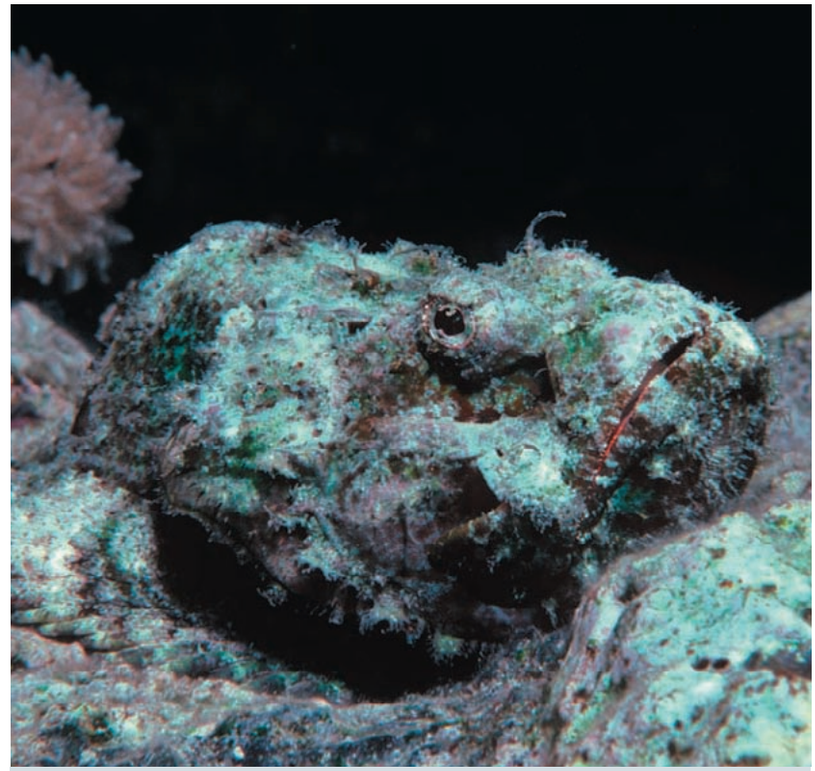
15

CHAPTER 15

The Basic Unit of Life—The Cell



It's a rock. Or wait—could it be a well-disguised stonefish waiting for a juicy crab to come near? We know a living thing when we see one, even if our eyes fool us sometimes. But what, exactly, is a living thing? Do living things all share characteristics that differentiate them from nonliving things? Do they all reproduce? Use energy? Evolve? Are all living things made up of one or more cells? What are cells? How do cells "talk" with each other? How do cells make new cells? How do cells obtain energy, and how do we take advantage of this process when we bake bread and brew beer? How do plant cells use sunlight, air, and water to build living tissue, and how is this process the basis of life as we know it? In this chapter, we will explore the nature of life and the world of the cell.

15.1 Characteristics of Life

LEARNING OBJECTIVE
List and describe the characteristics of living things.

EXPLAIN THIS How can you tell a plant is alive even though it doesn't talk or run around?

Biology is the study of life and living organisms. But what is a living thing? What distinguishes living things from nonliving things?

Living things share certain characteristics. For one thing, they use energy. Living things, such as the sunflowers and lions in Figure 15.1, take energy from the environment and convert it into other forms of energy for their own use. Plants take electromagnetic energy from sunlight and convert it into chemical energy, which they can use to build their stems and leaves or fuel their activities. Animals eat, converting the energy they get from food into chemical energy, which they store in their bodies. This chemical energy is eventually converted again into kinetic and potential energy and heat as animals crawl, or fly, or grow. Of course, all the ways in which living things convert energy are consistent with the laws of physics. This means, first, that energy is always conserved and, second, that in any energy conversion, some energy is lost to the environment as heat.

UNIFYING CONCEPT

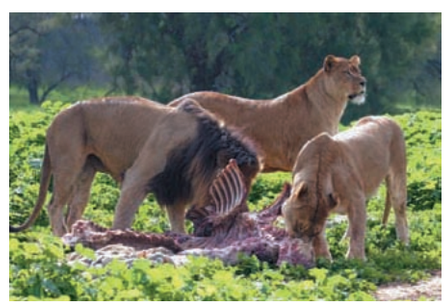
- ***Conservation of Energy***
  Section 4.10
- ***Second Law of Thermodynamics***
  Section 6.5

Another characteristic of living things is that they develop and grow. When chicks hatch, they are small and covered with downy yellow feathers. Over time, they grow bigger, and their downy feathers are replaced by stiff adult feathers (Figure 15.2).

Living things maintain themselves. They generate structures, such as stems and leaves or skin and bones, and they repair damage done to those structures. When you scrape your knee, your blood clots to stop the bleeding, and the wounded skin scabs over and heals. Living things also maintain their internal environment, keeping it stable in the face of changing external conditions. Whether it is freezing cold or blisteringly hot, your body temperature stays right around 37C (98.6°F).

Living things have the capacity to reproduce. They make offspring that are exact or inexact copies of themselves. Figure 15.3 shows the two ways living things reproduce, asexually and sexually. In *asexual reproduction* a living organism reproduces all by itself, such as by dividing into two. Bacteria and sea anemones are organisms that are able to reproduce asexually. In *sexual reproduction*

(a)



(b)

FIGURE 15.1
Living things take energy from the environment and convert it into other forms of energy. (a) Plants such as these sunflowers convert energy from sunlight into chemical energy, which can be used to build tissues or fuel activity. (b) Animals such as these lions convert the chemical energy stored in food into motion or other activity, or use it for growth and reproduction.

FIGURE 15.2
Living things grow and develop over time.

FIGURE 15.3
Living things have the capacity to reproduce. (a) A sea anemone reproduces asexually by dividing. (b) Penguins reproduce sexually.

(a)

(b)

organisms form special sex cells, such as sperm and eggs, that join to develop into new individuals. Humans, penguins, beetles, and oak trees reproduce sexually.

Finally, living things are parts of populations that evolve. Populations do not remain constant from one generation to the next but change over time. Often, populations change in response to their environments. During the Industrial Revolution, when cities became polluted and blackened with soot, peppered moth populations evolved so that better-camouflaged dark-winged moths became more prevalent than light-winged moths. After antipollution laws were passed and cities were cleaned up, light-winged moths again became more common.

CHECK YOURSELF

1. **We know that cars are not living things. Check cars against the list of characteristics of living organisms. Which characteristics do cars have and which are they lacking?**
2. **Do all living things have all the characteristics of life we have listed?**

CHECK YOUR ANSWERS

1. Cars use energy, converting the energy in gasoline into motion. We might be able to argue that cars "develop" over time, acquiring nicks and dents and wearing down the treads on their tires. However, cars definitely do not maintain themselves, do not reproduce, and do not evolve.
2. There are some exceptions; for example, mules are sterile and unable to reproduce, but they are certainly alive.

LEARNING OBJECTIVE
Describe the structure and functions of the four types of molecules that make up living things: proteins, carbohydrates, lipids, and nucleic acids.

Integrated Science 15A
CHEMISTRY

Macromolecules Needed for Life

EXPLAIN THIS Do the same ingredients go into both you and a fried egg sandwich?

Living things are made up of four main types of macromolecules, or "big molecules." Some of these may already be familiar to you if you've heard that protein helps you grow or that a healthy diet should not include