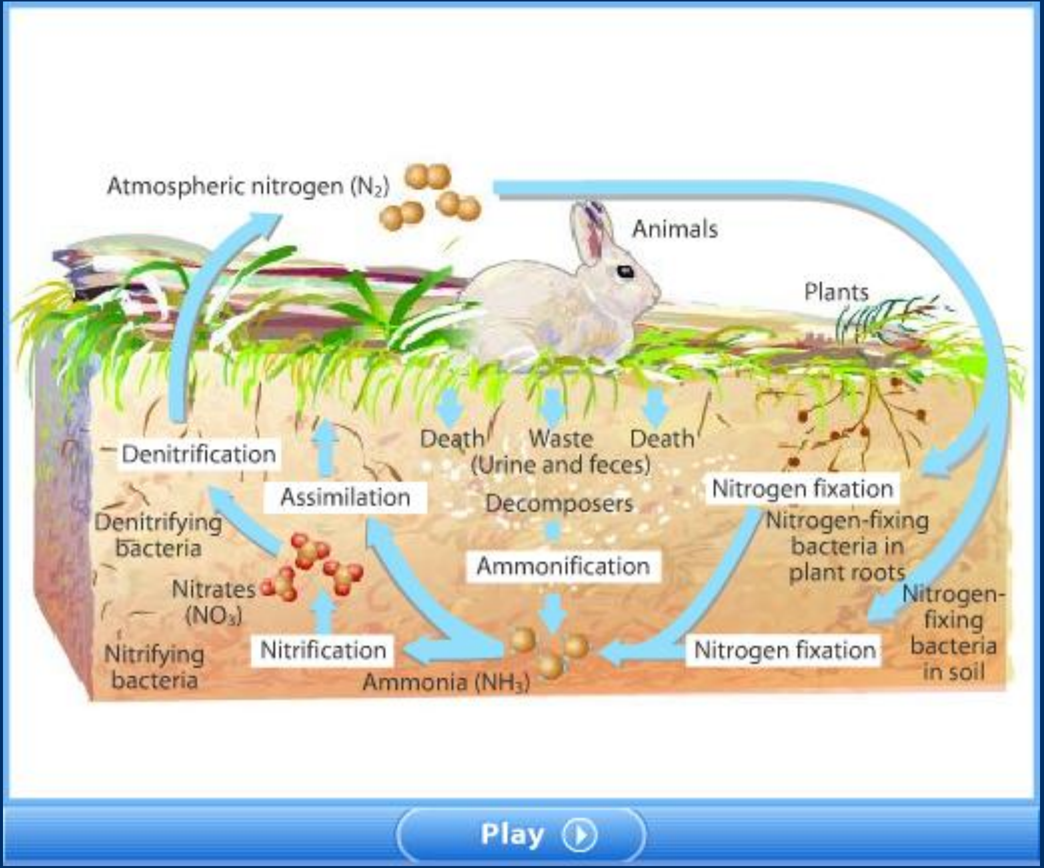
Nitrification



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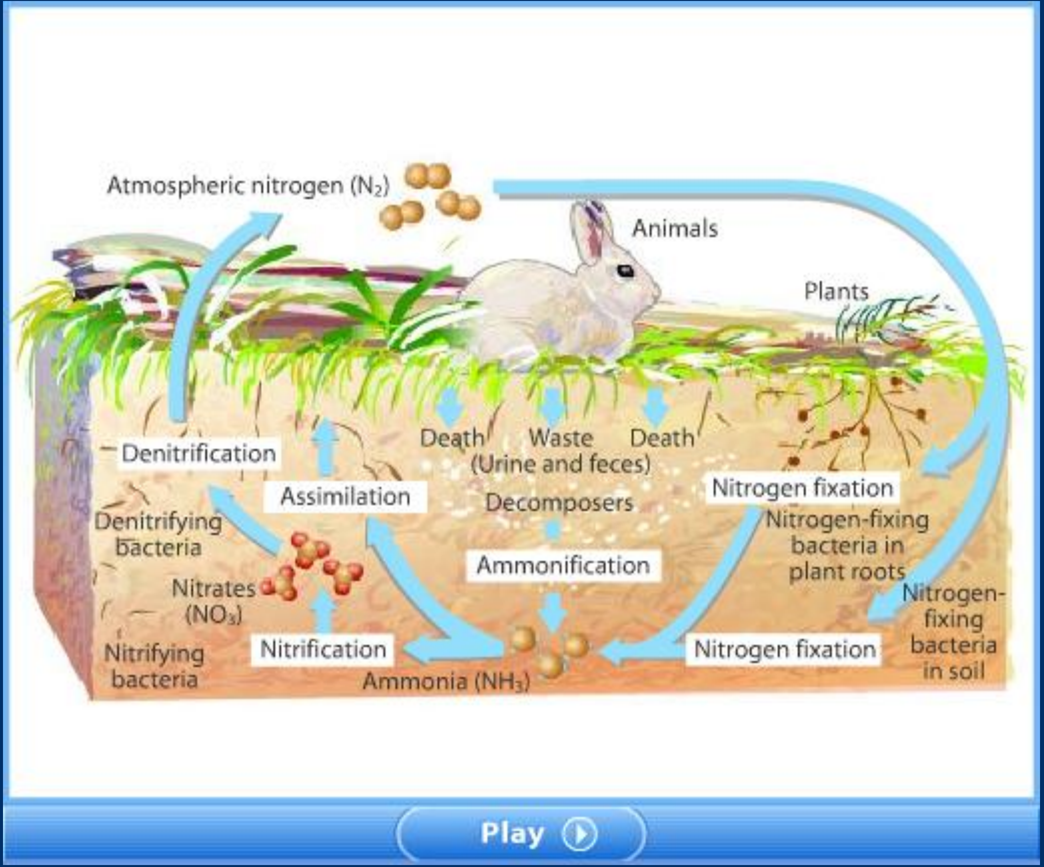
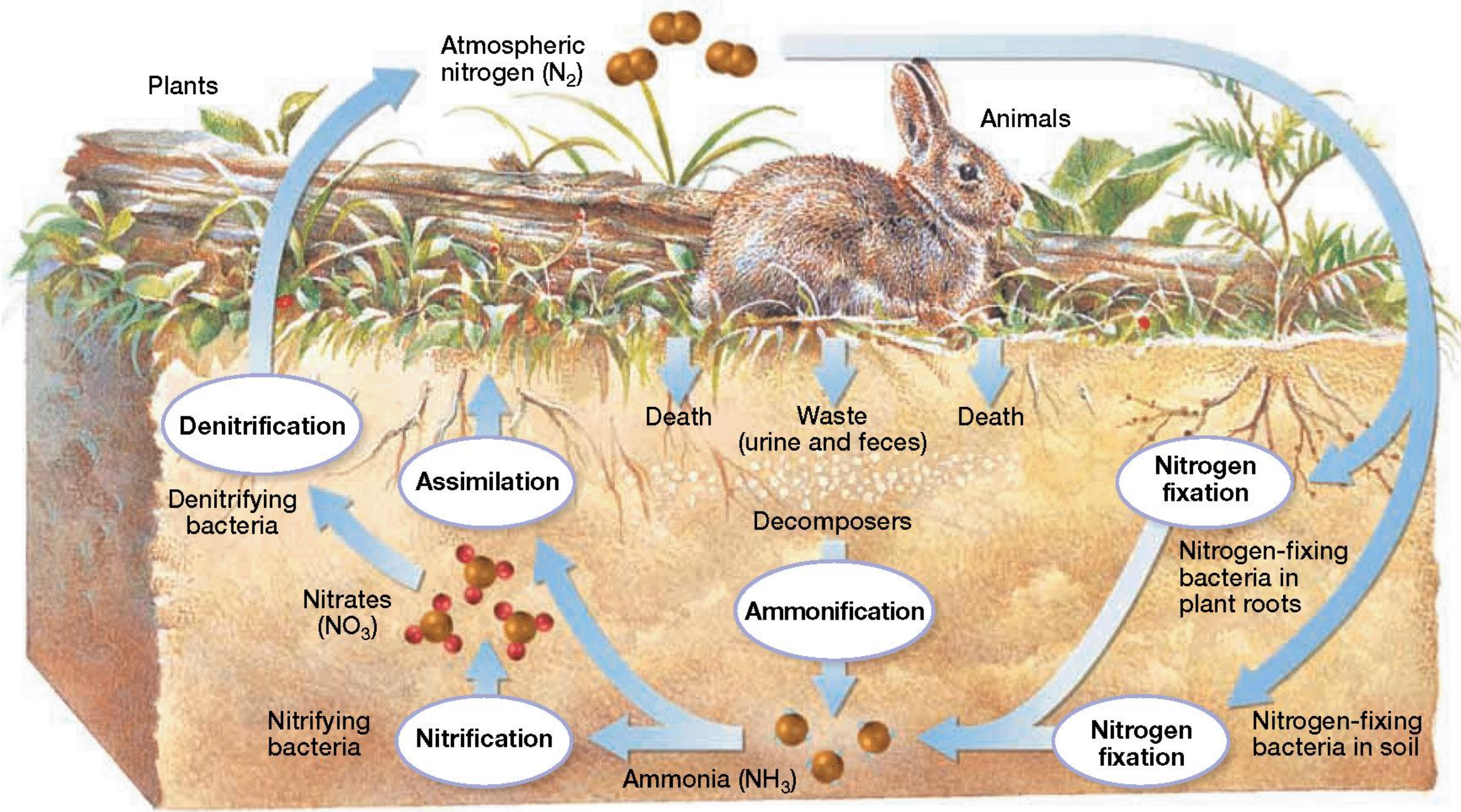
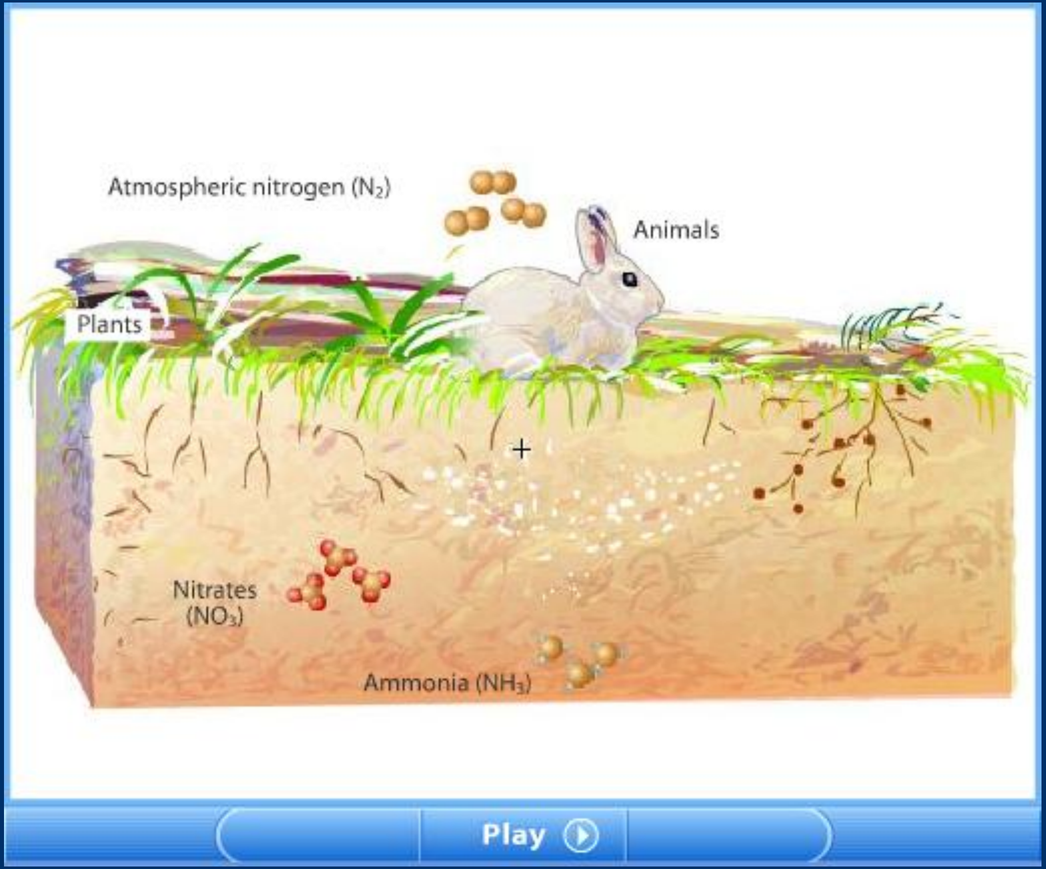
Denitrification



Nitrogen Cycle

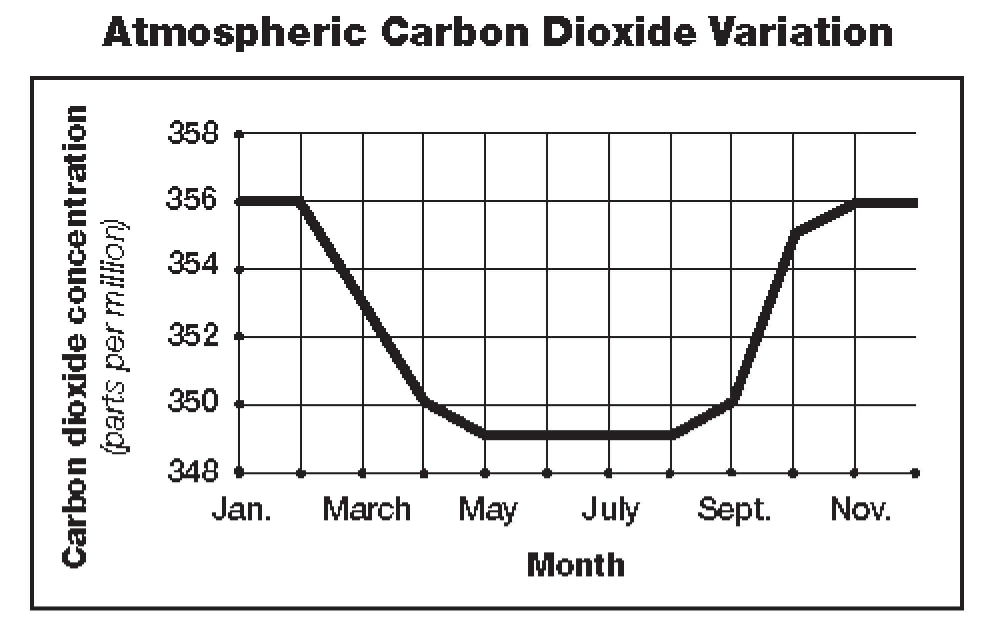


Nitrogen Cycle



Multiple Choice

The chart below shows the monthly variation in atmospheric carbon dioxide concentration over a deciduous forest. Use the chart to answer questions 1–3.



Multiple Choice, *continued*

1. During which of the following months is the rate of photosynthesis greatest?

    A. May
    B. March
    C. January
    D. September

Multiple Choice, *continued*

1. During which of the following months is the rate of photosynthesis greatest?

   A. May
   B. March
   C. January
   D. September

Multiple Choice, *continued*

2. If the data were obtained from the atmosphere over an evergreen forest, the curve likely would

F. rise from February to May and fall from August to November.

G. vary less throughout the year.

H. rise steadily from January to December.

J. fall steadily from January to December.

Multiple Choice, *continued*

2. If the data were obtained from the atmosphere over an evergreen forest, the curve likely would

F. rise from February to May and fall from August to November.

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H. rise steadily from January to December.

J. fall steadily from January to December.

Multiple Choice, *continued*

3. If the y-axis of a graph displayed the rate of *transpiration* of a deciduous forest, the curve likely would

   A. rise from February to May and fall from August to November.
   B. vary little throughout the year.
   C. rise steadily from January to December.
   D. fall steadily from January to December.

Multiple Choice, *continued*

3. If the y-axis of a graph displayed the rate of *transpiration* of a deciduous forest, the curve likely would

A. rise from February to May and fall from August to November.
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