

# ECOLOGY



## INTRODUCTION

No **organism**, or individual living thing, exists in isolation from other organisms or its **environment**, the surroundings and conditions within which an organism lives. To understand what each organism needs, how to get along with it, and how to protect it requires knowledge of the organism within its environment. **Ecology** is the study of the relationships between living things and their environments.

Each organism exists within an **ecosystem**, a system of plant and animal communities

that depend on each other and on the non-living environment for survival. Each ecosystem functions as a coherent unit within the larger environment of the earth — generating oxygen, purifying the air and water, and providing food and shelter.

Within an ecosystem there are always many forms of life, a condition known as **biodiversity**, the variety of living things within an ecosystem and in the world. Biodiversity helps create balance in an ecosystem by ensuring there are many different types of organisms to fill any available places in the complex web of relationships.

The many forms of life in an ecosystem are connected in extremely complex ways, creating a system of interdependent relationships. And every ecosystem is related with every other ecosystem, through animal migrations, seed dispersal, and air and water circulation. Taken together, this creates the **web of life**, the complex web of interdependence and interrelationships of life on earth.

In fact, it is this interdependence of living things that creates balance and resilience in an ecosystem and in the web of life. If any type of organism tries to dominate an ecosystem, there is usually some limitation that controls it, such as lack of food or space, or the buildup of waste. Such limitations ensure a rich diversity of life in most ecosystems.

Some scientists estimate that the earth is home to between 10 and 13 million different **species**, groups of organisms made up of members that resemble each other sufficiently to be able to produce healthy offspring when they breed. These millions of species live in a broad range of environments, with conditions such as temperature, moisture, and landscape all varying tremendously. Still, organisms find ways to survive in almost all environments.

With the possible exception of bacteria, no organism has proved as adaptable as humans. The result is that humanity is an integral part of most ecosystems. Within an ecosystem, each person is dependent on the environment for everything needed for survival, including air, water, food, and shelter. Almost everything humans use in their everyday lives was grown or dug up from the ground.

## Note to the teacher

When presenting topics in Ecology, guide students to link the subject with what they learned in the Five Great Lessons, especially in the Second Great Lesson, Life Comes to Earth, and the Third Great Lesson, Humans Come to Earth.

Humans also depend on the environment as a place to dispose of waste. Unfortunately, humanity is destroying the environment. The earth is damaged from humans taking its raw materials, from their manufacturing industries that produce dangerous by-products, and from their consumer waste piling up in landfills and garbage dumps. Water and air carry dangerous residues into all ecosystems and into the food supply. Humanity is putting biodiversity and the web of life itself at risk. Consequently, as people have come to understand the scope and importance of biodiversity and the threats to it, people have made efforts to preserve and repair ecosystems.

## THE WEB OF LIFE

### Background Information

Life on earth is a unified whole. The **atmosphere**, the blanket of gases surrounding the earth, circulates constantly. Water also circulates constantly because of the **water cycle**, in which rain and snow fall from the atmosphere, moisture evaporates into the atmosphere and condenses to form clouds, and then falls again as rain and

snow. Each year birds fly thousands of miles through the atmosphere and fish swim thousands of miles through the oceans. There is no place on the earth that is truly isolated, allowing life on earth to be considered one large system — the web of life. The web of life is the complex web of interdependence and interrelationships of life on earth.



*A spider's web*

To understand the web of life, it is necessary to break the web down into smaller systems. Scientists focus on smaller systems in order to investigate, classify, and discuss the relationships of different organisms in their environments. A common system of classification breaks the web of life into three levels:

- **Biomes** are naturally occurring, relatively distinct areas on the earth defined by **vegetation**, the plant life in an area, and **climate**, an area's average weather pattern over a long period of time.
- Ecosystems are the relatively distinct plant and animal communities within a biome.

- A **niche** (pronounced “neesh”) is the local environment and ecological role of an organism within an ecosystem.

This breakdown allows a discussion of the many interconnections and interrelationships within the web of life.

Biomes are classified by their vegetation and their climate. There are several systems of classification, but one simple system has five major biomes: forest, tundra, desert, grassland, and aquatic. Of the five major biomes, the forest, tundra, desert, and grassland biomes are also known as **terrestrial biomes**, biomes that exist on land. The **aquatic biome** includes all areas covered by water, both seawater and freshwater. The following table summarizes the five biomes.



*forest*



*tundra*

## Biome characteristics

Biome	Characteristics
forest	<ul style="list-style-type: none"> <li>• considerable rainfall</li> <li>• hot or cold</li> <li>• extensive land area dominated by trees</li> <li>• includes the tropical rain forest and northern <b>coniferous</b>, or evergreen, forest</li> </ul>
tundra	<ul style="list-style-type: none"> <li>• moderate rainfall</li> <li>• cold</li> <li>• treeless, with small hardy plants growing close to the ground includes the Russian steppe and sub-arctic Canada</li> </ul>
desert	<ul style="list-style-type: none"> <li>• very dry</li> <li>• hot or cold</li> <li>• plants have water-conserving features</li> <li>• includes the Sahara Desert and Antarctica</li> </ul>
grassland	<ul style="list-style-type: none"> <li>• low rainfall</li> <li>• warm or cold</li> <li>• mostly grass, with some hardy shrubs and a few trees</li> <li>• includes the North American prairies</li> </ul>
aquatic	<ul style="list-style-type: none"> <li>• warm or cold</li> <li>• has plants and animals able to live with low to high salt content</li> <li>• includes all water-covered areas of the earth</li> </ul>



*desert*



*grassland*



*aquatic*

In each of the biomes, vegetation is largely determined by climate (or water temperature in the case of the aquatic biome). In turn, climate is largely determined by two factors:

- **Latitude** is a system of imaginary lines (often called parallels) encircling the earth, parallel to the equator.
- Geographic location helps to determine the amount of sunlight and rainfall, and the temperature within any specific area of a biome.

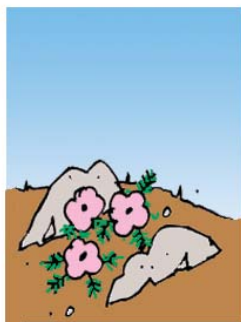
Latitude and geographic location work together to create each unique instance of a biome. For example, different types of desert biomes are caused by varying combinations of latitude and geographic location. The Sahara Desert is a very hot desert because of the Sahara's geographic location in the heart of northern Africa, and its latitude near the **equator**, an imaginary line encircling the earth. In contrast, Antarctica's latitude of 90 degrees south makes it a very cold desert, but a desert nonetheless because it receives so little precipitation — at that latitude, the air is too cold to carry moisture.

But deserts do not have to be either very hot or very cold. They can also develop solely because of geographic location, as occurs in a **rain shadow**, an area beside a mountain range that is deprived of moisture because the air passing over the mountains loses its moisture. For example, the Okanagan Valley in British Columbia, Canada, is a desert of moderate temperatures within a rain shadow.

A continent can contain all of the biomes, and each biome can contain many different ecosystems. For example, a continent such



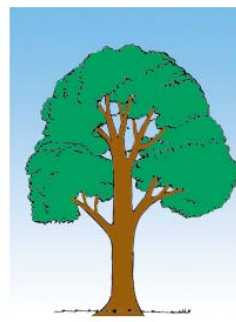
ice and snow



tundra



needleleaf forest



temperate deciduous forest

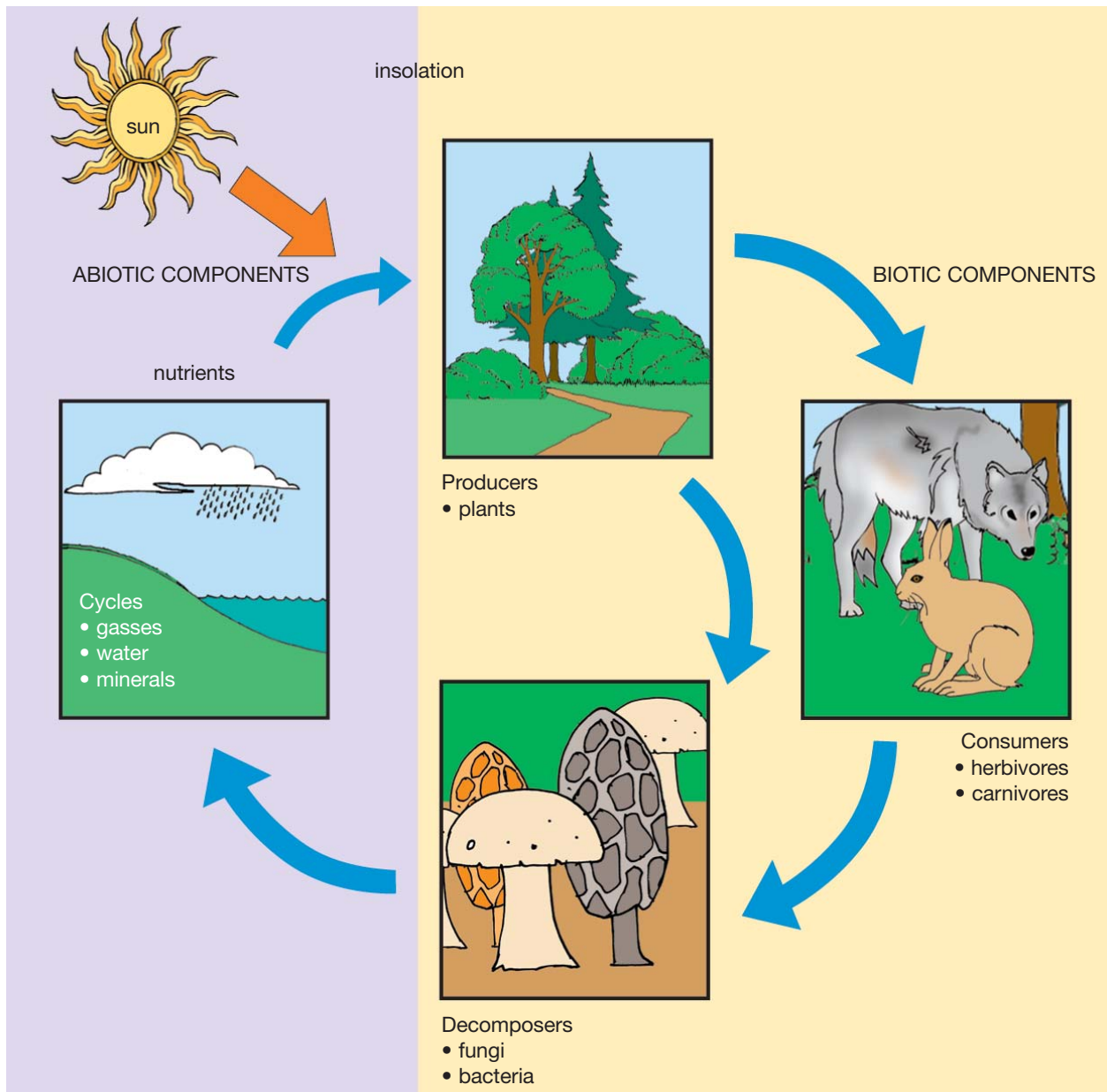


tropical rain forest



Latitudinal zonation increasing latitude from the equator

*Biomes created by latitude*



*Relationships between the biotic and abiotic parts of an ecosystem*

as North America has all of the biomes: forest biomes in the north and the western and eastern mountain ranges; grassland (prairie) and desert biomes in the rain shadow of the mountains; tundra in the far north; and aquatic throughout.

Each biome contains many ecosystems separated by physical boundaries such as rivers and valleys. Relationships exist between the ecosystems within each

biome, and between each biome, such as birds or animals migrating. Most life stays put, however, because of physical barriers between ecosystems and climate differences between biomes.

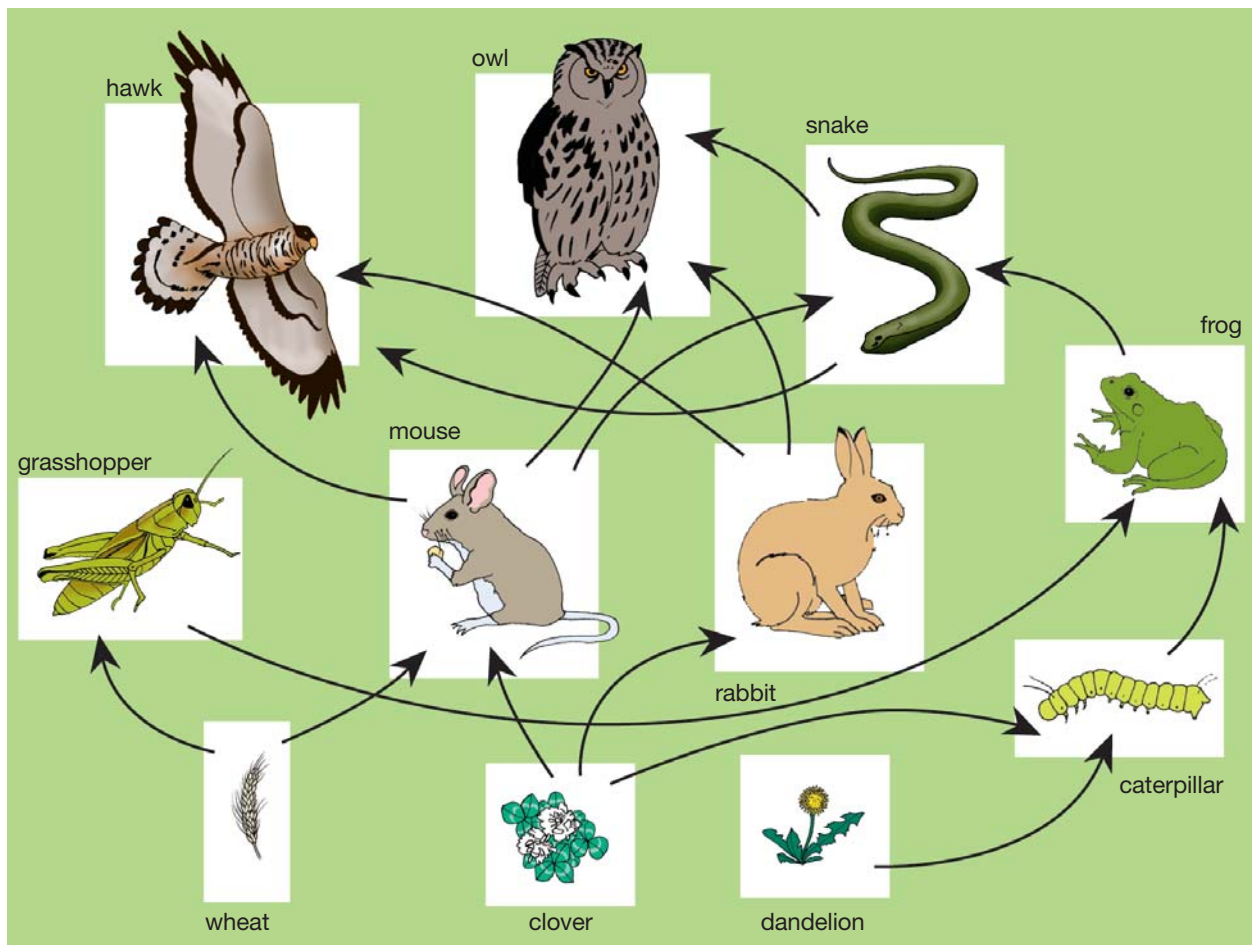
Within an ecosystem, there are many different kinds of life and many non-living components upon which that life depends. The **biotic components** of an ecosystem are its living things, like plants and animals.

The **abiotic components** of an ecosystem are its physical, non-living surroundings like rock, soil, and water. Together, the abiotic components form the non-living **habitat**, or home, of the living organisms. Habitats also include some biotic components for other living things, such as plants providing a habitat for aphids and animals providing a habitat for fleas.

An organism's habitat and its role in that habit are the organism's niche. An organism's niche is formed from what the organism eats, what eats the organism, and the place it lives, such as a burrow or nest. A particular niche is filled by a species, whether plant or animal. A species is a group of organisms that are similar enough

to produce healthy offspring when they interbreed. This means that the organisms are very similar physically, even though there may be superficial differences. For example, all human beings are of the species *Homo sapiens*, and all can interbreed, even though there may be superficial differences in appearance.

An important factor of a species' niche is the role the species plays in the **food web**, the set of **food chains**, or feeding relationships, in an ecosystem. A plant gets its food from the soil and energy from the sun, and also provides food for animals or other plants. An animal may feed upon other animals and be fed upon. Even those animals at the top of their own food chains,



A food web

that are not hunted themselves, eventually die, decompose, and are eaten by other organisms. In this way, a food web is formed in which sustenance circulates in a complex series of exchanges.

In this way, the web of life is composed of many interacting and multilayered components: niches mingle with other niches to form food chains; food chains crisscross with other food chains to produce a food web; food webs pervade ecosystems; ecosystems butt up against other ecosystems to form biomes; and biomes compose the earth. And through it all, air, moisture, dust, seeds, bacteria, insects, birds, fish, animals, people, and much, much more circulate constantly, blurring whatever superficial boundaries there are between the many parts.

### Did you know?

- Tropical rainforests are the world's oldest living ecosystem. Rainforests make up 2 percent of the earth's surface but contain 50 percent of the earth's total plant and animal species.
- The largest of the earth's biomes are the coniferous forests found in the northern parts of North America, Europe, and Asia.
- Canada's northern forest covers 2.3 million square mi (6 million square km), or about the size of 21 United Kingdoms. It is the largest intact forest ecosystem in the world.

## Resources

There are many excellent resources about the web of life. Here are some examples:

- Daubert, Stephen. *Threads from the Web of Life: Stories in Natural History*. Nashville, TN: Vanderbilt University Press, 2006.
- World Wildlife Fund.  
<<http://www.wwf.org>>
- WorldBiomes.com.  
<<http://www.biomes.org/default.htm>>
- National Geographic. *National Geographic's Strange Days on Planet Earth*. National Geographic Society, producer. Washington, DC: National Geographic Society. 240 min. 2005. DVD (2 disks).

## ACTIVITY 1

# Exploring the Biomes of the Earth

### Purpose

To understand the biomes of the earth.

### Material

Globe.

Table, Biome characteristics.

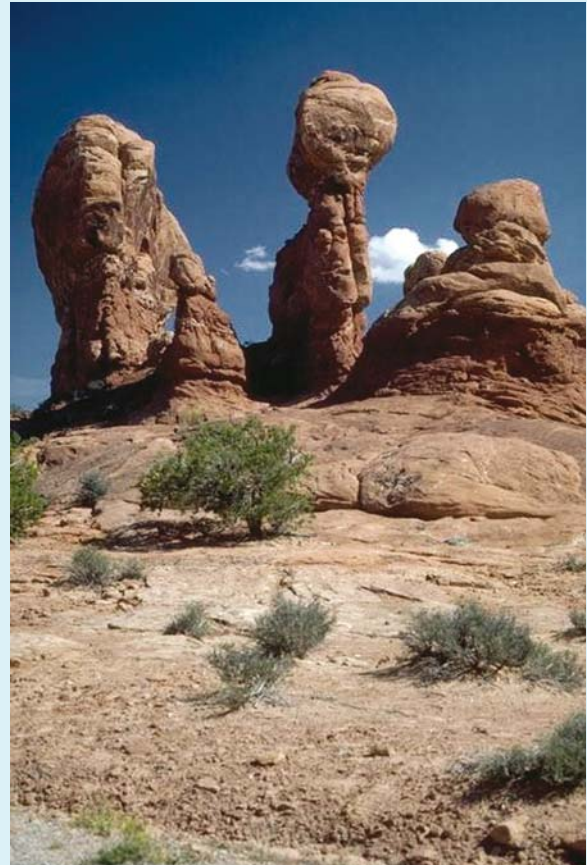
Illustrations of forest, tundra, desert, grassland, and aquatic biomes.

Illustration, Biomes created by latitude.

Natural Sciences journals and pencils.

### Presentation

- Most Montessori teachers introduce this concept in Year 4 and review it in Year 5.
- Announce to the students that they will be exploring a way to describe the earth in terms of biomes.
- Explain that a biome is an area of the earth that has similar plants and climate. The climate allows only certain types of vegetation to grow, whether because of the temperature or the amount of moisture. Add that the major biomes are forest, tundra, grassland, desert, and aquatic, or water.
- Present the illustration for each biome and invite the students to briefly describe each biome's obvious characteristics. Discuss and clarify each biome's characteristics with the students using the table, Biome characteristics.
- Present the globe and remind the students of the significance of lines of latitude. Explain that the same type of biome can be created at different latitudes because the climate changes with latitude.
- Add that the extremes of latitude combined with geographic location produce deserts. For example, there are hot deserts like the Sahara Desert that are caused by a combination of high temperatures and geographic location, and cold deserts like Antarctica caused mostly by low temperatures. There are also deserts of moderate latitude and



temperature that are caused by the rain shadows of mountains, such as the desert in the Okanagan Valley in British Columbia, Canada.



- Invite the students to name different types or locations of each biome, such as rain forest and evergreen forest, freshwater and seawater, Canadian prairie and Russian steppe. Discuss and clarify that not all examples of a biome are the same and that the reasons for each occurrence must be examined.
- Point out that biomes overlap. For example, forest biomes often overlap with aquatic biomes, since there are rivers and lakes within most forests. Invite the students to say other places where biomes overlap, such as swamps and foothills.
- With the students, identify and discuss the local biome, its climate, and types of plant and animal life.
- Ask the students to use their journals to research and write a short report outlining the five biomes, and how climate and geographic location shapes each one.

## Extensions

- In a world atlas, find a map that indicates different climates. Try to identify and list the different biomes in the student's home country and on each continent.
- Determine what the local biome is. If possible, do so by walking around the local community and observing the surrounding plants, animals, and climate. What characteristics identify the local environment as that type of biome? Support conclusions with climate data on temperature and rainfall. How does the local climate compare to other examples of the same biome?
- Identify and list plants and animals characteristic to the local biome. Find an example of the same biome in another part of the world, and compare that biome's plant and animal life with local plant and animal life. Are the same types of plants and animals found in both locations?
- Research one example of each of the five main biomes and write about what characteristics make that area typical of its biome. Briefly describe how the plants and animals in that biome are similar to each other. For example, what is similar about all desert biome plants and animals?

## ACTIVITY 2

# Understanding Biomes, Ecosystems, and Niches

### Purpose


To understand the relationships between biomes, ecosystems, and niches.

### Material

Illustration, Relationships between the biotic and abiotic parts of an ecosystem.

Natural Sciences journals and pencils.

### Presentation

- Most Montessori teachers introduce this concept in Year 4 and review it in Year 5.
  - Announce to the students that they will be investigating biomes, ecosystems, and niches.
  - Review with the students the major types of biomes. Remind them that biomes are ways of classifying areas of the earth with similar types of vegetation and climate.
  - Point out that because the biomes refer to such large areas of the earth, each contains many distinct communities of plants and animals within smaller geographic areas. Explain that these communities are known as ecosystems, and that each biome is made up of many ecosystems. Explain that an ecosystem is a system of plant and animal communities that depend on each other for survival.
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- Explain that ecosystems within a biome are usually defined by some geographical boundary such as a mountain range or river. Such boundaries make it difficult for animals and plants to move freely out of their ecosystems. In this way, the abiotic, or non-living, physical parts of the environment affect the biotic, or living, makeup of an ecosystem.
  - Discuss and clarify that each organism, or living thing, plays its own role and occupies its own physical space. Add that this includes what the organism eats, what eats it, and the place it lives, such as a burrow or nest. Taken together, the organism's role and place are called its niche.
  - Add that a particular niche is filled by a species, whether plant or animal. A

species is a group of organisms that are similar enough to produce healthy offspring when they interbreed. This means that they are very similar physically, even though there may be superficial differences. For example, all human beings are of the species *Homo sapiens*, and all can interbreed, even though there may be superficial differences in appearance.

- Point out that each organism depends on its physical environment in many ways, for shelter, water, and to support the plants upon which much of life depends. Present the illustration, Relationships between the biotic and abiotic parts of an ecosystem. Discuss and clarify the relationship.
- Ask the students to use their journals to write a short research report on their local ecosystem. To start, choose any local animal and find out what it eats, what eats it, and where it lives. Ask them to expand the discussion, showing other relationships that expand out from the main animal. For example, what animal eats the animal that eats the local animal? Ask them to explore as many relationships as possible. Include illustrations or diagrams, showing the relationship between organisms.

## Extensions

- Research and write about what happens to an ecosystem when a significant animal or plant becomes extinct or has its numbers greatly reduced. For example, what were the consequences to



the Atlantic Ocean ecosystem after the east coast cod fish stocks collapsed, or the consequences to the coniferous forest when wolves were hunted until they were endangered?

- Research and write about what happens to an ecosystem when a significant physical part is altered, whether by people or nature. For example, write about the effects of building dams on rivers, natural forest fires, or polar ice melting.
- Explore the local ecosystem. Draw pictures or photograph examples of plants and animals in the ecosystem. Create and label a display using the illustrations and/or photographs.
- Interview a member of a local environmental organization about issues that affect the local ecosystem. Present a brief report about the interview to the rest of the class.
- Visit a local nature interpretive center.

## ACTIVITY 3

# Understanding the Web of Life

## Purpose

To understand the concept of the web of life.

## Material

Illustration, A spider's web.

Illustration, A food web.

Natural Sciences journals and pencils.

## Presentation

- Most Montessori teachers introduce this concept in Year 4 and review it in Year 5.
- Announce to the students that they will be exploring the web of life.

### COMPARING THE WEB OF LIFE TO A SPIDER'S WEB

- Ask the students to describe what comes to mind when they hear the term "web." Present the illustration, A spider's web.
- Discuss and clarify that the web of life means that, just like with a spider's web, there is no part that does not join with many other parts. All the parts are necessary for the web to retain its shape. Explain that interfering with any one part of the web affects all its other parts — that is what the spider depends upon to know when it has caught its supper!



### EXPLORING THE FOOD WEB

- Present the illustration, A food web. Invite the students to say why the relationships shown in the illustration might be called a food web.
- Discuss and clarify that each organism occupies its own physical place and plays a role in the food web. In other words, it occupies a niche. Add that within its niche, that organism depends on other forms of life to survive, as food, shelter, or both. In turn, other forms of life depend on the organism to survive. Loss of any part of the web will affect many other parts.
- Introduce the term extinction. Explain that an extinct species of plant or animal no longer exists.

- With the students, use the illustration, A food web to trace what plants and animals would be affected if one of the plants in the food web became extinct. For example, if a particular plant became extinct, that might reduce the number of a species that eats that plant, which would mean less food for animals that eat the plant eating species.
- Examine the extended effects of changes in the food web. For example, if there are fewer of a plant-eating species, more plants might grow to maturity, providing more food for insect or bird life, which would increase the insect or bird population, and so on. Discuss and clarify these sorts of balancing mechanisms in a food web.

## UNDERSTANDING THE LARGER ECOSYSTEM

- Explain that the animals and plants shown in the food web illustration are only one part of a larger ecosystem. There are animals such as foxes that eat owls, snakes, mice, and rabbits. And there are humans that trap foxes. There are also insects such as fleas that live on all of the animals; mold that grows on the animals' waste; and insects and plants that live on the dead bodies of the plants and animals. Invite the students to describe other relationships that go beyond the food web.
- Invite the students to discuss whether there is any food web that is isolated from other food webs within an ecosystem, or ecosystems that are



completely isolated from other ecosystems.

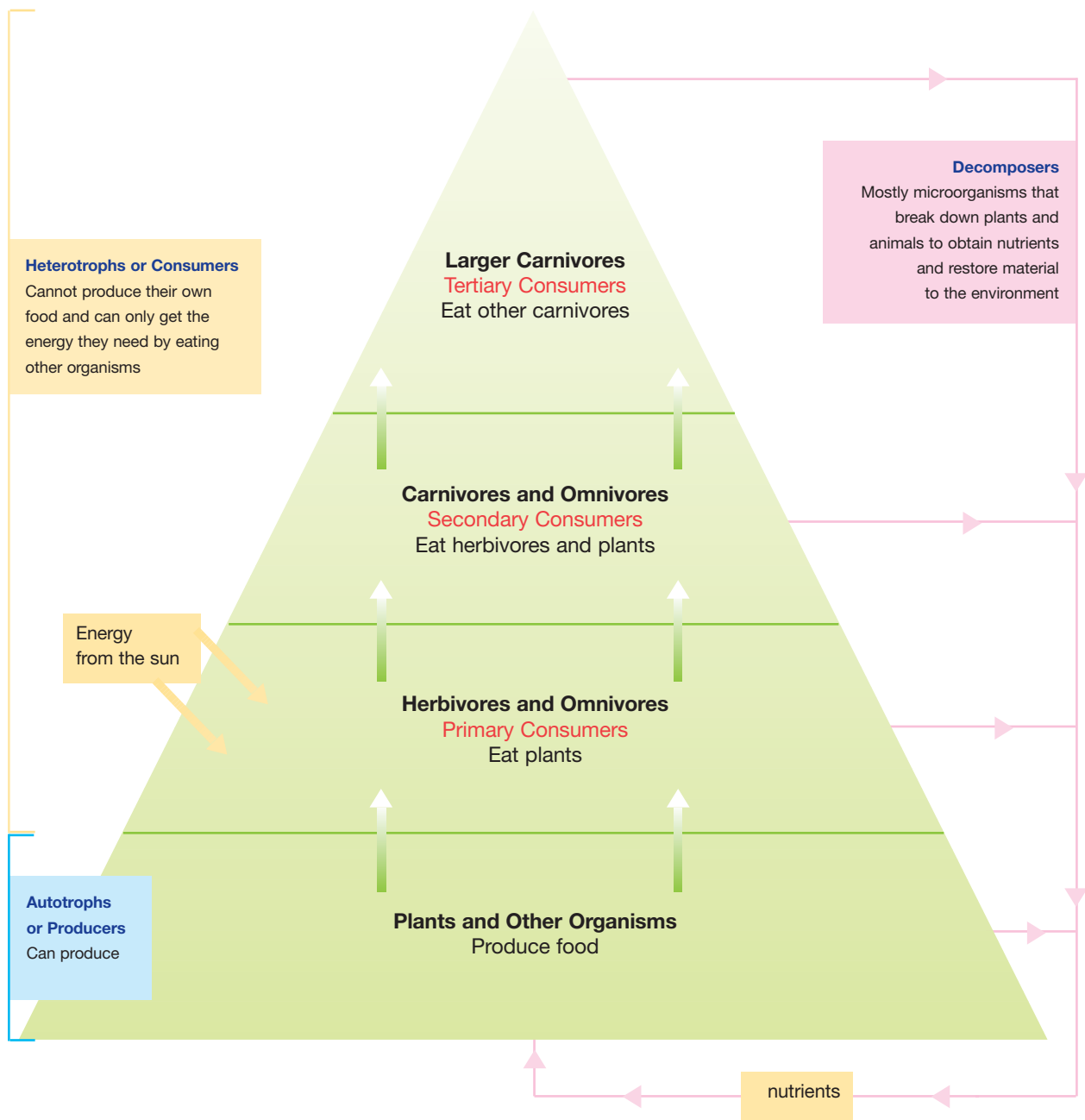
- Invite students to discuss how the wind circulates air and the rain circulates water throughout the world. Explain that plant seeds are carried by the wind, and migrating animals roam the oceans and continents.
- Discuss and clarify that no part of the world is isolated, and that means all of life is interconnected and interdependent. Add that this is called the web of life. Discuss and clarify the term.
- Ask the students to use their journals to write a definition of the web of life and explain what it means to them.

## Extensions

- Research and write a short report about the local food web. Include a hand-drawn chart of the web.

- Research and write a short report on a food web from a biome different than the local biome. How do the two food webs differ? Are there more or fewer animals and plants involved?
- Research and write a short report on an endangered plant or animal. Describe the impact to the organism's food web, ecosystem, and biome should this plant or animal become extinct.
- Research, write, and perform a short play about the food web and how a change in the web affects each of its organisms.





Food chain pyramid

## FOOD CHAINS

### Background Information

All living things within an ecosystem depend on one another to survive, creating a food web of interdependent relationships. Every ecosystem is a finely tuned collection of thousands of relationships, making

ecosystems very complicated. It is possible, however, to depict a simple food chain within an ecosystem. For example, a caterpillar eats a leaf, and is in turn eaten by a frog, which is eaten by a snake, which is eaten by an owl, which produces **excrement** or bodily waste, and feeds the plants on which the caterpillar feeds.