

TOPIC 1.1

What are the characteristics of living things?

Key Concepts

- Living things are made of cells, take in nutrients, use energy, and produce waste.
- Living things respond to stimuli, grow, and reproduce.

Curricular Competencies

- Make observations aimed at identifying your own questions about the natural world.
- Consider Aboriginal perspectives and knowledge, other ways of knowing, and local knowledge as sources of information.
- Experience and interpret the local environment.
- Generate and introduce new or refined ideas when problem solving.

You, and most people, make distinctions between what is and is not a living thing. A tree is a living thing, but a building is not. A White Admiral butterfly, common throughout much of British Columbia, is alive, but a bulldozer is not. What is life?

Scientists usually do not try to define what “life” is. Instead, they describe features or characteristics that are shared by all living things. These characteristics of living things include their physical features, how they behave, and how they use matter and energy to support and sustain their lives.



Starting Points

Choose one, some, or all of the following to start your exploration of this topic.

1. **Identifying Preconceptions** Examine the photos on these two pages. With the members of your group, brainstorm a list of characteristics that let you separate the living things from the non-living things. Compare your list with other groups. See if you can develop a class list of characteristics of life.
2. **Questioning** Some scientists search for life in our solar system and beyond. How will they know if they have found it? What characteristics do you think they should be looking for?
3. **Processing Information** Imaginary worlds abound on TV, in movies, in books, and in comics. These worlds are populated with all kinds of creatures. Choose a character from a show or story that you know, and list the characteristics that you think make it “alive.” (Special challenge: How would your thinking change for a character in a story that features zombies or vampires?)

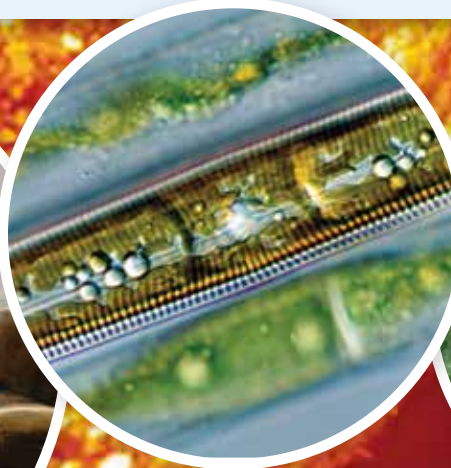


Key Terms

There is one key term that is highlighted in bold type in this Topic:

- cell

Flip through the pages of this Topic to find this term. Add it to your class Word Wall along with its meaning. Add other terms that you think are important and want to remember.



CONCEPT 1

Living things are made of cells, take in nutrients, use energy, and produce waste.

Activity

Hands-On with a Hand Lens

Obtain a hand lens and start observing objects in the places around you. For each, record and share what you see with and without the hand lens.



Why are ocean waves or rock formations considered to be non-living, but a bacterium and a plant are living? Throughout history, scientists have collected data and continued to define the characteristics of living things. Four of these characteristics are discussed below.

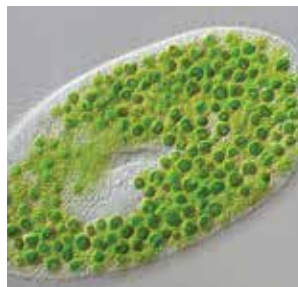
Living Things Are Made of Cells

All living things are made of one or more cells. Scientists consider the **cell** to be the basic unit of life. Cells have structures that enable them to carry out life processes. Life processes include all of the chemical reactions that help a living thing obtain and use energy, break down nutrients, build molecules, and grow. Life processes also enable a living thing to copy its genetic material, repair injuries, and excrete wastes.

As shown in **Figure 1.1**, some living things are only one cell. Examples of single-celled or unicellular organisms are bacteria and some protists, such as *Euglena* and *Paramecium*. **Figure 1.1** also shows multicellular organisms, which are made up of many cells. (The word “organism” means the same thing as “living thing.”) You and many other living things are multicellular organisms.

cell the basic structural and functional unit of life

Figure 1.1 Whether they are one-celled or many-celled, the cells of all organisms carry out life processes. What is the significance of the Spirit Bear to First Peoples? How do First Peoples use the Pacific Dogwood?



Paramecium



Pacific Dogwood



Spirit Bear

Living Things Take in Nutrients

All living things take in nutrients. These are substances that living things need but cannot make for themselves. Most organisms get the nutrients they need by eating food. Living things such as those shown in **Figure 1.2** are consumers. They eat (consume) other organisms for food. Other kinds of living things, such as plants, are called producers, because they can produce their own food using the Sun's energy and nutrients from their surroundings.



Figure 1.2 Squirrels, sea otters, and humans are all consumers. They get their nutrients from eating food. The grass the squirrel is eating is an example of a producer.

Living Things Use Energy

All living things use energy to carry out life processes (**Figure 1.3**). Producers use the food they make as a source of energy. Consumers get energy from the food they eat. The energy in food is released through a process called cellular respiration. The energy from food is used for many purposes, such as growth, responding to changes in the environment, movement, and even sleep.

Living Things Produce Waste That Must Be Removed

Through their life processes, living things produce waste substances that are harmful if they are not removed. All cells have structures that store and remove waste. Unicellular organisms have different ways to do this. For example, some waste passes naturally across the outer membrane of a cell into the surrounding environment. Other waste is expelled from the cell through a structure called a vesicle.

Multicellular organisms have structures or systems that collect and remove waste from the body. For example, humans have structures called kidneys that filter waste from the blood. The waste is removed from the body when a person urinates.

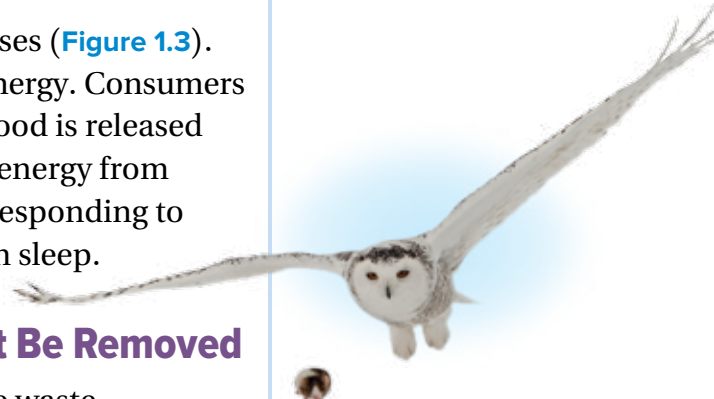


Figure 1.3 The snowy owl visits southern parts of B.C. from the Arctic in late fall and winter. Mice are among its sources of food energy. **Snowy owl is sacred to many First Peoples. What stories can you learn about snowy owl?**



Before you leave this page . . .

1. How are unicellular and multicellular living things similar and different?
2. Why do living things need energy, and where do they get it?

CONCEPT 2

Living things respond to stimuli, grow, and reproduce.

Activity

Investigating the Characteristics of Life

Choose three organisms that you are familiar with in the places you live and visit. Explain how each organism has all of the characteristics of living things that you have explored so far.

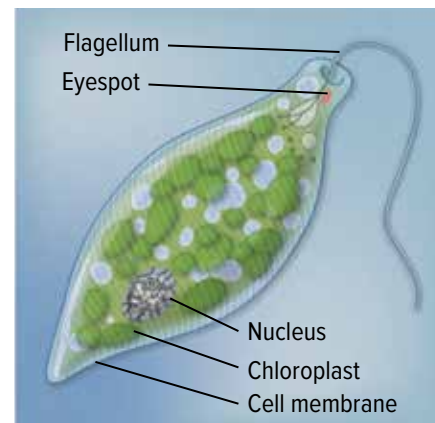


Living Things Respond to Stimuli

A stimulus is anything that causes a living thing to react (respond) in a certain way. The plural of stimulus is stimuli. Living things respond to internal stimuli—things that occur inside their bodies. For example, when your stomach growls, you know you are hungry and you respond to this internal stimulus by eating. Feeling thirsty is another example of an internal stimulus. When animals, such as the caribou in **Figure 1.4**, are thirsty, they find water to drink.

Living things also respond to external stimuli—things that occur outside their bodies, in their surroundings. For example, if you have a dog or a cat, you may have seen its ears flick up in response to a noise at the door. The plant in **Figure 1.4** is responding to the light by growing toward it. Multicellular animals have sense organs and/or a nervous system to respond to stimuli. Unicellular organisms, such as *Euglena*, have structures that allow them to sense and respond to changes in their environment.

Figure 1.4 Organisms respond to internal and external stimuli. The caribou drinks in response to an internal stimulus. A plant growing toward the light is responding to an external stimulus. *Euglena* have a structure called an eyespot that allows them to sense the external stimulus of light.



Living Things Grow

All living things grow by increasing in size, or in the number of their cells, or both. Unicellular organisms grow by increasing in cell size, up to a certain point. Multicellular organisms grow by increasing the number of cells in their body.

Living Things Reproduce

All living things reproduce, which means that they produce more of their own kind (species). Organisms reproduce in different ways. Many unicellular organisms, such as the bacteria in **Figure 1.5**, reproduce by dividing into two cells. Each new cell is the same as the original cell, because it has the same genetic material. Other organisms must have a mate to reproduce.

As shown in **Figure 1.5**, when organisms mate, their offspring are not identical to their parents. The offspring differ because each parent provides different genetic information.



Figure 1.5 Some living things reproduce by dividing into two cells that are identical. Other organisms produce offspring with a mate.

Extending the Connections

Comparing How Different Peoples Define “Life”

Scientists have agreed on a set of characteristics to separate living and non-living things. However, science is just one of many different ways of knowing about and understanding ourselves and the world. Reflect on your own cultural background, and collaborate with your classmates to share the many ways that people think about and understand life.

Before you leave this page . . .

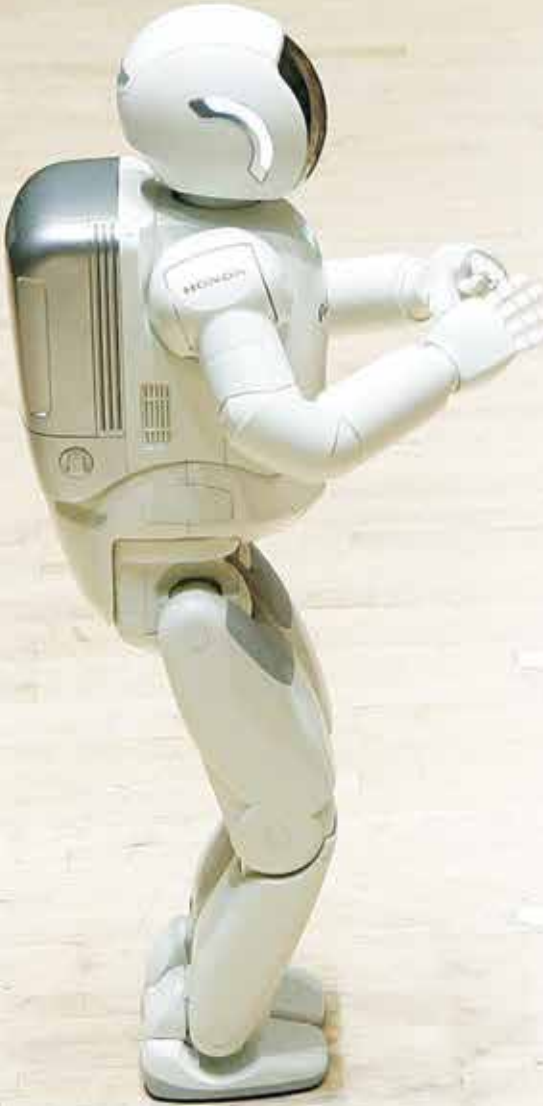
1. Create a scenario that includes six stimuli (three external and three internal). Your scenario must demonstrate your understanding without defining the words stimulus, external, and internal.
Your scenario could take the form of a paragraph, a comic strip, a song, or another format of your choice.
2. Explain how growing is different from reproducing.

How Does Artificial Intelligence Challenge Us to Think About Life?

What's the Issue?

Have you ever used a computer that recognizes and responds to your voice? Maybe you've played a computer game in which non-player characters act in very intelligent and realistic ways. Or perhaps you've heard of Asimo, a human-like robot that can challenge you to a game of soccer and even pour you a drink! These are all applications of artificial intelligence. Artificial intelligence (AI) is the science of creating intelligent machines. This definition may sound simple at first, but is it? For instance, what is intelligence? Can a machine be intelligent or capable of independent thought? Or is this a property only of living things?

People who work in AI write advanced computer programs that enable the machines they build to sense and respond to their environment. For example, some machines with AI can learn and solve problems. Some can recognize human speech and faces. Others can move and handle objects. These abilities are also a crucial part of a field that is closely linked to AI: robotics. Robots are becoming more advanced as scientists build upon their past successes. Will robots someday be able to carry out complicated jobs that only humans can do now? It's quite possible. If this happens, machines will likely lend a robotic hand in bringing it about.



Dig Deeper

Collaborate with your classmates to explore one or more of these questions—or generate your own questions to explore.

1. In 2011, an artificially intelligent computer named Watson played against and beat human players on the TV game show *Jeopardy*. Does knowing this change your opinion about what makes something living or not? Explain your reasoning.
2. Robots with artificial intelligence have some characteristics of living things. Which of the characteristics apply to robots? Do you think robots should be classified as living things? Why or why not?

Check Your Understanding of Topic 1.1

QP Questioning and Predicting **PC** Planning and Conducting **PA** Processing and Analyzing **E** Evaluating
AI Applying and Innovating **C** Communicating

Understanding Key Ideas

1. Choose an organism, and describe how it responds to one internal and one external stimulus. **PA**
2. Many non-living things have some of the same characteristics as living things. For example, a non-living thing might move, use energy, and grow in size. For each of the following, identify and describe the characteristics that it shares with living things. Then explain why scientists do not consider it to be living. **PA E AI**
 - a) a campfire
 - b) an icicle
 - c) a printer
 - d) a fossil
3. You are a multicellular organism. At this moment, there are millions of unicellular bacteria in and on your body. List five things that you have in common with a bacterium. **PA C**
4. The Columbian ground squirrel in the photo is a common sight in eastern B.C. Use this photo to describe the difference between an organism that is a consumer and an organism that is a producer. **PA C**



Connecting Ideas

5. Sundew plants grow in northern B.C. They make their own food like other plants do, but they also capture tiny insects with sticky droplets on their leaves. Nutrients from the rotting insects help the plant to grow. How would you classify a sundew: producer? consumer? something else? Explain your reasoning. **E AI C**
6. Scientists have defined several characteristics of living things. What evidence can you offer to demonstrate that your body displays the following characteristics? **PA AI E**
 - a) Your cells are dividing.
 - b) You respond to stimuli.
 - c) You use energy to carry out life processes.
7. Scientists have agreed on the characteristics that they use to tell living from non-living. Why is it beneficial for scientists to use the same system and understandings when talking about living and non-living things? **QP PA E C**

Making New Connections

8. Imagine that you live in a future where robots take in nutrients, use energy, and produce waste. They also respond to stimuli. Each robot is made of artificial cells that can increase in number, allowing the robot to grow. Finally, the robots are able to reproduce by building new robots. Explain why you would or would not consider the robots to be living things.

AI E C