CHAPTER 1

Human Biology, Science, and Society

Crew of the space shuttle *Atlantis*, November 20, 2007.

Key Concepts

- **Living things have certain characteristics** that make them different from nonliving things. All living things are composed of cells that harness energy to create unique chemical compounds. Living things grow and reproduce.
- **Humans are just one of several million different life-forms** on Earth. Our closest relatives are the other primates (including monkeys and apes). Features that *taken together* define humans as unique are bipedalism, opposable thumbs, a large brain, and a capacity for complex language.
- **Science is a process for studying the natural world.** It is based on observable, quantifiable data obtained by repeatedly questioning, observing, and drawing conclusions.
- **Science helps us understand what *is*, not what *should* be.** It does not provide us with "right" answers or give meaning to our lives.
- **We make choices** about how to use scientific knowledge every day whether we are consciously aware of it or not. We owe it to ourselves to make informed choices.

CURRENT ISSUE

Mandatory Childhood Vaccinations

All 50 states now require that school-age children be properly vaccinated before they can attend school. The trend is toward requiring specific vaccinations even for preschoolers. In 2009, New Jersey became the first state to require a vaccination against the flu for children who attend licensed day care and preschool programs. Connecticut followed suit in 2010, as did New York in 2014.

At the same time, more and more parents are seeking exemptions from vaccinations for their children. (All 50 states permit an exemption for medical reasons and 48 states also allow for an exemption for religious or personal beliefs.) What is going on?

Childhood Vaccinations Save Lives

The states' rationale is clear: Childhood vaccines introduced since the 1950s have all but wiped out many communicable diseases in the United States, including measles, mumps, whooping cough (pertussis), polio, and diphtheria. In the 1940s and 50s, before vaccines against these diseases were available, the five diseases combined caused an estimated 900,000 cases of disease and 7,700 deaths per year. By 2004, there were only 27 deaths from all five diseases combined—a 99.6% reduction. The number of cases of measles dropped from more than 500,000 per year before the measles vaccine was available to about 60 cases per year between 2001 and 2010.

Vaccines Become Controversial

In 1998, the prestigious medical journal *The Lancet* published a paper in which the author concluded that the vaccine for measles, mumps, and rubella (or a preservative in the vaccine, called thimerosal) was a likely cause of autism. Autism spectrum disorder, as it is more properly called, is a baffling group of neurological disorders that lead to social, communication, and behavioral difficulties. It generally develops at about the same time that most children are vaccinated. Since the cause of autism was not known at the time (and still isn't known), the paper caused widespread concern. However, the paper was later shown to be fraudulent and was retracted, and the author was found guilty of serious professional misconduct. Unfortunately, those facts barely made the news.

Since that paper appeared, scientists have searched for any connection between vaccinations and autism and have failed to find one. Nevertheless some parents, including actress and former *Playboy* model Jenny McCarthy and actress Alicia Silverstone, continue to promote their belief that vaccines may cause autism. Jenny McCarthy is on the board of Generation Rescue, a nonprofit organization that claims to be able to treat autism effectively with a special diet. Alicia Silverstone has written a book about parenting in which she dismisses the scientific evidence for vaccine safety. For parents unwilling to accept the research, emotions (fear and anxiety) are likely to continue to trump science until we know for certain what does cause autism. Science is just no match for an appearance by Ms. McCarthy on the *Oprah Winfrey Show* with an emotional story about an autistic child.

A child receiving a vaccination.

Vaccination Rates Decline, Preventable Diseases Return

In recent years, the number of exemptions from school immunization programs has increased. These exemptions, granted for philosophical or personal beliefs, coincide with a sharp uptick in the number of cases of measles and whooping cough. Because of their highly contagious nature, the two diseases are extremely sensitive to vaccination rates. In the first eight months of 2014, there were nearly 600 cases of measles in the United States, according to the Centers for Disease Control and Prevention (CDC). Nearly all of the measles victims had not been vaccinated, even though they were old enough. The CDC recommends that children be vaccinated against measles at 1 year old.

Public health officials are watching the decline in vaccinations against measles with growing concern. They know that the success of any vaccine is based on a concept called *herd immunity*. When most people in a community, or herd, have been vaccinated, a disease has a much harder time spreading among unvaccinated people. So, in addition to protecting the person who has been vaccinated, high vaccination rates protect the community as a whole from widespread disease outbreaks, especially among young children. Although there are always some people who aren't vaccinated and therefore at risk of contracting vaccine-preventable diseases, herd immunity substantially undercuts that risk. People who aren't vaccinated include children under 1 year old, whose immune systems are not yet developed enough for vaccines to be effective, and patients receiving chemotherapy or immunosuppressive therapy, whose immune systems are compromised.

Mandatory Vaccinations Remain Controversial

Compared to parents who vaccinate their children, parents who choose not to vaccinate their children are more likely to believe that the risk of their child getting a contagious disease is low and that the disease itself is not severe. The latter view is understandable, because most parents today have not lived through a major outbreak of any communicable disease. Today's parents were born after the →

Questions to Consider

1 What should medical professionals, politicians, or even just concerned citizens do, if anything, to help parents understand the risks and benefits of vaccines?

2 Will you vaccinate your children? Why or why not? What would you like to know in order to make an informed decision?

scourge of polio, for example. Polio killed nearly 10% of its victims and crippled countless others for life before the polio vaccine became available in 1955.

Some parents oppose mandatory childhood vaccinations because they are philosophically opposed to government intervention into what they see as a personal choice. Says Barbara Loe Fisher, a mother and the cofounder of the National Vaccine Information Center, representing parents against forced vaccinations, ". . . If the State can tag, track down and force citizens against their will to be injected with biologicals of unknown toxicity today, there will be no limit on which individual freedoms the State can take away in the name of the greater good tomorrow."[1]

Parents in favor of mandatory vaccinations are mounting lobbying campaigns as well. Their celebrity advocate is actress Amanda Peet, now a spokesperson for Every Child By Two, a vaccine-advocacy group founded by former first lady Rosalynn Carter. Ms. Peet once called anti-vaccine parents "parasites" for relying on other children's immunity to protect their own. She later apologized for the word and suggested that parents should get their advice from doctors, not celebrities like herself (and presumably Ms. McCarthy and Ms. Silverstone).

Health officials continue to stress that vaccines don't cause autism. It would be a shame if misinformation and fear allowed preventable diseases such as polio to return. We need to find a way to address parents' concerns about vaccine safety and about the role of government in our lives, while at the same time protecting the public from preventable, communicable diseases. How we do that is up to all of us.

[1]www.vaccineawakening.blogspot.com

SUMMARY

- **Childhood vaccination programs have been effective in all but eliminating certain communicable diseases.**
- **All 50 states have childhood vaccination (immunization) programs as a requirement for school attendance—all states also allow for certain exemptions.**
- **Exemptions from vaccination (and communicable diseases) are on the rise. Many parents object to mandatory vaccination programs out of concern that the vaccines may cause autism or certain other chronic childhood diseases.**
- **The available scientific evidence does not support the argument that vaccinations can cause childhood diseases, including autism.**

You were born into exciting times, when scientific discoveries are happening more rapidly than at any other time in human history. Like the Industrial Revolution of the nineteenth century and the discovery of DNA in the twentieth, today's scientific innovations will change the human condition forever.

In your lifetime, people may be able to select or modify their children's features before they are born. People may even be able to have clones (copies) made of themselves. At the very least, certain diseases that threaten us now will become curable. Perhaps your grandchildren will not even know what AIDS is because the disease will have disappeared.

What you are witnessing is the power of science. **Science** is the study of the *natural world,* which includes all matter and all energy. Because all living organisms are also made of matter and energy, they are part of the natural world. Biology is one of many branches of science. More specifically, **biology** (from the Greek words *bios,* meaning "life," and *logos,* meaning "word or thought") is the study of living organisms and life's processes. It is the study of life. Within biology, *anatomy* is the study of structure and *physiology* is the study of function. Other branches of science are chemistry, physics, geology, astronomy, and related fields such as medicine.

This text is specifically about *human* biology. We will explore what it means to be alive. We will see how the molecules that make up our bodies are created from molecules in the air and in our food and drink. We will learn how the trillions of cells that comprise our bodies grow and divide. We will explore how our bodies function, why we get diseases, and how we manage to survive them. We will look at how we develop into adults, reproduce, and influence the destinies of other organisms on Earth.

A recurrent theme in all of biology is the theory of *evolution:* that over the billions of years of Earth's history, living organisms (including humans) have undergone slow change over time. Based on the evidence available to us, it is hard to escape the conclusions that all living organisms evolved from single-celled organisms and that single-celled organisms arose from nonliving chemical elements nearly 3.5 billion years ago. We'll explore evolution more thoroughly later in the book. ■

With the power of science comes an awesome responsibility. All of us, individually and collectively, must choose how to use the knowledge that science gives us. Will human cloning be acceptable? Can we prevent global warming? Should you be required to vaccinate your children against certain infectious childhood diseases? (See the Current Issue feature, *Mandatory Childhood Vaccinations*.)

We all have to make responsible decisions concerning not only our own health and well-being but also the long-term well-being of our species. This book considers many aspects of human connections with the natural