1.1 The Study of Life
Biologists study life in all its forms.

1.2 Unifying Themes of Biology
Unifying themes connect concepts from many fields of biology.

1.3 Scientific Thinking and Processes
Science is a way of thinking, questioning, and gathering evidence.

1.4 Biologists’ Tools and Technology
Technology continually changes the way biologists work.

1.5 Biology and Your Future
Understanding biology can help you make informed decisions.

Review Academic Vocabulary
Write the correct word for each definition.

diversity  function  inquiry  structure  issue

1. ____________ : an activity or job
2. ____________ : a topic of discussion or debate
3. ____________ : variety
4. ____________ : the way parts are put together
5. ____________ : asking questions or investigating

Preview Biology Vocabulary
Four key terms from this chapter share the same word part. Read the definitions and guess what the word part means.

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
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<tbody>
<tr>
<td>biology</td>
<td>the scientific study of life</td>
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<tr>
<td>biosphere</td>
<td>all life on Earth and where it lives</td>
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<tr>
<td>biodiversity</td>
<td>the different types of life on Earth</td>
</tr>
<tr>
<td>biotechnology</td>
<td>the use of living things</td>
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What I think bio– means: ____________________________________________
Earth is home to an incredible diversity of life.

Living things are found almost everywhere on Earth. There is life in the deepest parts of the ocean, in hot springs, and even in Antarctic ice. Living things can be all shapes and sizes. The blue whale is the largest animal living on Earth. Other living things are so small they can only be seen through a microscope.

The Biosphere

Everything that lives on Earth, and every place where those things live, is part of the biosphere. Prairies, forests, deserts and other land environments are all part of the biosphere. Oceans, lakes, and other water environments are also part of the biosphere. Even the inside of your nose, where bacteria and fungi live, is a part of the biosphere.

Biodiversity

The word diversity means “variety.” If you have lots of different kinds of t-shirts, you have a variety of t-shirts, or a diversity of t-shirts. The word part bio- means “related to life.” Biodiversity is the variety, or all the different types, of life on Earth. There is more biodiversity in warm areas of Earth. More living things can survive in consistently warm areas. These areas have a larger food supply for more forms of life. The region around the equator* has the most consistently warm temperatures on Earth, so there is the greatest biodiversity near the equator.

* ACADEMIC VOCABULARY

equator the imaginary circle around the middle of the Earth
A **species** is a particular type of living things that can breed and reproduce. Humans are one species, and monarch butterflies are another species. About 2 million different living species have been identified. Biologists think that there could be millions more species that have not yet been discovered. Over half of all known species are insects.

**Where on Earth would you find the greatest variety of species?**

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**All organisms share certain characteristics.**

**Biology** is the scientific study of all forms of life, or all types of organisms. An **organism** is any individual living thing. All organisms have some things in common.

1. **Cells** All organisms are made up of one or more cells. The **cell** is the basic unit of life. Many living things are made of just one cell. Other living things, such as humans, are made up of many cells.

2. **Need for energy** All organisms need a source of energy. Some organisms, such as plants, use energy from sunlight to make their own food. Animals get their energy by eating other organisms. Energy is used in metabolism. **Metabolism** is all of the chemical processes that happen in an organism. These chemical processes break down molecules and build up other molecules that an organism needs.

3. **Response to environment** Organisms react to light, temperature, touch, sound, and other parts of their environment. For example, plants grow toward light. The pupils of your eyes get smaller when you are in bright light.
4. **Reproduction and development** Members of a species must be able to reproduce, or make new organisms. The new organisms, or offspring, must be able to grow and develop into mature* organisms that can have more offspring. When organisms reproduce, they pass on their genetic information to the offspring. The genetic information is in a molecule called **DNA**, or deoxyribonucleic acid. DNA contains molecular instructions for growth and development.

Highlight four characteristics that all organisms share.

* **ACADEMIC VOCABULARY**
  - mature: fully grown

### 1.1 Vocabulary Check

| biosphere | organism |
| biodiversity | cell |
| species | metabolism |
| biology | DNA |

Fill in the blanks with the correct term from the list above.

1. ___________ is the scientific study of all living things.
2. Genetic material that is passed on to offspring is called ____________.
3. A ____________ is a particular type of living things that can breed and reproduce.
4. The smallest unit of life is the ____________.
5. All organisms use energy for ____________, which is the breakdown and buildup of molecules necessary for life.

### 1.1 The Big Picture

6. Put the following three terms in order from smallest to largest: species, biosphere, cell.

7. List at least three characteristics that all living things share.

This drawing shows the structure of DNA. This shape is called a double helix.

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*McDougal Littell Biology*
When you hear the word theme, you might think of the music that starts your favorite TV show every week. Or you might think of something that happens over and over again. In biology, themes are ideas that come up time after time. They connect, or unify, different areas of biology.

All levels of life have systems of related parts.

Think about the different parts of a car—doors, tires, engine, seats, and so on. Even if you have all the different pieces of a car, it will not work unless all the pieces are put together in the right way. A car is a system. A **system** is a group of related parts that work together to make a whole.

There are many systems in biology. Some systems are tiny. A single heart cell, for example, is a system. Different cell parts and different chemicals all work together to make the heart cell function. Your heart, blood, arteries, and veins all work together in another system, your circulatory system.

An **ecosystem** is a biological system that includes living things, such as plants and animals, and nonliving things, such as water and rocks. A forest and a desert are both ecosystems. An ecosystem can also be a small area. A single tree or a pond is also an ecosystem.

Circle three examples of ecosystems.

Structure and function are related in biology.

Think about a car again. The structure, or shape, of each car part is related to its function, or how it works. For example, the round shape of a tire allows it to roll. The treads help it not to slip.

Structure and function are connected in living things, too. The structure of your ear allows you to hear—something that you cannot do with your knees or hands. The structure of your hands allows you to hold a pencil or a baseball bat—something you cannot do with your ears.
Your sharp front teeth help you bite into food, and your flat back teeth help you grind up the food.

Structure and function are connected on all levels. The structure of your nerve cells, for example, is different from the structure of your red blood cells and white blood cells. The differences in structure allow each type of cell to do its job.

What is another example—not given above—of a relationship between structure and function in the human body?

Organisms must maintain homeostasis to survive in diverse environments.

How can people be outside when the temperature is below freezing, but still have a body temperature that stays around 37°C (98.6°F)? Although temperature and other conditions in the environment are always changing, the conditions inside of an organism usually stay the same. The ability of an organism to keep its internal conditions about the same is called \textbf{homeostasis}.

It is very important that the conditions inside organisms stay the same, because cells can survive only in certain ranges of conditions. Changes in temperature, blood sugar, or other conditions in an organism’s body can be life threatening.

Systems in your body help to keep you in homeostasis. If your body temperature gets higher than normal, for example, your body will start sweating to help you cool down. This is an example of negative feedback. Your body sends information that it is too hot; sweating helps return your temperature to its normal state. In negative feedback, a change in a system causes a response to return the system to normal. Behavior also helps to maintain homeostasis. If you feel too cold, for example, you may put on warmer clothes.

Why is homeostasis important for survival?
Evolution explains the unity and diversity of life.

Evolution is the change in living things over time. Evolution is not a change in an individual. Instead, evolution is the change in the genetic makeup of a population—a group of individuals—of a species over time.

Adaptation

There is a lot of variation among the individuals in a species. Some variation can be inherited, or passed on to offspring through DNA. Some characteristics help an organism to survive and reproduce in a particular environment. An inherited characteristic that gives an advantage is called an adaptation. Organisms with an adaptation for a particular environment are more likely to survive and have offspring. Their offspring will also have the adaptation, and so they will be more likely to survive and reproduce. Over time, more individuals in the population will have the adaptation. This process is called natural selection.

The meaning of the word adaptation in evolution is different from the common meaning of the word. For example, if you say that you are adapting to a new classroom or to a new town, you are not talking about evolution. Instead, you are talking about becoming familiar with something new. Evolutionary adaptations are changes that occur over many generations* in response to changes in the environment.

Unity and Diversity

Fish, birds, mushrooms, bacteria, and humans share many similarities. For example, they are all made of cells, and they all pass on genetic information through DNA. Their cells contain many similar structures with similar functions. These are examples of the similarities, or the unity, of life.

Although living things share many similarities, they also have many differences. Fish, birds, mushrooms, bacteria, and humans live in different environments, get energy from different sources, and reproduce in very different ways. The diversity of life means the differences among living things.

* ACADEMIC VOCABULARY

generation a single stage of offspring in the history of a family: You and your brothers and sisters are one generation; your parents are another generation.
Evolution explains both the unity and the diversity of life. Over billions of years, living things have changed, resulting in a huge variety of species. Still, all species have things in common, because they all share common ancestors.

What is the difference between the biological meaning of *adaptation* and the common meaning of *adaptation*?

Choose the correct term from the list for each description.

1. conditions inside an organism do not change __________
2. an inherited characteristic that gives an organism an advantage __________
3. change over time of the genetic makeup of a population __________
4. all the living and nonliving things in an area and their interactions __________
5. a group of parts that function as a whole __________

How are the words *system* and *ecosystem* related?

How are structure and function related in living things?

What could happen if an organism could not maintain homeostasis?

What does it mean that there is both unity and diversity of life?
Like all science, biology is a process of inquiry.

Science is a process of inquiry, or investigation. Science is one way we try to understand the world around us. All sciences have certain things in common, but there is no one way of doing science.

**Observations**  Science begins with observation, or collecting information about a topic. Some observations are made directly with our senses. Other observations might involve using tools and technology.

**Data**  When observations are recorded, saved, or written down, they are called data. Sights, sounds, and smells are examples of qualitative data. They describe a “quality” of an observation. Mass, volume, and temperature are examples of quantitative data. They can be measured.

**Hypotheses**  Scientists use observations and data to form a hypothesis. A hypothesis (plural, hypotheses) is a possible answer to a scientific question. A hypothesis must be able to be tested.

What part of science do you think the young woman in the picture is involved in? Why?
Biologists use experiments to test hypotheses.

Scientific experiments allow scientists to test hypotheses and find out how something happens. In an experiment, scientists change one factor, or variable, to see how it affects the outcome of a situation. The factor that is changed in an experiment is called the independent variable. For example, suppose a scientist is testing how much of a medicine is necessary to treat high blood pressure. The independent variable is the dose of medicine, or how much medicine a patient gets. Then, the scientist sees how changes in the independent variable affect the dependent variable. The dependent variable is what the scientist measures as the outcome or result of the experiment. In this example, the dependent variable is blood pressure. The change in blood pressure depends on the amount of medicine given.

The independent variable should be the only part of a controlled experiment that changes. All other conditions should not change. The factors that do not change are called constants. For example, the form of medicine would be a constant—it would always be a pill.

What is the difference between the dependent variable and the independent variable in an experiment?

A theory explains a wide range of observations.

Many words have several different meanings. Depending on how a word is used, its meaning can change completely. For example, the word right could mean correct, or it could refer to a direction. Similarly, the word theory has different meanings. In everyday conversation, the word theory can mean a wild idea, or something that is imagined to be true. In science, the meaning of theory is very different.

Recall that a hypothesis is a proposed answer to a scientific question. A theory is a proposed explanation for a wide range of observations and experimental results that is supported by a wide range of evidence. Both gravity and natural selection are scientific theories.
Science is an ongoing process. Theories can change based on new evidence. New theories that better explain observations and experimental results can replace older theories. Our understanding of the world around us has changed very much over the past few decades*, and the study of biology has changed and expanded as well.

**STANDARDS CHECK**
What is the difference between a scientific theory and a hypothesis?

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* ACADEMIC VOCABULARY

decades  periods of ten years

**1.3 Vocabulary Check**

observation  independent variable
data  dependent variable
hypothesis  constant
experiment  theory

1. In the list above, circle the word that means what a scientist changes in an experiment.

2. Put a box around the word that means a factor that does not change.

3. Underline the word that means a written record of observations.

**1.3 The Big Picture**

4. Why are most factors held constant in a scientific experiment?

5. How are hypotheses and theories related?

6. What is science? Write a definition for the word.
Cars, computers, and cell phones are examples of technology. Technology has helped biologists learn a lot about life. Today, technology even allows scientists to observe activity inside the human brain.

**Imaging technologies provide new views of life.**

Cells are too small to see with just your eyes. Before the microscope was invented, no one knew about cells. Many different technologies have extended humans’ abilities to view life.

**Microscopes**

A **microscope** provides an enlarged image of an object. Light microscopes, like the one in the drawing to the right, can be used to see cells as small as bacteria. Light microscopes can be used to view living things. Other types of microscopes are used to see even smaller things. Electron microscopes can be used to see things as small as protein molecules. However, electron microscopes cannot be used to view living things.

**Medical Imaging**

Different types of technology are used to see inside organisms—without cutting the organism open. X-rays pass through soft skin and can show images of bones and teeth. A tool called magnetic resonance imaging (MRI) can be used to see things that are softer than bone. A functional MRI can even show images of brain activity.

**What did scientists discover with the help of microscopes?**
Complex systems are modeled on computers.

Computers can be used to study living systems that cannot be studied directly. Computer models are also used when actual experiments are not safe, ethical, or practical. For example, computer models can be used to study heart attacks. Computer models can also help to study large systems. For example, they can help predict how fast a disease might spread, and how many people will get sick.

The tools of molecular genetics give rise to new biological studies.

When your parents were in high school, no one would have imagined the DNA technologies in use today. In just the last 40 years, we have learned how the genetic code works, studied the functions of genes, and have even changed genes. A gene is a segment of DNA that stores genetic information. The study of genes has led to new fields of biology.

- **Molecular genetics** is the study and manipulation of DNA on a molecular level. Manipulation of DNA means the ability to change the DNA of organisms.
- **Genomics** is the study of the entire DNA sequences of humans and other organisms. The entire DNA sequence of an organism is called its genome.

Where do you think biology will be in another 40 years?

**What two new fields of biology use DNA technologies?**

**1.4 Vocabulary Check**

microscope molecular genetics

gene genomics

**Mark It Up**

Go back and highlight each sentence that has a vocabulary word in bold.

1. What is the study of the entire DNA sequence of an organism?

2. A ____________ is a segment of DNA?

**1.4 The Big Picture**

3. Give an example of how technology has changed human understanding of life. ________________________________

4. A person who is working to insert a new gene into an organism might be in the field of ________________________________
YOUR HEALTH AND THE HEALTH OF THE ENVIRONMENT DEPEND ON YOUR KNOWLEDGE OF BIOLOGY.

Do energy drinks really give you energy? Is bottled water healthier than tap water? Are you at risk for any genetic diseases or health problems? What are the benefits of exercise? How does sleep affect your brain? What are the effects of alcohol, illegal drugs, and tobacco? What are the health risks of pollution in your area? An understanding of biology can help you make choices and decisions that affect your health.

Biologists and other scientists research environmental issues such as pollution, biodiversity, land conservation, and natural resource use. But decisions about the future are made by everyone, not just by scientists. An understanding of many areas of biology—from genetics to ecosystem studies—can help you make informed decisions.

What is one health issue that biology can help you to better understand?

BIOTECHNOLOGY OFFERS GREAT PROMISE BUT ALSO RAISES MANY ISSUES.

Biotechnology is the use of living things and biological processes. Some forms of biotechnology have been around for centuries*, such as the use of microorganisms to make bread and cheese. Today, other uses of biotechnology include DNA testing and DNA fingerprinting. DNA fingerprinting has helped to free people who were accused of a crime that they did not commit. Two other examples of biotechnology are described on the next page.

* ACADEMIC VOCABULARY

informed based on facts

centuries periods of one hundred years
1. **Genetically modified organisms** Through centuries of breeding, humans have slowly modified, or changed, many different plant and animal species. For example, carrots and poodles are genetically modified organisms because they have been selectively bred over many years. Today’s technologies allow for genetic changes in short periods of time. Now we can move, or transfer, genes from one species into another species. Organisms that have genes from a different species are called **transgenic** organisms.

Transgenic bacteria can make human insulin to treat people with diabetes. Transgenic, or genetically modified, food is a topic of debate all around the world. Genetic changes could make foods more nutritious. Genetic changes could also make plants grow well without the use of pesticides. However, there are many questions about genetically modified foods that no one knows the answers to yet. Are they safe to eat? Could they spread genes to wild plants? An understanding of the possible benefits and risks of transgenic organisms requires knowledge of biology.

2. **Genetic screening** Another form of biotechnology is human genetic screening. Genetic screening could help to see if a person is at risk for a genetic disorder. Genetic screening also raises questions about ethics*. Who should be allowed to see a person’s genetic information? Should parents be allowed to use genetic screening to choose the characteristics of their children?

What is one benefit and one risk of biotechnology?

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**Biology presents many unanswered questions.**

About 50 years ago, the structure of DNA was discovered. By 2003 the entire human DNA sequence was known. Today, however, there are still more questions than answers. Can cancer be cured? Does life exist on other planets? How are memories kept in the brain?

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**VOCABULARY**

Pesticides are poisons used to kill insects.

**THE GENE WORD FAMILY**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Gene</td>
<td>segment of DNA that stores genetic information</td>
</tr>
<tr>
<td>Genome</td>
<td>entire DNA sequence of an organism</td>
</tr>
<tr>
<td>Genomics</td>
<td>study of genomes</td>
</tr>
<tr>
<td>Molecular genetics</td>
<td>study and manipulation of DNA molecule</td>
</tr>
<tr>
<td>Genetic screening</td>
<td>testing DNA to see if a person is at risk for a genetic disorder</td>
</tr>
<tr>
<td>Transgenic</td>
<td>an organism that has a gene from a different species</td>
</tr>
</tbody>
</table>
A huge number of questions in biology are not just unanswered—they have not been asked. Before the microscope was invented, no one studied anything microscopic. Before biologists knew what the genetic material was, no one used genetic screening or DNA testing. As technology and biology advance, what do you think will be discovered in the next 20 years?

**Will all biology questions be answered some day? Explain your answer.**

**1.5 Vocabulary Check**

**biotechnology**

**transgenic**

1. If *bio-* means “life,” then *biotechnology* means _____________ is applied to technology.

2. If *trans-* means “over or across,” then *transgenic* organisms have genes that have been brought _____________ from other organisms.

**1.5 The Big Picture**

3. How could your understanding of biology help you to make decisions about your health and the environment? ________________

4. An issue is a topic of discussion, or something that can raise concerns. Why is biotechnology sometimes called an issue? ________________

5. Why are some biology questions still unanswered? ________________
Chapter 1 Review

1. What are four characteristics that living things share? ____________

2. Write the terms organism, biosphere, and cell onto the diagram in order of biggest system to smallest system. The biggest circle should be labeled with the biggest system and the smallest circle with the smallest system.

   a. ____________
   b. ____________
   c. ____________

3. Draw an example of a relationship between structure and function in a living thing.

4. Which of the following is an example of homeostasis?
   a. genetically modified organisms that produce insulin
   b. unchanging body temperature even in hot and cold environments
   c. the inheritance of an evolutionary adaptation
   d. front teeth that bite into food and back teeth that grind up food

5. What is the difference between a scientific hypothesis and a scientific theory? ____________

6. Choose the word that completes the following sentence:
   Biological evolution is the result of ____________ changes in a population of a species.

   a. ecosystem
   b. metabolism
   c. genetic
   d. molecular

7. How has technology changed the way biologists study living things? Give an example. ____________

8. What is one reason a computer model might be used in biological research? ____________

9. Write a definition of the word biology that a younger student would understand. ____________

10. Describe one benefit and one risk involved in the use of transgenic organisms. ____________