Chapter 3 The Biosphere

Section Objectives:

- Distinguish between the biotic and abiotic factors in the environment.
- Compare the different levels of biological organization and living relationships important in ecology.
- Explain the difference between a niche and a habitat.

Sharing the World

- What affects the environment also affects you.
- Understanding what affects the environment is important because it is where you live.

Studying nature

- The study of plants and animals, including where they grow and live, what they eat, or what eats them, is called natural history.
- These data reflect the status or health of the world in which you live.

What is ecology?

- The branch of biology that developed from natural history is called ecology.
- Ecology is the study of interactions that take place between organisms and their environment.

Ecological research

- Scientific research includes using descriptive and quantitative methods.
- Most ecologists use both descriptive and quantitative research.
- They obtain descriptive information by observing organisms.

Ecological research

- They obtain quantitative data by making measurements and carrying out controlled experiments in the field and in the laboratory.

The Biosphere

- The biosphere is the portion of Earth that supports living things.
- It extends from high in the atmosphere to the bottom of the oceans.

The Biosphere

- Although it is thin, the biosphere supports a diverse group of organisms in a wide range of climates.
- Living things are affected by both the physical or nonliving environment and by other living things.

The nonliving environment: Abiotic factors

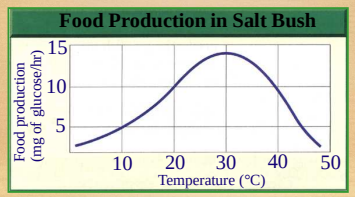
- The nonliving parts of an organism's environment are the abiotic factors.
- Examples of abiotic factors include air currents, temperature, moisture, light, and soil.

The nonliving environment: Abiotic factors

- Ecology includes the study of features of the environment that are not living because these features are part of an organism's life.
- Abiotic factors have obvious effects on living things and often determine which species survive in a particular environment.

The nonliving environment: Abiotic factors

- This graph shows how the plant's glucose (food) production is affected by temperature.



The living environment: Biotic factors

- A key consideration of ecology is that living organisms affect other living organisms.
- All the living organisms that inhabit an environment are called biotic factors.
- All organisms depend on others directly or indirectly for food, shelter, reproduction or protection.

Levels of Organization

- Ecologists study individual organisms, interactions among organisms of the same species, interactions among organisms of different species, as well as the effects of abiotic factors on interacting species.
- Ecologists have organized the living world into levels—the organism by itself, populations, communities, and ecosystems.

Organism

- An individual living thing that is made of cells, uses energy, reproduces, responds, grows, and develops.

Interactions within populations

- A population is a group of organisms, all of the same species, which interbreed and live in the same area at the same time.

Interactions within populations

- Members of the same population may compete with each other for food, water, mates, or other resources.
- Competition can occur whether resources are in short supply or not.

Interactions within communities

- Just as a population is made up of individuals, several different populations make up a biological community.

Interactions within communities

- A biological community is made up of interacting populations in a certain area at a certain time.

Interactions within communities

- A change in one population in a community may cause changes in the other populations.
- Some of these changes can be minor, such as when a small increase in the number of individuals of one population causes a small decrease in the size of another population.

Interactions within communities

- Other changes might be more extreme, as when the size of one population grows so large it begins affecting the food supply for another species in the community.

Ecosystem

- Populations of plants and animals that interact with each other in a given area and with the abiotic components of that area.

Biotic and abiotic factors form ecosystems

- An ecosystem is made up of interacting populations in a biological community and the community's abiotic factors.
- There are two major kinds of ecosystems—terrestrial ecosystems and aquatic ecosystems.

Biotic and abiotic factors form ecosystems

Table 2.1 Examples of Ecosystems

Terrestrial Ecosystems	Aquatic Ecosystems	Other Sites for Ecosystems
• Forest	Freshwater	Human body
• Old farm field	• Pond	• Skin
• Meadow	• Lake	• Intestine
• Yard	• Stream	• Mouth
• Garden plot	• Estuary	Buildings
• Empty lot	Salt water (marine)	• Mold in walls, floors, or basement
• Compost heap	• Ocean	• Ventilation systems
• Volcano site	• Estuary	•Bathrooms
• Rotting log	• Aquarium	Food
		• Any moldy food
		• Refrigerator

- Terrestial ecosystems are those located on land.

Biotic and abiotic factors form ecosystems

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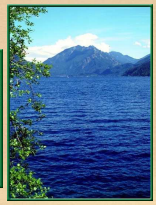
- Aquatic ecosystems occur in both fresh- and saltwater forms.

Biotic and abiotic factors form ecosystems

- Freshwater ecosystems include ponds, lakes, and streams.


Biotic and abiotic factors form ecosystems

- Saltwater ecosystems, also called marine ecosystems, make up approximately 70 percent of Earth's surface.

Organisms in Ecosystems

- A habitat is the place where an organism lives out its life.

Organisms in Ecosystems

- Habitats can change, and even disappear. Habitats can change due to both natural and human causes.

Niche

- Although several species may share a habitat, the food, shelter, and other essential resources of that habitat are often used in different ways.
- A niche is the role or position a species has in its environment—how it meets its specific needs for food and shelter, how and where it survives, and where it reproduces in its environment.

Niche

- A species' niche, therefore, includes all its interactions with the biotic and abiotic parts of its habitat.
- It is thought that two species can't exist for long in the same community if their niches are the same.

Symbiosis

- The relationship in which there is a close and permanent association between organisms of different species is called symbiosis.
- Simbiosis means living together. Three kinds of symbiosis are recognized: mutualism, commensalism, and parasitism.

Mutualism

- A symbiotic relationship in which both species benefit is called mutualism.

Commensalism

- Commensalism is a symbiotic relationship in which one species benefits and the other species is neither harmed nor benefited.

Parasitism

- Some interactions are harmful to one species, yet beneficial to another.
- A symbiotic relationship in which a member of one species derives benefit at the expense of another species (the host) is called parasitism.

Parasitism

- Parasites have evolved in such a way that they harm, but usually do not kill the host species.

Parasitism

- A predator is a type of consumer. Predators seek out and eat other organisms.

Parasitism

- Predation is found in all ecosystems and includes organisms that eat plants and animals.
- The animals that predators eat are called prey.

Section Objectives

- Compare how organisms satisfy their nutritional needs.
- Trace the path of energy and matter in an ecosystem.
- Analyze how matter is cycled in the abiotic and biotic parts of the biosphere.

How Organisms Obtain Energy

- One of the most important characteristics of a species' niche is how it obtains energy.
- Ecologists trace the flow of energy through communities to discover nutritional relationships between organisms.

The producers: Autotrophs

- The ultimate source of the energy for life is the sun.

- Plants use the sun's energy to manufacture food in a process called photosynthesis.

The producers: Autotrophs

- An organism that uses light energy or energy stored in chemical compounds to make energy-rich compounds is a producer, or autotroph.
- Other organisms in the biosphere depend on autotrophs for nutrients and energy. These dependent organisms are called consumers.

The consumers: Heterotrophs

- An organism that cannot make its own food and feeds on other organisms is called a heterotroph.
- Heterotrophs include organisms that feed only on autotrophs, organisms that feed only on other heterotrophs, and organisms that feed on both autotrophs and heterotrophs.

The consumers: Heterotrophs

- Heterotrophs display a variety of feeding relationships.
- A heterotroph that feeds only on plants is an herbivore.

The consumers: Heterotrophs

- Some heterotrophs eat other heterotrophs. Animals such as lions that kill and eat only other animals are carnivores.

The consumers: Heterotrophs

- Scavengers eat animals that have already died.

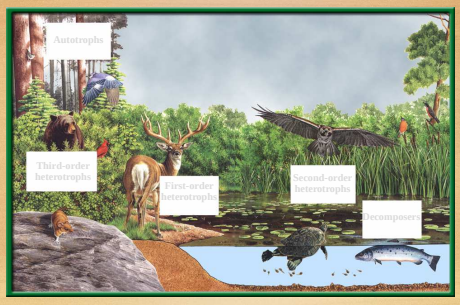
The consumers: Heterotrophs

- Some organisms, such as bacteria and fungi, are decomposers.

The consumers: Heterotrophs

- Decomposers break down the complex compounds of dead and decaying plants and animals into simpler molecules that can be more easily absorbed.

Flow of Matter and Energy in Ecosystems



Food chains: Pathways for matter and energy

- A food chain is a simple model that scientists use to show how matter and energy move through an ecosystem.
- In a food chain, nutrients and energy move from autotrophs to heterotrophs and, eventually, to decomposers.

Food chains: Pathways for matter and energy

- A food chain is drawn using arrows to indicate the direction in which energy is transferred from one organism to the next.

berries → mice → black bear

Food chains: Pathways for matter and energy

- Most food chains consist of two, three, or four transfers.
- The amount of energy remaining in the final transfer is only a portion of what was available at the first transfer.
- A portion of the energy is given off as heat at each transfer.

Trophic levels represent links in the chain

- Each organism in a food chain represents a feeding step, or trophic level, in the passage of energy and materials.
- A first order heterotroph is an organism that feeds on plants, such as a grasshopper.

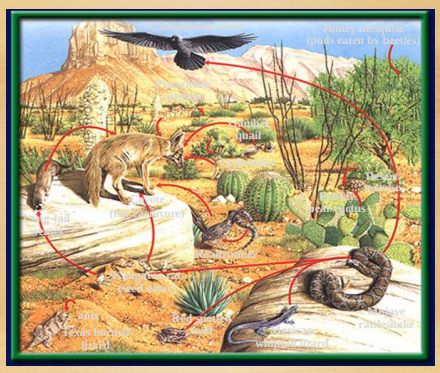
Trophic levels represent links in the chain

- A second order heterotroph is an organism that feeds on a first order heterotroph.
- A food chain represents only one possible route for the transfer of matter and energy through an ecosystem.

Food webs

- Ecologists interested in energy flow in an ecosystem may set up experiments with as many organisms in the community as they can.
- The model they create, called a food web, shows all the possible feeding relationships at each trophic level in a community.

Food webs

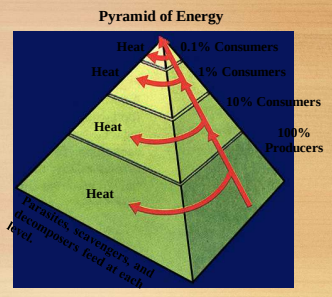


Energy and trophic levels: Ecological pyramids

- An ecological pyramid can show how energy flows through an ecosystem.
- The base of the ecological pyramid represents the autotrophs, or first trophic level. Higher trophic levels are layered on top of one another.

Energy and trophic levels: Ecological pyramids

- The pyramid of energy illustrates that the amount of available energy decreases at each succeeding trophic level.



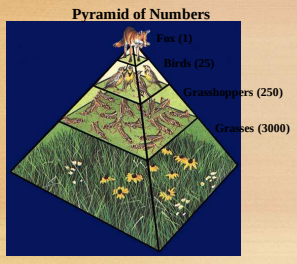
Energy and trophic levels: Ecological pyramids

- The total energy transfer from one trophic level to the next is only about ten percent because organisms fail to capture and eat all the food energy available at the trophic level below them.

Energy and trophic levels: Ecological pyramids

- Some of the energy transferred at each successive trophic level enters the environment as heat, but the total amount of energy remains the same.

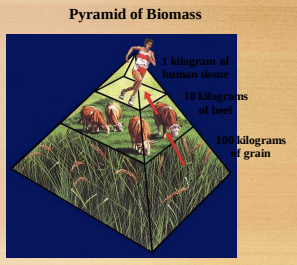
Energy and trophic levels: Ecological pyramids



- A pyramid of numbers shows that population sizes decrease at each higher trophic level.

Energy and trophic levels: Ecological pyramids

- Biomass is the total weight of living matter at each trophic level. A pyramid of biomass represents the total weight of living material available at each trophic level.

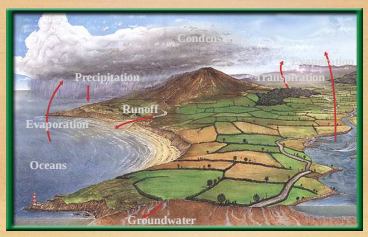


Cycles in Nature

- Matter, in the form of nutrients, moves through, or is part of, all organisms at each trophic level.
- But matter is cycled and is not replenished like the energy from sunlight. There is a finite amount of matter.

The water cycle

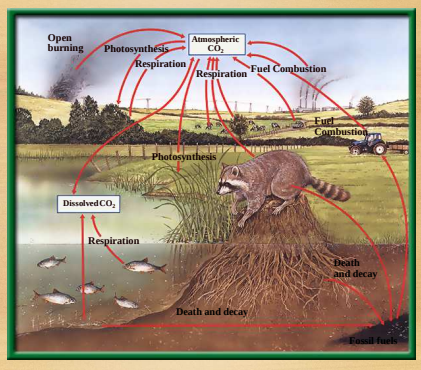
- In the water cycle, water is constantly moving between the atmosphere and Earth.



The carbon cycle

- From proteins to sugars, carbon is the building block of the molecules of life.
- Linked carbon atoms form the frame for molecules produced by plants and other living things.
- Organisms use these carbon molecules for growth and energy.

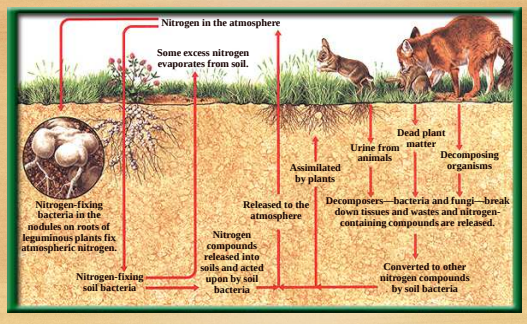
The carbon cycle



The nitrogen cycle

- In the nitrogen cycle, nitrogen is converted from a gas to compounds important for life and back to a gas.

The nitrogen cycle



The phosphorus cycle

- In the phosphorus cycle, phosphorus moves between the living and nonliving parts of the environment.

The phosphorus cycle