Section 1 Themes of Biology

Objectives

- **Relate** the seven properties of life to a living organism. 4B
- **Describe** seven themes that can help you organize what you learn about biology.
- **Identify** the tiny structures that make up all living organisms.
- **Differentiate** between reproduction and heredity and between metabolism and homeostasis. 4B

Key Terms

biology
cell
reproduction
metabolism
homeostasis
gene
heredity
mutation
evolution
species
natural selection
ecology

Characteristics of Living Organisms

You are surrounded by living things, which a scientist calls *organisms*. Many organisms, such as people, plants, and animals, are obvious. Other living things are so small that you cannot see them without a microscope. How do we know if something is alive? What does it mean to be alive?

While most people are capable of distinguishing between living and nonliving, actually defining life can be quite difficult. Perhaps you consider movement, sensitivity, development, and even death as characteristics of living organisms. While present in all living things, these properties are not enough to describe life.

Clouds, for example, move when stimulated by the wind and develop from moisture that is suspended in the atmosphere. Clouds grow and change shapes. Some might view the breakup of clouds as being similar to death. Disorder, however, is not the same as death. Clouds may break up and vanish, but they do not die.

Biology is the study of life. Biologists recognize that all living organisms, such as the cheetahs shown in **Figure 1,** share certain general properties that separate them from nonliving things. As summarized in Figure 1, every living organism is composed of one or more cells, is able to reproduce, and obtains and uses energy to run the processes of life. Living organisms also maintain a constant internal environment and pass on traits to offspring. Responding and adjusting to the environment as well as growing and developing are other characteristics shared by all living organisms.

As you read further, you will have an opportunity to think more about the properties that help define life. Life is characterized by the presence of *all* of these properties at some stage in an organism's life. Remember this fact as you attempt to determine what is living and what is not.

Figure 1 What does it mean to be alive? Life is characterized by the presence of all seven of these properties at some stage in an organism's life.

Unifying Themes of Biology

In the study of biology, certain broad themes emerge that both unify living things and help explain biology as a science. The word *science* is Latin for "to know." Science is a systematic process of inquiry. As you study the science of biology by reading this textbook, you will repeatedly encounter these themes.

Theme ❶ Cellular Structure and Function

All living things are made of one or more cells. **Cells** are highly organized, tiny structures with thin coverings called membranes. A cell is the smallest unit capable of all life functions. The basic structure of cells is the same in all organisms, although some cells are more complex than others. Some organisms have only a single cell, while others are multicellular (composed of many cells). Your body contains more than 100 trillion cells. **Figure 2** shows a single-celled organism called a paramecium.

Figure 2
Single-celled paramecium

Theme ❷ Reproduction

All living things can reproduce. **Reproduction** is the process by which organisms make more of their own kind from one generation to the next. Some rapidly growing bacteria divide into offspring cells approximately every 15 minutes, and bristlecone pine trees that are 5,000 years old still produce seedlings. Because no organism lives forever, reproduction, as represented in **Figure 3,** is an essential part of living.

Figure 3 **Hatchling snakes**

Theme ❸ Metabolism

Living organisms carry out many different chemical reactions in order to obtain and use energy to run the processes of life. All living things use energy to grow, to move, and to process information. Without energy, life soon stops. **Metabolism** is the sum of all of the chemical reactions carried out in an organism.

Almost all the energy used by living organisms is originally captured from sunlight. Plants, algae, and some bacteria capture this solar energy and use it to make complex molecules in a process called photosynthesis. These molecules then serve as the source of energy, or food, for other organisms. For example, paramecia, such as the one shown in Figure 2, eat bacteria. Humans eat plants or animals that, in turn, have eaten plants. Energy flows from the sun to plants, from these plants to plant-eating organisms, and from plant-eating organisms to meat-eating organisms. The teens shown in **Figure 4** are extracting energy from the food they eat.

Figure 4
Extracting energy from food

Figure 5 Harp seal

Theme 4 Homeostasis

All living organisms must maintain a stable internal environment in order to function properly. Organisms respond to changes in their external environment, and their internal processes adjust accordingly. The maintenance of stable internal conditions in spite of changes in the external environment is called **homeostasis** *(hoh mee oh STAY sihs)*. An organism unable to balance its internal conditions with its environmental conditions could become ill and die. Arctic seals, such as the one shown in **Figure 5,** are able to maintain a constant body temperature in spite of their cold environment because of their body shape and thick layer of body fat.

Theme 5 Heredity

All living things are able to pass on traits to their offspring through genes that are passed from parent to offspring each generation. A **gene** is the basic unit of heredity. Genes are coded in a molecule called deoxyribonucleic *(dee AHKS ee rie boh nu klay ik)* acid (DNA) and determine an organism's traits. The passing of traits from parent to offspring is called **heredity.** Heredity is the reason children tend to resemble their parents, as shown in **Figure 6.**

Sometimes damage causes genes to change. A change in the DNA of a gene is called a **mutation.** Most mutations are harmful, but sometimes mutations can help an organism survive. For example, in humans a mutation for the blood protein hemoglobin, which carries oxygen to the body's cells, has both a harmful effect and a positive effect. The harmful effect is that the mutated form of the gene results in sickle cell anemia. Sickle cell anemia is a disease in which the defective form of hemoglobin causes many red blood cells to bend into a sickled—that is, a hooked—shape that reduces the oxygen-carrying capability of the cell. The positive effect is that the mutation produces resistance to malaria, a deadly infectious disease.

Figure 6 Passing on traits

Mutations that occur in sex cells (egg and sperm) are passed on to other generations. Mutations that occur in body cells are not passed on, but they can disrupt the control of cell reproduction and result in cancer.

Theme 6 Evolution

The great diversity of life on Earth is the result of a long history of change. Change in the inherited traits of species over generations is called **evolution.** A **species** is a group of genetically similar organisms that can produce fertile offspring. Individuals in a species are similar, but not identical. Those individuals with genetic traits that better enable them to meet nature's challenges tend to survive and reproduce in greater numbers, causing these favorable traits to become more common. Charles Darwin, the great nineteenth-century British naturalist, called this process in which organisms with favorable genes are more likely to survive to reproduce **natural selection.**

Darwin's theory of evolution by natural selection is the essence of biology, providing a consistent explanation for life's diversity. The many different species of animals, plants, and other organisms on Earth today are the result of a long process of evolution. **Figure 7** shows an example of a plant that has flowers modified for attracting insects.

Figure 7 Bee pollinating flower

Theme 7 Interdependence

The organisms in a biological community live and interact with other organisms, as shown in **Figure 8.** A biological community is a group of interacting organisms. **Ecology** is the branch of biology that studies the interactions of organisms with one another and with the nonliving part of their environment. Organisms are dependent on one another and their environment—that is, they are interdependent. Interdependence within biological communities is the result of a long history of evolutionary adjustments. The complex web of interactions in a biological community depends on the proper functioning of all of its members, even those too small to be seen without a microscope.

Figure 8 Owl capturing a rat

Section 1 Review

1. **Identify** the seven properties that all living organisms share. 4B
2. **Relate** three of the seven major themes of biology to the life of a harp seal. 9D 11B
3. **Name** the very small, organized structure that is bound by a membrane and that is the basic unit of structure and function in all organisms.
4. **Define** *homeostasis* and *metabolism,* and describe their differences. 4B 11A
5. **Critical Thinking Recognizing Verifiable Facts** If you find an object that looks like an organism, how might you determine if your discovery is indeed alive? 4B
6. **TAKS Test Prep** The mutation that results in sickle cell anemia produces effects that are 6C
   - **A** only harmful.
   - **B** only positive.
   - **C** both harmful and positive.
   - **D** unimportant.