Chapter 1

Exploring the Living World

In This Chapter

- Seeing how cells are part of all living things
- Finding out the fundamentals of where babies come from and why you have the traits you do
- Recognizing that all of Earth's ecosystems are interconnected
- Surveying animal anatomy and physiology
- Exploring the similarities and differences between plants and people

Biology is the study of life, as in the life that covers the surface of the Earth like a living blanket, filling every nook and cranny from dark caves and dry deserts to blue oceans and lush rain forests. Living things interact with all of these environments and each other, forming complex, interconnected webs of life. For many people, a hike in the forest or a trip to the beach is a chance to reconnect with the natural world and enjoy the beauty of life.

In this chapter, we give you an overview of the big concepts of biology. Our goal is to show you how biology connects to your life and to give you a preview of the topics we explore in greater detail later in this book.

It All Starts with a Cell

Quick. What's the smallest unit of life you can think of? (Here's a hint: Try to recall the basic properties of life; if you can't, head to Chapter 2 to discover what they are.) Your mind may automatically call up images of ants, amoebas, or bacteria, but that's not quite the answer. The absolute smallest unit of life is a single cell.

Everything an organism's body does happens because its cells make those actions happen, whether that organism is a single-celled *E. coli* bacteria or a human being made up of approximately 10 trillion cells.

Of course, the number of cells you have isn't the only difference between you and *E. coli.* The structure of your cells is a little bit different — your cells have more specialized internal compartments, such as the nucleus that houses your DNA (we cover cell structure in Chapter 4). Yet you have some distinct similarities as well. Both you and *E. coli* are made up of the same raw materials (flip to Chapter 3 to find out what those are) and have DNA as your genetic material (more on DNA in Chapter 8). You also use food the same way (see Chapter 5), and you build your proteins in the same manner (see Chapter 8).

Life Begets Life: Reproduction and Genetics

You began life as a single cell, when a sperm cell from your dad met an egg cell from your mom. Your parents made these reproductive cells through a special type of cell division called meiosis (we explain meiosis in detail in Chapter 6). When their reproductive cells combined, your dad and mom each donated half of your genetic information — 23 chromosomes from mom and 23 from dad — for a total of 46 chromosomes in each of your cells. The genes on those 46 chromosomes determined your characteristics, from your physical appearance to much of your behavior. The science of genetics tracks the inheritance of genes and studies how they determine traits (see Chapter 7). Through genetics, you can understand why your skin is a certain color or why some traits seem to run in your family.

Your genes are found in your DNA, which is in turn found in your chromosomes. Each chromosome consists of hundreds of different blueprints that contain the instructions for your cells' worker molecules (which are mostly proteins). Each type of cell in your body uses the blueprints found in your genes to build the proteins it needs to do its particular job. So what exactly does all that mean? Here it is, plain and simple: DNA determines your traits because it contains the instructions for the worker molecules (proteins) that make your traits happen.

Scientists are discovering more and more about DNA; they're also developing tools to read and alter the DNA in cells (see Chapter 9). Chances are you're already experiencing the impacts of scientists' work with DNA, even if you don't know it. Why? Because scientists use *recombinant DNA technology* to alter organisms used in food and medicines. This technology allows them to take genes from one organism and place them into the cells of another, changing the characteristics of the receiving organism. For example, scientists alter the cells of bacteria with human genes, turning them into tiny living factories that produce human proteins needed to treat diseases.

Making the Connection between Ecosystems and Evolution

As you discover in Chapter 10, the amazing diversity of life on Earth helps ensure that life continues in the face of environmental change. Each type of organism plays a role in the environment, and each one is connected to the other. Green organisms such as plants combine energy and matter to make the food on which all life depends, predators hunt prey, and decomposers such as bacteria and fungi recycle dead matter so it becomes available again to other living things. (For more on the interconnectedness of all living things on Earth, head to Chapter 11.)

Humans are part of the natural world, and like all living things, we use resources from the environment and produce wastes. However, the human species is unusual in its ability to use technology to extend its reach, drawing heavily on the natural resources of the Earth and changing environments to suit its needs. The human population has expanded to cover most of the Earth, and the numbers just keep on growing.

Yet as humans draw more heavily upon the Earth's resources, we're putting stress on many other species and possibly driving them to extinction. The great lesson of biological evolution (a topic we cover in Chapter 12) is that not only do populations change over time but they're also capable of going extinct. The challenge that humans face today is discovering ways to get what we need but still live in balance with the Earth's various ecosystems.

Getting Up Close and Personal with the Anatomy and Physiology of Animals

All animals work hard to maintain *homeostasis,* or internal balance, as change occurs in the environment around them (see Chapter 13 for more on homeostasis). In a complex, multicellular animal like you, all of your organ systems must work together to maintain homeostasis.

Following is a rundown of all of your organ systems, including what they do and what they consist of:

- **Skeletal system:** Provides support, helps with movement, and forms blood cells. Made up of your bones (see Chapter 14).
- **Muscular system:** Enables movement. Consists of your skeletal and smooth muscles (see Chapter 14).

- **Respiratory system:** Brings in oxygen and expels carbon dioxide. Made up of your lungs and airways (see Chapter 15).
- **Circulatory system:** Transports materials throughout the body. Consists of your heart, blood, and blood vessels (see Chapter 15).
- **Digestive system:** Takes up nutrients and water and eliminates wastes. Made up of your stomach, intestines, liver, and pancreas (see Chapter 16).
- **Excretory system:** Maintains the balance of water and electrolytes in your body and removes wastes. Consists of your kidneys and bladder (see Chapter 16).
- **Integumentary system:** Serves as your first line of defense against infection. Made up of your skin (see Chapter 17).
- **Immune system:** Defends against foreign invaders. Consists of your thymus, spleen, and lymph nodes (see Chapter 17).
- **Nervous system:** Controls your body functions via electrical signals. Made up of your brain, spinal cord, and nerves (see Chapter 18).
- **Endocrine system:** Produces hormones that control your body functions. Consists of your glands (see Chapter 18).
- **Reproductive system:** Is responsible for sexual reproduction. Made up of ovaries, fallopian tubes, a uterus, a cervix, a vagina, and a vulva if you're female, and testes, a scrotum, vas deferens, a prostate gland, seminal vesicles, and a penis if you're male (see Chapter 19).

Comparing Plants to People

At first glance, plants seem pretty different from people, but actually humans and plants occupy nearby branches on the tree of life. Both humans and plants engage in *sexual reproduction,* meaning they produce new offspring from the fusion of sperm and eggs that contain half the genetic material of the parents (see Chapter 20 for more information on how plants reproduce). Also like you, plants have systems for moving materials throughout their bodies (flip to Chapter 21 for the scoop on this), and they even control their functions with hormones.

Of course, plants also have major differences from humans. Most importantly, they make their own food using carbon dioxide, water, and energy from the Sun, whereas humans have to eat other organisms to survive. As a byproduct of their food production, plants give off oxygen as waste. Humans gladly breathe oxygen in and return the favor by breathing out carbon dioxide that the plants can use to make food (see Chapter 5 for more on photosynthesis and respiration and how they lead to this gas exchange between humans and plants).