UNIT 4

Diversity of Life

Sable Island lies 300 km off Nova Scotia's east coast. While it is best known for its herd of wild horses, it is home to many more living things. Over 175 kinds of plants, 330 kinds of birds, and more than 600 small organisms, including beetles, moths, worms, and even a species of freshwater sponge, call Sable Island home. That is a lot of life packed into a tiny island only 45 km long and 1.5 km wide!

From the wind-battered sand dunes of Sable Island to the mudflats of the Bay of Fundy to the rocky seashore of Northumberland Strait, Nova Scotia has a wide range of habitats for living things. Each of these regions has its own geography, climate, plants, and animals. Even within Sable Island, there is a variety of habitats. Sand dunes, fields of grass, freshwater ponds, and the seashore all provide food and shelter to living things.

The horses that live on Sable Island would be able to survive in different parts of Nova Scotia or elsewhere in southern Canada, but a tiny snail that lives in one of the ponds on the island would not be able to survive if it was moved to a tidal pool, just metres away.

Living things are adapted to the environment in which they live. This unit will introduce you to the variety, or diversity, of living things and the places in which they live. You will learn how and why scientists classify living things to help us understand the natural world. You will also explore how living things are able to survive in a particular environment.

Unit Contents

Getting Ready...

- A rose, a mushroom, and a wolf have some similar characteristics. Can you list what they are? Can you list the characteristics that make them different?
- How does a seaweed growing on the seashore survive both the hot, damp days of summer and the cold, dry days of winter?
- What tools could you use to learn more about living things in the world around you?

CHAPTER 7

Classifying Living

Getting Ready...

- How is a daisy different from a dragonfly? How are they similar?
- How could you describe a turtle to another student so that she would know exactly what type of turtle you are talking about?
- Librarians sort books by topic. How do biologists sort living things?

Figure 7.1 Scientists monitor the organisms and natural resources within Kejimkujik National Park, in southwestern Nova Scotia, in order to collect and record information about the organisms and their environment.

Kejimkujik National Park, in Nova Scotia, is home to thousands of organisms, such as birds, insects, ferns, fungi, and aquatic life. The park has a mixture of tree types, including pine, maple, and spruce, in its forests. Scientists monitor forest plots in the park year after year. They listen for bird calls, catch insects, monitor air quality and pollution, and record the type of plants found growing there.

How do scientists organize and classify (group) all of the kinds of organisms (living things) on Earth? How do they identify new types of organisms that they have not seen before? This is what you will be learning about in this chapter.

Have you ever seen an organism like the one shown on the opposite page? Do you think it is a plant or an animal? How would you decide if it was a plant or an animal? Plants and animals are two of the six major groups of organisms that biologists refer to when they classify living things. You will learn about these groups in this chapter.

Things

What You Will Learn

In this chapter, you will learn

- the system that scientists use to sort and classify living things
- the characteristics of six major classifications of living things
- similarities and differences between groups of animals, such as amphibians, reptiles, and fish

Why It Is Important

- All organisms are grouped because they share certain characteristics. In order to identify organisms, you should know what makes them similar to, and different from, other organisms.
- By learning how organisms are sorted and grouped, you are better able to find out more information about organisms.
- Classification is a way to organize information.

Skills You Will Use

In this chapter, you will

- classify organisms into groups using their internal (inside) and external (outside) features
- use a classification key to identify and classify an organism
- use variables to test the best conditions for the growth of mould
- use a microscope to observe and classify organisms that live in pond water

Is this organism a plant or an animal? How do you know?

Starting Point ACTIVITY 7–A

What Am I?



Humpback whales, oyster mushrooms, and *Streptococcus*, the bacteria that cause strep throat, are all living things. They have many obvious differences, but they have many things in common as well. What features would you use to classify a group of organisms?

What to Do

1. Your teacher will supply cards showing living things. Place the cards face down.
2. With a partner, turn two cards face up. Discuss how things in the pictures are similar and how they are different. If you had to use one word to describe a broad category in which to put each organism, what would it be? (e.g., plant, animal, etc.)
3. Repeat step 2 until you have turned up all of the cards.
4. Divide your cards into groups based on your broad categories. (The cards may not be divided equally.)

What to Do

1. Compare your categories with those of other students. How did the system you used to group the organisms differ from that of other students in your class?
2. What feature(s) did you use to sort the organisms into their groups?

Section 7.1 Grouping Living Things

Key Terms

- classification systems
- kingdom
- species

When you go into a grocery store, do you find lettuce, bread, and milk in the same section? Most grocery stores group similar types of foods together. You will probably find milk, yogurt, and cheese in the dairy department while lettuce, tomatoes, and apples are in the produce department. When you group similar items together, you are classifying them. To *classify* means to group objects, information, or even ideas based on the similarities they share. You use different **classification systems** (ways of grouping things) in your everyday life. For example, when you visit a library, a bookstore, or a department store, objects that are similar in some way are grouped together.

There are several reasons for using classification systems. One reason is to put items in order so that you can find them. Librarians, for example, use a classification system to organize and label the thousands of books in a library. How hard would it be to find a book in a library if books were not organized in some way?

Scientists also use classification systems. Scientists who study life (biologists) show how types of organisms are similar by grouping them. Over 1.5 million types of organisms have been classified to date, and millions more have not yet been identified. Grouping them is a way of organizing the information about all living things in one system. How would you classify the organisms in the tidal pool in Figure 7.2?

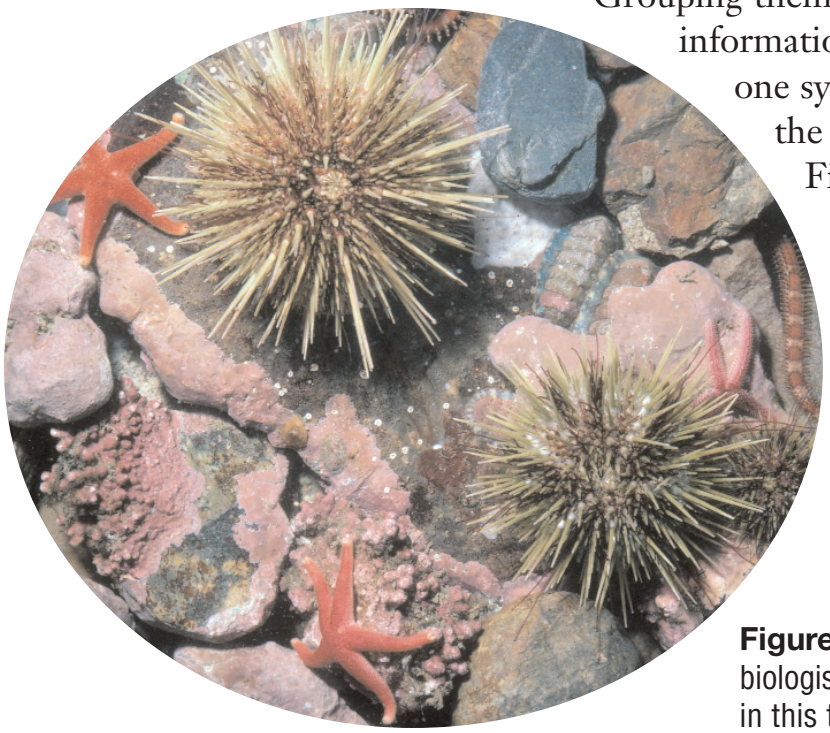


Figure 7.2 Classification systems help biologists organize and identify the organisms in this tidal pool.

How Are Organisms Classified?

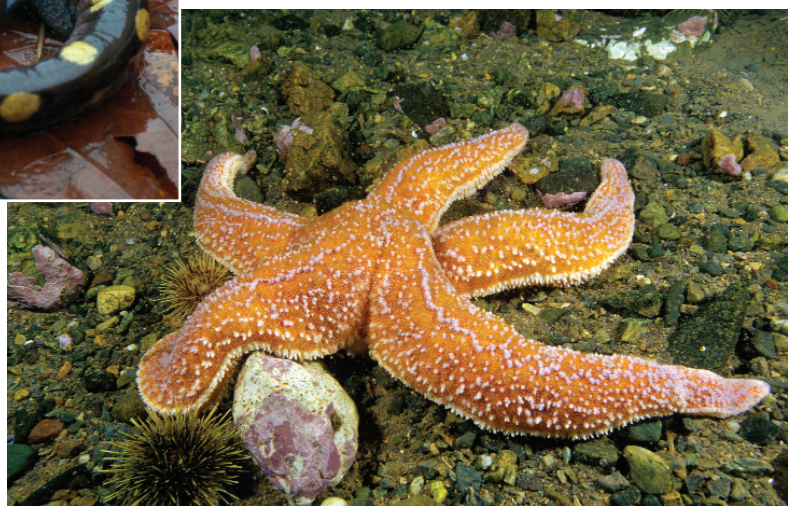
Throughout history, scientists have classified living things in different ways. At first, they used only two categories: plants and animals. As our understanding of the living world increased, these categories changed. One technology that helped increase our understanding was the microscope. A microscope is a tool that magnifies objects (makes them look larger). Microscopes allowed scientists to see organisms made up of a single cell, the basic unit of life. Additional categories were needed to classify these organisms. Today, scientists divide all living things into six large groups, called kingdoms.

Kingdom is the most general grouping of organisms. Organisms within the kingdom category can be divided into smaller and smaller groups. Each kingdom is divided into two or more phyla (singular, *phylum*). All members of a phylum share one or more important characteristics or structures. For example, the sea star and the salamander in Figure 7.3 are both in the animal kingdom. However, salamanders have a backbone, but sea stars do not. All animals with backbones are classified in the same phylum. The sea star and other animals without backbones belong to other phyla within the animal kingdom.

DidYouKnow?

In the 1670s, a Dutch scientist named Antony van Leeuwenhoek made a simple, handheld microscope to magnify samples of blood and pond water. He was able to observe single-celled organisms that no one knew existed. These organisms did not fit into either the plant or animal kingdoms.

Yellow-spotted salamander (a member of phylum Chordata)



Sea star (a member of phylum Echinodermata)

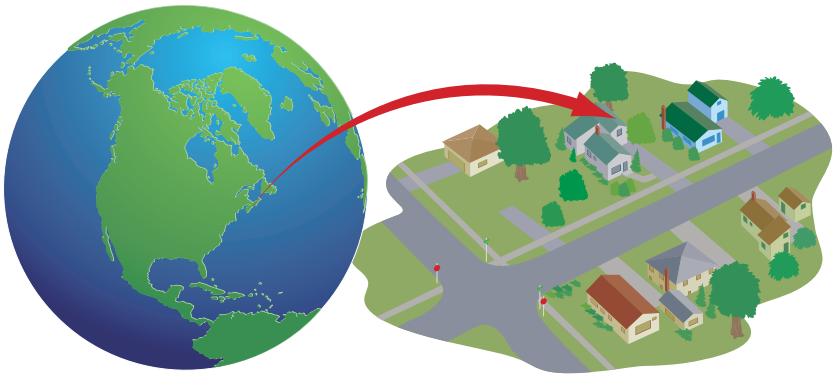
Figure 7.3 Both of these organisms in the same kingdom, but are in different phyla.

READING Check

Look up the words "generic" and "specific" in a dictionary. How are they related to the words "genus" and "species" that are used in scientific classification?

Following the category phylum, organisms are divided into levels of organization called *classes*, *orders*, *families*, *genera* (singular, *genus*), and *species* (singular, also *species*). As you go down the levels, the types of organisms in each level are more and more alike. At the bottom of the series, a genus is a group of organisms that share many similar characteristics. A **species** is the most specific level of classification for an organism. Organisms belonging to the same species can mate to produce healthy young that can also reproduce successfully.

You can compare the scientific classification system to a system that you might use to classify or explain where you live as shown in Figure 7.4.

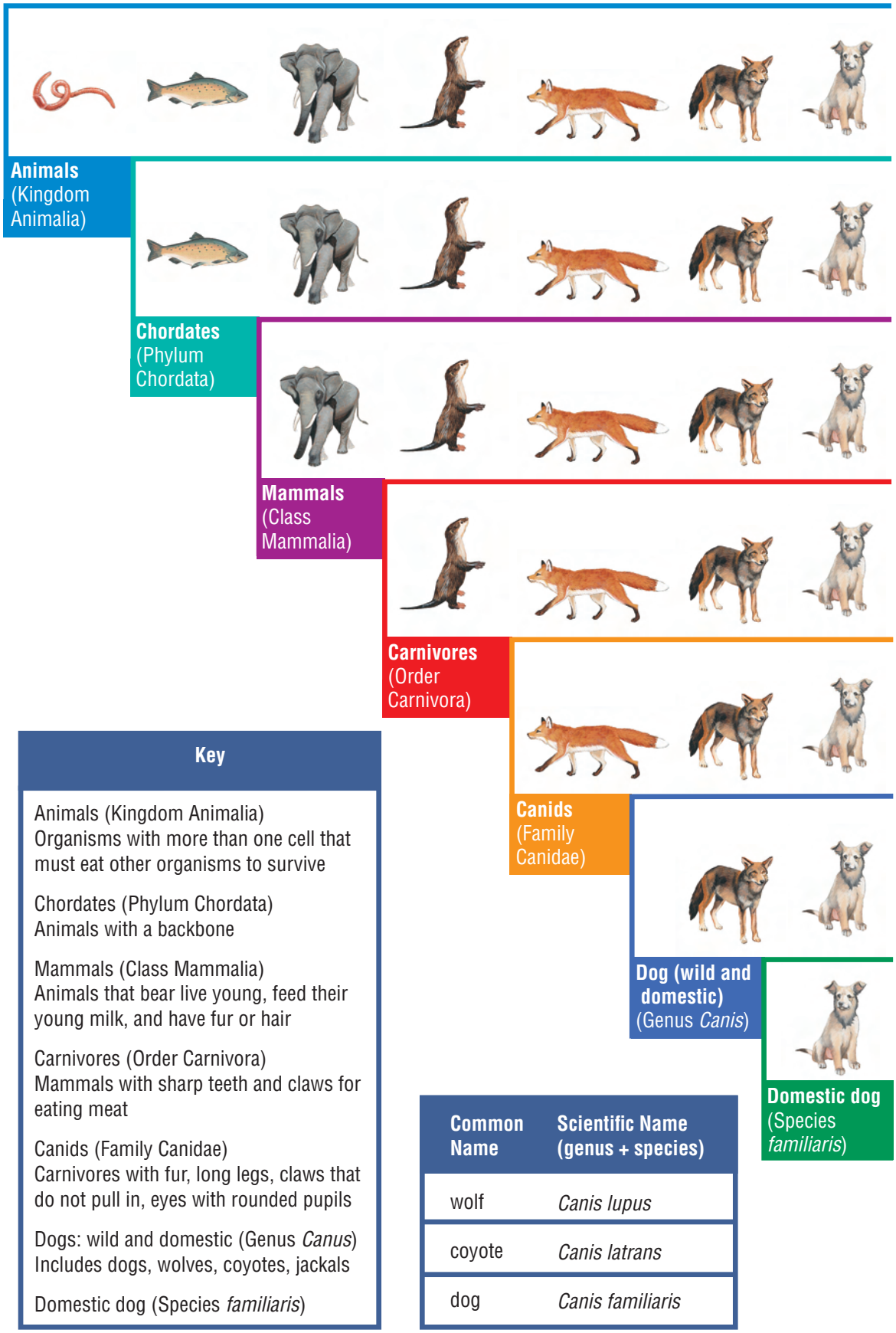


Categories for Classification

Addresses	Organisms
Continent	Kingdom
Country	Phylum
Province	Class
Town	Order
Neighbourhood	Family
Street	Genus
House Number	Species

Figure 7.4 Information about where you live can be broken down into categories that progress from general to specific. This is similar to the way organisms are divided in the scientific classification system.

Each level of classification becomes more specific. The example in Figure 7.5 shows how dogs are classified using the seven-level scientific classification system. Some of the words used in this system may seem strange, because they are from an old language called Latin. At one time, most scientists wrote in Latin, and this tradition continues with classifying and naming organisms.



Key

Animals (Kingdom Animalia)
Organisms with more than one cell that must eat other organisms to survive

Chordates (Phylum Chordata)
Animals with a backbone

Mammals (Class Mammalia)
Animals that bear live young, feed their young milk, and have fur or hair

Carnivores (Order Carnivora)
Mammals with sharp teeth and claws for eating meat

Canids (Family Canidae)
Carnivores with fur, long legs, claws that do not pull in, eyes with rounded pupils

Dogs: wild and domestic (Genus *Canus*)
Includes dogs, wolves, coyotes, jackals

Domestic dog (Species *familiaris*)

Common Name	Scientific Name (genus + species)
wolf	*Canis lupus*
coyote	*Canis latrans*
dog	*Canis familiaris*

Figure 7.5 Classification key for dogs

Pause & Reflect

Think of all of the people you know with the same first name. For example, how many people named John do you know? How does using a system in which every person has at least two names help you distinguish one person from another?

Two-Part Scientific Names

Scientists use a two-part scientific name to identify different organisms. The first part of an organism's scientific name is its genus, and the second is its species. If you look at the classification for dogs on the previous page, you can see that the scientific name for a pet dog is *Canis familiaris*. The scientific name for humans is *Homo sapiens*. *Homo* is the genus for humans, and *sapiens* is the species.

No two types of organisms can have the same scientific name. For example, the wolf in Figure 7.6(A) has the scientific name *Canis lupus*, and the coyote in Figure 7.6(B) has the scientific name *Canis latrans*. The wolf and the coyote (and dogs) are similar enough to be in the same genus, *Canis*, but they are separate species because wolves do not tend to mate with coyotes.

When people talk about an organism in everyday speech, they rarely use its scientific name. Instead, they use its common name. This can be confusing, since several different common names may refer to the same organism, or a single common name may describe more than one organism in different parts of the world. "Mayflower" is a common name for Nova Scotia's provincial flower, *Epigaea repens* (Figure 7.7, on the next page), but the mayflower has another common name, which is trailing arbutus. As well, a European plant called the midland hawthorn (*Crataegus laevigata*) is also known by the common name mayflower.

Scientists around the world use the scientific name and know that they are all looking at or discussing the same species. This means that they can also share information about this species.

A Wolf

B Coyote

Figure 7.6 Both of these organisms are in the same kingdom, phylum, class, order, family, and genus, but they are different species.

Tools for Identifying Organisms

What would you do if you were asked to identify the plant shown in Figure 7.7? You could ask someone who knows a lot about plants, or you could use a plant field guide to help you find the plant's common names as well as its scientific name. Field guides have pictures and descriptions that enable you to identify living things. There are also field guides for non-living things such as rocks. Field guides often contain classification keys that give step-by-step instructions to help you to identify organisms. Try to use a classification key, and then make your own, in Find Out Activities 7-B and 7-C.

Figure 7.7 Mayflower is a common name of Nova Scotia's provincial flower. Its scientific name is *Epigaea repens*.

Find Out **ACTIVITY 7–B**

Identifying Canadian Cats

You can use classification keys to identify organisms. Try this activity to see how it's done.

Classification Key to Cats of North America

1. Tail length:
   - **(a)** short, go to 2
   - **(b)** long, go to 3
2. Ear tufts:
   - **(a)** long ear tufts tipped with black; lynx, *Lynx canadensis*
   - **(b)** short ear tufts; bobcat, *Lynx rufus*
3. Coat:
   - **(a)** plain coloured, go to 4 (a)
   - **(b)** patterned, go to 4 (b)
4. Coat colour:
   - **(a)** yellowish to tan on back; white to beige on belly; cougar, *Puma concolor*
   - **(b)** all brown or black; jaguarundi, *Herpailurus yaguarondi*

What to Do

1. Start at step 1. Choose either (a) or (b) to find either the scientific name of a species or directions to go to the next step.

What Did You Find Out?

1. What are the scientific names of the two cats?
2. Is it important to begin with the first step instead of in the middle of a classification key?

Now that you've used a classification key, try to make your own in the next Find Out Activity.

Find Out ACTIVITY 7–C

Create Your Own Classification Key

Classification keys are also called dichotomous keys. *Dicho* means "split in two". In every step, you have two choices.

What You Need

a collection of tree leaves and needles
a large sheet of paper
ruler

What to Do

Group Work

1. Cover your work area with a large sheet of paper and copy the following table onto the sheet. Leave lots of room to write in each space in your chart.

My Collection

A				B			
C		D		E		F	
G	H	I	J	K	L	M	N

2. With a partner, decide how to divide the collection of objects into two groups: A and B. All of the items must belong in either group. For example, your collection might be divided into needles and leaves. If this is how you divided the items, your divisions would be:
   A = Needles
   B = Leaves
3. Record your reasons for grouping the items on your chart and place the items where they belong on the chart.
4. After you have divided the collection into two groups, divide group A into two more groups. For example, if group A contains needles, group C might contain needles in bundles of two and group D might contain needles in bundles of more than two.
5. Divide group B into two more groups.
6. Continue to divide the groups until each item has its own place on the chart. Make up a two-part name for each item based on the bottom two levels.
7. When you have completed your chart, put the items back into a pile and ask a classmate to use your chart to classify them.

What Did You Find Out?

1. Is it possible to create more than one dichotomous key for classifying and identifying the same group of objects? Explain your answer.
2. When two people use the same dichotomous key to identify the same object, is it possible for each of them to have different final answers?
3. Are classification tools such as dichotomous keys useful? Explain.

Section 7.1 Summary

We use different classification systems to sort and organize many things, including books in a library or items in a grocery store. In science, organisms are sorted according to similar characteristics.

- Different types of organisms are sorted by kingdom, phylum, class, order, family, genus, and species. Kingdom is the broadest category, and species is the most specific.
- All organisms have a two-part scientific name that includes both their genus and their species names.
- No two types of organisms share the same genus and species names. Each type of organism is a species. Several types of organisms can share the same genus name.
- You can identify organisms using classification keys.

Check Your Understanding

1. What is the largest category in the classification system? What is the smallest?
2. What kinds of information do scientists use to classify organisms?
3. Scientific names have two parts. Explain why.
4. **(a)** What is a dichotomous key?
   (b) Is it useful? Explain. Give an example.
   (c) Does it matter if all dichotomous keys for the same group of organisms are different? Explain.
   (d) Does it matter if all classification systems for the same group of organisms are different? Explain.
5. **(a)** What is a field guide?
   (b) How is it used?
6. Create a classification system to do *one* of the following:
   (a) organize your desk
   (b) organize your drawers or closet
   (c) plan a meal
   (d) decide what clothes to take on a trip
7. What are some examples of everyday words that name groups or classes of things? Think about subjects you study in school such as science, grammar, math, and social studies. What problems would there be if words such as "noun" and "fraction" did not exist?

Key Terms

classification systems
kingdom
species

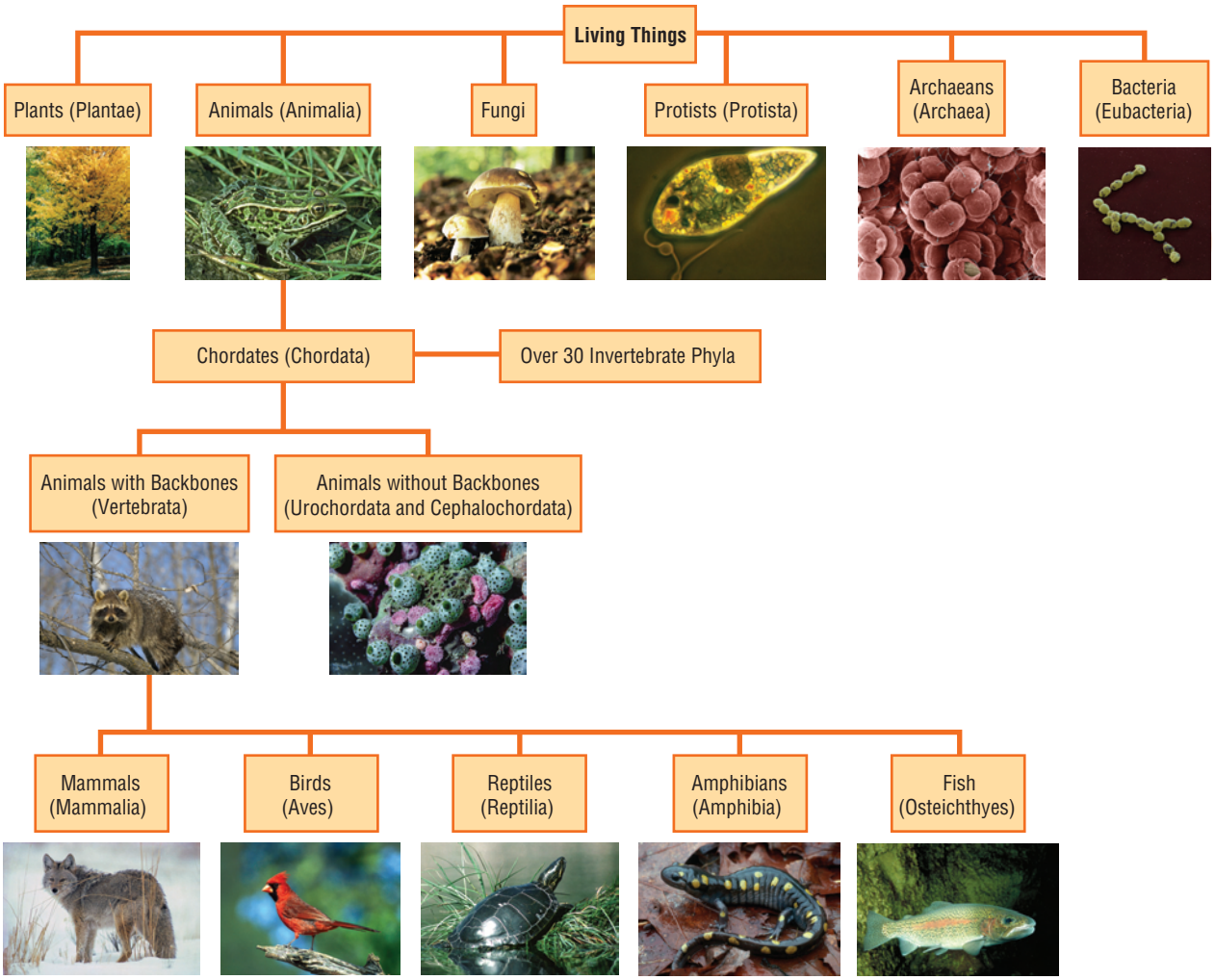
Section 7.2 The Kingdoms of Life

Key Terms

- bacteria
- protists
- fungi
- vertebrates
- invertebrates
- arthropods

One classification system scientists commonly use today groups organisms into six kingdoms: animals, plants, fungi, protists, bacteria, and archaeans. Types of organisms are classified in a kingdom based on similar characteristics. The six kingdoms and some of their characteristics are shown in Figure 7.8. Each kingdom can be further divided into phyla, classes, orders, families, genera, and species. The chordate phylum in the animal kingdom is actually divided into sub-phyla, including vertebrates (Vertebrata) and two invertebrate sub-phyla.

Figure 7.8 The six kingdoms of life. The names in brackets come from an old language called Latin. Chordates are one phylum within the animal kingdom. Classes of chordates within the vertebrate sub-phylum are shown.



Archaean Kingdom

Archaea (pronounced Ahr-KEE-uh) are micro-organisms with one cell. Archaean species can live in environments that are hostile to most other organisms. Examples include hot sulfur springs, air-starved swamps, and places deep in the ocean where lava and hot water seep through cracks in the ocean floor. Some archaeans make their own food using the energy of the Sun. Others get their food by breaking down (decomposing) other living and once-living things.

Scientists used to classify archaeans as part of the bacteria kingdom. However, as they learned more about the characteristics of archaeans, scientists realized that they have less in common with bacteria than was once thought. That is why archaeans are placed in a different kingdom now.

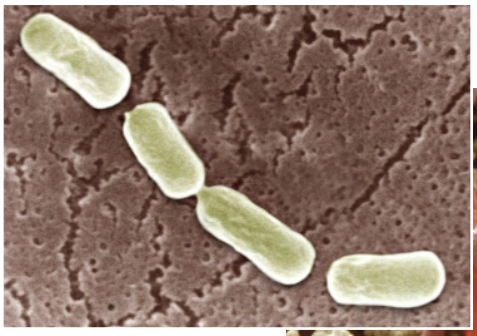
Off the Wall

One type of archaean lives in the digestive system of cattle. It enables the cattle to digest the tough parts of grasses, which they eat but cannot digest without the archaean.

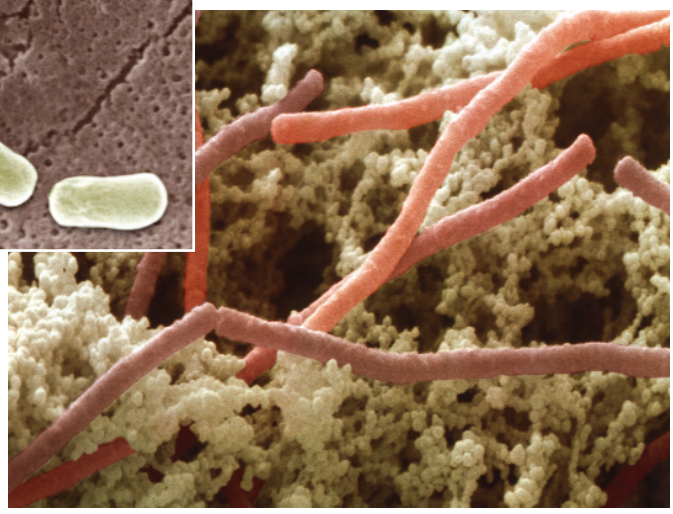
Bacteria Kingdom

Bacteria (singular, *bacterium*) are micro-organisms with one cell. Bacteria species live all around us — in the soil, in the air, in the water, and in and on our bodies and other organisms.

Bacteria can be one of three shapes: rods (shown in Figure 7.9), spirals, and spheres. Most bacteria do not make their own food. Instead, they decompose other living and once-living things.



These rod-shaped bacteria (magnified 15 000) cause food poisoning.



The pink, rod-shaped bacteria in this photo help to turn milk into yogurt or cheese.

Figure 7.9 The kingdom of bacteria includes species that can be harmful to humans, as well as species that are useful to humans.

Good Bacteria, Bad Bacteria

We often think of bacteria as "germs", or things that can make us sick. Some are dangerous to people and other organisms, and cause diseases such as tuberculosis or food poisoning (botulism). In reality, though, very few bacteria actually cause serious illness.

Most species of bacteria are helpful, not harmful. They decompose dead organisms and recycle nutrients needed for the survival of living things. Bacteria help make some of the foods you eat (such as cheese, yogurt, and even vinegar). Some of the bacteria that live in your body help you digest your food.

Find Out ACTIVITY 7–D

Wanted: Bacteria That You Need

In this activity, you will research a bacterium species that is useful to people.

What You Need

poster-size paper
art supplies

What to Do

1. Select one of the following food items that require bacteria in their production: yogurt, cheese, pickles, sour cream, chocolate, olives, or coffee.
   Or, investigate how bacteria in your intestines help keep you healthy.
2. Use library or Internet resources to find as much of the following information as possible:
   - a diagram or picture of the bacterium as seen under a microscope
   - a written description of the size and shape of the bacterium
   - a description of how the bacterium is useful or helpful to people
   - any other information of your choice
3. Create a bacterium "wanted" poster that will tell your classmates why this is a useful bacterium.

Controlling the Growth of Bacteria and Other Micro-Organisms

Have you ever found sour-smelling milk or slimy lettuce leaves in your refrigerator? When our food begins to spoil or go bad, it is because bacteria, fungi, or other micro-organisms are feeding on it. They release chemicals that break down the food, and then they absorb the nutrients into their own cells.

From the beginning of human history, people have looked for ways to control the growth of micro-organisms on our food. Storing food in well-covered or sealed containers helps to keep micro-organisms from getting into it. Sometimes, though, we need to kill or slow the growth of micro-organisms that are already on our food. Canning, freezing, drying, and smoking are some methods commonly used to preserve food.

It is also important to control micro-organisms to prevent and treat disease. Strep throat, pneumonia, and dysentery ("the runs") are all caused by the growth of bacteria in the human body. Uncontrolled growth of micro-organisms in the body is known as an infection. Antibiotics are medications used to treat the infection by killing the bacteria. (Antibiotics only work on bacteria, not on viruses or on other micro-organisms.)

Figure 7.10 Surgeons must use instruments that have been carefully cleaned, or *sterilized*, to rid them of micro-organisms. If dirty equipment is used during surgery, a patient can develop a serious infection.

In the following activity, you will find out more about controlling the growth of micro-organisms on food and in the body.

Find Out ACTIVITY 7–E

Keeping Micro-Organisms Under Control

Science and technology can help to preserve foods, prevent infection, and treat disease. In this activity, you will research ways that scientists have developed to control the growth of harmful micro-organisms.

What You Need

library or Internet resources
poster supplies (optional)

What to Do

1. Choose one of the following ideas for a research topic:
   - Compare methods of food preservation in the past and present.
   - Research how fruit, vegetables, and meat are preserved for shipping from other countries to supermarkets in your province.
   - Explain how canning, freezing, drying, or smoking can be used to preserve food.
   - Report on additives or preservatives that are used in packaged foods.
   - Create a timeline showing important discoveries in prevention and treatment of bacterial infections in humans.
   - Compare antibacterial products, such as soaps and cleaning products, with antibiotics.
2. Make a brief proposal of the project you wish to do, using these suggestions or an idea of your own. With your teacher's approval, carry out your project and make a presentation to the class.
3. Your presentation can be in the form of a display, collage, demonstration, or other technique.

What Did You Find Out?

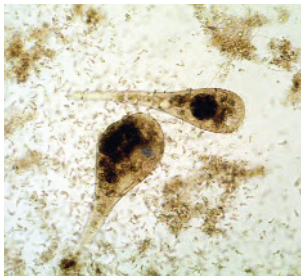
1. Explain the importance of one form of technology in the topic you chose to research.
2. What did you learn about the characteristics of micro-organisms while doing your research?

Protist Kingdom

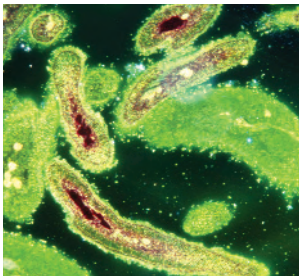
Look at the organisms in Figure 7.11. Although these organisms look quite different from each other, they are all in the same kingdom. The kingdom of **protists** (Protista) has the biggest variety of members of all of the kingdoms of life. Protists can have one or many cells. They usually live in moist or wet environments. Some protists make their own food using the energy of the Sun (photosynthesis), while others absorb nutrients from their environment or feed on other organisms. Some protists such as the amoebas and paramecia shown below are microscopic; others, such as seaweeds, can be very large.

Slime mould

Seaweed



Amoebas



Paramecia

Figure 7.11 Slime mould, seaweed, amoebas, and paramecia are all types of protists. Amoebas and paramecia move around to find food, such as bacteria.

The amoebas and paramecia in Figure 7.11 are protists that, like animals, move and capture food. These protists live in water, soil, or in both living and dead organisms and use different ways to move around as they pursue food. Some have many tiny hairs that they use to propel themselves. Others use one or two long "whips" to move. Others move by extending a flexible "foot."

To look at some protists, try Conduct an Investigation 7-F.

Off the Wall

The brightly coloured slime mould in Figure 7.11 forms a delicate, web-like structure on the surface of its food. It obtains nutrients by decomposing its food. Slime moulds live on decaying logs or dead leaves in cool, moist, shady forests. Although slime moulds might look like fungi, they are different in many ways. For one thing, slime moulds can move. As they creep along, they feed on bacteria and decaying plants and animals.

CONDUCT AN

INVESTIGATION 7-F

SKILLCHECK

- Observing
- Interpreting
- Classifying
- Communicating

Looking for Micro-Organisms

In this investigation, you will look for micro-organisms, such as protists, in a sample of pond water. To increase the number of micro-organisms in the pond water, you will make a hay infusion by adding hay or grass to the water to provide food for the organisms living there.

Question

What micro-organisms live in pond water?

Safety Precautions

- If your microscope has an electrical cord, make sure that your hands are dry when you plug in or disconnect it.
- Always hold onto the *plug* to remove an electrical cord from the socket. *Never* pull on the cord.
- Handle microscope slides carefully so that they do not break or cause cuts or scratches.
- Do not put your hands on your face or near your mouth during this investigation.
- Wash your hands with soap and water after handling the pond water sample.
- Tell your teacher if you are allergic to mould, algae, or other living things.

Materials

pond water
1 a large jar
grass or hay
1 medicine dropper
microscope
microscope slides
1 plastic drinking straw
cover slips
pond life identification guide

Procedure

Group Work

1. To make the hay infusion, put the pond water in the large jar and add a small handful of grass or hay and a few grains of yeast. Cover the jar with a lid (not too tightly) and keep it at room temperature for several days.
2. Observe how the water looks each day and record your observations. For example, note the colour of the water and whether you can see anything moving.
3. After one week, use the medicine dropper to remove a few drops of water from the surface. Prepare a wet mount of the sample.
4. View the slide under low power on the microscope. Use drawings and words to describe what you see.
5. Put your thumb over the end of the straw and put it into the jar. When the other end of the straw is at the bottom of the jar, release your thumb. Water will move up the straw. Put your thumb back on the straw and remove the water sample.
6. Put a drop of pond water on a clean slide by touching the end of the straw on the slide. Do not release your thumb; you will release far too much water. Prepare a slide from a sample from the bottom of the jar. Repeat step 4.
7. Repeat step 5, but remove a sample from the middle of the jar.
8. Make a slide from a sample from the middle of the jar. Repeat step 4.

Analyze

1. Describe the daily changes you observed in the jar of pond water.
2. **(a)** How many different micro-organisms did you observe?
   (b) Describe the size, colour, and shape of each organism. Also describe any movement you saw.
3. What importance was there in sampling the different levels in the jar?
4. Use the pond life identification guide to identify some, or all, of the organisms that you observed.

Conclude and Apply

5. **(a)** Which pond water sample (from the top, middle, or bottom of the jar) contained the most micro-organisms?
   (b) What caused the samples to be different?
6. Predict what you might see in a sample of pond water one month after you started a hay infusion.
7. Continue to feed the hay infusion by adding more pond water and hay or grass each week. Record your observations after taking new samples and viewing them under a microscope.

Plant Kingdom

Wildflowers, grasses, trees, and mosses are all members of the plant kingdom (Kingdom Plantae). All plants have more than one cell and most use the energy of the Sun to make food. Plants have roots or root-like structures that help hold them in the ground and enable them to absorb water. They also have stems or stem-like structures that help the plant stay upright and allow water and nutrients to be transported within the plant. Finally, they have leaves or leaf-like structures that help to absorb sunlight and carbon dioxide so that plants can make their own food.

Plants grow in almost all parts of the world. You will examine some different kinds of plants in Find Out Activity 7-G.

Find Out ACTIVITY 7–G

Plant Survey

In this activity, you will investigate the similarities and differences between various plants.

What You Need

paper
plant samples
magnifying glass
pencil
ruler

What to Do

1. Divide a sheet of paper into four sections.
2. For each plant sample, make notes and sketches of your observations in one section of your paper. Include overall size; leaf or needle size; whether the plant has seeds, tiny, grain-like spores, or flowers; stem length. On the back of your sheet, predict how each plant (a) reproduces, and (b) gathers water.
3. Use field guides to learn more about your plants. Record a definition of each plant type (e.g., moss, fern).

What Did You Find Out?

1. How were the plants similar? How were they different?
2. How could you divide these plants into two different groups? What are your criteria for placing them in these two groups?

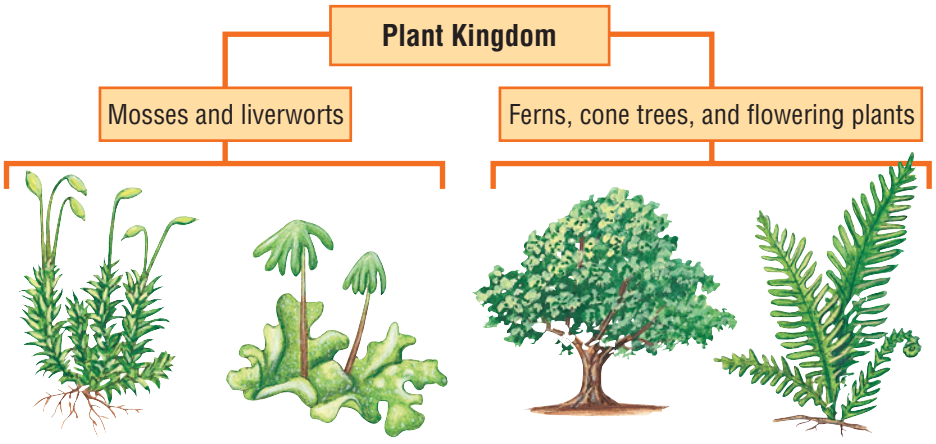


Figure 7.12
By examining characteristics of plants, biologists have divided the plant kingdom into 11 different groups.

Plants can be divided into two large groups (Figure 7.12). The first group contains mosses and other simple plants, such as the *liverwort* shown in Figure 7.12. These plants absorb water directly through their cell walls. They reproduce using tiny *spores* that resemble grains of sand.

The second group contains plants such as trees, grasses, ferns, and wildflowers. These plants have structures within their stems that are like tubes. Water absorbed by the plant's roots moves up one set of tubes to the leaves. At the same time, food (sugar) made in the leaves is moving through another set of tubes, which lead to all of the other parts of the plant. These plants reproduce with seeds or tiny *spores*.

Fungi Kingdom

You are probably more familiar with fungi (singular *fungus*) than you realize. The mushrooms in your soup or on your pizza are a type of fungus. The moulds that grow on bread or other foods and the mildew that grows on damp objects like shower curtains are also fungi.

Fungi obtain the nutrients they need to survive by absorbing them from other organisms. Often, they do this by decomposing dead organisms. These fungi break down everything from food scraps to dead plants and animals, and return the nutrients of the dead organisms to the soil. Other fungi are parasites. This means that they absorb nutrients from living things, usually in amounts small enough that the organisms providing the nutrients are not harmed.

DidYouKnow?

Many fungi are very useful. For example, the mould *Penicillium notatum* produces a chemical that kills bacteria. It is used in a medicine called penicillin, which is used to fight bacteria that make people ill.

Most fungi have more than one cell, although there are some that have only one. The mushroom shown in Figure 7.13 is an example of a fungus with many cells. Inside the giant ball of the fungus, trillions of tiny spores are produced. The spores are released when it is time for the fungus to reproduce. The fungus also extends tiny thread-like tubes into the soil to absorb nutrients. Take a closer look at a fungus in Conduct an Investigation 7-H.

Figure 7.13 This fungus, called a giant puffball, grows in Nova Scotia forests. It can reach the size of a soccer ball, or larger.

CONDUCT AN

INVESTIGATION 7-H

SKILLCHECK

- Observing
- Communicating
- Measuring and Reporting
- Predicting

Grow a Fungus Garden

In this investigation, you will grow mould in a variety of conditions.

Question

What conditions are necessary for the growth of a fungus we call bread mould?

Safety Precautions

- If you have any allergies to any type of mould, inform your teacher before the class begins this investigation.
- Wash your hands carefully after completing each part of this investigation.
- Once the plastic bags are sealed, do not open them again.
- After the investigation, all plastic bags must be put into the garbage. They should not be washed and reused.

Materials

permanent marker
1 slice of bread
plastic knife
4 new, resealable plastic bags
spray bottle filled with water
duct tape

Procedure

1. Use the marker to label each bag with your name.
   - Label one of your four bags "light", one "dark", one "dark and moist", and the fourth, "light and moist."
2. Take the slice of bread and wipe it on dusty surfaces around the classroom.

3. Cut the bread into four equal-sized pieces using the plastic knife.
4. Dampen two of the pieces of bread with the spray bottle. The bread should be moist, not soggy.
   - Place one piece of damp bread in the bag marked "dark and moist".
   - Seal the bag and cover the opening with duct tape.
   - Place the bag in a drawer or cupboard. The location you place the bag in should remain closed except when you make your observations.
5. Place the second piece of dampened bread in the bag marked "light and moist" and seal it as you did in step 4.
   - Place the bag in a location where it is exposed to indirect (some, but not a lot of) light.

6. Put the third piece of bread in the bag labelled "light" and seal it as you did in step 4.
   - Place the bag in a location where it is exposed to indirect light.

7. Put the last piece of bread in the bag labelled "dark" and seal it as you did in step 4.
   - Place the bag in a drawer or cupboard. The location in which you place the bag should remain closed except when you make your observations.

8. Wash your hands thoroughly with soap and water.

9. Copy the table below into your science journal. Observe the bread slices daily and record your observations in the data table.

Observations

Day	Dry Bread Exposed to Light	Dry Bread in the Dark	Moist Bread Exposed to Light	Moist Bread in the Dark
1				
2				
3				
4				
5				

Analyze

1. Which bread sample had the most mould growth?
2. Which bread sample had the least mould growth?
3. Which bread sample was the first to show mould growth?
4. Compare your observations with the observations of other groups in your class. How are they similar? How are they different?

Conclude and Apply

5. Are you more likely to find mould and other fungi in areas that receive indirect light or in dark, shady areas? Explain your answer.
6. If you were a mushroom grower, what conditions would you need to grow your mushrooms?
7. What was the purpose of wiping the bread on surfaces in your classroom before beginning this experiment?

DidYouKnow?

There are thousands of types of fungi in Nova Scotia. Some people harvest and eat mushrooms. However, since many mushrooms are poisonous, you should *never* eat mushrooms that you cannot identify with certainty.

Atlantic puffin

Moon jellyfish

Moose

Figure 7.14 A wide variety of animals live in Nova Scotia.

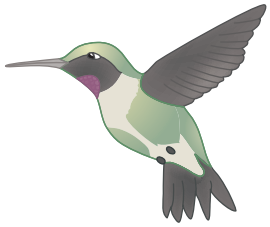
Animal Kingdom

The animals shown in Figure 7.14 are all found in Nova Scotia. The body characteristics of all of these animals are quite different, yet they all belong to the animal kingdom. What are the characteristics that all animals share?

Animals are made up of more than one cell. All animals need to eat plants or other animals to obtain food. Animals can move from place to place to find food, shelter, and mates, and to escape from enemies.

As is true of the other kingdoms, the animal kingdom is further divided into phyla, class, order, family, genus, and species. Some of the phyla in the animal kingdom are shown in Figure 7.15.

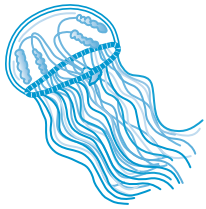
Arthropods:
Insects and Spiders
(Phylum Arthropoda)



Chordates:
Birds, Mammals, Reptiles, Amphibians, Fish, Tunicates, and Lancelets (Phylum Chordata)

Molluscs:
Slugs, Snails, Clams, etc.
(Phylum Mollusca)

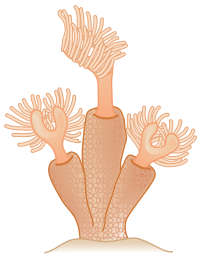
Echinoderms:
Spiny-skinned Animals
(Phylum Echinodermata)



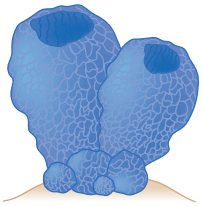
Cnidarians:
Jellyfish, Sea Anemones, and Corals
(Phylum Cnidaria)

Annelids:
Earthworms and Other Segmented Worms
(Phylum Annelida)

Rotiferans:
Wheel Animals
(Phylum Rotifera)



Bryozoans:
Moss animals
(Phylum Bryozoa)



Poriferans:
Sponges
(Phylum Porifera)

Figure 7.15 These are nine of the approximately 35 groups (phyla) in animal kingdom.

Invertebrates: Animals Without Backbones

The earthworm and the snake in Figure 7.16 share the characteristics of all animals. As well, they both have long, thin bodies without any arms or legs. But there are also important differences—one is spineless! Animals with spines (backbones), such as the snake, are called **vertebrates**. Earthworms, which do not have backbones or any other bones, are called **invertebrates**.

Since most invertebrates are small, they do not need large structures to support their bodies. However, some invertebrates do have rigid body parts. For example, insects and spiders have a hard covering on the outside of their bodies. Snails have shells, and sponges have tiny glass- or bone-like spikes in their body. Invertebrates are much more common than vertebrates. In fact, most of the members of the animal kingdom are invertebrates.

Vertebrates: Animals With Backbones

The backbone of vertebrates is part of the internal skeleton that supports their bodies. Most vertebrates have two sets of paired limbs, such as fins, arms, or legs. Compare invertebrates and vertebrates in Find Out Activity 7-I.

Earthworm

Rubber boa snake

Figure 7.16 These organisms are similar in appearance, but the earthworm is an invertebrate, while the rubber boa snake is a vertebrate.

Find Out ACTIVITY 7–I

Animal Collage

In this activity, you will classify pictures of animals as invertebrates or vertebrates.

What You Need

- old nature and outdoor magazines
- pencils, pens, or markers
- glue
- poster paper
- scissors

What to Do

1. Draw or cut out pictures of animals.
2. Divide your poster paper in half and label one half "Vertebrates" and the other half "Invertebrates".
3. Sort your pictures into the two groups and glue them under the correct label.

What Did You Find Out?

1. How many different types of invertebrates and vertebrates did you find?
2. **(a)** What characteristics do invertebrates share?
   (b) What characteristics do vertebrates share?
3. Which side of your poster has more species of animals? Explain why this might be so.

CONDUCT AN

INVESTIGATION 7-J

SKILLCHECK

- Measuring
- Inferring
- Interpreting Data
- Communicating

Classifying Arthropods

In this investigation, you will classify arthropods that can be found around your school, as well as examples shown in illustrations or photographs.

Question

What characteristics are most useful for identifying members of different arthropod classes?

Safety Precautions

- Do not handle any organisms with bare hands.
- If you disturb the habitat, be sure to return it to its original condition.
- Do not harm organisms in your study site.

Materials

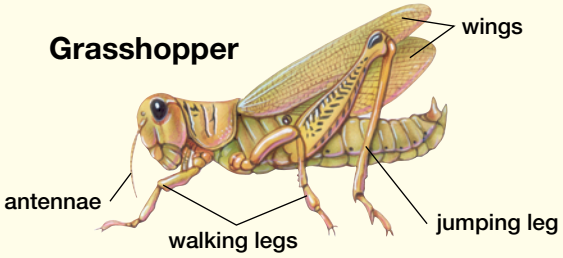
clipboards
hand-held magnifiers
pictures of arthropods
computers with Internet access

Procedure

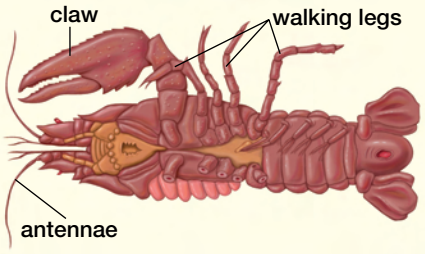
1. Explore the area around your school and make a list of arthropods that you find. Observe and record their characteristics in a table. Include a rough sketch of each organism you find. Use the following list of questions to guide your observations:
   - Is its body divided into segments? If so, how many segments can you see?
   - Does it have an external skeleton (that is, hard like the material of your fingernails, not soft like the material of your skin)?
   - How many legs does it have?
   - If it has legs, are they jointed?
   - Does it have any other limb-like parts? If so, describe them.
   - Does it have wings? If so, how many pairs does it have?
   - Does it have antennae? If so, how many does it have?
   - Does it have any other features that stand out?

Spider

Grasshopper



Crayfish



2. Your teacher will give you pictures of a variety of arthropods. Observe and record their characteristics using the questions listed above to guide your observations.
3. Divide the organisms into groups based on similarities and differences in the characteristics you have recorded.

Analyze

1. Explain why you grouped the organisms the way you did.
2. Which characteristics were most useful in choosing categories?
3. Which characteristics were the same in all of the organisms you observed?

Conclude and Apply

1. What characteristics would you use to decide if an organism belonged to the arthropod phylum?
2. If you observed an organism with six legs and no antennae, would you identify it as a spider, an insect, or a crustacean?

Invertebrates You Know

Within the animal kingdom, there is only one phylum containing vertebrates. All of the other phyla are made up of invertebrate species. The largest animal phylum is one that you are probably familiar with: the **arthropods**. This phylum contains millions of species, including various types of spiders, insects, and crustaceans, such as crabs, lobsters, shrimp, and copepods.

The Arthropods

Arthropods come in all shapes and sizes, and can be found in a wide variety of habitats. The word arthropod means "jointed foot", but arthropods actually have jointed legs—many pairs of them. Their bodies are divided into segments, which are covered by a hard, waterproof covering called an exoskeleton. The exoskeleton is like a protective coat of armour. Most arthropods feed on plants or plant materials, while some feed on animals and organisms from other kingdoms.

Classes of Vertebrates

Vertebrates are divided into classes according to various features that are shared by some but not by others. Classes include fish, amphibians, reptiles, birds and mammals (Figure 7.17). Animals can be separated into these classes based on the following characteristics:

- where they live (i.e., on land or in water)
- the texture and/or covering on their skin
- the material of which their bones are made (i.e., bone or cartilage)
- how they give birth to their young (i.e., eggs or live young; eggs with or without shells; shells hard or soft)
- how they gather oxygen.

Fish *(Osteichthyes)*
Example: trout

Amphibians *(Amphibia)*
Example: frogs

Reptiles *(Reptilia)*
Example: turtles

Birds *(Aves)*
Example: herons

Mammals *(Mammalia)*
Example: squirrels

Figure 7.17 There are five major classes of vertebrates.

Find Out ACTIVITY 7–K

Guess Who?

In this game, you will examine the characteristics of different classes of vertebrates and try to classify different animals.

What You Need

spare outdoor and nature magazines, drawings of animals, or pictures printed from the Internet
scissors
glue
5 index cards

What to Do

1. Choose five vertebrate animals to research. Try to choose a wide variety of animals.
2. Using library or Internet resources, find out the characteristics of these animals. You should give special attention to the types of characteristics listed on the previous page.
3. On the front of an index card, either draw a picture of one of the organisms you chose or glue a picture from a magazine if one is available.
4. On the back of the same index card, neatly include the following information in this order:
   - characteristics of the organism
   - class
   - common name
5. Repeat steps 3 and 4 for the other organisms you chose.
6. Your teacher will collect the cards and redistribute them throughout the class.
7. Play the game as follows.
   - Find a partner.
   - Take turns asking your partner

questions about the card they hold. (You should not be able to see your partner's card.) The questions can be answered only with "Yes" or "No." For example, "Does this organism have scaly skin?"
   - Ask questions until you think you know the class to which this organism belongs.
   - For an added challenge, you could continue asking questions until you think you can identify the organism by its common name.

What Did You Find Out?

1. Draw a classification table to help you review the characteristics of each class. A sample table with some of the columns titled is shown below.

Class	Live on land or in water?	Lay eggs or give birth to live young?	
Fish			
Amphibians			
Reptiles			
Birds			
Mammals			

Create your own table in your science journal. Give your table a title.

Section 7.2 Summary

Scientists group living things into one of six kingdoms: Archaeans, Bacteria, Protists, Fungi, Plants, and Animals.

- All archaeans and bacteria are micro-organisms made of one cell. Most bacteria and some archaeans do not make their own food; they decompose other living or once-living things.
- Protists can have one cell or many. Protists can make their own food by using the energy of the Sun, or they can eat food, or they can absorb food into their bodies by decomposing other organisms.
- Most, but not all, fungi have more than one cell. Fungi obtain nutrients by absorbing them from other living things, often by decomposing these other organisms.
- Plants have more than one cell. Plants use the energy of the Sun to make their own food.
- Animals have more than one cell. Animals obtain nutrients by eating other organisms.
- Animals can be divided into two main groups: vertebrates and invertebrates. There are many more invertebrates than vertebrates.
- Classes of vertebrate animals include fish, amphibians, reptiles, birds, and mammals.

Key Terms

bacteria
protists
fungi
vertebrates
invertebrates
arthropods

Check Your Understanding

1. What are the six kingdoms that are commonly used to classify living things?

2. **(a)** How do fungi obtain their food energy?
   (b) How is this different from how plants obtain their energy?

3. What is the difference between a vertebrate and an invertebrate? Give an example of each.

4. **(a)** What are the major groups of vertebrates?
   (b) What are the characteristics of each of these groups?

5. Some parts of the scientific system of classification use common physical characteristics. Create your own system of classification using some other idea—behaviour or habitat, for example. In your system, what organisms would be grouped together that are not presently grouped together?

Prepare Your Own Chapter Summary

Summarize this chapter by doing one of the following:

- Create a graphic organizer.
- Produce a poster.
- Write a summary to include the key chapter ideas.

Here are a few ideas to use as a guide:

- Explain why scientists have developed a classification system for organisms.
- Use a chart to compare the different kingdoms.
- Describe how you would classify a newly discovered organism.
- What are the strengths and weaknesses of using two-part scientific names to identify organisms?
- Demonstrate how organisms could be classified in different ways using examples and a dichotomous key.
- Create a step-by-step guide explaining how you would examine the organisms in a sample of pond water.
- List characteristics you would use to identify common arthropods. Use drawings to illustrate these characteristics.
- Use a table or flowchart to compare the characteristics of the different groups of vertebrates.