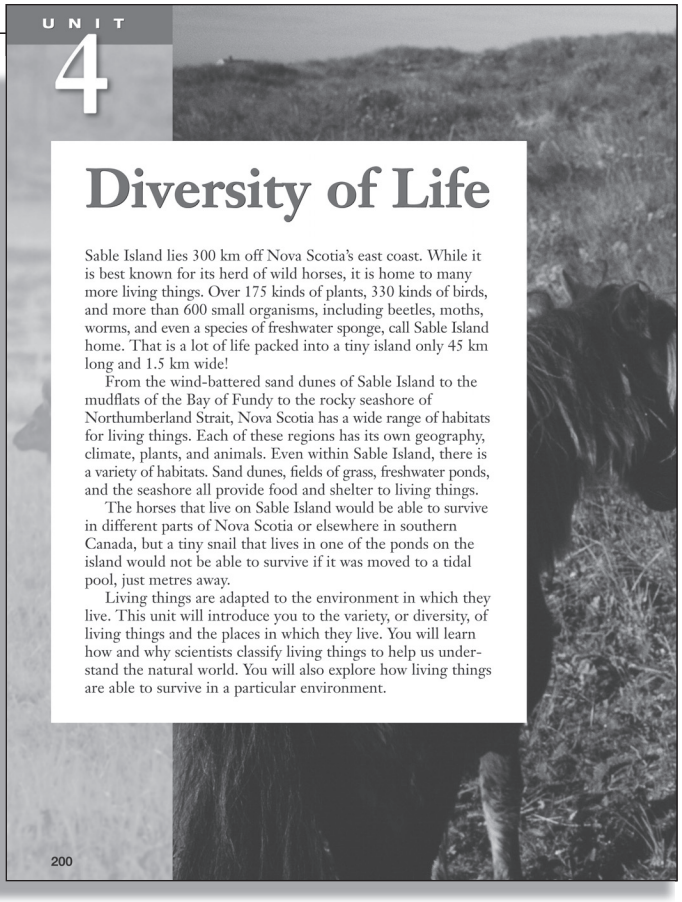


USING THE UNIT 4 OPENER

TEACHING STRATEGIES

- **Begin the Lesson**—Use a KWL chart or other tool to find out what students think the word "diversity" means. Explore related words, such as diversify, divert, diverse, and diversion. Many of these words come from a very old root word *vertere*, which meant "to turn." Consider discussing the idea that noting something is different does not include a judgement that requires ranking things as good, better, best or desirable and undesirable. It is possible to assess differences in a neutral way.
  – Alternatively, use a RAN (Reading and Analyzing Non-Fiction) chart, based on the work of Tony Stead. Begin with "What you think you know" before students read; after reading, students fill out the next two columns, "Misconceptions" and "Confirmations." Finally, a column for "New Information" and one for "Questions."
- **During Teaching**—Most of Sable Island's residents are staff of the Sable Island Station, a research station that collects weather data and assists visitors. Visitors come to the island to maintain marine navigation aids, conduct scientific research on plants and animals, and provide support for the offshore energy industry. Ask students to consider why it might be good to do research in such an isolated place.
- **After Teaching**—For students who wish to learn more, a good link for the natural history and scientific studies of Sable Island is The Green Horse Society. The publications or web sites from the Nova Scotia Museum of Natural History and the Sable Island Preservation Trust site are also helpful.

to Introduce Unit 4

- Take the students on a short field trip into the schoolyard or neighbourhood to look at the different plants and animals in their own backyard. Ask students to consider why the organisms live where they do and what helps them survive.
- If you can show students on-line videos, visit teachersdomain.org. To introduce the idea that organisms can do amazing things to ensure survival, search for "Frozen Frogs." This is a video segment adapted from *NOVA scienceNOW* that shows how the common wood frog freezes solid every winter, an adaptation that allows the organism to survive cold winters.

Getting Ready Answers

- **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?** A rose, a mushroom, and a wolf are all living things made up of cells. Students should be able to make general observations of the differences, such as appearance, habitat, how they reproduce or how they obtain food and what kind of food they need.
- **How does a seaweed growing on the seashore survive both the hot, damp days of summer and the cold, dry days of winter?** Most plants in Canada must survive a cycle of seasons that are quite different. Root systems of perennials or how annual plants seed themselves are also ways to survive. A few students may know that some seaweeds produce a type of antifreeze to protect their cells during the winter. Or that others can survive drying out during hot, windy summer days and reconstituting themselves when covered by the tide.
- **What tools could you use to learn more about living things in the world around you?** Tools could include binoculars, hand lenses (magnifying glass), bug boxes, microscopes, and cameras. Tools can also include field guides, classification keys, as well as naturalists who can lead field trips.
- Further question: What does "diversity of life" mean? There are many definitions of the term. The Canadian Biodiversity Strategy defines it as "…the variety of species and ecosystems on Earth and the ecological processes of which they are a part." ("Canada's Response to the Convention on Biological Diversity," Environment Canada, Report of the Biodiversity Working Group, 2000)

Connecting to the World Outside the School

- This unit is suited to getting students out into the natural world. Field trips, whether they are looking at the plants in the schoolyard or taking students on an extended outdoor, experiential program at a provincial park, are a key component to meeting the outcomes of this unit.

Cross-Curricular Connections

- Mathematics: Skills such as organizing data, measurement, and graphing can be used during this unit.
- Physical Education: Orienteering can be demonstrated during the collection of data for classifying organisms.
- Literacy: Science uses graphic organizers, and students will have opportunities to use these skills. The Conversation with an Elder features enable students to practise writing letters and proposals.
  - A number of the activities and investigations in this unit require the students to do a presentation, which could involve fine arts, drama, or music. Students could meet ICT outcomes by developing multimedia presentations.

Promoting Positive Attitudes

- This unit is also an opportunity for students to further develop a sense of respect for all living things and their right to a suitable habitat.

USING THE CHAPTER 7 OPENER

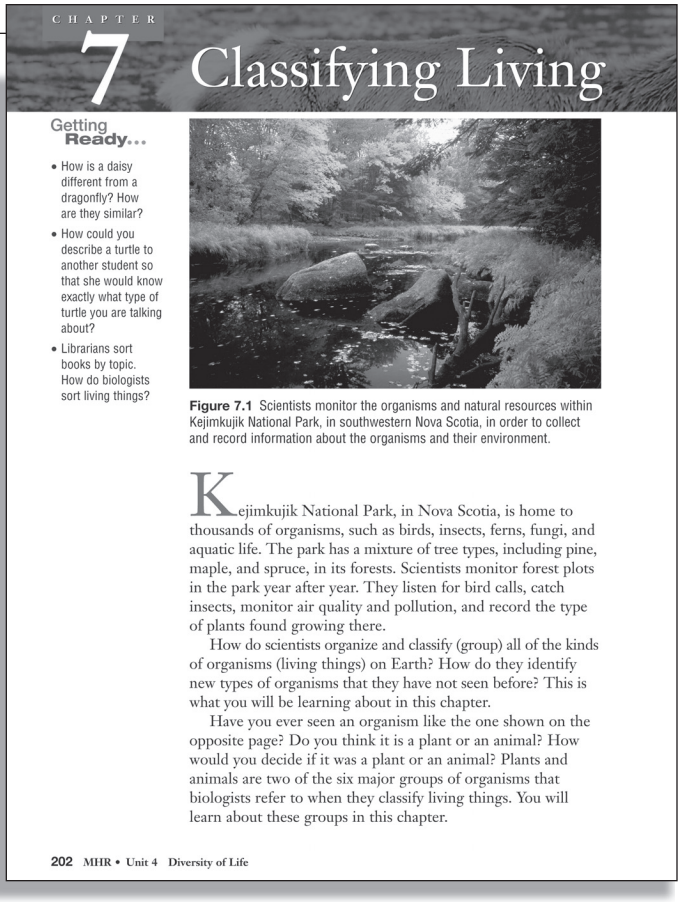
TEACHING STRATEGIES

- Ask students to begin a new section in their science logbook titled "Diversity of Life." As each new section is explored, have students write notes, draw pictures, or create concept maps. To begin, students could consider what they already know about living things. Possible starter questions include:
  – What is the difference between a living thing and a non-living thing?
  – What do living things need in order to survive?
  – Are some living things more important than others?

  Have students share their answers in small groups.
- Have students read and discuss the *What You Will Learn*, *Why It Is Important*, and *Skills You Will Use* sections.
- Read and discuss the information on page 202. Challenge students to answer the questions and classify the organism shown on page 203.
- The sea anemone shown on page 203 is classified as an animal. Students may find it difficult to decide if this organism is a plant or an animal because it is stationary, it appears to have petals, and it is green. (The green is actually a symbiotic algae that lives in the sea anemone's tissues.) Most sea anemones are predators that feed on plankton or other organisms that come in contact with its tentacles. Stinging cells, called nematocysts, in the tentacles help the sea anemone capture prey.
- Have the students answer the *Getting Ready* questions in a group discussion. Explain that as the unit progresses they will be able to add to their answers as they learn more about living things.

Getting Ready Answers

- **How is a daisy different from a dragonfly? How are they similar?** Both are living things. They exchange gases, use energy, reproduce, grow, and respond to stimuli, but in different ways. Students may note that a daisy is a plant and a dragonfly is an insect. The plant makes its own food from sunlight and water and nutrients taken up by its roots; the dragonfly must go to the sources to get food and water and can move freely. (Consider having photos of each available so students can make the comparisons.)



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.

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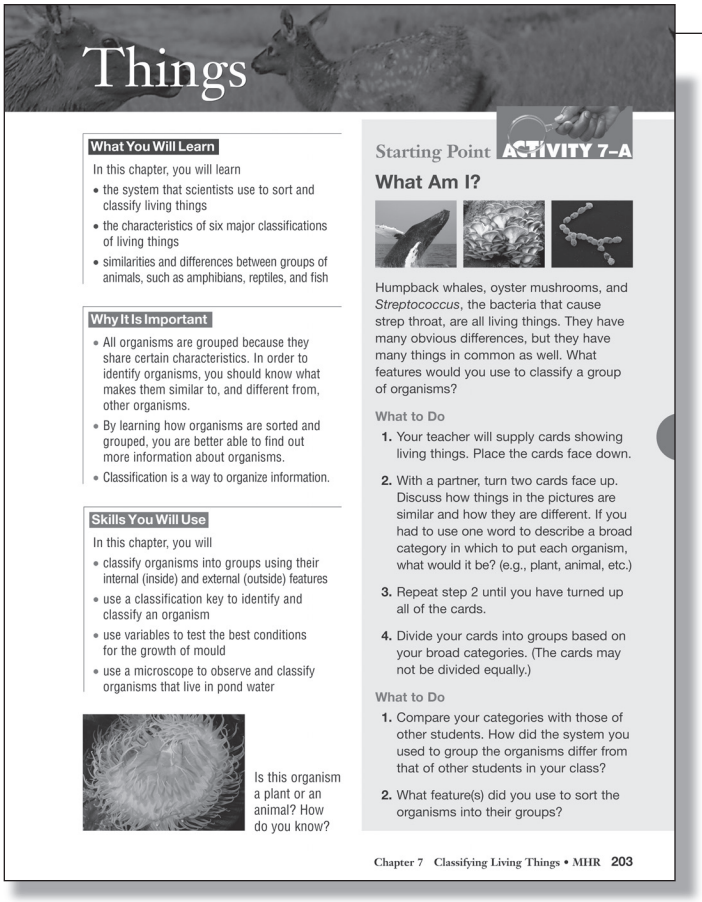
- **How could you describe a turtle to another student so that she would know exactly what type of turtle you are talking about?** In order to distinguish one turtle from another—there are four types in Nova Scotia—students should list details such as size, colour, special markings, where it lives or was found, or the kind of food it eats (plants or meat). A description of the type of shell, flippers, and legs would help.
- **Librarians sort books by topic. How do biologists sort living things?** Biologists sort living things by type, just as librarians sort books by type. In the case of daisies and dragonflies, these two are part of very large, general groups (plants, insects). Students may note that other large general groups are fish, animals, and birds. Within those large groups, there are smaller and smaller ones, until scientists distinguish among things that are exactly alike, such as a certain kind of turtle. In this chapter, students will learn the names of the categories scientists use to sort and classify living things.



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?

Chapter 7 Classifying Living Things • MHR 203

STARTING POINT ACTIVITY 7-A WHAT AM I?

Purpose

- Students use observable differences and similarities to group living things into different categories. Students will discover that not everyone groups living things the same way.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
2 weeks before	– Cut out pictures of living things, including plants, animals, bacteria, and fungi from the land and sea and glue them on a set of index cards. Create enough cards for each pair of students to have 10–12 to examine.

MATERIALS
– index cards – scissors – pictures of living things

Suggested Time

- 30 min

Hints & Tips

- Laminate a class set of cards that can be re-used.

Implementing the Activity

- Group students into pairs and have them create their own classification system. Ask them to write down in their logbooks how they chose to group the living things the way they did.
- This activity is an excellent opportunity to get students thinking about different ways that living things are classified. Different cultures and peoples have different world views and knowledge systems. This means that they often have different ways of grouping living things. (For example, Aboriginal peoples do not distinguish between living and non-living things.) Be conscious that these methods are not "wrong" but are simply another way of looking at the world.

Adaptations

- You may have to explain what some of the organisms are before the students can proceed with this activity.
- You may wish to project the images of living things and do this as a class activity.

Activity Wrap-Up

- If each pair of students is using the same cards, have them compare their categories to one or two other groups in the room. Discuss the fact that grouping living things is not an exact science and the categories selected often depend on the point of view of the person doing the grouping.

What Did You Find Out? Answers

1. Students should find that there can be a wide range of categories used to group living things.
2. Students may have sorted the organisms by habitat, how they obtain food, how they reproduce, whether they move or not, or some other characteristic. Discuss some of the chosen categories and try to apply them to other organisms to find out if the form of classification would work. The key learning here is that grouping living things is not an exact science.

SECTION 7.1 GROUPING LIVING THINGS

What Students Do in Section 7.1

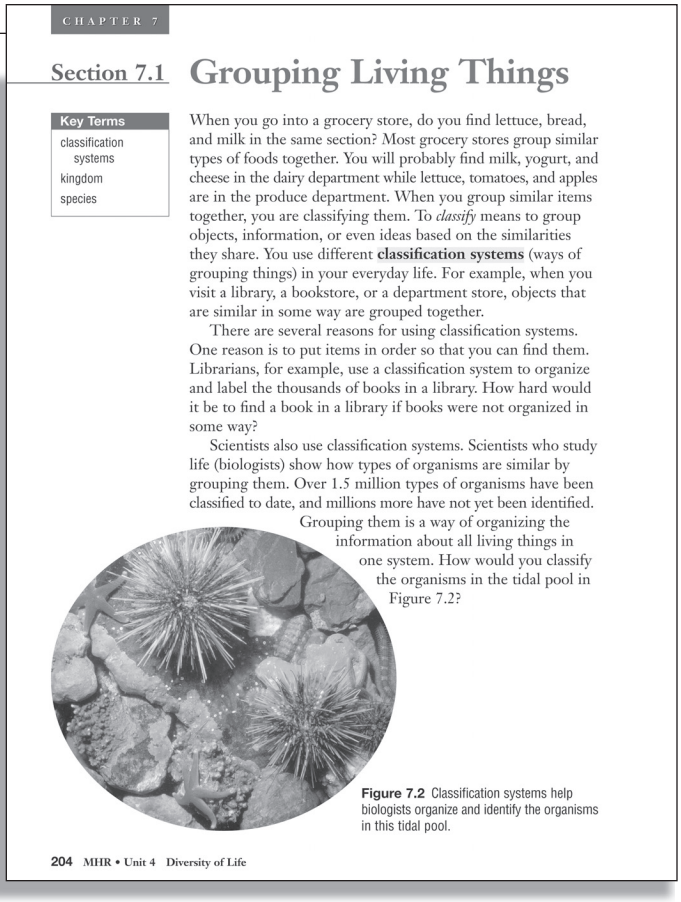
- learn how and why scientists sort and classify living things
- describe the two-part scientific system used to name living things
- use a dichotomous key to identify organisms
- design a dichotomous key to classify plants

BACKGROUND INFORMATION

- The organisms in Figure 7.2 include sea urchins, sea stars, a chiton, and coralline algae (the pink growth on the rocks). Students may not realize that the pinkish growth is a type of seaweed that encrusts rocks. The hard, crusty growth inhibits grazing by snails.
- Sea urchins and sea stars are both animals. They are in the Phylum Echinodermata, which means spiny (echino) skinned (derm). The spines on the urchins are visible, but you may want to direct students to the single sea-star arm on the right side of the photo. The spines on this sea star are more visible. Students may use the term starfish, but encourage them to use sea stars instead, since these organisms are not fish. The mouths of both organisms are on the undersides of their bodies.
- Chitons are a type of mollusc (the sausage creature just top of the sea urchin on the right). Instead of having a single shell like a snail, or two hinged shells like clams or mussels, chitons have eight shells, which are shaped like butterfly wings. The shells overlap to provide a protective armour on the animal's back.

TEACHING STRATEGIES

- If using, distribute a copy of BLM 7.1, Key Terms for students to use as a reference throughout the chapter. Alternatively, students could use a graphic organizer for learning new vocabulary in context. Advise students that they will be creating definitions of key term using their own words.
- Try a classification exercise before reading the information. Ask students to cut a sheet of paper into five strips. Have them write down their five favourite songs, one per strip. (You may choose another topic, depending on the class, however, ensure that it includes things that can be classified and that there will be a debate about the classification.) Brainstorm with the class to identify the different music genres, for example, rock, hip-hop, country, heavy metal, rap, or pop, and write these across the board. Give each student a bit of masking tape and have them come up and place their songs into the different genres in order to classify them. It is unlikely that all students will agree with the groupings. There isn't a right or wrong answer, which shows that classification is an arbitrary process and subject to much debate.
- As an alternative example, ask students where they would go in a grocery store to find milk or fresh fruit or canned goods. What would happen if there was no grocery store organization or classification?



CHAPTER 7

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.

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Common Misconception

- Many students may think that there is only one way to classify living things. Point out that the system used in their textbook identifies six kingdoms of living things. Ten years ago, there were only five kingdoms, and, in 2008, biologists debated increasing the number of kingdoms to eight. Classification systems are subject to change as new technologies are developed, new species are discovered, and new relationships between organisms are established.

How Are Organisms Classified?

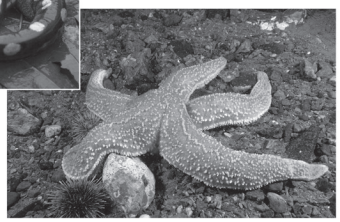
Throughout history, scientists have classified living things in different ways. At first, they used only two categories: plants and animals. As our understanding of the living world increased, these categories changed. One technology that helped increase our understanding was the microscope. A microscope 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.

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HOW ARE ORGANISMS CLASSIFIED?

BACKGROUND INFORMATION

- Classification of organisms involves studying the similarities and differences and categorizing the organisms according to characteristics such as:
  - structural similarities and differences
  - genetic similarities and differences
  - biochemical similarities and differences
  - evidence from evolutionary relationships
- A species is a closely related group of organisms. In order to be a species, these individuals must be capable of reproducing with one another and the offspring produced must be able to reproduce. For example, a donkey and horse can reproduce together, and the offspring is a mule. A mule, however, is sterile.

TEACHING STRATEGIES

- Ask students to write or draw in their logbooks to speculate "What if…" or any open-ended question dealing with a classification system (or lack of).
- Have the students discuss the importance of using classification systems, examples could include music or food in the grocery store.
- Make a list of classification systems that students use in their daily lives (for example, to organize food storage or clothes or dishes).
- In partners, have students study Figure 7.2 and brainstorm ways they might classify the organisms. Their answers may be as simple as "some are plants, some are animals" or "some can survive out of water, others cannot." Have students record their ideas in their science logbooks so that they can return to the question when they have learned more about classifying organisms.

Common Misconceptions

- Rather than being rigid, classification systems are arbitrary and subject to change, in terms of both grouping and terminology. Older reference books and Internet resources will give students a variety of terms and classifications. Names and categories are regularly changed as researchers find out more about the organism.
- Some students may believe that the behaviour of the organism and/or its habitat is the basis for classification. For example, since whales, seals, and fish all swim in the ocean, they must be in the same group.

DidYouKnow? Relate van Leeuwenhoek's discovery of single-celled organisms to the release of a new song or recording artist who produces a song that doesn't fit into an existing genre of music, for example, hip-hop. Because it didn't fit in any of the existing categories, a new genre of music needed to be named.

Figure 7.3

- Both of the organisms in this figure belong to the same kingdom. Ask students the significance of the fact that they belong to different phyla. (The similarities they share are limited to the fact that both are animals.)

BACKGROUND INFORMATION

- Latin and sometimes ancient Greek words are still used in the classification system because they were languages that scientists in the west all understood when the first system was being devised.

TEACHING STRATEGIES

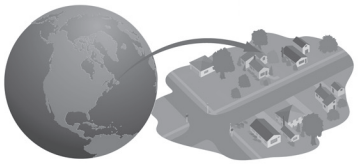
- Have students classify the whole class according to what each student is wearing as a shirt or upper-body clothing.
- Use Figure 7.4 to help students practise breaking information down into smaller categories.
- Make BLM 7.2, Classification of Dogs (Figure 7.5) into an overhead transparency. Walk students through each category of the classification system. Students do not need to memorize the categories; the goal is that they are aware of how the categories are arrived at.
  - Row 1: Explain how an organism is eliminated at each step because it has a key characteristic that is different from the other organisms.
  - Row 2: All of the organisms except the earthworm have a backbone. Earthworms belong to the same kingdom but a different phylum.
  - Row 3: All the organisms are mammals except the fish. It is in a different class.
  - Row 4: The order of carnivores includes all meat-eaters. The elephant eats only grasses, shrubs, and other vegetation.
  - Row 5: The river otter is not part of the family of canid, a carnivorous dog. It is part of the Family Mustelidae, which includes weasels, skunks, and wolverines.
  - Row 6: The red fox belongs to a different genus, called Vulpes.
  - Row 7: The coyote is a different species. It cannot mate with a domestic dog and produce fertile offspring.

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.

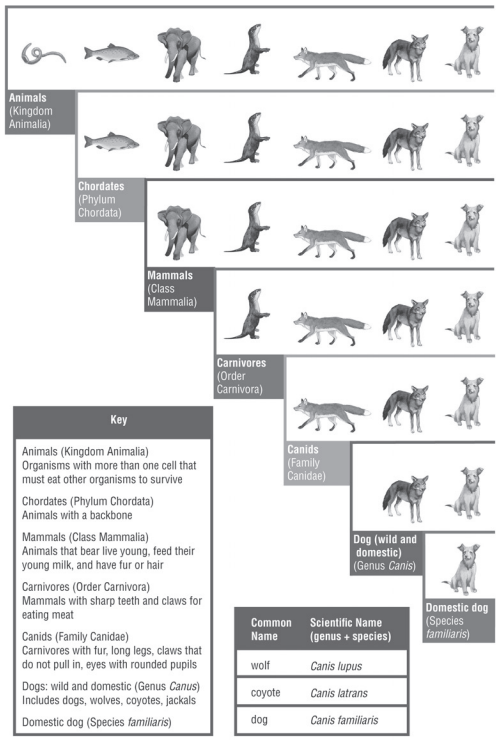


Figure 7.5 Classification key for dogs

- The following descriptions will give students an idea of how scientists make distinctions among the categories of classification. It is not intended that they learn the examples.
  - **Kingdom** is the most inclusive group. The six kingdoms include ancient bacteria (Archaebacteria), true bacteria (Eubacteria), protists, fungi, plants, and animals. Each kingdom differs from the others by the type and number of cells that form the organisms and by the major mode of nutrition.
  - **Phyla** (*singular:* **phylum**) contain organisms that have structures or characteristics in common, e.g., Phylum Arthropoda in the Kingdom Animalia contains the animals that have jointed legs (*arthro* = joint, *pod* = of legs). This phylum includes crabs, lobsters, spiders, and insects.
  - **Classes** are subdivisions of phyla that select for a smaller group of organisms, e.g., Class Insecta contains animals with three pairs of jointed limbs.
  - An **order** is a subdivision of a class that contains fewer organisms with another structure in common. For example, Order Coleoptera (koly–op–tera) (*cole* = sheathed, *ptera* = wing) contains beetles with two pairs of wings, one pair of which has been enlarged as a hard sheath or covering.
  - **Family** is a subdivision of order that identifies a further characteristic that only some members of the order have, e.g., Family Coccinellidae (cock-si-NEL-li-dee) are beetles that have short antennae. This family is made up of ladybugs.
  - **Genus** groups organisms that share many behavioural, biochemical, ecological, and biological characteristics because they are closely related evolutionarily. *Hippodamia* is one genus of ladybugs whose members have orange-red colouration and eat aphids.
  - **Species** is a group of organisms (within a genus) that have common characteristics and can interbreed and produce fertile offspring. The species *convergens* includes ladybugs that have 13 black spots on their body and two white lines on their head. *Hippodamia convergens* is the most common ladybug in North America.

READING Check "Generic" describes things that are generally the same, a whole group or class. The genus is the group of organisms that share many similar characteristics. "Specific" is defined as particular, distinctive, or unique. Species is the most specific level of classification for an organism.

TWO-PART SCIENTIFIC NAMES

BACKGROUND INFORMATION

- People developed their own naming system for the organisms around them and used their own languages. As scientists began to communicate with each other and share information, local naming systems made it impossible for them to share their findings.
- In the 1730s, a Swedish scientist, Carolus Linnaeus, developed a way to classify organisms that scientists all over the world agreed to use. He was the first to present the system of classifying things that divided the large category of kingdoms (first used by Aristotle) into smaller and smaller groups of organisms that were more and more alike.
- Rather than using all six parts of the classification to name an organism, only the last two are used. The first name is the genus. The second name is the species. Therefore the domestic dog is called *Canis familiaris*. Biologists all over the world adopted the system so they could share information.
- The genus part of the organism's name always begins with a capital letter; the species name is lower case. The scientific name is written in italics or underlined. In some cases, there is a third name that refers to the variety or subspecies of the organism.

TEACHING STRATEGIES

- Note that the purpose for including scientific names in the student textbook is to help students become familiar with the practice and encourage them to use the same terms that scientists all over the world use when they are looking at or discussing the same species. The names are not there for students to memorize.

Common Misconception

- Some students may be surprised that all domestic dogs, from a Mastiff to a Chihuahua, have the same scientific name—*Canis familiaris*. A species consists of subspecies (or breeds) that, despite being slightly different and/or having distinctly different appearances and behaviours, can still successfully interbreed.

Pause& Reflect Having at least two names makes it much easier to distinguish individuals with the same first name.

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.

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Figure 7.6
Ask your students why they think the wolf and the coyote are not members of the same species. (Although the animals could interbreed, their behaviour makes this unlikely—the wolf would probably have the coyote for lunch.)

TOOLS FOR IDENTIFYING ORGANISMS

BACKGROUND INFORMATION

- Classification keys use observable, physical characteristics to identify organisms.
- Dichotomous keys are also called "either/or" keys. The organism either has the characteristic or it doesn't have the characteristic. For example, an organism either has a body covered with feathers or it doesn't have a body covered with feathers.
- Students have been classifying using dichotomous keys with the instruction to sort "this" and "not this" since Science Primary. Begin by choosing from the first pair of descriptions and then follow through the key.

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.

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TEACHING STRATEGIES

- Bring in a field guide for birds found in your area and some binoculars. Take students out to the schoolyard and have them observe any birds that may be in the area. Have them use the field guide to identify a bird that they see and then use the field guide, Internet, or other resources to identify the kingdom, phylum, class, order, family, genus, and species of the bird.

Common Misconceptions

- Students may be surprised to learn that some dichotomous keys fill up entire books.
- Some students may think that classification keys are only used to classify living organisms. They are also used to classify non-living things such as rocks and minerals.

Figure 7.7

Common local names for *Epigaea repens* include mayflower, mountain pink, gravel plant, ground laurel, and water pink. It is a low-lying plant that spreads along the ground.

FIND OUT ACTIVITY 7-B IDENTIFYING CANADIAN CATS

Purpose

- Students use a classification key to identify two different cats.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 day before	– Use the Internet or other sources to locate larger images of the *Puma concolor* and the *Lynx canadensis* (optional).

Suggested Time

- 10 min

HINTS & HELPS

- Remind students that they have to start at step 1 and follow the steps in order. Use the analogy of walking down a flight of stairs.
- Remind them that they have to look closely at the physical characteristics of the organisms. You may need to point out the specific parts such as the ear tufts.
- Cougars (*Puma concolor*) are the largest cats found in Canada. The long tail is a distinctive feature. Cougars range in colour from grey to brown, cinnamon, or buff and a variety of shades in between.
- Lynx (*Lynx canadensis*) are often confused with the bobcat. Lynx have longer fur, longer legs, a black-tipped tail, and black-tufted ears. Their oversized paws act as snowshoes, allowing them to pursue prey in deep snow.

Implementing the Activity

- Write the key on the board or flipchart paper. Walk your students through the process, looking at both parts of each step before they begin. When they look at the tail length, the tail is either short or it is long. If it is short, they proceed to step 2. If the tail is long, then they move down to step 3.

Activity Wrap-Up

- Discuss the students' answers to the *What Did You Find Out?* questions.

Assessment Option

- Use Science Skills Checklist 15, Making Observations and Inferences.

What Did You Find Out? Answers

1. The cat on the left is a cougar (*Puma concolor*). The cat on the right is a lynx (*Lynx canadensis*).
2. Classification keys use step-by-step instructions. If you miss a step, you will have trouble classifying the organism.

FIND OUT ACTIVITY 7-C CREATE YOUR OWN CLASSIFICATION KEY

Purpose

- Students design and use their own classification keys.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 to 2 weeks before	– Begin collecting tree leaves, needles, and cones or find clear pictures of Nova Scotia trees.
1 day before	– Make an overhead transparency of BLM 7.3, Create Your Own Classification Key. – Photocopy Learning Skills Rubric 3, Co-operative Group Work (optional).

MATERIALS
– collection of tree leaves, needles, and cones or photographs of Nova Scotia coniferous and deciduous trees – large poster paper or paper used to cover tables

Suggested Time

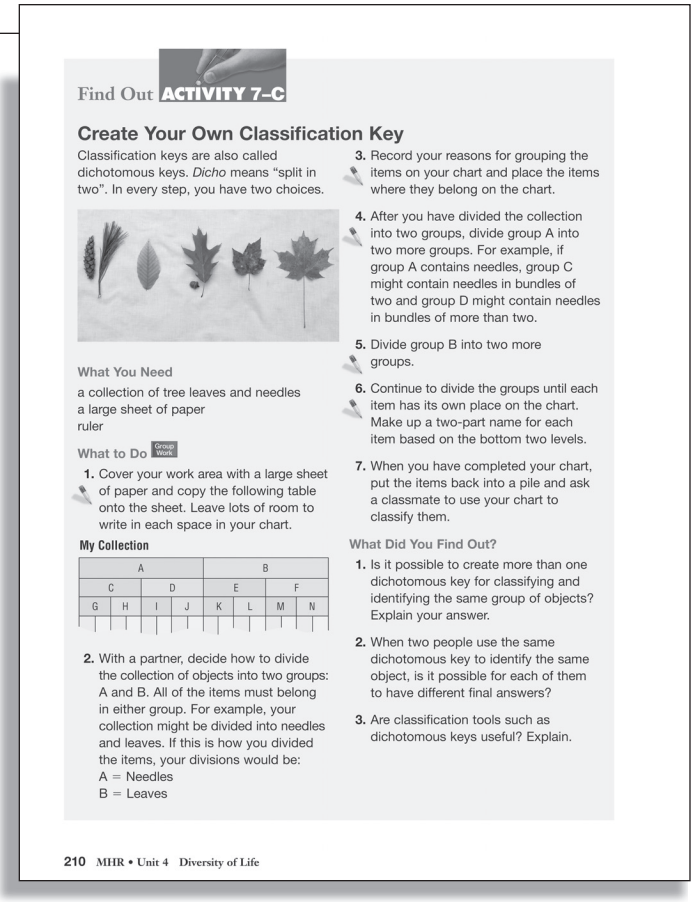
- 40-60 min

Safety Precautions

- Make sure that you are not bringing in any poisonous plant material.
- Fir or pine needles may trigger contact allergies.

HINTS & HELPS

- Try to get a variety of plant material. Ask your students to help you collect them. However, ask for materials that have fallen to the ground, not been cut from living trees. Or bring in photographs of the different coniferous and deciduous trees in Nova Scotia.
- Advise your students that there isn't a right or wrong answer. Dichotomous keys are arbitrary and based on observable characteristics.
- Put students into larger groups to reduce the amount of plant material required or use photographs instead of living material.
- Make sure you have a complete collection of plant material or photographs for each group. As an alternative, students could sort items such as shells. (Bags of shells are available at reasonable prices.)



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.

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Implementing the Activity

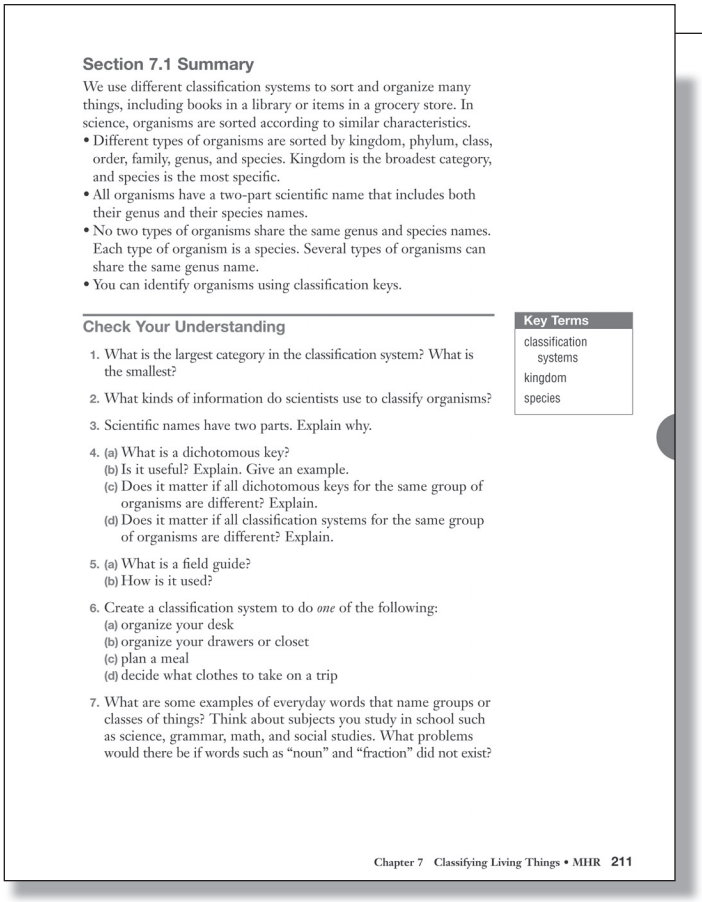
- Have your students make a copy of the Create Your Own Classification Key chart.
- Have students use their classification key to construct a dichotomous key that someone else could use to identify any tree in the given group. Ask your students to create a series of numbered steps, with the first step showing the first characteristic that they used. At each step, they must offer two choices for classifying the tree based on a single characteristic. For example, students likely used the characteristics "has needles" or "does not have needles" as their first dividing characteristic. The first numbered step would be
  1 a. has needles ..... go to number ___
  1 b. does not have needles ..... go to number ___
  Continue until all of the trees have been accounted for.

Adaptations

- Help your students with steps 2, 3, and 4 of the procedure, or set up a model of the first 2 or 3 steps for your students. This will help them visualize what you want them to do.

Activity Wrap-Up

- Ask students to exchange their classification key with another student team and use it to classify the plant materials. Have teams compare their results.



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

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Assessment Options

- Use Learning Skills Rubric 3, Co-operative Group Work or Learning Skills Checklist 6, Classification System to assess this activity. Alternatively, you may wish to work with the students to develop a rubric for assessing their classification systems.

What Did You Find Out? Answers

1. Yes, it is possible to make more than one classification key for classifying the same group of objects. All classification activities are arbitrary and depend on the characteristics selected by the individual who made the key.
2. If the key has been properly constructed, then it is unlikely that two people would end up with different final answers. The key should be specific enough for anyone to follow.
3. Classification keys are useful for identifying living or non-living things that someone has never seen before.

SECTION 7.1 SUMMARY

Review the section summary as a class. Make sure that students update their science logbooks and key terms list. Have students share some of their definitions of the key terms with the class and compare different interpretations of the same words.

✓ ASSESSMENT OPTIONS FOR SECTION 7.1

- Consider creating some extension activities for students who wish to meet higher expectations.
- Collect and review science logbooks, using Learning Skills Rubric 2, Science Logbook to evaluate student logbooks.
- Use the following checklists to assess student work:
  – Science Skills Checklist 15, Making Observations and Inferences for *Find Out Activity 7-B: Identifying Canadian Cats*
  – Learning Skills Checklist 6, Classification System for *Find Out Activity 7-C: Create Your Own Classification Key*

Check Your Understanding Answers

1. The largest category is kingdom. The smallest category is species.
2. Many classification systems are based on the physical characteristics of an organism.
3. Scientific names have two parts to accurately identify organisms. For example, there are many organisms (wolf, coyote, domestic dog) grouped in the Genus *Canis*. The second name clearly identifies the individual species. For example, *Canis lupus* distinguishes a wolf from a coyote (*Canis latrans*).
4. (a) A dichotomous key is a two-step classification key.
   (b) Yes. Dichotomous keys are useful when trying to identify unknown organisms such as a lynx or a cougar.
   (c) No. Dichotomous keys do not have to be the same for the same group. Scientists may use different characteristics to classify individual organisms.
   (d) In order to discuss organisms with each other, the classification systems should be the same.
5. (a) A field guide has pictures and descriptions of living or non-living things.
   (b) They often contain classification keys that give step-by-step instructions to help identify organisms.
6. Student answers should show how they separate the various items. Recommend that they use a chart similar to the *My Collection* chart found on page 210.
7. Answers could include generic terms such as fast-food restaurants, cars, socks, or boats. Without words for groups (noun or fraction), it would be very difficult to discuss things.

SECTION 7.2 THE KINGDOMS OF LIFE

What Students Do in Section 7.2

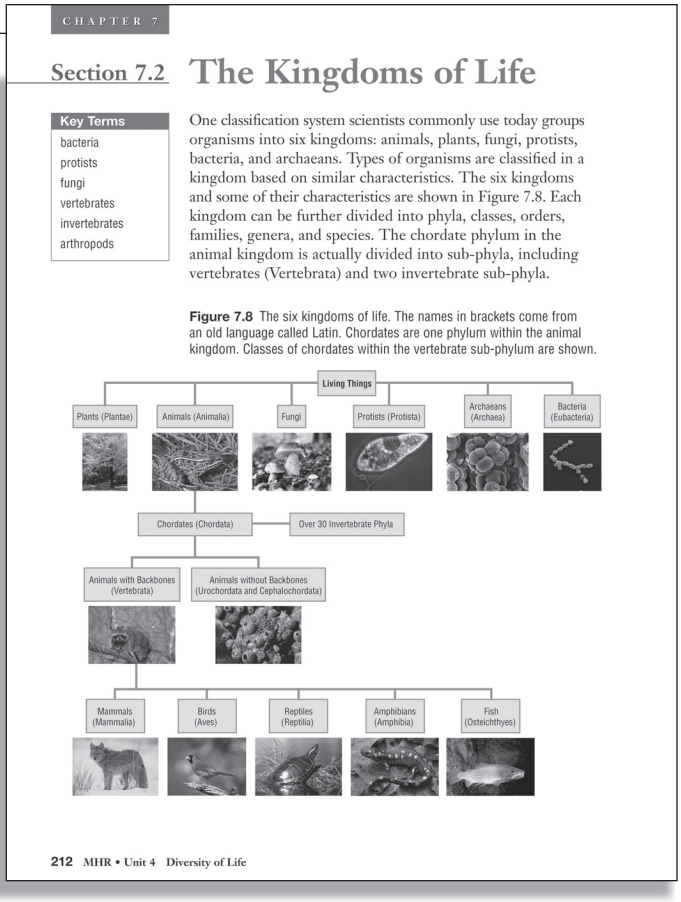
- explore the six kingdoms of life
- research a bacterium species that is useful to people
- research ways to control the growth of harmful micro-organisms
- use a microscope to look for micro-organisms in a sample of pond water
- investigate the similarities and differences among various members of the plant kingdom
- grow a mould in a variety of conditions
- classify pictures of animals as invertebrates or vertebrates
- classify arthropods

BACKGROUND INFORMATION

- The chart below summarizes the key differences among the kingdoms.

TEACHING STRATEGIES

- Photocopy and distribute BLM 7.4, Kingdoms of Life to your students. Make an overhead transparency or digital image to project on a whiteboard or screen. Use this chart to help students with the misconceptions or confusion that may arise when they look at this chart. Encourage students to add examples of each category on their copy of the chart.


CHAPTER 7

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.

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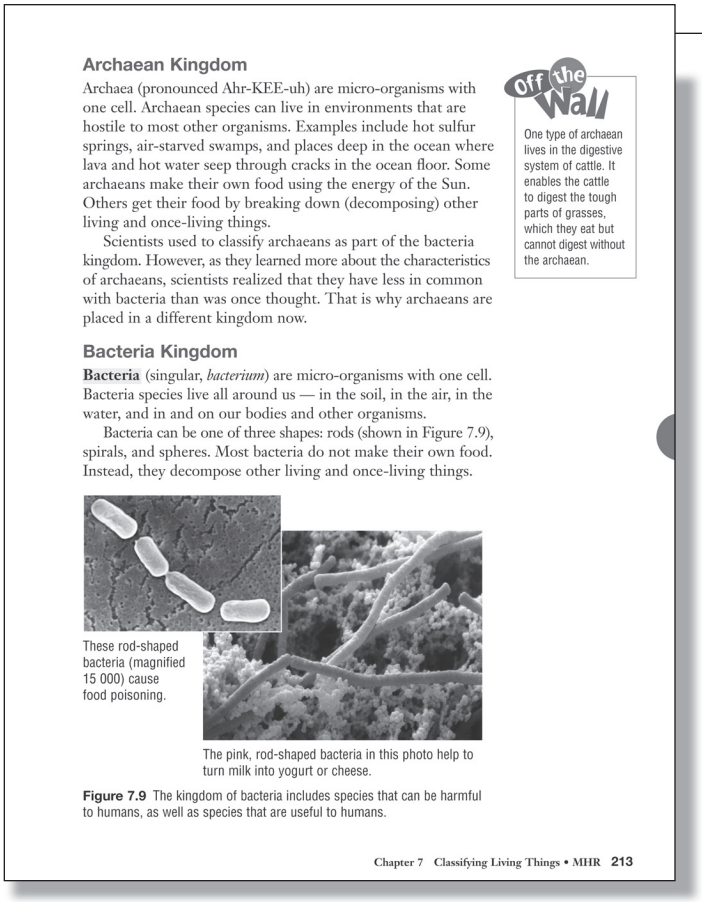
Common Misconceptions

- Point out there isn't a single phylum called "invertebrates." This is a general term that applies to over 30 different phyla of animals.
- When interpreting Figure 7.8 on page 212, note that chordates are one phylum in the animal kingdom and there are 30 other invertebrate phyla that belong to the animal kingdom. The other 30 phyla are not an offshoot of chordata.

PLANTS	ANIMALS	FUNGI	PROTISTS	ARCHAEANS	BACTERIA
make own food through photo-synthesis	must eat other organisms to obtain food	obtain food from other organisms	some use photo-synthesis; others obtain food from other organisms	some make own food; others obtain food from other organisms	some make own food; most obtain food from other organisms
				can live in extreme environments (temperature or without light or oxygen)	



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.

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ARCHAEAN KINGDOM

BACKGROUND INFORMATION

- Archaeans [AHR-kee-ons] are micro-organisms—so tiny they can only be seen with a microscope.
- Anaerobic bacteria can live without oxygen in extreme conditions. Certain kinds of anaerobic bacteria are thought to have existed for billions of years.
- Archaeans (also called ancient bacteria) and bacteria were placed in separate kingdoms because of differences in their molecular biology. Advanced studies of their RNA (ribonucleic acid; related to DNA) structure showed that they are very different from each other.
- Archeobacteria are grouped according to how they obtain energy. The methanogens use carbon dioxide for energy and produce methane gas. The extreme halophiles live in salty environments; some of them in a habitat 10 times saltier than seawater. The thermophiles get their energy by oxidizing sulfur compounds.

TEACHING STRATEGIES

- Ask students to write or draw in their logbooks to answer the question, "Do you think there is a place on Earth where there are no living things? Explain your answer."

Common Misconception

- Many students may not realize that not all food chains start with the energy of the Sun and photosynthesis. All of the organisms in the archaean kingdom are producers but do not have chlorophyll. Instead, they use chemosynthesis (a reaction that begins with a chemical instead of sunlight to create energy) to convert inorganic compounds into organic molecules (carbohydrates).

Off the Wall Animals such as cows, horses, sheep, goats, and termites have bacteria (archaebacteria) in their intestinal tracts. These bacteria possess the necessary enzymes to digest cellulose.

BACTERIA KINGDOM

BACKGROUND INFORMATION

- Some bacteria contain chlorophyll, which enables them to use carbon dioxide, water, and sunlight to make their own food through photosynthesis. Most bacteria, however, do not make their own food. Instead, these bacteria break down, or decompose, other living things to obtain energy. Other organisms, such as fungi and earthworms, also perform the vital role of breaking down wastes and dead organic matter. This recycles nutrients into the environment for use by other organisms.
- Most bacteria are one of three basic shapes—spheres, rods, or spirals.

TEACHING STRATEGIES

- Use the Internet or other resources to obtain a photomicrograph of the bacteria living on the human skin.

GOOD BACTERIA, BAD BACTERIA

BACKGROUND INFORMATION

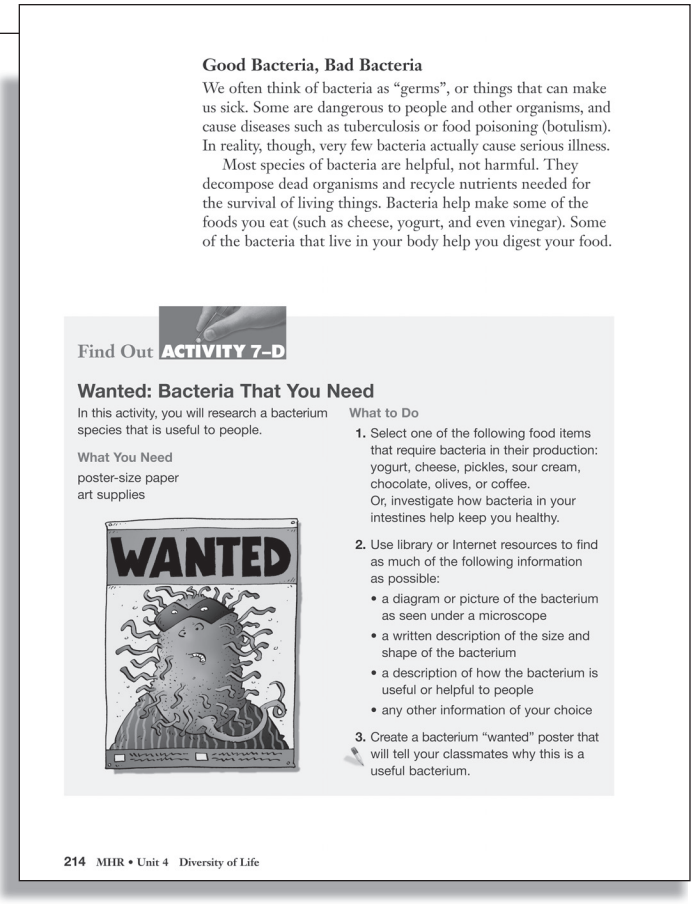
- Ask students to define the word micro-organism in their own words in their science logbooks or use BLM 7.1, Key Terms for the activity.
- Good bacteria keep our intestinal tracts healthy and are a first line of defence against invading viruses, yeasts, parasites and bad bacteria. Good bacteria also help make things like yogurt. Ask students how they think this could be. Other good bacteria help decompose plant material in soil or break down wastes during sewage treatment.
- Pathogenic bacteria cause disease. Pathogens can be dangerous because they are extremely invasive (they can grow quickly once they are established in a host) or they are toxic (they can produce damaging chemical substances). Sometimes they are both, but bacteria do not need to be both highly invasive and highly toxic to be rated as highly dangerous (virulent). For example, the bacterium *Streptococcus pneumoniae* (causes pneumonia) is not toxic, but it is so highly invasive that it causes the lungs to fill up with fluid. In contrast, the bacteria *Clostridium tetani* (causes tetanus) is not very invasive, but it produces such a potent toxin that it can cause damage at a very small concentration.

TEACHING STRATEGIES

- Provide students with the following information on the benefits of helpful bacteria: improved intestinal health, improved immune response, reduced risk of cancer and heart disease, improved milk tolerance for those who are lactose intolerant, decreased food allergies, lower "bad" cholesterol levels, protection from toxic substances, normalized blood pressure.

Common Misconceptions

- When most students think of bacteria they probably associate it with sore throats or other illnesses. However, very few bacteria cause illnesses. Most are important for other reasons. Bacteria are everywhere—in the air we breathe, the food we eat, and the water we drink. A shovelful of soil contains billions of them. Millions of bacteria live on and in the human body. Most are beneficial.
- Some students may become fearful when they find out that bacteria live in and on their bodies. They may want to remove bacteria from their skin. Stress that these bacteria, in their place, have an important role to play.



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.

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FIND OUT ACTIVITY 7-D WANTED: BACTERIA THAT YOU NEED

Purpose

- Students research a bacterium species that is useful to people and make a poster or collage about it. Alternatively they could prepare a poem, song, or multimedia presentation.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
2 to 3 weeks before	– Book library for students to conduct their research.
1 to 2 days before	– Students choose the bacterium they will study. You may wish to prepare a list in advance for them to choose from. – Photocopy Assessment Checklist 11, Poster (optional)

MATERIALS
– print and digital resources – poster-size paper – art supplies

Suggested Time

- 20 min for research
- 30 min for creating poster

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.

HINTS & HELPS

- You could include nitrogen-fixing bacteria in the list of beneficial bacteria. Nitrogen-fixing bacteria are found in the nodules of plants such as peanuts, peas, and alfalfa. Nitrogen-fixing bacteria change nitrogen from the air into forms useful for plants.
- If your students are going to use the Internet to do their research, bookmark specific web sites that you want them to look at.
- Assign each student or group of students a specific bacterium to research before going to the library or on a computer to save time.
- Use a stopwatch or a timer to limit the amount of time students spend "researching" their bacterium.

Implementing the Activity

- Distribute and discuss Learning Skills Checklist 5, Poster or Learning Skills Checklist 4, Computer Slide Show Presentation.
- There are likely a number of print resources in your school's library that provide the basic information required for this activity.

Adaptations

- You may have to explain what a "Wanted Poster" is to some students.
- You may have to help some students with the layout of their poster.

Activity Wrap-Up

- Have students share their posters with another class.

Assessment Options

- Use Learning Skills Checklist 5, Poster to evaluate the students' posters or Checklist 4, Computer Slide Show Presentation.

CONTROLLING THE GROWTH OF BACTERIA AND OTHER MICRO-ORGANISMS

BACKGROUND INFORMATION

- The four basic requirements bacteria have for growth are food, moisture, warmth, and time. The pH (acidity) of the environment also aids reproduction. Controlling these factors is the key to either supporting or killing off bacteria.
- Under optimal conditions, many bacteria can divide and produce a new generation every 20 to 30 minutes. Assuming that no bacteria die and they have an unlimited food supply, in 12 hours a single bacterium could produce approximately 5 billion offspring. (Under natural conditions this never occurs.)
- The basic premise of food preservation is to either slow down the action of the micro-organisms that are causing the food to spoil or kill these organisms altogether.

TEACHING STRATEGIES

- Review Health Canada's Food Handling Tips and compare them with what students know about bacteria and micro-organisms. Ask students to suggest why certain food handling techniques are recommended.
- Ask students why they think bread left out in a kitchen will turn mouldy, and bread in the fridge does not get mouldy as quickly. Remind them of the conditions that living things need to survive. Why would a refrigerator change the outcome?

Common Misconception

- Many people believe that antibiotics can be used on all types of illnesses and diseases. Reinforce the fact that antibiotics are only effective on conditions that are caused by bacteria.

FIND OUT ACTIVITY 7-E KEEPING MICRO-ORGANISMS UNDER CONTROL

Purpose

- Students will research ways that scientists have developed to control the growth of harmful micro-organisms.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 to 4 weeks before	– Book the library. Ask your librarian to set aside relevant print resources. – Contact parents or community members who can or smoke food to preserve it and ask if they would be willing to discuss how these techniques work.
1 to 2 days before	– Photocopy Learning Skills Rubric 7, Multimedia Presentation (optional). – Photocopy BLM 7.5, Food Preservation Techniques.

MATERIALS
– Internet or print resources – poster or presentation supplies (optional)

Suggested Time

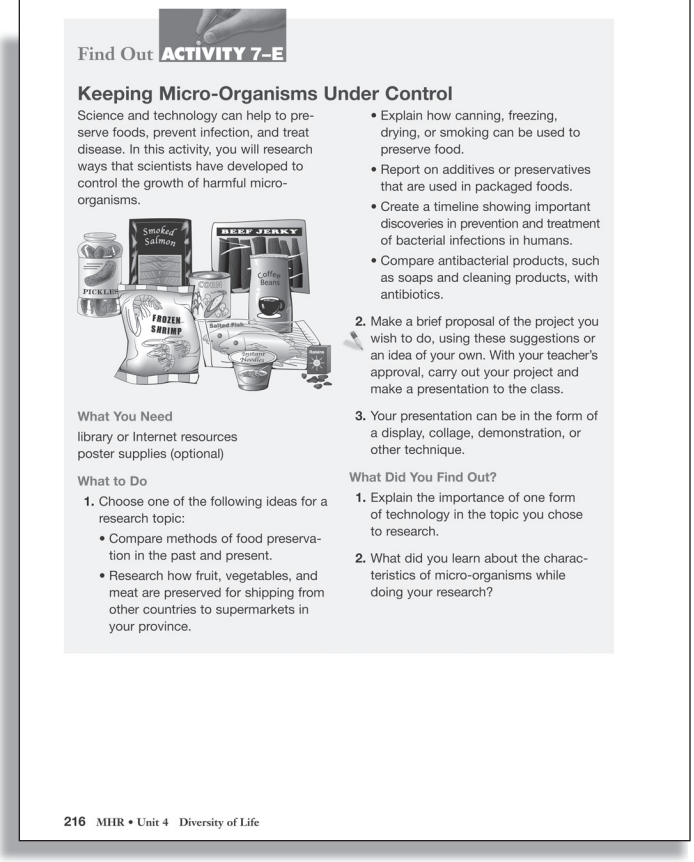
- 30 min to complete research
- 30 min (minimum) to develop presentations

HINTS & TIPS

- Book the library ahead of time. Talk to the librarian and ask for any print resources on food preservation.
- If your students are going to use the Internet to do their research, bookmark specific web sites.
- Students may wish to conduct an interview with someone skilled in a particular food preservation technique and base their presentation on the interview.
- Determine the type of presentations that you want your students to do ahead of time. Although the procedure provides students with some latitude, it would save instructional time if you had a list of presentation ideas, such as a computer slide show presentation, posters, or collage, for them to choose from.

Implementing the Activity

- Distribute and discuss any checklists or rubrics that you will use to assess this activity.
- Photocopy, distribute, and discuss BLM 7.5, Food Preservation Techniques. Advise students to indicate, if possible, how the technique they are researching inhibits the growth of or kills the micro-organisms.
- Advise students to include the answers to *What Did You Find Out?* questions 1 and 2 in their presentation.



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?

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Adaptations

- Pairing students with learning difficulties with community members to demonstrate a specific food preservation technique may be a good way to get the students involved in this activity.

Activity Wrap-Up

- Have students complete their presentations. If they are researching a specific technology, reinforce how the technology inhibits the growth of or kills the micro-organisms that cause food to spoil.

Assessment Options

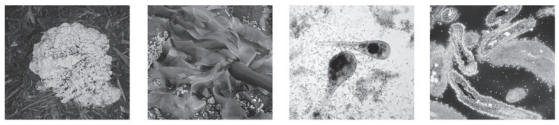
- Use Learning Skills Rubric 5, Research Project or 7, Multimedia Presentation to assess student work.

What Did You Find Out? Answers

1. Answers must link the technology to the control of micro-organisms. Accept all reasonable answers.
2. Answers should include details about the idea conditions for growth of micro-organisms, how they reproduce, or what they need to survive.

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.

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PROTIST KINGDOM

BACKGROUND INFORMATION

- Amoebas (Figure 7.11) move by extending parts of their cells as pseudopods (sue-doh-pods) or "false feet." As the pseudopod stretches out, the fluid flows into it, causing the organism to move in that direction.
- Plant-like protists are known as algae.
- Ciliates, such as the paramecia shown in Figure 7.11 swim by beating their cilia (tiny hairs) in a rhythmic pattern.
- Fungus-like protists include several small phyla of protists that have features of both protists and fungi. Slime moulds (Figure 7.11) and water moulds are fungus-like protists. Slime moulds form delicate, brightly coloured, web-like structures on the surface of their food supply. They obtain energy by decomposing organic materials.

Off the Wall Students may wonder why some moulds are classed in the Kingdom Protista while others are in the Kingdom Fungi. Moulds that can move, such as slime moulds, are protista. Moulds that grow in size rather than actually moving, such as bread moulds and yeast, are fungi.

TEACHING STRATEGIES

- Order a living slime mould kit from a scientific supply company. (Approx. $40.00) The organism will be easy to manipulate in culture and observe. Students could make daily observations and drawings of the mould as it grows and moves.

Common Misconception

- Many students may believe that members of the protist kingdom are single-celled organisms. This is a very diverse kingdom that includes multicellular organisms as well as single-celled organisms.

CONDUCT AN INVESTIGATION 7-F LOOKING FOR MICRO-ORGANISMS

Purpose

- Students use a microscope to view micro-organisms in a sample of pond water.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 to 4 weeks before	– Order prepared slides of pond water organisms from a scientific supply company (optional).
2 weeks before	– Gather materials for the hay infusion or ask students who live near a pond to bring in samples of pond water.
1 week before	– Option: Photocopy, distribute, and review (Science Skills Review) BLM SSR-3, Using a Microscope to refresh students' memories on the workings of a microscope. (Or prepare it as a poster for display.) – Prepare hay infusion according to steps 1 and 2 on page 218 of student textbook.

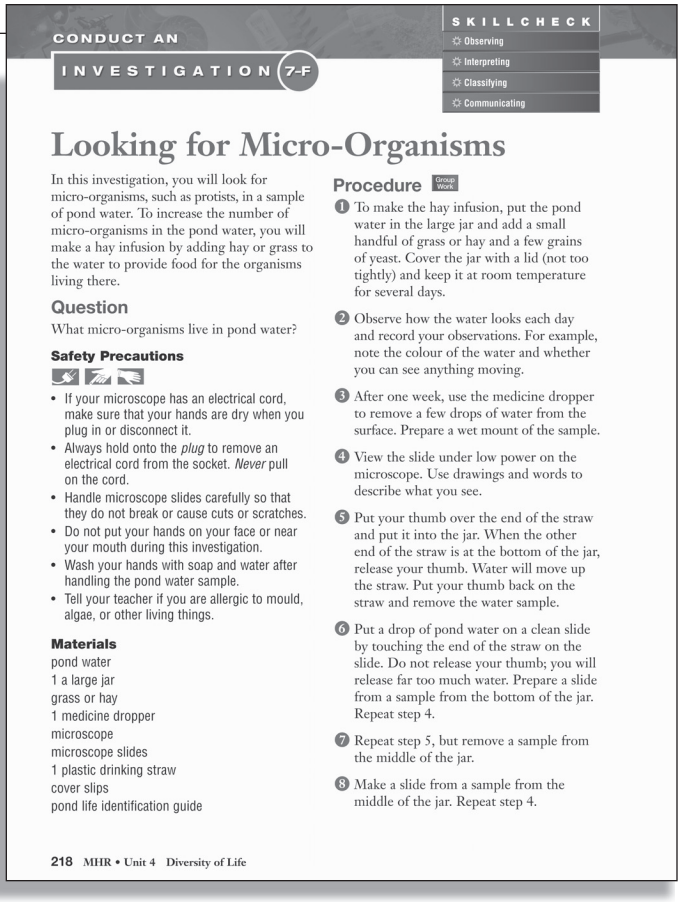
MATERIALS
– microscopes – prepared slides of pond water micro-organisms (optional) – microscope slides – microscope cover slips – large jars – grass or hay and active yeast – pond water – medicine droppers – plastic drinking straws – pond life identification guide

Suggested Time

- 20 min to make hay infusion; 5 minutes per day for the first week to tend to and observe hay infusion jars
- 30 minutes to complete steps 3 and 4 (including set-up and clean-up); 30 minutes to complete steps 5 to 8

Safety Precautions

- Before you begin, find out if any students are allergic to mould, algae, or other living things.
- Remind students not to touch their faces or mouths during this investigation and to wash their hands with soap and water after handling the water samples.
- Review the steps for safe handling of a microscope, slides, and cover slips.
- Ensure that students wear gloves and protective eye wear through this activity.
- Ensure that students wipe down work areas, microscope slides, and cover slips with a mild bleach solution (or disinfectant approved by the board) when they are finished.



CONDUCT AN INVESTIGATION 7-F

SKILL CHECK
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.

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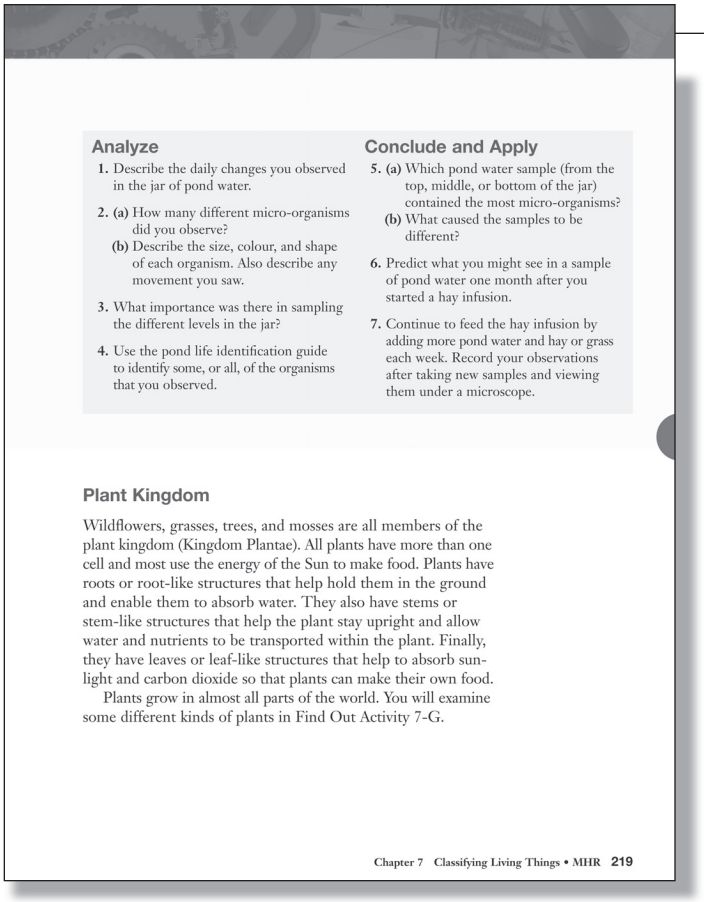
- Have students bring the water samples to you when the investigation is finished. Add bleach solution (or disinfectant approved by the board) to the infusion to kill the organisms. Dispose of the samples according to school safety guidelines.

HINTS & HELPS

- Option: Photocopy and distribute BLM SSR-3, Using a Microscope at least one week prior to this investigation to remind students of proper techniques for handling and using a microscope as well as how to make wet mount slides.
- Consider having students view prepared slides of pond water organisms for a chance to observe samples of the micro-organisms they will be seeking.
- Suggest that students include a very tiny bit of plant material in their slide; a number of protists attach themselves to this type of debris.
- A hay infusion can also be used to demonstrate that not all organisms are found at the same time. One organism will replace another with time.

Implementing the Investigation

- Review the safety precautions. Ensure students are wearing proper gloves and safety glasses to reduce the chances of coming into contact with potentially pathogenic micro-organisms.
- Demonstrate how to get water samples from various levels in the jar using the straw.



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.

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Adaptations

- Arrange to borrow 3-D models of pond water organisms for visually impaired students.

Investigation Wrap-Up

- Discuss where the micro-organisms might have come from. (They were already on the hay as spores.)

Assessment Option

- Use Science Skills Rubric 19, Conduct an Investigation to assess student work in this activity.

Analyze Answers

1. Students should observe that the colour became a darker yellow during the investigation.
2. (a) Students should be able to observe five to 15 different species depending on the area that they are observing, how the hay infusion was made, and the time the sample was taken. For example, there are predators in the hay infusion that could change populations throughout the duration of this activity.
   (b) Students should include drawings and descriptions of what they see and compare these with a field guide/book to determine what bacteria they have seen. The following may be present: paramecia, volvox, rotifers, spirogyra, green algae, and amoebas. Other organisms may also be present.
3. The organisms live at different levels in an aquatic ecosystem. For example, photosynthetic protists would be found in areas where more light penetrates the water column. Decomposer protists would be found near the bottom of the system where dead organisms and waste products tend to accumulate.
4. Expect lists to include paramecia, amoebas, rotifers, algae, stentors, volvox, and euglenas.

Conclude and Apply Answers

5. (a) The water from the top of the jar, the bottom of the jar, and the middle of the jar should produce about the same number of microbes. Each level should produce different types of microbes
   (b) Answers could include different food sources, different amounts of oxygen exist at different levels, variations in the amount of light, and other physical factors may affect the different populations.
6. Students may have difficulty predicting what will happen with time. Accept that the beaker will change colour or it will stink more or there will be different organisms in the infusion after a month.
7. If you do allow the activity to go on for several weeks, your students may observe flagellates, ciliates, and diatoms. These should be visible using either the 200- or the 400-power objective lens.

PLANT KINGDOM

BACKGROUND INFORMATION

- There are over 375 000 species of plants. They have chlorophyll and make their food from the Sun's energy. Plants are divided into two main groups: vascular and non-vascular.
- Vascular tissues conduct either food or water. These are tubular tissues, often called the veins of the plant. They can be easily seen in a celery stem.
- Non-vascular plants do not have vascular tissues such as roots, stems, or leaves and are smaller than most vascular plants. Non-vascular plants live in fewer types of environments.

TEACHING STRATEGIES

- Ask students to define the word "plant" in their science logbooks.
- Have students make a network tree in their science logbooks to highlight the differences between vascular and non-vascular plants.

FIND OUT ACTIVITY 7-G PLANT SURVEY

Purpose

- Students investigate the similarities and differences between various plants.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 to 4 weeks before	– Order, purchase, or arrange to borrow field guides identifying the plants that you are going to use.
2 to 3 weeks before	– Start collecting plant samples.
1 to 2 days before	– Photocopy appropriate field guide information for each type of plant that you are providing for students.

MATERIALS
– magnifying glass – pencil – ruler – paper – plant samples – plant identification field guides – digital camera(s)

Suggested Time

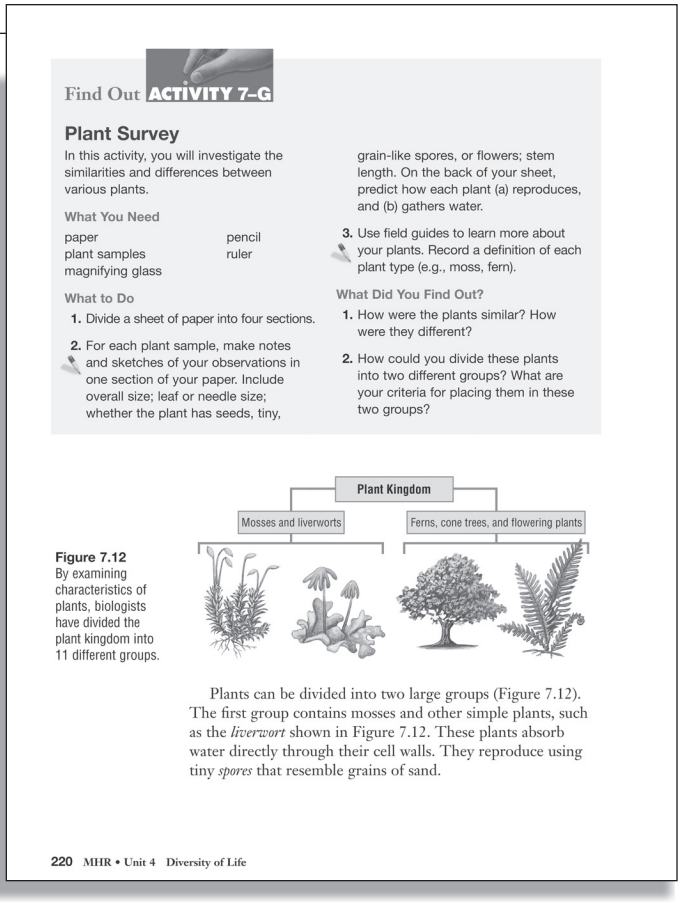
- 60 min

Safety Precautions

- Check for allergies before bringing specific plants into your classroom.

Implementing the Activity

- Set up stations in your classroom. Place one type of plant at each station, and make sure there's enough room for students to do their sketches and make notes. Group your students and have them rotate through at least two stations. Use a kitchen timer to make sure students move through each station efficiently.
- Photocopy the relevant information on each plant, plus a few others, from a field guide or Internet resource. Once students have viewed all the plants, invite them to identify the samples.



Find Out ACTIVITY 7–G

Plant Survey

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

What You Need

paper, pencil, plant samples, ruler, magnifying glass

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.

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HINTS & HELPS

- If you are going to bring in living plants, make sure you are not collecting plant samples from protected areas. Only collect small samples of each type of plant to reduce your impact on the environment. If you are bringing in coniferous samples, include the cones as well as the needles.
- Check with a local floral shop or even a grocery store in your area to see if you can beg, borrow, or purchase samples of various plants they may have. Consider inviting a representative from a local nursery or conservation area in to make a presentation on native plants.
- If you live near a national park, invite their biologists in to talk. Kejimkujik National Park will make arrangements for their people to travel out to schools within a 2-hour radius.
- If you live near a woodland area, plan a field trip to study the plants in their environment. Use the opportunity to talk about stewardship of the environment or students' ecological footprints. Check with your principal and school board regarding policies on field trips.

Adaptations

- To help students with ESL or students with reading problems, highlight or underline the key points from field-guide entries.
- Students with allergies to plant material should be given a comparable assignment that uses print or digital resources only under the supervision of another teacher or the librarian.

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

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.

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.

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.

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- Students with visual impairments could be provided 3-D models or enlarged photocopies of the different representatives of the plant kingdom.
- Challenge advanced students to create a classification system for the plants.

Activity Wrap-Up

- Check with your school librarian, public library, or other sources for a video/DVD on the major plant groups.
- Discuss the importance of preserving native plants and of not exporting plants to other areas of the province or country.

Assessment Options

- Use Learning Skills Rubric 4, Scientific Drawing or Science Skills Checklist 15, Making Observations and Inferences to assess student work.

What Did You Find Out? Answers

1. Similarities could include colour, presence of leaves; differences could include size, presence of flowers or needles.
2. Student answers will likely group their plants based on needles, leaves, and perhaps the presence of flowers. The criteria should reflect the plants supplied and the characteristics that the students have selected.

FUNGI KINGDOM

BACKGROUND INFORMATION

- Mushrooms, moulds, mildews, yeasts, rusts, and smuts are all members of the Kingdom Fungi. Fungi are consumers and decomposers.
- Fungi feed by secreting a mixture of digestive enzymes and fluid onto their food and then absorbing the resulting nutrients.
- Most of the body of a fungus is thread-like (hyphae) with the threads interwoven to produce a mat-like structure (the mycelium). This is often white and is easily seen on the outside of soft cheeses such as Brie or Camembert. Fungi such as the puffball shown in Figure 7.13 grow well in damp conditions.
- Yeasts are fungi that grow on the surface of fruit (for example, the bloom on black grapes) and in flowers.
- Most fungi reproduce by forming spores and are classified according to how they form spores.

TEACHING STRATEGIES

- Survey the class for allergies to plants and mushrooms. If possible, bring in several examples of mushrooms to demonstrate the variety of fungi. Clearly note that many species of mushrooms are very poisonous, so eating mushrooms in the wild is very dangerous.
- Have your students cut through the cap and stipe (stalk) of the mushroom and use a hand lens or dissecting microscope to see the hyphae and spores. They should wear gloves and eye protection and ensure that they do not inhale any of the spores. Ensure they wash their hands thoroughly after the activity.

Common Misconception

- At one time, fungi were classified as plants. However, they are consumers/decomposers and have since been moved into their own kingdom.

DidYouKnow? *Penicillium notatum* is a bluish-green mould that grows on old bread and on fruit. It produces the antibacterial drug penicillin, discovered by Alexander Fleming in 1929 but not used extensively until the 1940s. Penicillin has saved over 50 million lives since World War II.

CONDUCT AN INVESTIGATION 7-H GROW A FUNGUS GARDEN

Purpose

- Students determine what conditions are necessary for the growth of bread mould.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 day before	– Gather all materials. – Photocopy BLM 7.6, Grow a Fungus Garden.

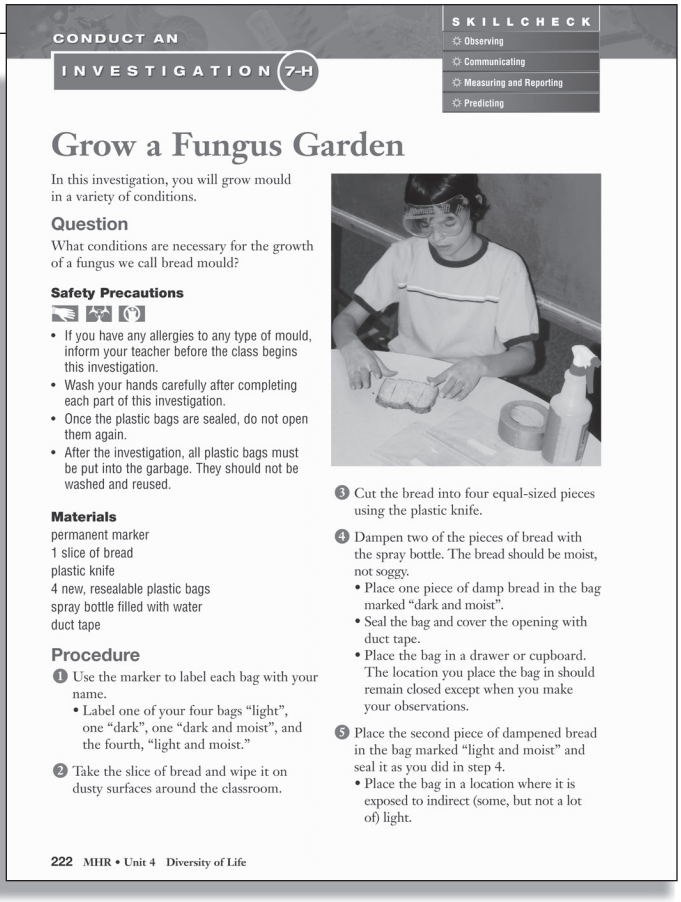
MATERIALS
– spray bottle filled with water – permanent marker – 1 slice of bread – plastic knife – 4 new, resealable plastic bags – duct tape

Suggested Time

- 20 min to prepare samples and table for recording observations
- 10 min to record observations each day
- 20 min for questions 1-7

Safety Precautions

- Be aware of any students who have allergies to mould and plan how they will do the activity.
- Take great care with step 2. Depending on the site chosen, students could pick up and culture pathogenic bacteria or fungi. Only students wearing gloves should do this step.
- Keep the plastic bags sealed at all times. As an extra precaution, use the duct tape to seal the bags securely.
- Grow cultures only at room temperature or in the range of 25°C to 32°C—incubation at 37°C encourages growth of micro-organisms capable of living in the human body.
- All plastic bags containing mould samples must be disposed of according to school policy when the investigation is completed.
- Students must wash their hands with soap and warm water after each part of the investigation.



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.

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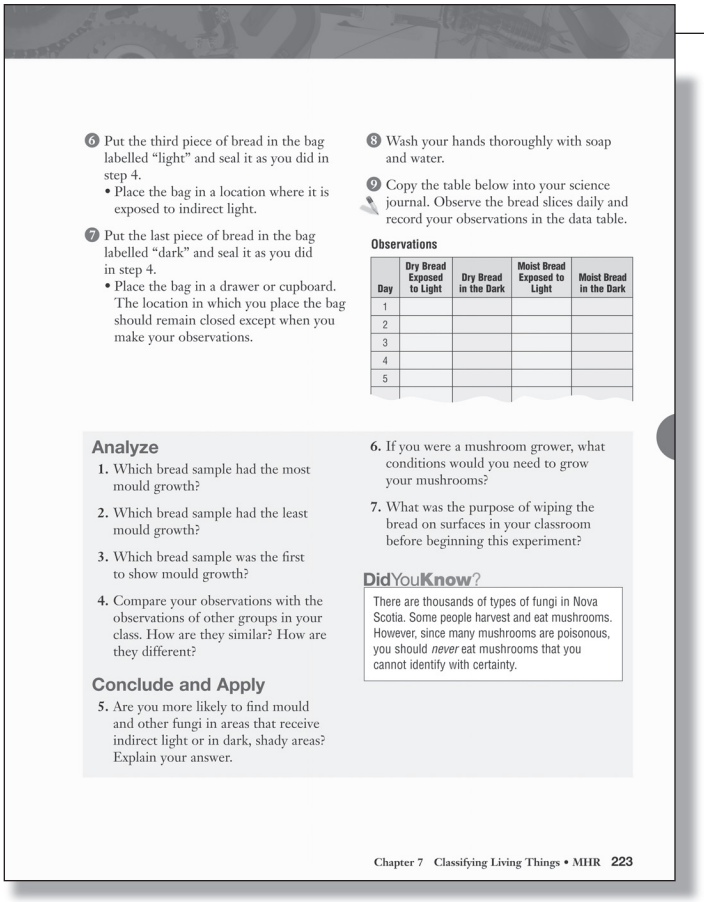
- Clean up any spills or dispose of the samples using proper procedures: wear disposable gloves; cover the spill with paper towels; pour a disinfectant such as 10 percent bleach solution (or disinfectant approved by the school board) on top of the towels and leave it for 10 to 15 minutes; wipe up the spill with the towels and discard into an airtight plastic bag or other appropriate container; autoclave if possible.

HINTS & HELPS

- Mould may grow faster on bread that is already a little stale.
- If possible, use bread made without preservatives.
- You may find that mould grows fastest on white bread.
- It may take several weeks or longer for mould to grow.

Implementing the Investigation

- Prior to beginning the investigation, have the students make a prediction as to which bread sample will develop the most mould.
- Distribute BLM 7.6, Grow a Fungus Garden for students to record their observations.



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.

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Adaptations

- Students with allergies should have other activities to complete the investigation away from the classroom.
- Those who finish this project early might be challenged to expand on the *Did You Know?* activity as described below.

Investigation Wrap-Up

- Have students comment on whether their prediction was correct and what they have learned.

Assessment Option

- Use Science Skills Rubric 19, Conduct an Investigation to assess students' work.

Analyze Answers

1. The bread sample with the most mould was moist and kept in a dark place.
2. The bread sample with the least mould was dry and kept in the light.
3. The first bread sample to show signs of mould was moist and kept in a dark place.
4. In comparing observations, students should note that the moist sample kept in a dark place grew the most mould. Some samples, even though stored in the same manner, may have grown even more mould, possibly because of the amount of water added or the amount of dust (spores) on the bread to begin with.

Conclude and Apply Answers

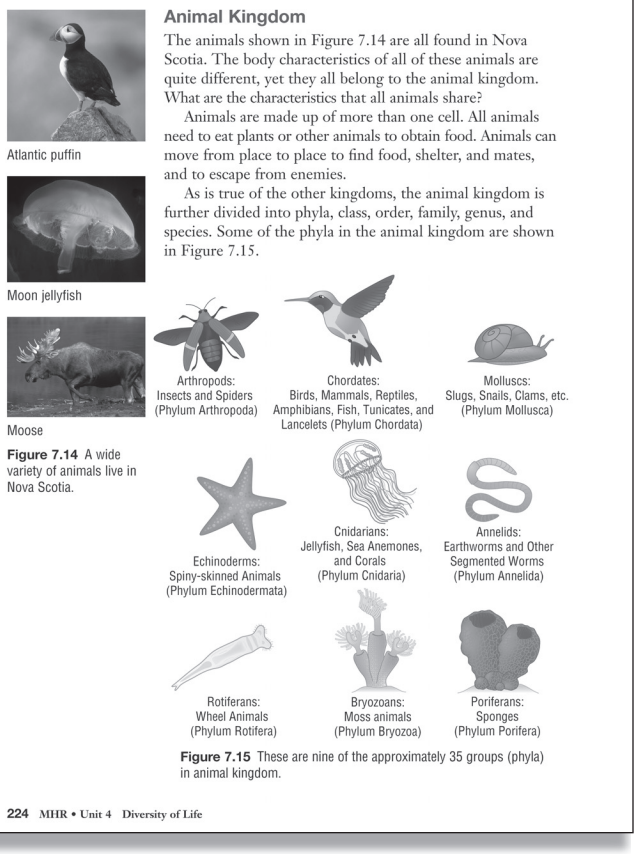
5. You would more likely find mould and other fungi in areas that are shady, because they grow best away from light, in areas that retain some moisture.
6. A mushroom grower would want moist and dark growing conditions for best results.
7. Fungi use tiny spores to reproduce. The bread was wiped on surfaces in the classroom to collect spores. The more spores there are, the more noticeable the amount of mould growth.

DidYouKnow? Have pictures of different types of mushrooms available. Students can research the name of the mushroom they chose, where it grows, any special features it has, and whether it is edible. Ask students to record findings on one side of an index card and illustrate the mushroom on the other side. Students could use the information to develop a classification key for mushrooms.

ANIMAL KINGDOM/INVERTEBRATES: ANIMALS WITHOUT BACKBONES/ VERTEBRATES: ANIMALS WITH BACKBONES

BACKGROUND INFORMATION

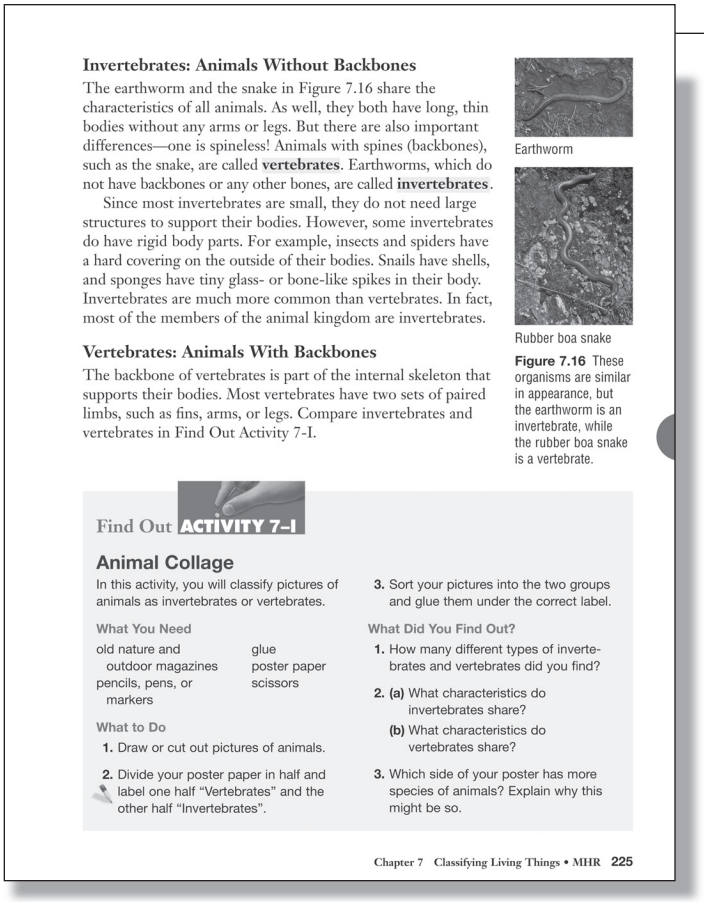
- To classify an animal, scientists usually start by checking for a backbone. Animals with a backbone are called vertebrates, while those without a backbone are called invertebrates.
- Currently there are 38 phyla in the animal kingdom; that number is likely to increase as scientists discover new species of invertebrates. 37 of the phyla feature invertebrates.
- The Atlantic puffin (*Fratercula arctica*) (Figure 7.14 top) lives on the east coast of North America. During the breeding season, adults have a large, brightly coloured bill. They spend their winters at sea.
- The moon jellyfish (*Aurelia aurita*) (Figure 7.14 middle) is found around the world. It uses small tentacles to sting and capture prey.
- The moose (*Alces alces*) (Figure 7.14 bottom) is the largest living member of the deer family. The word "moose" comes from an Aboriginal word that means "eater of twigs."
- The following phyla within the animal kingdom are shown in Figure 7.15:
  - Arthropods: 80 percent of the planet's organisms are arthropods; about 1 million species have been identified to date.
  - Chordates have a hollow nerve cord in their backs and a notochord, at some stage in their lives. Vertebrates comprise 95 percent of the Phylum Chordata.
  - Molluscs include animals whose soft body is protected inside a shell, such as clams and whelks; it also includes octopi and squid.
  - Echinoderms: sea stars, sand dollars, sea urchins, sea cucumbers.
  - Cnidarians (nye-dare-rians; the C is silent): "stinging creatures" such as jellyfish, anemones, and corals. At one time, sponges, anemones, and corals were thought to be related to plants. However, studies under the microscope made it clear that these organisms are animals.
  - Annelids: the body is a tube within a tube, wrapped with ring muscles.
  - Rotiferans: microscopic worms that have one or two rotating structures on their heads to help with feeding; most feed on bacteria, algal cells, small protists, or organic detritus.



  - Bryozoans: aquatic animals living mainly in colonies of interconnected individuals on the surfaces of others or of objects such as the bottoms of boats.
  - Poriferans: the simplest animals; as adults they are filter feeders.

TEACHING STRATEGIES

- Ask students to write or draw their impressions of animals without backbones in their logbooks. Ask them to describe these organisms. Where do they think they would find them?
- If you have access to a beach or rocky intertidal zone, organize a field trip for your students to these areas. Your students will be able to see representatives of at least nine phyla of invertebrates during the outing. Make sure that you have sufficient supervision, have a sound safety plan in place, and have received the appropriate approval from parents, your principal and/or school board.
- Contact local nature centres, colleges, or universities to see if you can arrange to have a naturalist or marine biologist accompany your group. Alternatively, arrange for a visit from Parks Canada biologists or fisheries biologists to talk to students about organisms with and without backbones.



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.

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.

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.

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.

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Common Misconceptions

- Students may believe that all animals can travel. Many invertebrates, such as barnacles, mussels, sponges, and corals, do not move as adults. However, most of these have free-swimming larval forms.
- All snails are slow. *Haliotis* is a snail that travels 48 metres in one hour.

FIND OUT ACTIVITY 7-I ANIMAL COLLAGE

Purpose

- Students classify pictures of animals as invertebrates or vertebrates.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 month before	– Collect old nature and outdoor magazines.

MATERIALS
– scissors – old nature and outdoor magazines – glue – poster paper – pencils, pens, markers

Suggested Time

- 45 min

Hints

- Have students select only one picture for each species they find.

Implementing the Activity

- Instead of gluing the pictures, have the students place them under the right column.
- *ICT Option:* Pictures of animals can be obtained through the Internet, and an electronic collage could be created.

Adaptations

- Students with learning difficulties can make their own poster but could ask another student to assist with identifying whether each animal is a vertebrate or invertebrate.

Activity Wrap-Up

- Students share their findings and make any corrections.
- Review students' classification charts to assess their learning.

Assessment Option

- Use Learning Skills Checklist 5, Poster to assess students' work.

What Did You Find Out? Answers

1. The number of invertebrates and vertebrates each student found will depend on the resources used.
2. (a) Invertebrates do not have backbones and are usually very small.
   (b) Vertebrates have backbones as part of the internal skeleton that supports their bodies. Most vertebrates have two sets of paired limbs, such as fins, arms, or legs.
3. Students who have more invertebrate animals in their poster might say it is because there are more invertebrates than vertebrates in Kingdom Animalia. Those who have more vertebrate animals might say it is because of the type of magazines they used or because vertebrates are larger animals and therefore are more noticeable in pictures (and more likely to be photographed).

CONDUCT AN INVESTIGATION 7-J CLASSIFYING ARTHROPODS

Purpose

- Students identify the characteristics used to classify arthropods.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
2 or 3 weeks before	– Obtain permission from parents and school to take students out of the classroom. – Arrange to get a set of field guides for arthropods in your area.
1 week before	– Ask parents to indicate if students are allergic to bees, wasps, insect bites, or spider bites.
1 day before	– Review safe and respectful procedures for the outdoors.

MATERIALS
– clipboards – hand-held magnifiers – pictures of arthropods or field guides – computers with Internet access – digital cameras

Suggested Time

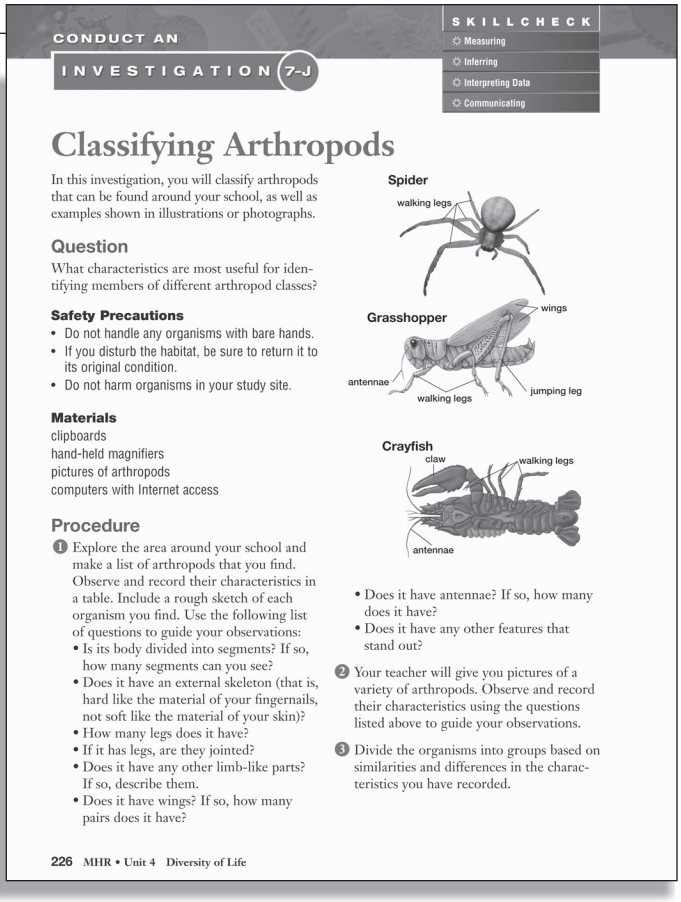
- 60 min

Safety Precautions

- Remind students not to handle any organisms with their bare hands.
- Ensure students are respectful of habitat and return it to its original condition.
- Make sure you are aware of any students with allergies to bee or wasp stings, insect bites, or spider bites. Have an alternative activity planned for those students.
- Students should have proper clothing, sun block, and insect repellent as needed. Remind them to tuck in sleeves and pant legs to avoid ticks.

Implementing the Investigation

- Suggest students prepare their observation tables ahead of time. Point out the main characteristics of this diverse group, including the number of legs and the presence or absence of wings or antennae. Students can use this information to create their tables, and they will need it to answer one of the questions at the end of this activity.
- Organize students into teams of three. Assign a specific responsibility, e.g., explorer, observer, recorder, to each student.
- Clearly define the boundaries of the study area.
- Clearly define the procedures that you want your students to follow. Review the safety precautions.



CONDUCT AN INVESTIGATION 7-J

SKILL CHECK
- 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?
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.

Spider
walking legs

Grasshopper
wings
antennae
walking legs
jumping leg

Crayfish
claw
walking legs
antennae

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HINTS & HELPS

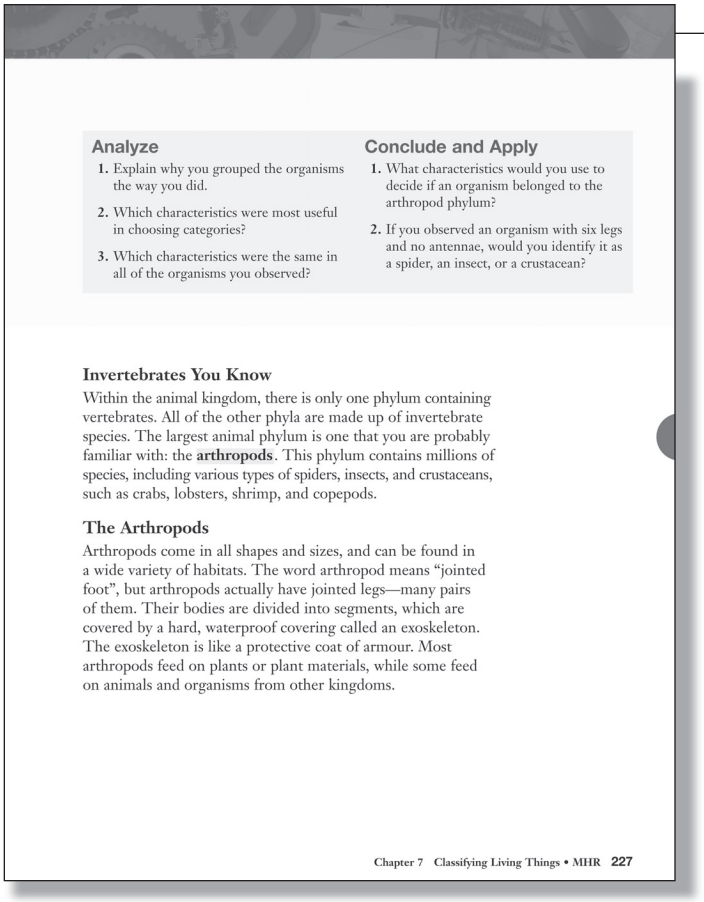
- This activity is best for spring or fall when the arthropods are most active.
- Make sure you follow all school policies and procedures for a field trip. This may include contacting parents to advise them of your plans.
- Have your students make up a list of the questions in step 1 and attach it to their clipboard.
- Bug boxes can be purchased at most toy stores. These have a built-in magnifier as well as a chamber to handle the arthropods.
- If students turn over rocks resting on vegetation, they will likely see millipedes or centipedes. Warn students not to pick up centipedes because they have a nasty bite. (Centipedes are carnivorous and have a pair of poisonous claws used to inject venom into their prey.) The rock should be returned to its original position.
- Each group should have a plastic spoon to gently move leaf litter.
- If it is not practical to do this activity outdoors, you can order preserved arthropod specimens from a scientific supply company.

Adaptations

- Students with allergies should view arthropods in books in the library or on the Internet.

Investigation Wrap-Up

- Bring in a crab, lobster, or shrimp (or visit a lobster pound) so students can investigate the characteristics of these animals in a controlled environment.
- Have students use the Internet to research a specific arthropod found in Nova Scotia. Suggest they look for ones they might not see every day.



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.

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Assessment Options

- Use Learning Skills Rubric 3, Co-operative Group Work or Learning Skills Rubric 4, Scientific Drawing or Science Skills Rubric 19, Conduct an Investigation to assess students' work.

Analyze Answers

1. Students will likely base their groups on physical characteristics such as number of legs, the presence of wings or pincers, the number of body segments, or if it has a hard or soft body.
2. Students might suggest the most useful characteristics would be the number of appendages and number of body segments. However, accept other answers based on the actual specimens they found during the study.
3. All arthropods have pairs of jointed legs and segmented bodies. Students may not recognize that butterflies and bees also have an exoskeleton.

Conclude and Apply Answers

1. All arthropods have pairs of jointed appendages, segmented bodies, and an exoskeleton.
2. Students may wonder which group of arthropods the animal described in this question fits. All insects have three pairs (six) of jointed legs and one pair of antennae; spiders have four pairs (eight) legs and no antennae; most crustaceans have five pairs (10) jointed legs and two pair of antennae. So, an animal with six legs and no antennae doesn't describe a spider, an insect, or a crustacean.

INVERTEBRATES YOU KNOW/ THE ARTHROPODS

BACKGROUND INFORMATION

- There are about 1.1 million known species of arthropods, compared to about 42 500 species of chordates. There are more species of arthropods than there are species in all other phyla combined.
- Arthropods are segmented inside and out. Arthropods also have strong jaws and well-developed nervous systems and sense organs.
- Most arthropods grow by moulting their exoskeleton.
- Key groups are: insects, arachnids (including spiders, scorpions, mites, and ticks); crustaceans (crabs, crayfish, lobster, shrimp, barnacles, and pill bugs); centipedes and millipedes.
- The insect group is the most numerous. It is estimated that the number of species of insects not yet described is in the tens of millions.

TEACHING STRATEGIES

- Have students go back to their answers to *Conduct an Investigation 7-J: Classifying Arthropods* to see if they want to revise their answers.

Common Misconceptions

- Barnacles have jointed appendages that they wave through the water column, funnelling food into their shell-like home—they are arthropods!
- Students may believe that insects and spiders are in the same class. This is incorrect. Insects have three pairs (six) of jointed legs and one pair of antennae; spiders have four pairs (eight) legs and no antennae.

CLASSES OF VERTEBRATES

BACKGROUND INFORMATION

- The trends in adaptations to habitats in the classes of the chordates suggest that the first animals lived in water.
- Fossil records show that fish, amphibians, and reptiles all appeared during the Paleozoic era in Earth's history, between 230 and 570 million years ago. Birds and mammals appeared later, during the Mesozoic period, 144 to 245 million years ago.
- Vertebrates are chordates and most have a backbone. They have a circulatory system with a heart and blood vessels, a digestive system to change food into a useful form, a skeletal system for support, a respiratory system for gas exchange, and a nervous system for control. Vertebrates have large brains and well-developed senses.
- The seven vertebrate classes include the jawless fish, cartilaginous fish, bony fish, amphibians, reptiles, birds, and mammals.
  - Jawless Fish (e.g., lampreys): live in water; do not have scales on skin; no jaw; small teeth in a round, sucking-type mouth; soft skeletons made of cartilage; lay eggs without shells; use gills to gather oxygen from water.
  - Cartilaginous Fish (e.g., sharks, skates, and rays): live in water; have scales on skin; have jaws and soft skeletons made of cartilage; most lay eggs without shells; use gills to gather oxygen from water.
  - Bony Fish (e.g., salmon and trout): live in water; have scales on skin; have jaws and skeletons made of bone; lay eggs without shells; use gills to gather oxygen from water.
  - Amphibians (e.g., frogs, salamanders, newts, toads): most live in water when young and on land as adults; have smooth skin; have jaws and skeletons made of bone; lay eggs without shells, in water; use gills to gather oxygen from water when young; as adults, small lungs and skin gather oxygen from air.
  - Reptiles (e.g., turtles, snakes, crocodiles, lizards): live in water and/or on land; have scales on dry skin; have jaws and skeletons made of bone; most lay eggs with soft shells, on land; lungs gather oxygen from air.

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.

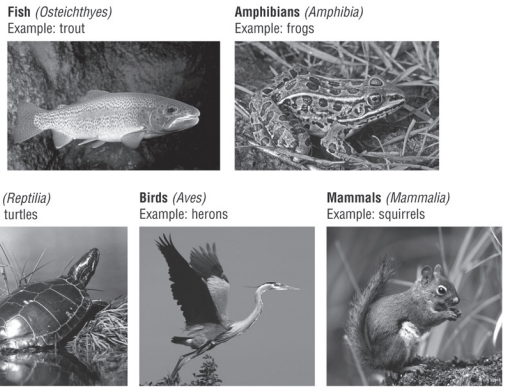

Figure 7.17 There are five major classes of vertebrates.

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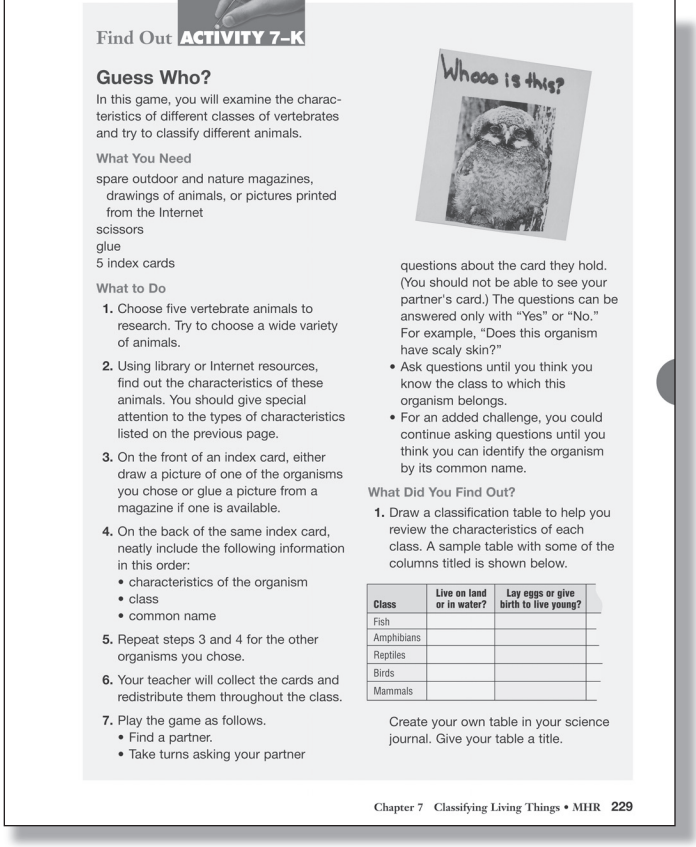
  - Birds: most live on land and most fly (with obvious exceptions such as the penguin and ostrich); have feathers on skin and scales on their legs; have jaws and skeletons made of hollow bones; lay eggs with hard shells, on land; lungs gather oxygen from air. Anthropologists are using fossils to connect modern birds with ancient dinosaurs.
  - Mammals: can live on land or in water; have hair or fur on skin; have jaws and skeletons made of bone; most give birth to live young and feed them mother's milk; lungs gather oxygen from air.

TEACHING STRATEGIES

- As you read and discuss this section, ask the students to provide names of other fish, amphibians, reptiles, birds, and mammals. Record them on a chart. If students are unsure as to which class an animal belongs, make a note to revisit the classification at the end of the chapter.



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.

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Common Misconception

- Students may think that all vertebrates have a bony set of backbones. This is not true of the members of the two subphyla that belong to the chordates. The common structure is the notochord, which in humans is reduced to the discs between the bones of the spine.

FIND OUT ACTIVITY 7-K GUESS WHO?

Purpose

- Students identify characteristics that help them classify different vertebrates.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 month before	– Collect old outdoor and nature magazines.

MATERIALS
– scissors – outdoor and nature magazines – glue – 5 index cards

Suggested Time

- 60–90 min to play the game
- If you wish to reduce the time allotted for this activity, have the students work in pairs to share the workload.

Implementing the Activity

- Review the steps and expectations for the activity.
- Collect the cards and allow time for marking and correcting before the game is played. This will ensure accuracy on the cards and fewer problems while playing the game.
- Students play the game, keeping track of which vertebrates they were able to place into the correct class.

Adaptations

- Many students may find this activity challenging because it requires a great deal of reading and writing. Have these students work with a partner or as a group with a teacher or peer helper to guide them.
- Students with visual impairments can use a picture from a magazine and record their information into a tape recorder.
- Advanced students may wish to explore the connection between birds and dinosaurs.

Activity Wrap-Up

- Students compare the information they put on their classification tables and discuss how the tables are different and alike.

Assessment Option

- Review the students' cards to assess their work in this activity.

What Did You Find Out? Answers

1. Table should include columns that relate to characteristics that distinguish the various classes of vertebrates, e.g., how the organism obtains food, how it reproduces, and where it lives.

SECTION 7.2 SUMMARY

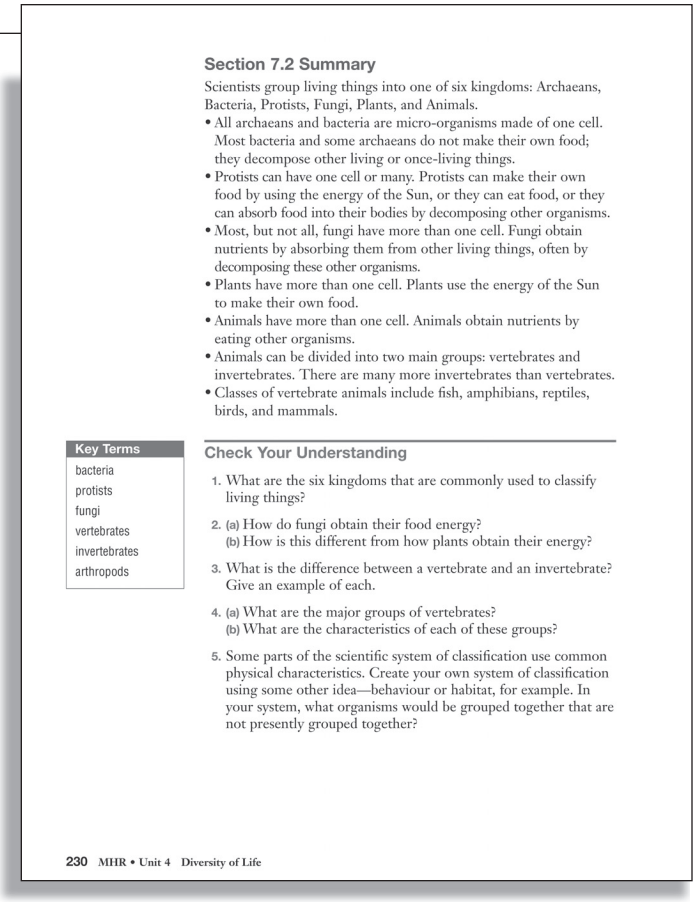
Review the section summary as a class and discuss any questions students may have. Make sure that students update their science logbooks and key terms list. Have students share some of their definitions of the key terms with the class and compare different interpretations of the same words.

✓ ASSESSMENT OPTIONS FOR SECTION 7.2

- Collect and review science logbooks, using Learning Skills Rubric 2, Science Logbook to evaluate student logbooks.
- Have students make a spider diagram or other organization chart to record the information in the summary for this section.
- Use the following rubrics to assess student work:
  - Learning Skills Checklist 5, Poster for *Find Out Activity 7-D: Wanted: Bacteria That You Need*
  - Learning Skills Rubric 5, Research Project or 7, Multimedia Presentation for *Find Out Activity 7-E: Keeping Micro-Organisms Under Control*
  - Science Skills Rubric 19, Conduct an Investigation for *Conduct an Investigation 7-F: Looking for Micro-Organisms*
  - Learning Skills Rubric 4, Scientific Drawing or Science Skills Checklist 15, Making Observations and Inferences for *Find Out Activity 7-G: Plant Survey*
  - Science Skills Rubric 19, Conduct an Investigation for *Conduct an Investigation 7-H: Grow a Fungus Garden*
  - Learning Skills Checklist 5, Poster for *Find Out Activity 7-I: Animal Collage*
  - Learning Skills Rubric 3, Co-operative Group Work or Learning Skills Rubric 4, Scientific Drawing or Science Skills Rubric 19, Conduct an Investigation for *Conduct an Investigation 7-J: Classifying Arthropods*

Check Your Understanding Answers

1. The six kingdoms are Archaeans, Bacteria, Protists, Fungi, Plants, and Animals.
2. (a) Fungi obtain their nutrients by absorbing them from other living things, often by decomposing these organisms.
   (b) Fungi must consume other organisms to obtain food. Plants have chlorophyll and use the process of photosynthesis to convert the Sun's energy into food (sugar).



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?

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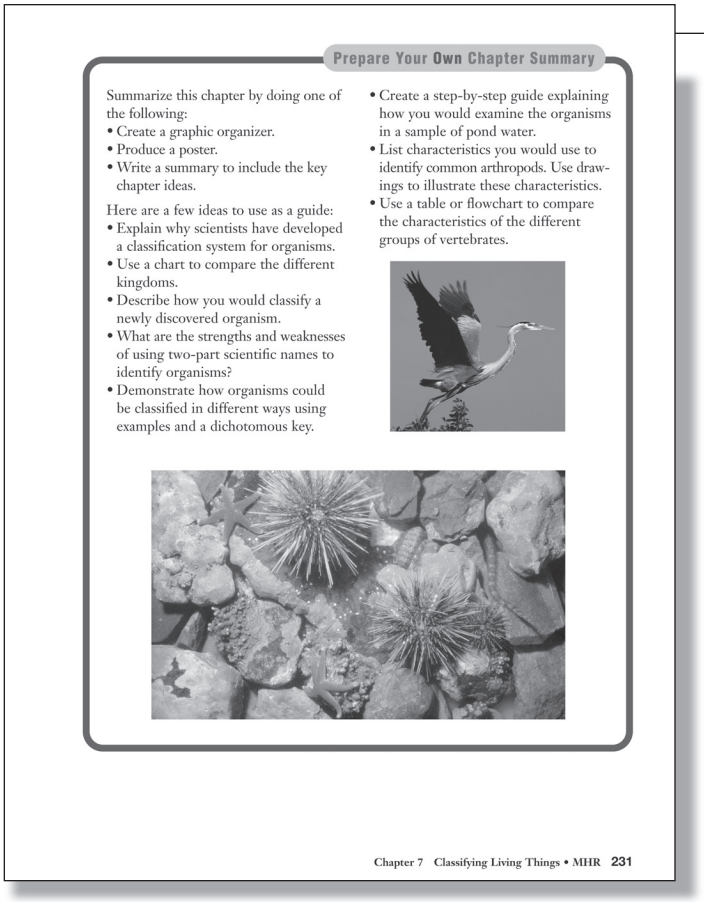
3. A vertebrate is an animal with a backbone. Examples: human, dog, cat, or fish (accept any vertebrate animal). An invertebrate is an animal without a backbone. Examples: spiders, insects, sea stars, or crabs (accept any invertebrate animal).
4. (a) The seven classes of vertebrates are jawless fish, cartilaginous fish, bony fish, amphibians, reptiles, birds, and mammals. Some students may show fish as one class and only have five.
   (b) Students may need to do research to answer this question. Accept any of the following
   - Jawless Fish (e.g., lampreys): live in water; do not have scales on skin; no jaw; small teeth in a round, sucking-type mouth; soft skeletons made of cartilage; lay eggs without shells; use gills to gather oxygen from water.
   - Cartilaginous Fish (e.g., sharks, skates, and rays): live in water; have scales on skin; have jaws and soft skeletons made of cartilage; most lay eggs without shells; use gills to gather oxygen from water.


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.

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– Bony Fish (e.g., salmon and trout): live in water; have scales on skin; have jaws and skeletons made of bone; lay eggs without shells; use gills to gather oxygen from water.
– Amphibians (e.g., frogs, salamanders, newts, toads): most live in water when young and on land as adults; have smooth skin; have jaws and skeletons made of bone; lay eggs without shells, in water; use gills to gather oxygen from water when young; as adults, small lungs and skin gather oxygen from air.
– Reptiles (e.g., turtles, snakes, crocodiles, alligators, tuatara, lizards): live in water and/or on land; have scales on dry skin; have jaws and skeletons made of bone; most lay eggs with soft shells, on land; lungs gather oxygen from air.
– Birds: most live on land and most fly (with obvious exceptions such as the penguin and ostrich); have feathers on skin and scales on their legs; have jaws and skeletons made of hollow bones; lay eggs with hard shells, on land; lungs gather oxygen from air.
– Mammals: can live on land or in water; have hair or fur on skin; have jaws and skeletons made of bone; most give birth to live young and feed them mother's milk; lungs gather oxygen from air.

5. Students' answers will depend on the behaviour or habitat chosen. For example, they may sort all things that live in the ocean into one group. Or, they could sort all organisms that hibernate or migrate from an area to avoid winter as a group.

Prepare Your Own Chapter Summary

Student summaries should incorporate many of the following main ideas:

- Classification systems are used for everything from books to grocery items.
- 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 name.
- Each species is made up of unique organisms. Two different organisms cannot share the same species and genus name, however, many different organisms can share the same genus name.
- Living things are grouped into one of six kingdoms: Archaeans, Bacteria, Protists, Fungi, Plants and Animals. These groupings can change when there are new discoveries about existing organisms or new organisms.
- All archaeans and bacteria are micro-organisms. Most bacteria and some archaeans do not make their own food; they decompose other living or once-living things.
- 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.
- Fungi obtain nutrients by absorbing them from other living things, often by decomposing these other organisms.
- Plants use the energy of the Sun to make their own food.
- 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.