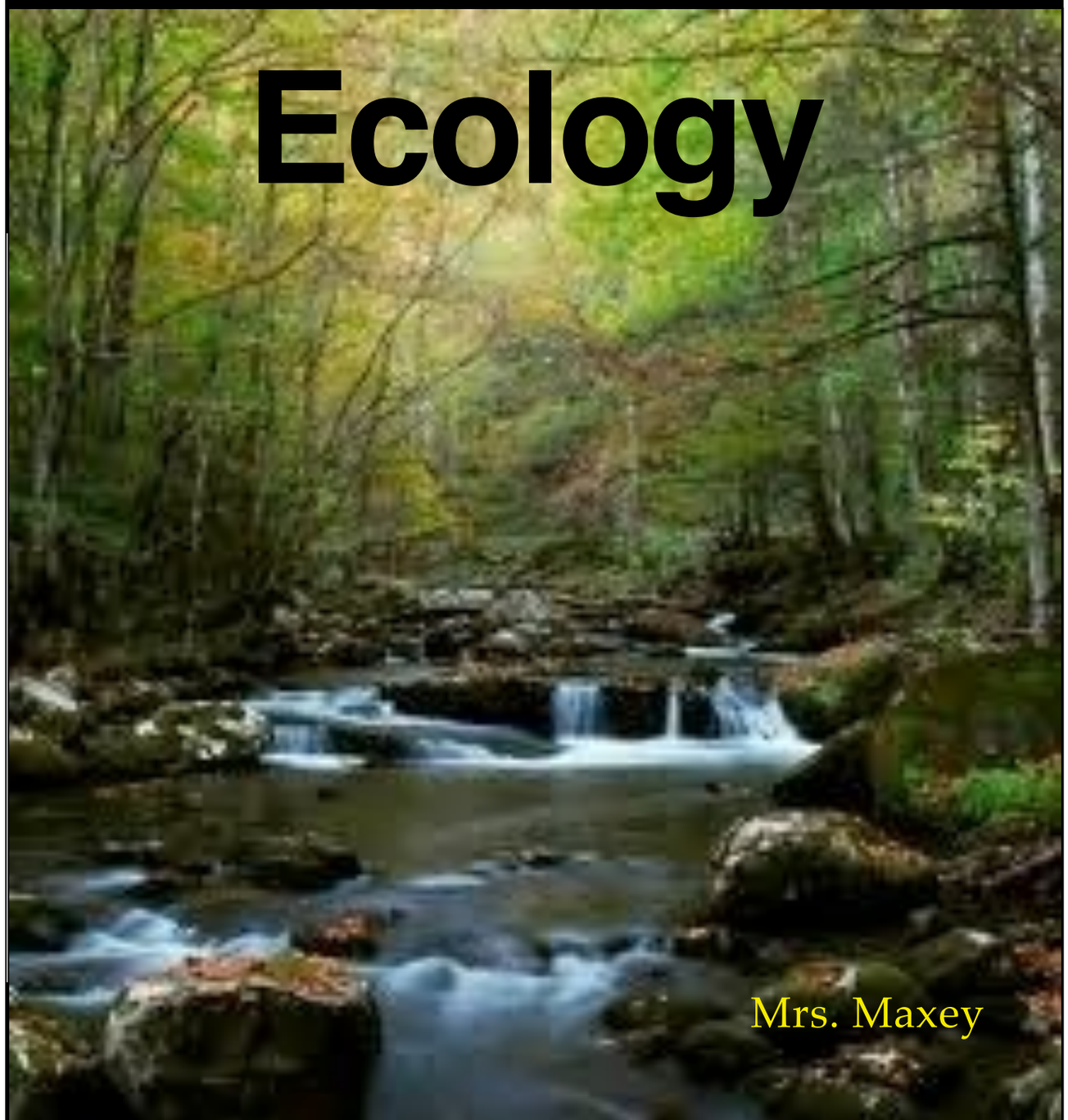

Ecology
Mrs. Maxey

CHAPTER 1

Ecosystems

Today is the perfect day for a field trip to a local stream. Carefully, quietly, you push aside some cattails. You lean in for a closer look when -- WHAM! A sticky tongue latches onto a nearby insect and flings it into the waiting mouth of a frog. You jump and the frog leaps into the water. SPLASH! You have just observed a living system in action.

What is an Ecosystem?

Goals

1. Describe the living and nonliving factors in an ecosystem.
2. Explain how the parts of an ecosystem interact.
3. Identify and understand the following vocabulary:
   - ecosystem
   - ecology
   - biosphere
   - biotic factor
   - abiotic factor

Take a walk outside and look around. What do you see? Woods? A street? A patch of weeds growing in a sidewalk crack? If you observe any of these up close, you might notice many different organisms living there. In a forest, for example, there are birds, deer, insects, plants, mushrooms, and trees. In your backyard, you might see squirrels, birds, insects, grass, and shrubs. All of these organisms, along with the nonliving things, such as air, soil, and light, make up an ecosystem. An ecosystem is made up of organisms interacting with one another and with the nonliving factors to form a working unit.

What does it mean for organisms to work with one another? Let's go back to the stream. A frog eating an insect is an example of one living organism interacting with another living organism. This interaction is a feeding interaction.

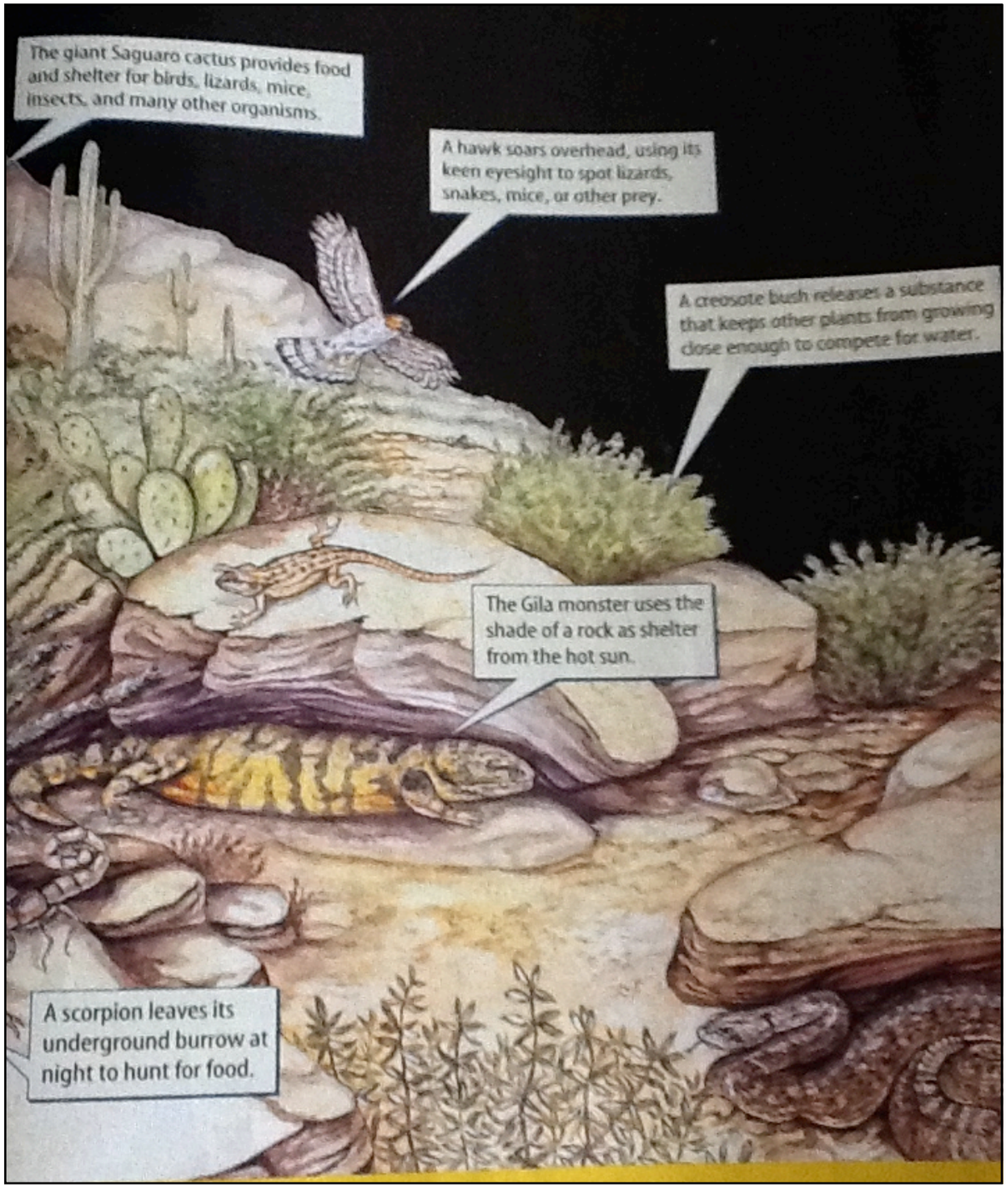
The same frog will jump into the stream when it is startled to use the water as shelter. Water is not a living thing, so the frog is interacting with a nonliving thing (water) in its environment.

When you observe and study these interactions in ecosystems, you are studying the science of ecology. Ecology is the study of interactions that take place among the living organisms and the nonliving parts of any ecosystem. Just as you took the field trip to the stream and knelt quietly by the cattails, ecologists will spend many hours outdoors observing ecosystems up close. Ecologists do conduct experiments in laboratories, but most of their work is completed outdoors in the field.

Ecosystems come in all sizes from a small pile of leaves to a large forest. The largest ecosystem on Earth is the biosphere. The biosphere is the part of the Earth where living things can live. It is made up of all the ecosystems on Earth. Some examples of ecosystems that are part of the biosphere are deserts, mountains, rivers, prairies, wetlands, forests, plains, and oceans. These are examples of larger ecosystems, so let's give some examples of some smaller ones, too. Underneath a rotting log would be an example of an ecosystem. A vacant lot, under a rock, an aquarium, and puddle would all be examples of ecosystems. Ecosystems come in all sizes from the smallest of the small to the largest of the large.

So, let's discuss the parts of an ecosystem, the living and nonliving parts. The living parts of the ecosystem are called biotic factors. Organisms depend on other biotic factors for food, shelter, protection, and reproduction. For example, a snake might use a rotting log for shelter. Termites are insects that depend on that same log for food.

The next page shows some biotic factors in a desert ecosystem.



Hawks, snakes, and many other organisms make up the desert ecosystem's living, or biotic, factors. Rocks, sand, soil, sunlight, air, and water are nonliving factors, abiotic factors. The desert is a place where rainfall is scarce. Bright sunshine can cause daytime temperatures to reach 100 degrees or more on many days of the year. Nights, however, can be very cold. The living and nonliving parts of the desert ecosystem interact in a variety of ways. Organisms must be able to survive long periods with little or no water. For example, cactus plants can store water in their tissues. Other organisms, including insects, obtain water by feeding on cacti. Desert organisms also must find ways to shelter themselves from extreme heat and cold. Kangaroo rats, shown to the right, burrow underground, coming out at night when temperatures have cooled.

Looking back at the picture on the previous page, how might a snake interact with the biotic and abiotic factors.

Let's take a closer look at abiotic factors.

The first abiotic factor we'll discuss is soil. Soil is made up of several substances, much like a recipe. Soil is made up of a combination of minerals, water, air, and organic matter (the decaying parts of plants and animals). Take into account that salt, flour, and sugar are found in many baking recipes, but not all foods made from these same ingredients taste or look the same. The chocolate cupcakes with chocolate icing that you bake for Mrs. Maxey look and taste very different than the chocolate chip cookies you bake for her because different amounts of the ingredients are used to make them. Soil is the same way. Different amounts of minerals, organic matter, water, and air make different types of soil. The soil in Oklahoma has a different makeup than the soil, say, in Montana.

Look at the pictures below. Different types of soil support different kinds of plant life. Cactus and other desert plants can thrive in dry, sandy, or rocky soils. Forest soils are deep, moist, and full of nutrients from decaying leaves.

Temperature also determines which organisms live in a particular place. How do tropical plants compare with mountainside plants? The mountainside wildflowers grow in clusters close to the ground, which protects them from strong winds. The tropical plants have large leaves to absorb as much light as possible in the dim light of the rainforest floor.

Another important abiotic factor is water. During your field trip to the local stream, you see fish darting through the water. Many organisms are adapted for life in the water, but they depend on water for more than just a home. Water also helps all living things carry out important life processes such as digestion and waste removal. In fact, the bodies of most organisms are made up mostly of water. Scientists estimate that two-thirds of the weight of the human body is water. Because water is so important to living things, it is also important to an ecosystem. The amount of water available in an ecosystem can determine how many organisms can live in that particular area. In addition to being shelter for organisms, it can also be used to move from place to place. We can use a boat to go to the other side of the lake or transport supplies across an ocean.

Sunlight is another important abiotic factor. The sun is the main source of energy for most organisms on Earth. If sun is the main source of energy for *most* organisms, then what must most organisms on Earth be? Plants, of course. Energy from the sun is used by green plants to produce food. Humans and other animals then obtain their energy by eating these plants and other organisms that eat the plants. When you eat food, you are consuming energy that originally started out as sunlight. How devastating would it be for a major climate change to occur that affected the amount of sunlight that reached the Earth?

Every ecosystem is made up of many different biotic and abiotic factors working together. When these factors are in balance, the system is also in balance. Ecosystems are always changing. Could an ecosystem get out of balance? Certainly. Many events can affect the balance of a system. One example would be a long period of time without rain. We, in Oklahoma, are very familiar with this. It is called drought. Let's go back to the stream in your field trip one more time. Predict what would happen if a drought occurred. Some organisms, like the fish, could not survive. Other organisms that are more mobile, like frogs and insects, might have to find another home. Even though these organisms are at risk, there are other organisms that might move into the stream area that are more adapted to drought-type conditions, such as mice, gophers, or maybe earthworms.

Relationships Among Living Things

Goals

1. Explain how ecologists organize living systems.
2. Describe relationships among living things.
3. Identify and understand the following vocabulary:

   population

   community

   limiting factor

   niche

   habitat

Imagine trying to study all of the living things on Earth at once! How hard would that be? When ecologists study living things, they don't start by studying the biggest ecosystem possible, which we know as the biosphere. They begin by studying smaller parts of the biosphere. In order to study smaller parts, ecologists need to organize living things into groups and then study how the members of a group interact with each other and their environment.

Look at the fish in the picture. This particular fish species lives in a coral reef. All of these fish that live in this coral reef make up a population.

A population is a group of the same type of organism living in the same place at the same time. Other examples of populations that might live in that same reef might be a sponge population, an algae population, or a shark population.

The next group that ecologists might study is how all of these populations interact together. All the populations that live in a particular area make up a community. The members of a community depend on each other for food, shelter, and other needs. For example, a shark depends on the fish population for food. On the other hand, the fish depend on the coral animals to build the reef that the fish use for shelter and protection from the sharks.

Can the fish population and the shark population on the coral reef grow larger and larger forever? No, there would not be enough food, space, and other resources to go around. The things that limit the size of a population, such as rainfall or food, are called limiting factors. Think back to the stream. One biotic limiting factor might be the mosquito population. How would this be a limiting factor? Ask the frogs! Frogs eat mosquitoes. If there was a lack of rainfall in the area, the mosquito population would decrease. There wouldn't be enough food for the frogs and their population numbers would also decrease.

Interactions in Communities

Are frogs the only organisms in the stream that eat mosquitoes? No. This is a good example of competition for resources. Some birds and spiders also eat mosquitoes, so the frogs are competing with them for food.

Imagine a large bowl of M&Ms in your classroom. As long as there is enough to go around, you don't have to worry about getting your share. But if the bowl were just a small bag, then you would be competing with your classmates to be in the front to get your share. The greater the population size of an area, the greater the competition for resources, such as food. Food isn't the only resource that organisms will compete for. Anything that limits the size of a population can be a resource organisms will compete for. Other examples of resources are space, water, sunlight, and shelter.

When talking about food as a resource, we have to talk about the feeding relationship between organisms. It is either eat or be eaten. Predation is the act of one organism feeding on another. The predator is the one eating, and the prey is the one being eaten.

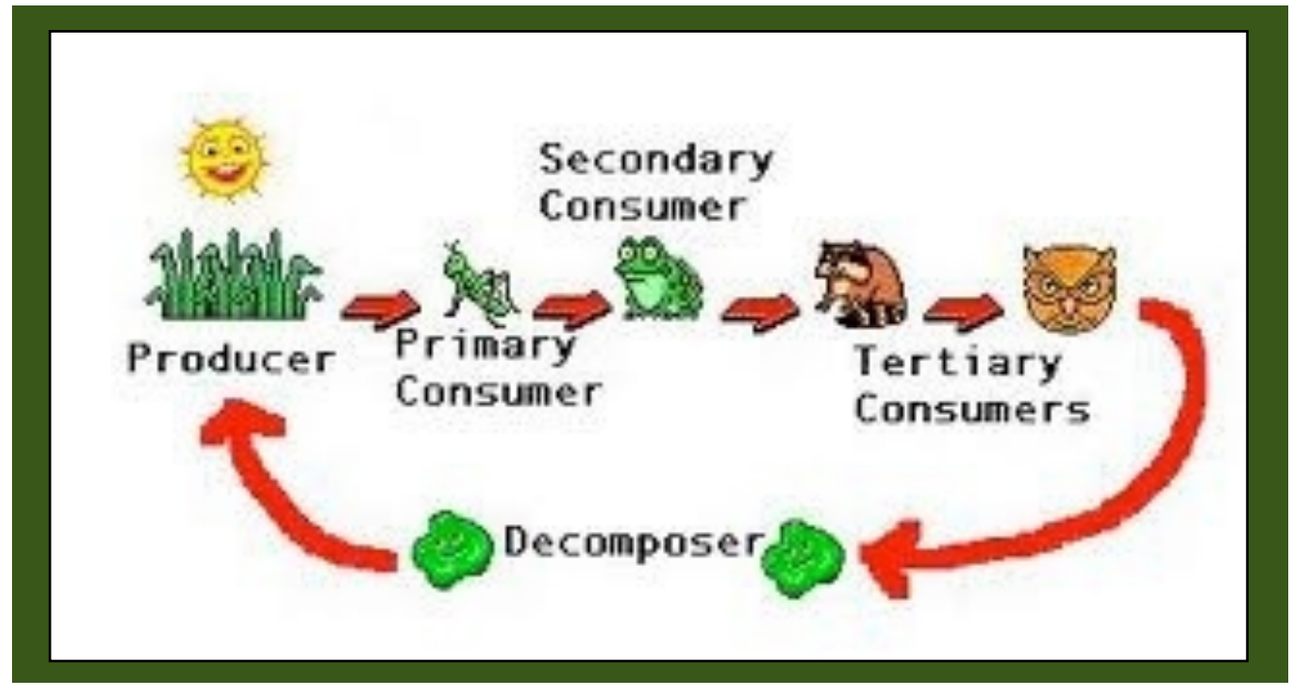
Organisms can live together and not necessarily be food for each other. There are different types of relationships among organisms. In the first type of relationship, both organisms benefit from the relationship. The African tickbird, for example, gets its food by eating insects off the skin of zebras. The tickbird gets food, while the zebra gets rid of harmful insects. In another type of relationship, only one organism benefits. The other organism doesn't benefit, but it is not harmed either. A bird building a nest in a tree is a good example. The bird benefits from the tree by getting protection. The bird and nest neither benefit or harm the tree. In the last type of relationship, one organism benefits while the other organism is harmed. The insects on the zebra's skin benefit from the zebra by getting nutrition. The zebra, however, can be harmed by the insects by getting sick.

With all of these competitions for resources and community interactions, how does an ecosystem survive? It's possible because each type of organism has a different role to play in the ecosystem. For example, let's look at an aquarium. A typical aquarium might have snails, fish, algae, and bacteria. The role of the snails is to feed on algae. The glass of the aquarium can become clouded by the growth of too much algae. Snails eat the algae that helps keep the glass clear for the light to get in. The role of the algae is not only to provide food for the snails and fish, but they also provide oxygen for the aquarium system through photosynthesis The role of an organism in an ecosystem is called the organism's niche. The place where an organism lives is called its habitat.

Energy and Trophic Levels

Goals

1. Explain how energy flows through an ecosystem.
2. Identify and describe the different trophic levels of the energy pyramid.
3. Compare and contrast food chains and food webs.



It's all about food! Think about the interactions that we've discussed so far. The frog and the mosquito, African tickbird and zebra - most of the interactions involve food. Energy moves through an ecosystem in the form of food. Let's see how!

Let's look at the three main groups: producers, consumers, and decomposer. Producers are organisms that make their own food, such as plants. Consumers eat other organisms. Decomposers, such as fungi and bacteria, use dead organisms and the waste material of other organisms for food.

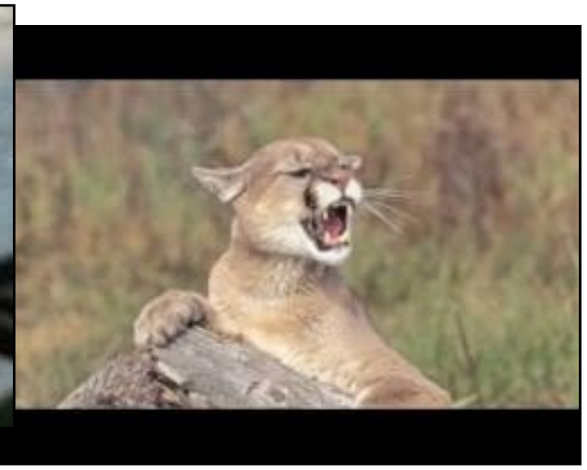
Let's take it a step further and break down the consumers into more detailed categories. Let's start with primary consumers.

Primary consumers, also known as herbivores, eat only plants or parts of plants. You can see examples in the pictures below.

Next in line are the secondary consumers. Secondary consumers, also known as carnivores, eat herbivores.

Omnivores are both primary and secondary consumers which means they eat both plants and animals.

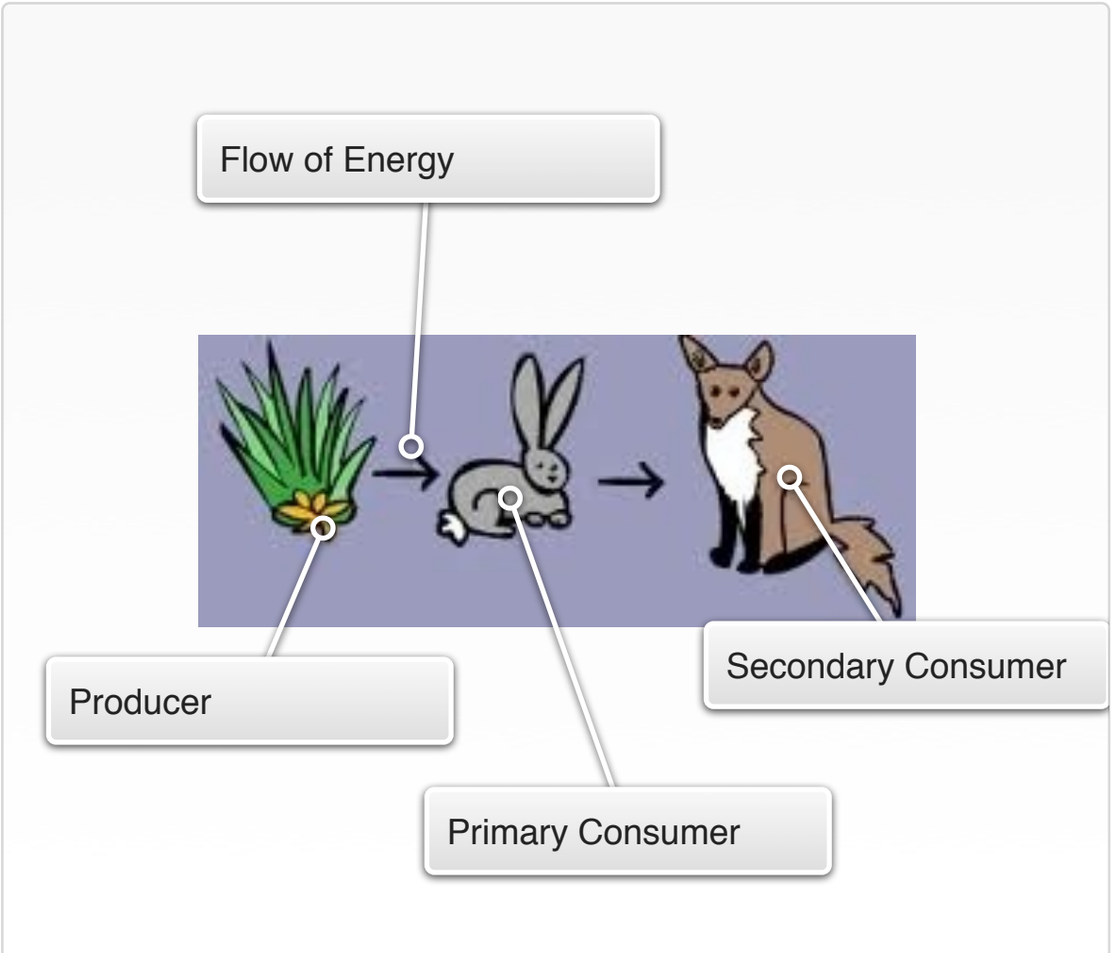
Tertiary consumers are carnivores that eat other carnivores.



Apex predators are at the top of the food chain and have no predators.

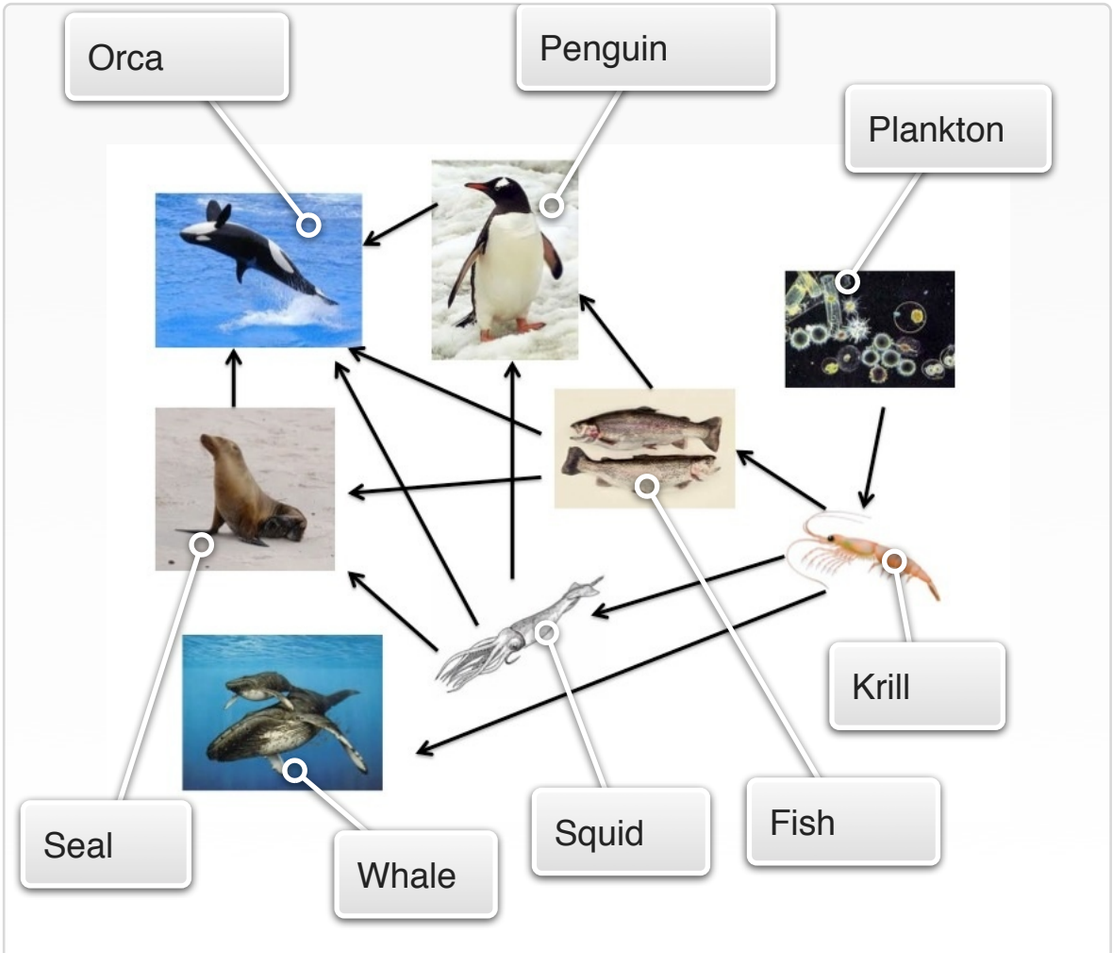
How do we model the flow of energy through an ecosystem? The diagram below represents a simple food chain. A simple food chain shows one possible feeding relationship. Click on the labels to follow the food chain.

Interactive 1.1 Simple Food Chain



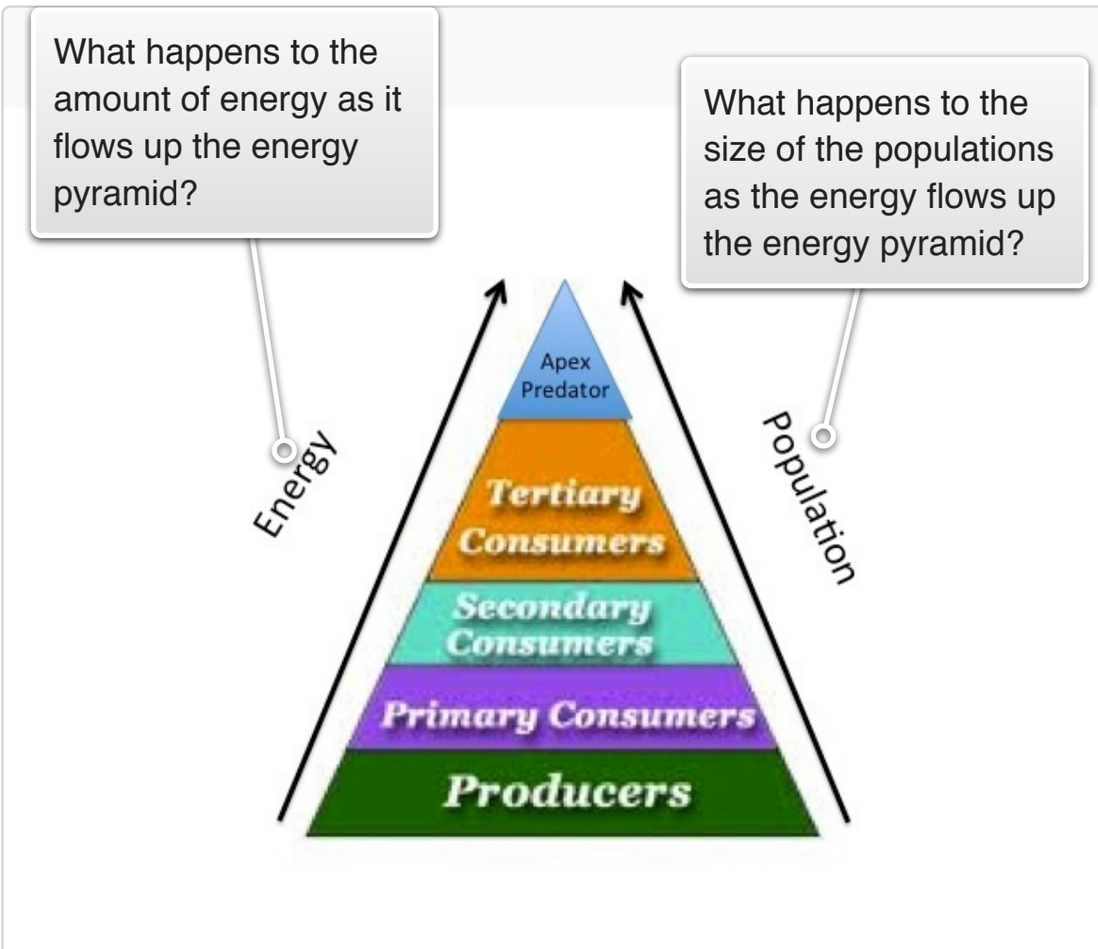
Ecosystems have many food chains that overlap. A series of overlapping food chains that show all the possible feeding relationships in an ecosystem is called a food web. Look at the food web on the following page. See if you can identify the producers, primary consumers, secondary consumers, tertiary consumers, and apex predators.

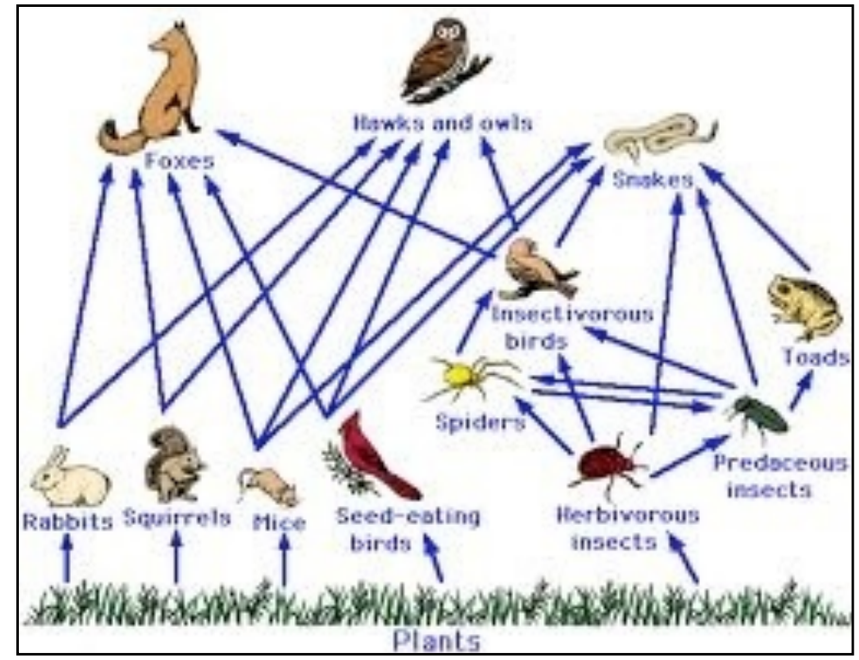
Interactive 1.2 Food Web



As you can see, there are many complex interactions in the feeding relationships in ecosystems. All of these interactions can best be modeled in an energy pyramid. The levels of the pyramid represent the types of organisms present in any ecosystem, and scientists refer to these levels as the trophic levels. The diagram below shows the energy pyramid with the different trophic levels.

Interactive 1.3 Energy Pyramid



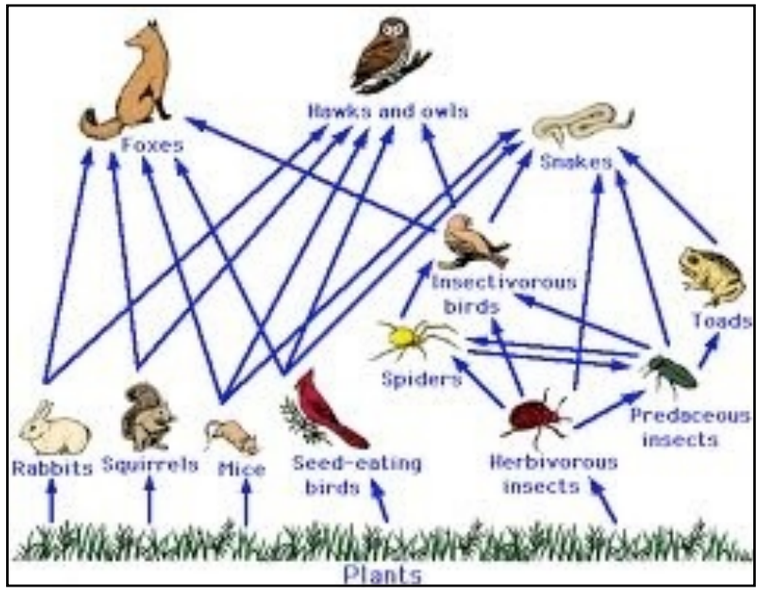


Review 1.1

In the food web above, who is getting energy from the seed-eating birds?

- **A.** foxes
- **B.** hawks and owls
- **C.** snakes
- ✓ **D.** all of the above

Check Answer

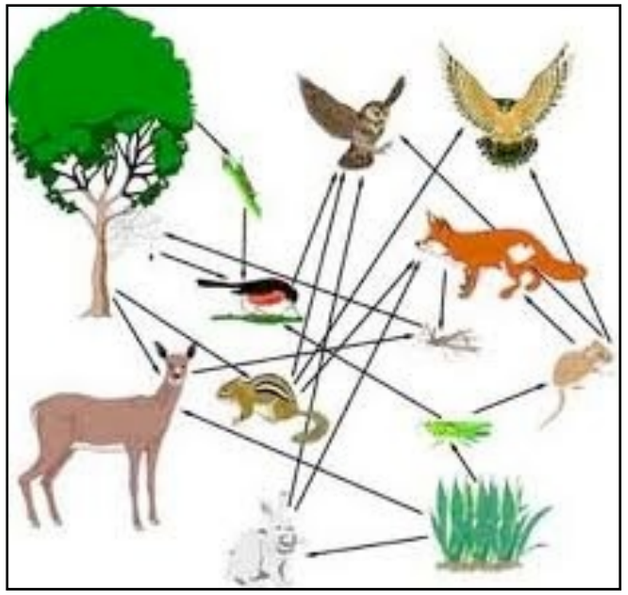


Review 1.2

Which organism completes this food chain: plants, herbivorous insects, _____, insectivorous birds, hawks and owls?

- **A.** mice
- **B.** toads
- ✓ **C.** spiders
- **D.** none of the above

Check Answer

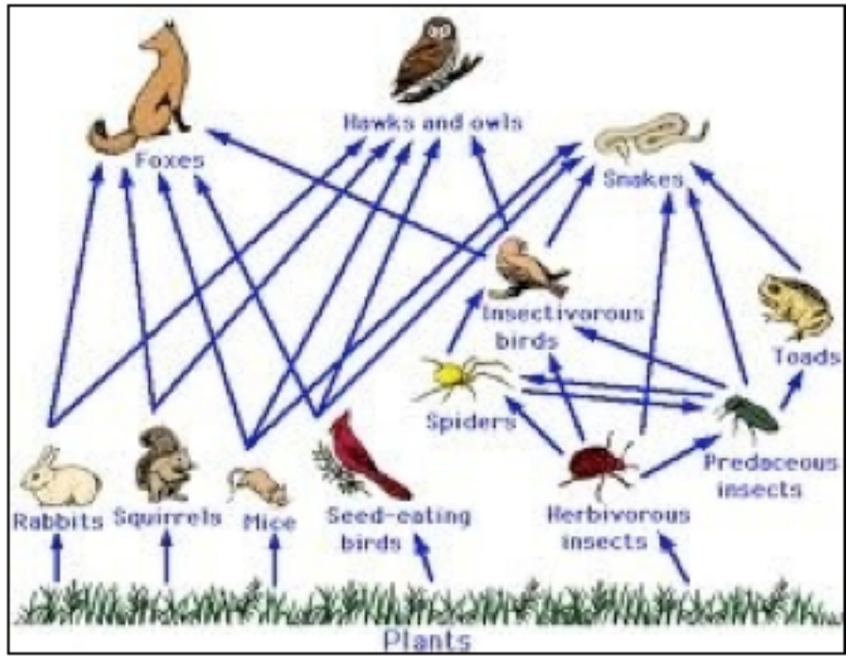


Review 1.3

Which organism completes this food chain: plants, grasshopper, _____, owl?

- **A.** fox
- ✓ **B.** bird
- **C.** squirrel
- **D.** none of the above

Check Answer


Foxes
Hawks and owls
Snakes
Insectivorous birds
Toads
Spiders
Predaceous insects
Rabbits
Squirrels
Mice
Seed-eating birds
Herbivorous insects
Plants

Biomes

Goals

1. Identify a variety of biomes.
2. Describe biodiversity.

Biomes are groups of ecosystems that share similar types of weather, soil, and organisms.

The following pages will describe the major biomes on Earth.

Desert Biome:

areas that receive extremely low amounts of precipitation

Marine Biome:

includes all bodies of water that are salty

Prairie / Grassland Biome:

lands dominated by grasses rather than large shrubs or trees

Deciduous Forest:

forests where majority of the trees lose their foliage at the end of the typical growing season

Coniferous Forest:

area of wooded land predominately made up of cone-bearing trees

Rainforest:

characterized by high rainfall; 40-75% of all species live here

Tundra:

near the North Pole; trees do not grow here; winters are very cold and summers last a very short time; under the soil, the Earth is frozen and never melts

Taiga:

the taiga is the largest biome; winters are cold, summers are warm; lots of conifers grow here

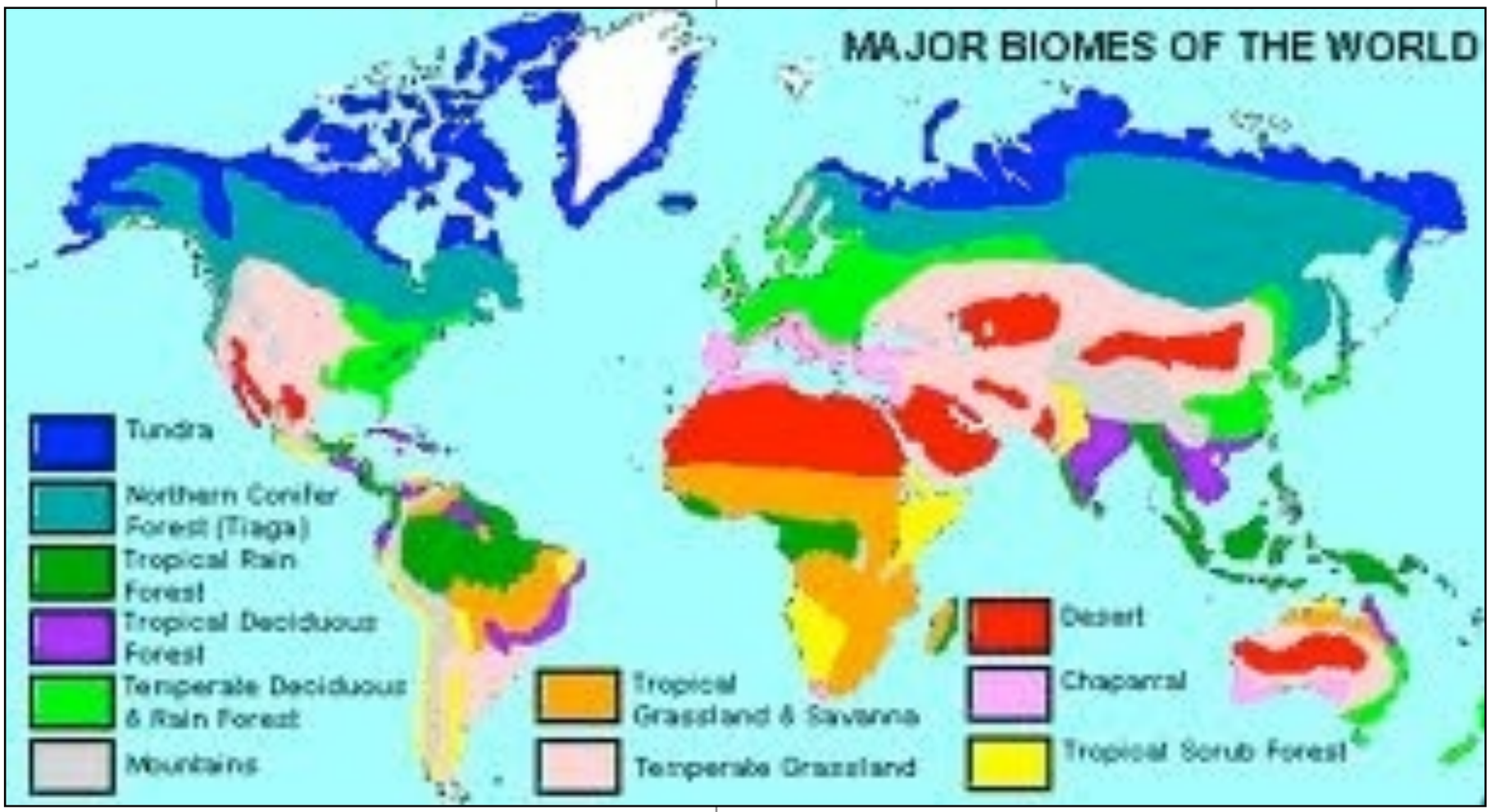
So, how is the biome determined? Biomes are large geographic areas described by specific characteristics. It is these characteristics that determine the diversity of organisms living there. An example might be the tundra. With such drastic climate conditions, the numbers of organisms living there are competing for little food and resources available to them. Would you see bears there? Probably, but would you see a wide variety of bears? No. The conditions of the climate do not allow for a diverse species of bears to survive there. But what about the taiga? Would you see bears there?

Yes, and probably a wide variety of species as well since there is plenty of resources available to support them.

The diversity of the organisms determines the health and stability of the biome. An indicator of the condition of the biome is the biodiversity. The biodiversity is the variety of organisms that live in a biome. If a biome has a high biodiversity, meaning there is a diverse amount organisms living there, then the biome is most likely healthy and stable. If it has a high biodiversity, then it could also mean there are plenty of resources for the organisms living there.

Is any biome ever perfect all the time? No. Change in biomes is inevitable, but if the biome has good biodiversity, then it helps to ensure that the biome can survive whatever change comes its way.

On the next two pages, you'll see a biomes of the world map and how different the world really is.


MAJOR BIOMES OF THE WORLD
Tundra
Northern Conifer Forest (Tiaga)
Tropical Rain Forest
Tropical Deciduous Forest
Temperate Deciduous & Rain Forest
Mountains
Tropical Grassland & Savanna
Temperate Grassland
Desert
Chaparral
Tropical Scrub Forest

Cycles in the Ecosystem

Goals

1. Identify and describe: atmosphere, hydrosphere, biosphere, and geosphere.
2. Explain the processes and importance of the carbon cycle, nitrogen cycle, and water cycle.

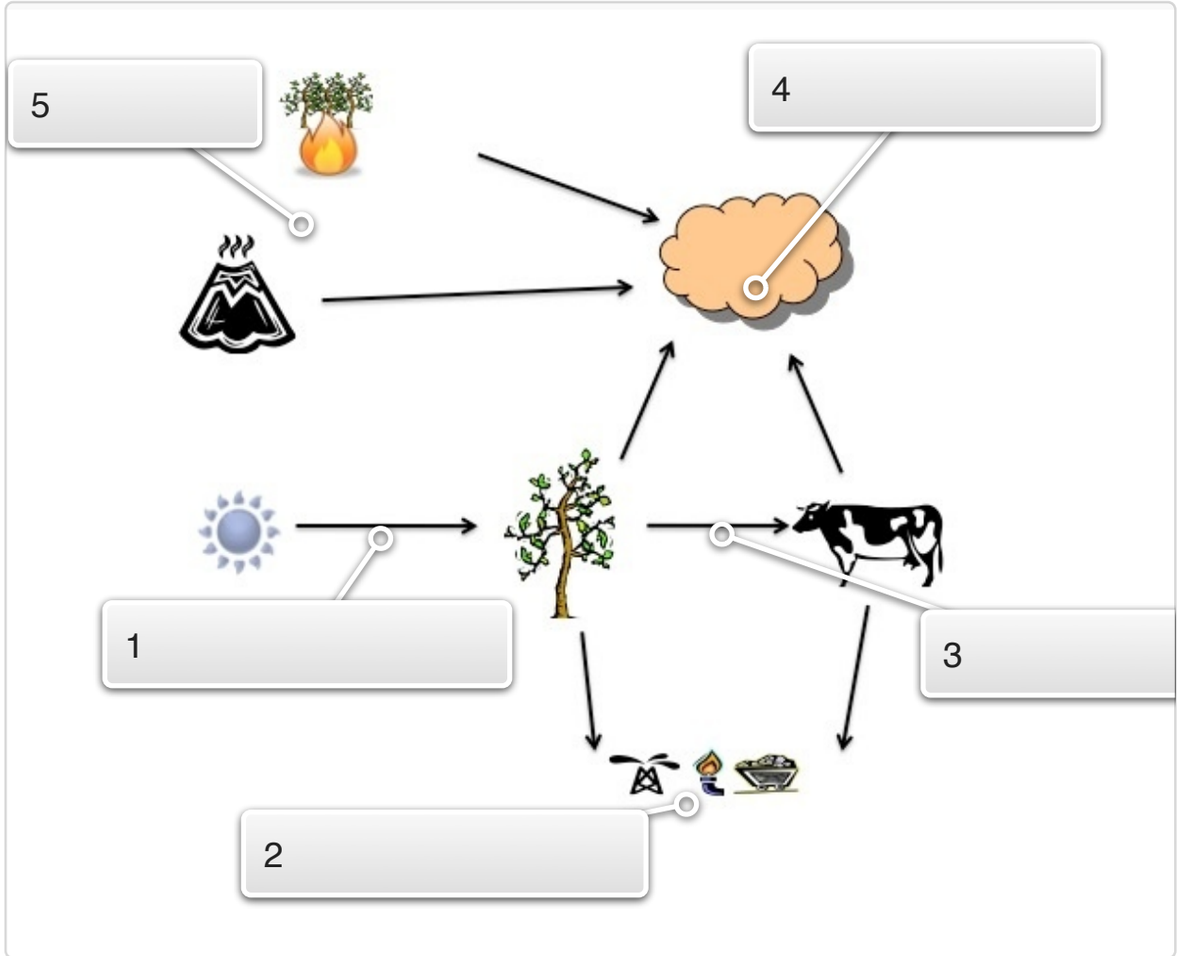
What happens when you recycle a soda can? The can is taken to a processing plant and melted so that the aluminum can be used again. This is an example of a simple cycle. The same aluminum can be used over and over again.

Cycles are important to ecosystems. Instead of aluminum cans, however, its the materials that make up organisms that get recycled in an ecosystem. Before we talk about the cycles, let's look at the parts of the Earth involved in cycles.

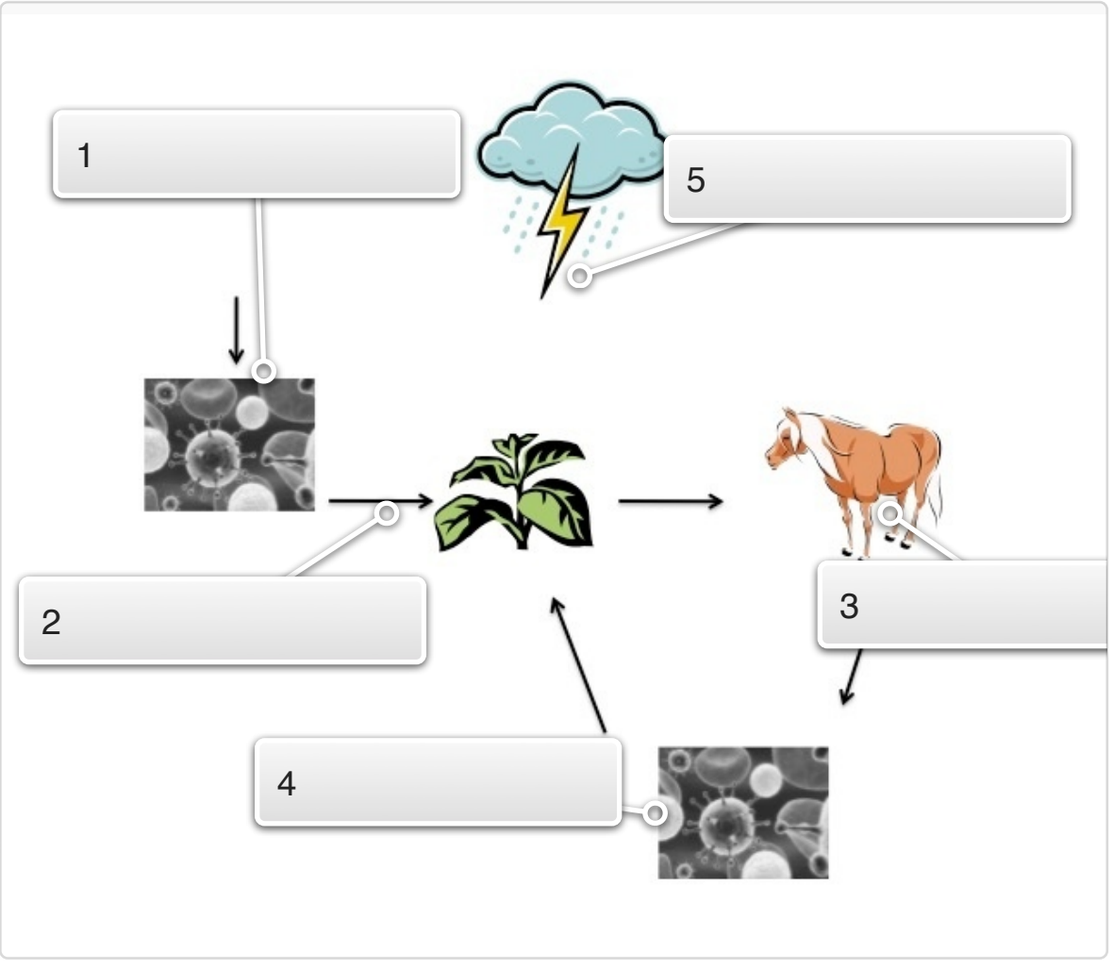
The atmosphere is the layer of gases surrounding the planet. The hydrosphere is all of the Earth's water from lakes, streams, oceans, rivers, etc. The biosphere, we already know, is any place on Earth an organism can live. The geosphere is the portion of the Earth system that includes Earth's interior, rocks and minerals,

landforms, and the processes that shape the Earth's surface. So, let's see how these spheres are related to the different cycles of the ecosystem.

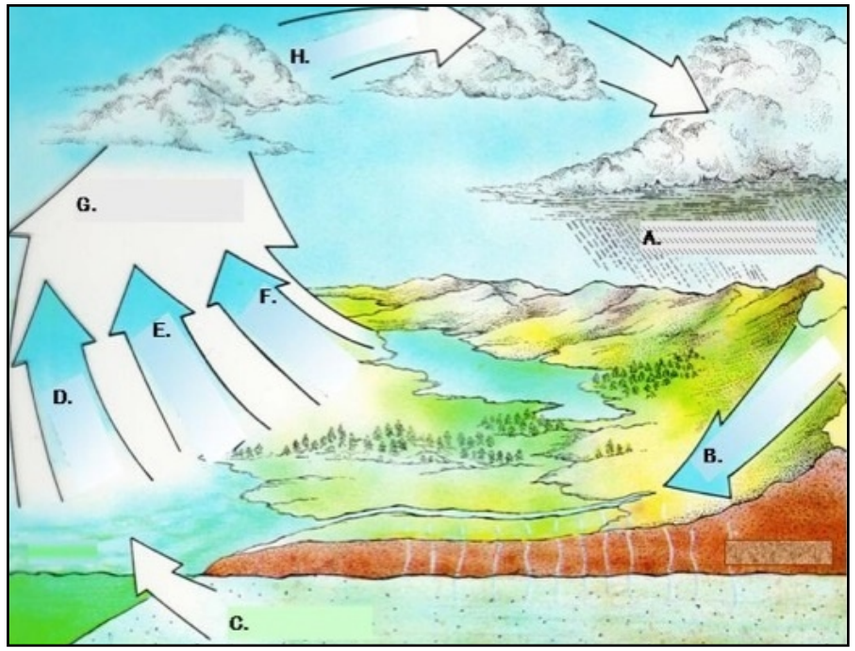
Interactive 1.4 Carbon Cycle



Interactive 1.5 Nitrogen Cycle



Water Cycle



Let's begin with evaporation (G). When water evaporates, it becomes water vapor and rises. As it rises, it cools and becomes water droplets to form clouds in a process called condensation (H). When the clouds become too dense, precipitation (A) comes back to the Earth as rain, sleet, snow, or hail. Precipitation will runoff (B) and can become groundwater (C) that will eventually make its way back to oceans. It can also runoff to lakes and streams (F) and plants and soils (E) where it can also make its way back to oceans. It can also runoff directly into oceans. No matter where it runs off, it will all eventually begin the evaporation process again starting the water cycle again.

Review

Review 1.4

Human activities often reduce the number of animals in an area. Which human activity might increase the number of rabbits in an area?

- **A.** building houses and roads that destroy the rabbits' habitat
- **B.** growing crops that rabbits do not eat
- **C.** using toxic chemicals on plants that rabbits eat
- ✓ **D.** killing predators that hunt and kill rabbits

Check Answer

Review 1.5

Which of the following examples shows a biotic factor interacting with an abiotic factor?

- **A.** fish eating smaller fish for food
- **B.** deer walking on the grass
- **C.** bird using a tree to build a nest
- ✓ **D.** bird flying through the air

Check Answer

Review 1.6

In which ecosystem would you expect animals to be able to obtain the most nitrogen?

- **A.** ecosystem with soil that contains many decomposers and few plants
- **B.** ecosystem with soil that contains few decomposers and many plants
- ✓ **C.** ecosystem with soil that contains many decomposers and plants
- **D.** ecosystem with soil that contains many decomposers, but no plants

Check Answer

Review 1.7

As agriculture in Oklahoma has grown over the past 100 years, populations of black-tailed prairie dogs have decreased. What affect does this have upon the producers eaten by the black-tailed prairie dogs?

- **A.** there would not be an effect on the producers
- **B.** the producers would decrease in numbers
- ✓ **C.** the producers would increase in numbers
- **D.** the producers would produce fewer leaves

Check Answer