SECTION 1.1  | THE STUDY OF LIFE
Study Guide

KEY CONCEPT
Biologists study life in all its forms.

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

MAIN IDEA: Earth is home to an incredible diversity of life.
Take notes about the diversity of life on Earth in the chart below.

1. In the box labeled The Biosphere, list examples of environments on earth in which life is found.

2. In the box labeled Biodiversity, write a definition of the term in your own words.

3. In the box labeled Species, briefly explain what a species is.

Earth is home to an incredible diversity of life.

4. How is biodiversity related to the biosphere?

5. In general, how does biodiversity vary across the biosphere?

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Unit 1 Resource Book
McDougal Littell Biology
STUDY GUIDE, CONTINUED

MAIN IDEA: All organisms share certain characteristics.

6. Before reading, take a quick look at the headings in this main idea. What are the four characteristics that identify something as living?

7. As you read, take notes on how the four basic characteristics help define what is a living thing.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Summary Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cells</td>
<td></td>
</tr>
<tr>
<td>Energy and metabolism</td>
<td></td>
</tr>
<tr>
<td>Response to environment</td>
<td></td>
</tr>
<tr>
<td>Reproduction and development</td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

8. The word biosphere is made up of two word parts: bio- and sphere. How can these two word parts help you to remember the definition of biosphere?

9. What is an organism?

10. The term metabolism is based on a Greek word that means “change.” How is this meaning related to the meaning of metabolism?

11. How is DNA related to reproduction?
SECTION 1.2 UNIFYING THEMES OF BIOLOGY

Study Guide

KEY CONCEPT
Unifying themes connect concepts from many fields of biology.

VOCABULARY

<table>
<thead>
<tr>
<th>system</th>
<th>homeostasis</th>
<th>adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ecosystem</td>
<td>evolution</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: All levels of life have systems of related parts.

1. What is a system?

2. What are some examples of systems?

Complete the table by writing either the level of life or an example of a system at that level of life.

<table>
<thead>
<tr>
<th>Level</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Cells</td>
<td>Chemicals and processes interact in a precise way so that a cell can function properly.</td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5. Ecosystem</td>
<td>Different parts of a living thing work together so that the living thing can survive.</td>
</tr>
<tr>
<td>6.</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Structure and function are related in biology.

7. What are structure and function?

8. Give an example of how structure and function are related on the cellular level.
STUDY GUIDE, CONTINUED

MAIN IDEA: Organisms must maintain homeostasis to survive in diverse environments.

9. What is homeostasis?

10. Why is homeostasis important to the survival of an organism?

11. In the space below, draw a sketch to help you remember what negative feedback is.

Body temperature decreases. \(\rightarrow\) \(\rightarrow\) Body systems send messages.

12. What is evolution?

13. Over the course of time, evolution \(\ldots\) the genetic makeup of a population.

14. \(\ldots\) are genetic traits that give an advantage to an individual and can be passed on to offspring.

Vocabulary Check

15. A system in which living and nonliving things in a certain area interact is called a(n) \(\ldots\)

16. The maintenance of constant internal conditions in an organism is called \(\ldots\).
SECTION 1.3

SCIENTIFIC THINKING AND PROCESSES

Study Guide

KEY CONCEPT
Science is a way of thinking, questioning, and gathering evidence.

VOCABULARY

| observation | hypothesis | independent variable | constant
| data        | experiment  | dependent variable    | theory |

MAINT IDEA: Like all science, biology is a process of inquiry.

Complete the table below by giving a brief description and a brief example of each of the scientific process terms.

<table>
<thead>
<tr>
<th>Scientific Process</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>1.</td>
<td>2.</td>
</tr>
<tr>
<td>Data</td>
<td>3.</td>
<td>4.</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>5.</td>
<td>6.</td>
</tr>
</tbody>
</table>

7. How do scientists use statistics when they test a hypothesis?

8. Why is it important that a scientist’s results are evaluated by other scientists?
9. Look at Figure 1.10. Beginning with observation, what are the five parts of scientific thinking?

________________________________________________________________________

________________________________________________________________________

MAIN IDEA: Biologists use experiments to test hypotheses.

10. In ___________ studies, scientists do not interfere with what is going on.

11. Scientists can test hypotheses through ___________ .

12. A(n) ___________ variable is one which is observed and not manipulated by the scientist.

13. How are constants different from independent variables?

________________________________________________________________________

________________________________________________________________________

MAIN IDEA: A theory explains a wide range of observations.

14. What is the difference between a theory and a hypothesis?

________________________________________________________________________

15. Why are theories never proven?

________________________________________________________________________

Vocabulary Check

16. What is a hypothesis?

________________________________________________________________________

17. How can you remember the difference between an independent variable and a dependent variable? Think about what the words independent and dependent mean.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
KEY CONCEPT
Technology continually changes the way biologists work.

MAIN IDEA: Imaging technologies provide new views of life.
Compare and contrast the different types of microscopes and medical imaging techniques.

<table>
<thead>
<tr>
<th>Type of Technology</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light microscope (LM)</td>
<td>1.</td>
</tr>
<tr>
<td>Scanning electron microscope (SEM)</td>
<td>2.</td>
</tr>
<tr>
<td>Transmission electron microscope (TEM)</td>
<td>3.</td>
</tr>
<tr>
<td>X-ray</td>
<td>4.</td>
</tr>
<tr>
<td>Magnetic resonance imaging (MRI)</td>
<td>5.</td>
</tr>
</tbody>
</table>
MAIN IDEA: Complex systems are modeled on computers.

6. What is a model?

7. Why might scientists use computer models in research instead of conducting an experiment on the real system they would like to study?

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

8. What is a gene?

9. How are computers used in genomics?

10. How does a gene differ from a genome?

Vocabulary Check

11. The term genomics is related to the term genome. How does the definition of genome give you a clue about what genomics means?

12. The term molecular genetics is made up of two words: molecular and genetics. What are the meanings of these two words, and how can these words help you to remember what molecular genetics is?
KEY CONCEPT
Understanding biology can help you make informed decisions.

VOCABULARY
biotechnology
transgenic

MAIN IDEA: Your health and the health of the environment depend on your knowledge of biology.

1. Briefly describe three ways in which biology can help you make informed decisions about your health.

2. Briefly describe why biology and scientific thinking can help you make informed decisions related to the world around you.

MAIN IDEA: Biotechnology offers great promise but also raises many issues.

3. What is biotechnology?

Use the chart below to list the benefits of biotechnology, as well as the risks and ethical concerns about biotechnology.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Risks and Ethical Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>5.</td>
</tr>
</tbody>
</table>
MAIN IDEA: Biology presents many unanswered questions.

6. Most of our knowledge about DNA was discovered during the past ____________ years.

7. Many questions go ____________ because we don’t know enough about biology to even come up with those questions.

8. Before the invention of the microscope, people did not know about cells and bacteria. With this in mind, why do you think many questions go unanswered and unasked?

Vocabulary Check
Each of the vocabulary words has been divided into its root words. Define the roots. Then use the definitions to define the vocabulary word.

9. Transgenic organism can be divided into trans- and genic.

10. Biotechnology can be divided into bio- and technology.

Any Questions?
11. What questions do you have about biology or scientific research? List three topics in biology that you want to learn more about, and why they interest you.
SECTION 2.1

ATOMS, IONS, AND MOLECULES

Study Guide

KEY CONCEPT
All living things are based on atoms and their interactions.

VOCKABULARY

<table>
<thead>
<tr>
<th>atom</th>
<th>ion</th>
<th>molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td>element</td>
<td>ionic bond</td>
<td>compound</td>
</tr>
<tr>
<td>compound</td>
<td>covalent bond</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Living things consist of atoms of different elements.

1. How are atoms and elements related?

2. Sketch the structure of an atom. Label the protons, neutrons, nucleus, and electrons.

3. How do compounds differ from elements?

MAIN IDEA: Ions form when atoms gain or lose electrons.

4. What is an ion?

5. Why does an ion have an electrical charge?
6. In the spaces provided below, sketch how both positive and negative ions form. Label the nucleus and the electrons. Use Figure 2.3 as a reference.

MAIN IDEA: Atoms share pairs of electrons in covalent bonds.

7. What is a covalent bond?

8. What determines the number of covalent bonds that an atom can form?

Vocabulary Check

<table>
<thead>
<tr>
<th>element</th>
<th>compound</th>
<th>ion</th>
<th>molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9. atoms held together by covalent bonds</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10. composed of different types of atoms</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11. composed of one type of atom</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12. atom that has gained or lost electrons</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. What is the difference between how ionic and covalent bonds form?
SECTION 2.2 PROPERTIES OF WATER

Study Guide

KEY CONCEPT
Water’s unique properties allow life to exist on Earth.

VOCABULARY

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrogen bond</td>
<td>solution</td>
</tr>
<tr>
<td>cohesion</td>
<td>solvent</td>
</tr>
<tr>
<td>adhesion</td>
<td>solute</td>
</tr>
<tr>
<td></td>
<td>acid</td>
</tr>
<tr>
<td></td>
<td>base</td>
</tr>
<tr>
<td></td>
<td>pH</td>
</tr>
</tbody>
</table>

MAIN IDEA: Life depends on hydrogen bonds in water.

1. What is a polar molecule?

2. Explain why water is a polar molecule.

3. What is a hydrogen bond?

4. Describe where a hydrogen bond can form among water molecules.

Complete the table by writing short descriptions about the properties of water.

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High specific heat</td>
<td>5.</td>
</tr>
<tr>
<td>Cohesion</td>
<td>6.</td>
</tr>
<tr>
<td>Adhesion</td>
<td>7.</td>
</tr>
</tbody>
</table>
STUDY GUIDE, CONTINUED

MAIN IDEA: Many compounds dissolve in water.

8. What is the difference between a solvent and a solute?

9. What types of substances dissolve easily in water?

10. What types of substances do not dissolve easily in water?

MAIN IDEA: Some compounds form acids or bases.

11. Take notes about the characteristics of acids and bases in the table below.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Acid</th>
<th>Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect on $H^+$ concentration in a solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect on pH</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

12. In the space below, sketch a solution using the Visual Vocab on page 42 as a reference. Label the solution, solvent, and solute. Next to these labels, write brief definitions for the terms.
SECTION 2.3  CARBON-BASED MOLECULES
Study Guide

KEY CONCEPT
Carbon-based molecules are the foundation of life.

VOCABULARY
<table>
<thead>
<tr>
<th>monomer</th>
<th>lipid</th>
<th>amino acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>polymer</td>
<td>fatty acid</td>
<td>nucleic acid</td>
</tr>
<tr>
<td>carbohydrate</td>
<td>protein</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Carbon atoms have unique bonding properties.

1. Why is carbon often called the building block of life?

2. What ability allows carbon atoms to form a large number of molecules?

3. In the space below, sketch the three basic structures of carbon-based molecules: straight chain, branched chain, and ring.
MAIN IDEA:  Four main types of carbon-based molecules are found in living things.
Complete the table with functions and examples of each type of carbon-based molecule.

<table>
<thead>
<tr>
<th>Molecule Type</th>
<th>Functions</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>4.</td>
<td>5.</td>
</tr>
<tr>
<td>Lipid</td>
<td>6.</td>
<td>7.</td>
</tr>
<tr>
<td>Protein</td>
<td>8.</td>
<td>9.</td>
</tr>
<tr>
<td>Nucleic acid</td>
<td>10.</td>
<td>11.</td>
</tr>
</tbody>
</table>

12. What determines a protein’s structure and function?

13. What are nucleic acids made of?

Vocabulary Check

14. The prefix *mono-* means “one,” and the prefix *poly-* means “many.” How are these meanings related to the terms *monomer* and *polymer*?
KEY CONCEPT
Life depends on chemical reactions.

VOCABULARY
<table>
<thead>
<tr>
<th>chemical reaction</th>
<th>bond energy</th>
<th>exothermic</th>
</tr>
</thead>
<tbody>
<tr>
<td>reactant</td>
<td>equilibrium</td>
<td>endothermic</td>
</tr>
<tr>
<td>product</td>
<td>activation energy</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Bonds break and form during chemical reactions.

1. Label the reactants and products in the chemical reaction shown below. Write brief definitions for these terms next to their labels.

   \[ CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \]

2. What causes chemical bonds to break during a reaction?

3. What is bond energy?

4. In a chemical equation, what symbol is used to show that a chemical reaction goes in both directions?

5. When does a chemical reaction reach equilibrium?
MAIN IDEA: Chemical reactions release or absorb energy.

6. The ______________________ of the reactants and products determines whether energy will be released or absorbed during a chemical reaction.

7. Before a chemical reaction can start, __________________ must be absorbed by the reactants. The amount that must be absorbed to start the reaction is called the ___________________.

8. In an exothermic reaction, the products have a ____________________ bond energy than the reactants. Overall, energy is ____________________.

9. In an endothermic reaction, the products have a ____________________ bond energy than the reactants. Overall, energy is ____________________.

Vocabulary Check

10. Write one sentence that uses the words chemical reaction, reactant, and product.

________________________________________________________________________

11. Write your own analogy to remember the meaning of activation energy.

________________________________________________________________________

12. The term equilibrium is based on two Latin roots that mean “equal” and “balance.” How do these meanings tell you the meaning of equilibrium in a chemical reaction?

________________________________________________________________________

13. The prefix exo- means “out,” and the prefix endo- means “in.” What do these prefixes tell you about exothermic and endothermic reactions?

________________________________________________________________________
SECTION 2.5 | ENZYMES

Study Guide

KEY CONCEPT
Enzymes are catalysts for chemical reactions in living things.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>catalyst</td>
</tr>
<tr>
<td>substrate</td>
</tr>
<tr>
<td>enzyme</td>
</tr>
</tbody>
</table>

MAIN IDEA: A catalyst lowers activation energy.

1. What is activation energy?

2. Take notes about catalysts in the chart below. In the first two boxes, write detail notes about the main functions of catalysts. In the third box, write a detail about another characteristic.

A catalyst lowers activation energy.

3. When a catalyst is present, more / less activation energy is needed to start a chemical reaction.

---

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**MAIN IDEA:** Enzymes allow chemical reactions to occur under tightly controlled conditions.

4. Take notes about enzymes by filling in the Main Idea Web below.

   **Why enzymes are necessary:**

   **How structure affects function:**

   **Important factors in enzyme structure:**

   **Lock-and-key model:**

5. How do enzymes weaken the bonds in substrates?

   ____________________________________________________________

   ____________________________________________________________

**Vocabulary Check**

6. The word *catalyst* comes from the Greek word meaning “to dissolve.” How does this definition relate to the meaning of *catalyst*?

   ____________________________________________________________

7. How are substrates like keys and enzymes like locks?

   ____________________________________________________________

   ____________________________________________________________
KEY CONCEPT
Cells are the basic unit of life.

VOCABULARY
| cell theory | organelle | eukaryotic cell |
| cytoplasm   | prokaryotic cell |

MAIN IDEA: Early studies led to the development of the cell theory.
In a phrase, tell what each scientist did to help develop the cell theory.

<table>
<thead>
<tr>
<th>Scientist</th>
<th>Contribution to Cell Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hooke</td>
<td></td>
</tr>
<tr>
<td>2. Leeuwenhoek</td>
<td></td>
</tr>
<tr>
<td>3. Schleiden</td>
<td></td>
</tr>
<tr>
<td>4. Schwann</td>
<td></td>
</tr>
<tr>
<td>5. Virchow</td>
<td></td>
</tr>
</tbody>
</table>

6. What are the three parts of the cell theory?

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

7. Give two reasons why the cell theory is important.

____________________________________________________________________
____________________________________________________________________
MAIN IDEA: Prokaryotic cells lack a nucleus and most internal structures of eukaryotic cells.
In the top left side of the Y shape below, write the characteristics of eukaryotic cells. In the top right side of the Y shape below, write the characteristics of prokaryotic cells. At the bottom of the Y shape below, write the characteristics that both kinds of cells have in common. Then lightly cross out those characteristics at the top of the Y.

Eukaryotic cells

Prokaryotic cells

Both

Vocabulary Check
8. What is cytoplasm?

9. Where do you find organelles?

10. What statements summarize scientists’ concepts of cells?

11. Which type of cells have no nucleus?
SECTION 3.2

CELL ORGANELLES

Study Guide

KEY CONCEPT
Eukaryotic cells share many similarities.

VOCABULARY

<table>
<thead>
<tr>
<th>cytoskeleton</th>
<th>Golgi apparatus</th>
<th>lysosome</th>
</tr>
</thead>
<tbody>
<tr>
<td>nucleus</td>
<td>vesicle</td>
<td>centriole</td>
</tr>
<tr>
<td>endoplasmic reticulum</td>
<td>mitochondrion</td>
<td>cell wall</td>
</tr>
<tr>
<td>ribosome</td>
<td>vacuole</td>
<td>chloroplast</td>
</tr>
</tbody>
</table>

MAIN IDEA: Cells have an internal structure.

1. Look at Figure 3.5 in your textbook. What are the functions of a cytoskeleton?

2. How is a cytoskeleton like your skeleton?

3. How is a cytoskeleton like your muscles?

MAIN IDEA: Several organelles are involved in making and processing proteins.

Write either the function or the name of each organelle. Draw a sketch to help you remember it.

<table>
<thead>
<tr>
<th>Organelle</th>
<th>Function</th>
<th>Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. nucleus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>helps in the production of proteins and lipids</td>
<td></td>
</tr>
<tr>
<td>6. ribosomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Golgi apparatus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>carries certain molecules from place to place within a cell</td>
<td></td>
</tr>
</tbody>
</table>
MAIN IDEA: Other organelles have various functions.
Write the function of each organelle. Draw a sketch to help you remember it.

<table>
<thead>
<tr>
<th>Organelle</th>
<th>Function</th>
<th>Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. mitochrondrion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. vacuole</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. lysosome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. centriole</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Plant cells have cell walls and chloroplasts.
13. What role do cell walls play in a plant?

_____________________________________________________________________

14. What is the difference between a cell wall and a cell membrane?

_____________________________________________________________________

15. Why are chloroplasts important?

_____________________________________________________________________

Vocabulary Check
16. Which cell part is a maze of folded membranes where proteins and lipids are produced?

_____________________________________________________________________

17. Which cell part converts food into energy that is usable by a cell?

_____________________________________________________________________
KEY CONCEPT
The cell membrane is a barrier that separates a cell from the external environment.

VOCABULARY
- cell membrane
- selective permeability
- phospholipid
- receptor
- fluid mosaic model

MAIN IDEA: Cell membranes are composed of two phospholipid layers.
1. Draw a phospholipid in the box below. Label the three major parts.

   __________________________________________________________________________

2. Which part of a phospholipid is charged, or polar? ________________________________

3. Which part of a phospholipid is nonpolar? ____________________________

4. What type of molecules interact with water, polar or nonpolar? _____________________

5. Where does a cell membrane come into contact with water? _______________________

6. Why do the phospholipids surrounding the cell form a bilayer? ____________________

A cell membrane has other types of molecules embedded in the phospholipid bilayer. List a function of each type of molecule in the table below.

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Cholesterol</td>
<td></td>
</tr>
<tr>
<td>8. Proteins</td>
<td></td>
</tr>
<tr>
<td>9. Carbohydrates</td>
<td></td>
</tr>
</tbody>
</table>
10. In what way is a membrane fluid?

11. Draw a picture in the box below to represent selective permeability.

| outside | inside |

MAIN IDEA: Chemical signals are transmitted across the cell membrane.

12. A ___________ detects a signal molecule and carries out an action in response.

13. A ___________ is a molecule that acts as a signal when it binds to a receptor.

14. A ligand that can cross the cell membrane can bind to an ___________ receptor.

15. A ligand that cannot cross the cell membrane can send a message to a cell by binding to a ___________ receptor, which then ___________ shape.

Vocabulary Check

16. What is the fluid mosaic model?

17. The cell membrane allows some, but not all, molecules to cross. What term describes this property?
KEY CONCEPT
Materials move across membranes because of concentration differences.

VOCABULARY
<table>
<thead>
<tr>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>passive transport</td>
</tr>
<tr>
<td>osmosis</td>
</tr>
<tr>
<td>hypotonic</td>
</tr>
<tr>
<td>diffusion</td>
</tr>
<tr>
<td>isotonic</td>
</tr>
<tr>
<td>facilitated diffusion</td>
</tr>
<tr>
<td>concentration gradient</td>
</tr>
<tr>
<td>hypertonic</td>
</tr>
</tbody>
</table>

MAIN IDEA: Diffusion and osmosis are types of passive transport.

1. What is a concentration gradient?

2. What does it mean for a molecule to diffuse down a concentration gradient?

Complete the concept map below about passive transport.

8. The higher the concentration of dissolved particles in a solution, the ______________ the concentration of water molecules in that solution.
Suppose you have three solutions with different concentrations of particles. Relative to the concentration of particles in a cell, one solution is isotonic, one is hypertonic, and one is hypotonic. Use this information to answer the next two questions.

9. Which solution has the highest concentration of particles?

10. Which solution has the highest concentration of water molecules?

MAIN IDEA: Some molecules diffuse through transport proteins.

11. How does facilitated diffusion differ from simple diffusion?

12. In facilitated diffusion, do molecules move down a concentration gradient or against a concentration gradient?

Vocabulary Check

13. The difference in the concentration of a substance from one location to another is a _________________.

14. People with excess energy are described as hyper. How does this relate to the meaning of hypertonic?

15. The word facilitate means “to make easier.” How does this meaning apply to facilitated diffusion?
KEY CONCEPT
Cells use energy to transport materials that cannot diffuse across a membrane.

VOCABULARY
<table>
<thead>
<tr>
<th>active transport</th>
<th>phagocytosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>endocytosis</td>
<td>exocytosis</td>
</tr>
</tbody>
</table>

MAIN IDEA: Proteins can transport materials against a concentration gradient.

1. How is active transport different than simple diffusion and facilitated diffusion?

2. How is active transport similar to facilitated diffusion?

3. List two characteristics that almost all transport proteins share.

4. List the key distinguishing feature of active transport proteins.

5. Refer to Figure 3.25 to draw a picture in the box below to represent active transport.

6. Most active transport proteins use energy from the breakdown of _______________.

outside inside
STUDY GUIDE, CONTINUED

MAIN IDEA: **Endocytosis and exocytosis transport materials across the membrane in vesicles.**

7. A cell may transport a substance in _____________________ if the substance is too large to cross the membrane.

8. During endocytosis, the vesicle membrane fuses with a lysosome, and the membrane and its contents are broken down by _____________________.

Complete the Y diagram below to compare and contrast the processes of endocytosis and exocytosis. Under the heading “endocytosis,” list the characteristics of endocytosis. Under the heading “exocytosis,” list the characteristics of exocytosis. At the bottom of the Y, write the characteristics that both processes have in common. Then lightly cross out those characteristics at the top of the Y.

![Y diagram template]

**Vocabulary Check**

9. What term means “cell eating” and describes a type of endocytosis?

10. The prefix *exo-* means “out of,” and the prefix *endo-* means “taking in.” How do these meanings relate to the meaning of exocytosis and endocytosis?

11. What process drives molecules across a membrane against a concentration gradient?
KEY CONCEPT
All cells need chemical energy.

VOCABULARY
| ATP   | ADP   | chemosynthesis |

MAIN IDEA: The chemical energy used for most cell processes is carried by ATP.

1. What do all cells use for energy?

2. What is ATP?

3. What is the relationship between ATP and ADP?

Fill in the four parts of the cycle diagram below to take notes on the relationship between ATP and ADP.
MAIN IDEA: Organisms break down carbon-based molecules to produce ATP. Use the table below to organize your notes about the different types of molecules that are broken down to make ATP.

<table>
<thead>
<tr>
<th>Type of Molecule</th>
<th>Role in ATP Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>4.</td>
</tr>
<tr>
<td>Lipids</td>
<td>5.</td>
</tr>
<tr>
<td>Proteins</td>
<td>6.</td>
</tr>
</tbody>
</table>

MAIN IDEA: A few types of organisms do not need sunlight and photosynthesis as a source of energy.

7. What is chemosynthesis?

Vocabulary Check

8. The prefix *tri-* means “three,” and the prefix *di-* means “two.” How do these prefixes tell you the difference between adenosine triphosphate (ATP) and adenosine diphosphate (ADP)?

9. The prefix *chemo-* means “chemical,” and *synthesis* comes from a Greek word that means “to put together.” How do these meanings tell you what chemosynthesis does?
### KEY CONCEPT
The overall process of photosynthesis produces sugars that store chemical energy.

### VOCABULARY
<table>
<thead>
<tr>
<th>photosynthesis</th>
<th>light-dependent reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorophyll</td>
<td>light-independent reactions</td>
</tr>
<tr>
<td>thylakoid</td>
<td></td>
</tr>
</tbody>
</table>

### MAIN IDEA:
Photosynthetic organisms are producers.

1. Why are some organisms called producers?

2. What is the function of photosynthesis?

3. What is chlorophyll?

### MAIN IDEA:
Photosynthesis in plants occurs in chloroplasts.

4. What are chloroplasts?

5. In which two parts of a chloroplast does photosynthesis take place?

6. What are thylakoids?

7. Write the chemical equation for the overall process of photosynthesis. Then explain what the equation means and identify the reactants, products, and the meaning of the several arrows.

8. What are the differences between the light-dependent reactions and the light-independent reactions?
Use the space below to sketch and label a chloroplast. On the sketch, write the four steps of the photosynthesis process.

**Vocabulary Check**

9. The prefix *photo-* means “light,” and *synthesis* means “to put together.” How do those meanings tell you what happens during photosynthesis?

______________________________________________________________________________

10. The prefix *chloro-* means “green,” and the suffix *-phyll* means “leaf.” How are these meanings related to chlorophyll?

______________________________________________________________________________

11. The prefix *in-* means “not.” How does this meaning tell you which reactions in photosynthesis require light, and which reactions do not?

______________________________________________________________________________
KEY CONCEPT
Photosynthesis requires a series of chemical reactions.

VOCABULARY
<table>
<thead>
<tr>
<th>photosystem</th>
<th>ATP synthase</th>
</tr>
</thead>
<tbody>
<tr>
<td>electron transport chain</td>
<td>Calvin cycle</td>
</tr>
</tbody>
</table>

MAIN IDEA: The first stage of photosynthesis captures and transfers energy.

1. Overall, what is the function of the light-dependent reactions?

2. What are photosystems?

3. Which molecules carry energy to the light-independent reactions?

Fill in the sequence diagram below to follow the seven steps of the light-dependent reactions.
MAIN IDEA: The second stage of photosynthesis uses energy from the first stage to make sugars.

4. What is the function of the Calvin cycle?

Fill in the cycle diagram to summarize the four steps of the Calvin cycle.

Vocabulary Check

5. What is the electron transport chain?

6. The first part of an enzyme’s name tells you about its function. All enzymes end with the suffix -ase. What does this information tell you about ATP synthase?

7. What does the word cycle tell you about the chemical reactions of the Calvin cycle?
### Key Concept
The overall process of cellular respiration converts sugar into ATP using oxygen.

### Vocabulary
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>cellular respiration</td>
<td>Anaerobic process</td>
</tr>
<tr>
<td>aerobic</td>
<td>Krebs cycle</td>
</tr>
<tr>
<td>glycolysis</td>
<td></td>
</tr>
</tbody>
</table>

### Main Idea: Cellular respiration makes ATP by breaking down sugars.
1. What is cellular respiration?

2. Why is cellular respiration called an aerobic process?

3. Where does cellular respiration take place?

4. What happens during glycolysis?

### Main Idea: Cellular respiration is like a mirror image of photosynthesis.
5. In what two ways does cellular respiration seem to be the opposite of photosynthesis?

6. In which two parts of a mitochondrion does cellular respiration take place?

7. Write the chemical equation for the overall process of cellular respiration.

8. Explain what the equation means. Identify the reactants, products, and the meaning of the several arrows.
Use the space below to sketch and label a mitochondrion. On the sketch, write the four steps of the cellular respiration process that occur in the mitochondrion.

**Vocabulary Check**

9. The prefix *glyco-* comes from a Greek word that means “sweet.” The suffix *-lysis* comes from a Greek word that means “to loosen.” How are the meanings of these word parts related to the meaning of *glycolysis*?

   ____________________________

10. What does it mean to say that glycolysis is an anaerobic process?

   ____________________________

11. What is the Krebs cycle?

   ____________________________
KEY CONCEPT
Cellular respiration is an aerobic process with two main stages.

MAIN IDEA: Glycolysis is needed for cellular respiration.
1. What is the function of glycolysis?

2. What happens to the molecules formed during glycolysis when oxygen is available?

3. What is meant by a “net gain of two ATP molecules” from glycolysis?

MAIN IDEA: The Krebs cycle is the first main part of cellular respiration.
4. What is the function of the Krebs cycle?

Complete the cycle diagram below to summarize the six steps of the Krebs cycle.

[Diagram of the Krebs cycle with labeled boxes and arrows]
MAIN IDEA: The electron transport chain is the second main part of cellular respiration.

5. Where is the electron transport chain in cellular respiration located?

6. What is the function of the electron transport chain?

Fill in the sequence below to take notes on the four steps of the electron transport chain.

7. Why is oxygen needed for cellular respiration?
KEY CONCEPT
Fermentation allows the production of a small amount of ATP without oxygen.

VOCABULARY
fermentation
lactic acid

MAIN IDEA: Fermentation allows glycolysis to continue.

1. What is the importance of fermentation?

2. What is the function of fermentation?

3. When does fermentation take place in your muscle cells?

4. Why is fermentation an anaerobic process?

5. How is fermentation involved in the production of ATP?

In the space below, show and label the process of lactic acid fermentation.

Lactic Acid Fermentation
MAIN IDEA: Fermentation and its products are important in several ways.
In the space below, show and label the process of alcoholic fermentation.

Alcoholic Fermentation

6. How are lactic acid fermentation and alcoholic fermentation similar? different?

7. Name one commercial use of lactic acid fermentation.

8. Name one commercial use of alcoholic fermentation.

Vocabulary Check

9. The term fermentation is based on a word that means “to bubble.” How is this meaning related to your understanding of the fermentation process?

10. What is lactic acid?
KEY CONCEPT
Cells have distinct phases of growth, reproduction, and normal functions.

VOCABULARY
<table>
<thead>
<tr>
<th>cell cycle</th>
<th>cytokinesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>mitosis</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: The cell cycle has four main stages.
Summarize what happens during each stage of the cell cycle in the boxes below.

1. How did the G₁ and G₂ stages get their names?

2. Cells must pass through a critical checkpoint during which two stages of the cell cycle?

3. Where does DNA synthesis happen in eukaryotic cells?

4. What two processes make up the M stage?
MAIN IDEA: Cells divide at different rates.

5. Among different types of cells, which stage of the cell cycle varies most in length?

6. Why does a skin cell divide more often than a liver cell?

7. What is G0?

MAIN IDEA: Cell size is limited.

8. Write an analogy to explain why cell size is limited.

9. Which typically increases faster as a cell grows, surface area or volume?

10. For cells to stay the same size from generation to generation, what two things must be coordinated?

Vocabulary Check

11. Think of an example of a cycle. What does this cycle have in common with the cell cycle?

12. What process divides a cell’s cytoplasm? How do the two word parts of your answer help you remember it?

13. What process divides the cell nucleus and its contents?
SECTION 5.2
MITOSIS AND CYTOKINESIS
Study Guide

KEY CONCEPT
Cells divide during mitosis and cytokinesis.

VOCABULARY
<table>
<thead>
<tr>
<th>chromosome</th>
<th>centromere</th>
<th>metaphase</th>
</tr>
</thead>
<tbody>
<tr>
<td>histone</td>
<td>telomere</td>
<td>anaphase</td>
</tr>
<tr>
<td>chromatin</td>
<td>prophase</td>
<td>telophase</td>
</tr>
<tr>
<td>chromatid</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Chromosomes condense at the start of mitosis.
1. What is a chromosome?

2. Why do chromosomes condense at the start of mitosis?

3. Why are chromosomes not condensed during all stages of the cell cycle?

Refer to Figure 5.5 to sketch how DNA goes from a long stringy form to a tightly condensed form. Label the parts of the condensed, duplicated chromosome.

MAIN IDEA: Mitosis and cytokinesis produce two genetically identical daughter cells.
4. How does interphase prepare a cell to divide?
5. Mitosis occurs in what types of cells?

6. Develop a device, such as a short sentence or phrase, to help you remember the order of the steps of mitosis: prophase, metaphase, anaphase, telophase.

Complete the diagram illustrating the four phases of mitosis and one phase of cytokinesis.

7. How does cytokinesis differ between plant and animal cells?

Vocabulary Check

8. DNA wraps around organizing proteins called ________________.

9. The suffix "-tin" indicates that something is stretched and thin. ________________ is the loose combination of DNA and proteins that looks sort of like spaghetti.

10. Sister chromatids are held together at the ________________, which looks pinched.

11. The ends of DNA molecules form structures called ________________ that help prevent the loss of genes.
KEY CONCEPT
Cell cycle regulation is necessary for healthy growth.

VOCABULARY
<table>
<thead>
<tr>
<th>growth factor</th>
<th>benign</th>
<th>carcinogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>apoptosis</td>
<td>malignant</td>
<td>metastasize</td>
</tr>
</tbody>
</table>

MAIN IDEA: Internal and external factors regulate cell division.
Complete the concept map below to show important ideas about growth factors.

Use the word bank to complete the sequence diagram below.

kinases cell division phosphorylate cyclins

4. activate 5. 

6. target molecules result in 7. 

8. What is apoptosis?

MAIN IDEA: Cell division is uncontrolled in cancer.
9. What type of disease may result if cell division is not properly regulated?
Complete the concept map below about cancer cells.

Cancer cells

form

\[ \text{a.} \]

\[ \text{b.} \]

\[ \text{c.} \]

\[ \text{d.} \]

\[ \text{e.g.} \]

\[ \text{e.g.} \]

\[ \text{results in} \]

10. List three ways mutations can occur in genes involved in cell-cycle regulation.

Vocabulary Check

11. What does metastasize mean?

12. What is a substance known to produce or promote the development of cancer?

13. Draw a cartoon to help you remember the difference between benign and malignant.
5.4 ASEXUAL REPRODUCTION

**Study Guide**

**KEY CONCEPT**
Many organisms reproduce by cell division.

**VOCABULARY**
- asexual reproduction
- binary fission

**MAIN IDEA:** Binary fission is similar in function to mitosis.

1. Offspring resulting from asexual reproduction and those resulting from sexual reproduction differ in one major way. What is the difference?

Sketch the steps of binary fission in the boxes below. Beside each sketch, write a brief description of what is occurring.

2. ____________________________

3. ____________________________

4. ____________________________
Fill in the chart below to highlight the advantages and disadvantages of asexual reproduction.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Some eukaryotes reproduce through mitosis.

8. If a eukaryotic organism reproduces through mitosis, what is true about the offspring and the parent organism?

9. In what types of organisms is mitotic reproduction most common?

10. List three examples of mitotic reproduction.

11. What forms of reproduction does the sea anemone use?

**Vocabulary Check**

12. Write a word that starts with the letters “bi.” Explain what is similar between the meaning of the word you wrote and the meaning of “binary fission.”

13. What is the creation of offspring from only one parent organism called?
KEY CONCEPT
Cells work together to carry out complex functions.

VOCABULARY
<table>
<thead>
<tr>
<th>tissue</th>
<th>organ system</th>
<th>stem cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>organ</td>
<td>cell differentiation</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Multicellular organisms depend on interactions among different cell types.

Complete the diagram below that represents organization in multicellular organisms.

4. List two examples of tissues found in plants.

5. List two examples of organ systems found in plants.

6. How does an organism benefit from organ systems that work together and communicate?

MAIN IDEA: Specialized cells perform specific functions.

7. What is the process by which unspecialized cells develop into specialized cells?

8. Do different types of cells have different DNA? Explain.

9. What role does cell location play within a developing embryo?
**MAIN IDEA:** Stem cells can develop into different cell types. Complete the concept map below about stem cell classification.

![Stem cell classification concept map]

10. List the three identifying characteristics of stem cells.

11. List one advantage of using adult stem cells and one advantage of using embryonic stem cells.

12. What is cell differentiation?

13. Write the following words in order from the largest structure to the smallest structure: cell, organ, organ system, tissue
**KEY CONCEPT**
Gametes have half the number of chromosomes that body cells have.

**VOCABULARY**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>somatic cell</td>
<td></td>
</tr>
<tr>
<td>autosome</td>
<td></td>
</tr>
<tr>
<td>gamete</td>
<td></td>
</tr>
<tr>
<td>sex chromosome</td>
<td></td>
</tr>
<tr>
<td>homologous chromosome</td>
<td></td>
</tr>
<tr>
<td>sexual reproduction</td>
<td></td>
</tr>
<tr>
<td>diploid</td>
<td></td>
</tr>
<tr>
<td>haploid</td>
<td></td>
</tr>
<tr>
<td>meiosis</td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** You have body cells and gametes.

1. What are the two major groups of cell types in the human body?

2. Where are gametes located?

3. How many chromosomes are in a typical human body cell?

**MAIN IDEA:** Your cells have autosomes and sex chromosomes.

Fill in the concept map below to summarize what you know about chromosomes.

4. [Blank]
5. [Blank]
6. [Blank]
7. [Blank]
8. [Blank]

46 chromosomes in human body cells

- Include
- Include
- Include
- Include
- Consist of 22 homologous pairs

Half come from
9. What is the sex of a person with two X chromosomes?

10. Which chromosome carries the fewest number of genes?

**MAIN IDEA:** Body cells are diploid; gametes are haploid.

11. What happens to the nuclei of the egg and sperm during fertilization?

12. What type of cells are haploid?

13. What is the haploid chromosome number in humans?

14. How many autosomes are present in each human gamete? How many sex chromosomes?

15. Complete the following table to summarize the differences between mitosis and meiosis. Use Figure 6.2 to help you.

<table>
<thead>
<tr>
<th>Mitosis</th>
<th>Meiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makes diploid cells</td>
<td>Makes genetically unique cells</td>
</tr>
<tr>
<td>Happens throughout lifetime</td>
<td>Involved in sexual reproduction</td>
</tr>
</tbody>
</table>

**Vocabulary Check**

16. What are homologous chromosomes?

17. The word *soma* means “body.” How does this relate to the meanings of *autosome* and *somatic cell*?
**KEY CONCEPT**
During meiosis, diploid cells undergo two cell divisions that result in haploid cells.

**MAIN IDEA:** Cells go through two rounds of division in meiosis.

1. After a chromosome is replicated, each half is called a ________________.
2. Two chromosomes that are very similar and carry the same genes are called ________________.

In the space below, sketch the phases of meiosis I and II and write the name of each phase below it. Use Figure 6.5 to help you.

**Meiosis I**
3. __________
4. __________
5. __________
6. __________

**Meiosis II**
7. __________
8. __________
9. __________
10. __________

11. During which phase do homologous chromosomes separate?
12. During which phase do sister chromatids separate?
STUDY GUIDE, CONTINUED

MAIN IDEA: Haploid cells develop into mature gametes.

13. What does a sperm cell contribute to an embryo?

14. What does an egg contribute to an embryo?

15. Where are polar bodies made, in the male or in the female?

Complete the diagram of gametogenesis in the boxes below. Use Figure 6.6 to help you.

Sperm Formation

Egg Formation

Vocabulary Check

16. Genesis comes from a Greek word that means “to be born.” How does this relate to the meaning of gametogenesis?

17. What is a polar body?
SECTION 6.3 | MENDEL AND HEREDITY

Study Guide

KEY CONCEPT
Mendel’s research showed that traits are inherited as discrete units.

VOCABULARY

<table>
<thead>
<tr>
<th>trait</th>
<th>purebred</th>
<th>law of segregation</th>
</tr>
</thead>
<tbody>
<tr>
<td>genetics</td>
<td>cross</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Mendel laid the groundwork for genetics.

1. What is genetics?

2. Whose early work is the basis for much of our current understanding of genetics?

3. How did Mendel’s views on inheritance differ from the views of many scientists of his time?

MAIN IDEA: Mendel’s data revealed patterns of inheritance.

In designing his experiments, Mendel made three important choices that helped him see patterns of inheritance. In the table below, list Mendel’s three choices and write an example of how he put each of these choices into action.

<table>
<thead>
<tr>
<th>Mendel’s Choices</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
</tr>
</tbody>
</table>

7. Why did Mendel use pea plants?
8. Fill in the sequence diagram below to summarize Mendel’s experimental process.

- Bred flowers resulting in F₁ generation with dominant phenotype.
- Resulted in F₂ generation with both dominant and recessive phenotypes.

9. Mendel concluded that traits are inherited as “discrete units.” What do we call these discrete units today?

10. What two conclusions make up Mendel’s law of segregation?

---

**Vocabulary Check**

11. *Segregation* means “separation.” What is “segregated” in Mendel’s law of segregation?

12. What does “purebred” mean?
SECTION 6.4 | TRAITS, GENES, AND ALLELES

Study Guide

KEY CONCEPT
Genes encode proteins that produce a diverse range of traits.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>gene</td>
</tr>
<tr>
<td>heterozygous</td>
</tr>
<tr>
<td>phenotype</td>
</tr>
<tr>
<td>allele</td>
</tr>
<tr>
<td>genome</td>
</tr>
<tr>
<td>dominant</td>
</tr>
<tr>
<td>homozygous</td>
</tr>
<tr>
<td>genotype</td>
</tr>
<tr>
<td>recessive</td>
</tr>
</tbody>
</table>

MAIN IDEA: The same gene can have many versions.

1. What is the relationship between a gene and a protein?

2. What is an allele?

3. What term describes a pair of alleles that are the same? that are different?

4. Write a definition of homologous chromosomes using the terms “gene” and “allele.”

In the space below, draw a pair of homologous chromosomes. Label the chromosomes with two sets of genes, one with homozygous alleles (Gene A, Gene A) and one with heterozygous alleles (Gene B, Gene b).
MAIN IDEA: Genes influence the development of traits.

5. Write an analogy to show the difference between genotype and phenotype.

__________________________________________________

6. How are alleles represented on paper?

__________________________________________________

7. Fill in the table below with the missing genotype, phenotype (dominant or recessive), or alleles (TT, Tt, tt).

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Phenotype</th>
<th>Alleles</th>
</tr>
</thead>
<tbody>
<tr>
<td>homozygous dominant</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>recessive</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tt</td>
</tr>
</tbody>
</table>

8. If an organism has a recessive trait, can you determine its genotype for that trait?

__________________________________________________

9. What factors besides alleles affect phenotype?

__________________________________________________

Vocabulary Check

10. What type of alleles are present in an organism with a QQ genotype?

__________________________________________________

11. What is an alternative form of a gene?

__________________________________________________

12. What is the opposite of homozygous? of dominant?

__________________________________________________
KEY CONCEPT
The inheritance of traits follows the rules of probability.

VOCABULARY
<table>
<thead>
<tr>
<th>Punnett square</th>
<th>testcross</th>
<th>law of independent assortment</th>
</tr>
</thead>
<tbody>
<tr>
<td>monohybrid cross</td>
<td>dihybrid cross</td>
<td>probability</td>
</tr>
</tbody>
</table>

MAIN IDEA: Punnett squares illustrate genetic crosses.
Identify what each of the numbered parts represents in the Punnett square below. Then draw lines from each of the parents’ alleles to the corresponding alleles in the offspring.

4. Why does each parent contribute only one allele to the offspring?

MAIN IDEA: A monohybrid cross involves one trait.
5. You know a ratio is a comparison that tells how two or more things relate. What is a genotypic ratio? a phenotypic ratio?

6. What is the genotypic ratio of the offspring in Figure 6.15?

7. What is the phenotypic ratio of the offspring in Figure 6.15?
STUDY GUIDE, CONTINUED

MAIN IDEA: A dihybrid cross involves two traits.

8. What is a dihybrid cross?

9. Why does each parent organism in the F₁ generation have four alleles listed in Figure 6.17?

10. Suppose an organism had the genotype AABb. What two types of gametes could result from this allele combination?

11. What is the phenotypic ratio that results from a dihybrid cross between two organisms that are heterozygous for both traits? See Figure 6.17 for help.

MAIN IDEA: Heredity patterns can be calculated with probability.

12. Probability predicts the ______________ number of occurrences, not the ______________ number of occurrences.

13. To calculate the probability that two independent events will happen together, ______________ the probability of each individual event.

14. In Figure 6.18, the probability of getting one coin that is heads up and one coin that is tails up is ______________.

Vocabulary Check

15. What is a testcross?

16. What is independent in the law of independent assortment?
KEY CONCEPT
Independent assortment and crossing over during meiosis result in genetic diversity.

VOCABULARY
| crossing over | genetic linkage |

MAIN IDEA: Sexual reproduction creates unique gene combinations.
1. What are two ways that sexual reproduction helps create and maintain genetic diversity?

2. Which does sexual reproduction create, new alleles or new combinations of alleles?

3. How is the production of unique genetic combinations an advantage to organisms and species?

MAIN IDEA: Crossing over during meiosis increases genetic diversity.
4. Are chromosomes in a duplicated or an unduplicated state when crossing over occurs?

Use sketches to illustrate how crossing over contributes to genetic diversity. Use Figure 6.20 for reference. 1. Draw a cell with four chromosomes in the first box. Make one pair of chromosomes large and the other pair small. Color in one large chromosome and one small chromosome. Leave the other two chromosomes white. 2. In the next box, draw the cell in prophase I. Have each pair of homologous chromosomes line up together—large with large, small with small. 3. In the third box, show crossing over between each pair of homologous chromosomes. 4. In the last box, show what the chromosomes look like as a result of crossing over. You will use this sketch in the next exercise.
Refer to your cell sketch in the last box on the previous page. Also refer to Figure 6.5 if necessary. 1. In the first box below, show what your cell would look like at the end of meiosis I. Remember, the result will be two cells that have one duplicated chromosome from each homologous pair. 2. In the second box, show what your cell would look like at the end of meiosis II. Remember, the result will be four cells that have one (unduplicated) chromosome from each homologous pair.

5. If genes A and B are located on separate, nonhomologous chromosomes, will they follow Mendel’s law of independent assortment? Explain.

6. If genes A and B are located at opposite ends on the same chromosome, are they likely to follow Mendel’s law of independent assortment? Explain.

7. If genes A and B are located very close together on the same chromosome, are they likely to follow Mendel’s law of independent assortment? Explain.

Vocabulary Check

8. The exchange of chromosome segments between homologous chromosomes is called __________________________.

9. The tendency for two genes that are located close together on a chromosome to be inherited together is called __________________________.
KEY CONCEPT
The chromosomes on which genes are located can affect the expression of traits.

VOCABULARY
| carrier |
| sex-linked gene |
| X chromosome inactivation |

MAIN IDEA: Two copies of each autosomal gene affect phenotype.
1. What are sex chromosomes?

2. What are autosomes?

3. How is a carrier different from a person who has a genetic disorder?

Complete the two Punnett squares below to compare autosomal recessive disorders with autosomal dominant disorders. Fill in the possible genotypes for offspring, and write in the phenotype (no disorder, carrier, or disorder) for each.

Autosomal Recessive

\[
\begin{array}{c|c|c|c}
D & d & \text{ } & \text{ } \\
\hline
D & d & d & d \\
\hline
d & d & d & d \\
\hline
\end{array}
\]

Autosomal Dominant

\[
\begin{array}{c|c|c|c}
D & d & \text{ } & \text{ } \\
\hline
D & D & D & D \\
\hline
D & d & d & d \\
\hline
\end{array}
\]

MAIN IDEA: Males and females can differ in sex-linked traits.
4. What are sex-linked genes?
Fill in the Punnett square below to show the pattern of inheritance for sex chromosomes.

**Sex Chromosome Inheritance**

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. In humans, how does a gamete from a male determine the sex of offspring?

6. For what are genes on the Y chromosome responsible?

7. How are sex-linked genes expressed differently in the phenotypes of males and females?

---

**Vocabulary Check**

8. The verb *carry* means “to transport.” How is the everyday meaning of *carry* related to the meaning of the term *carrier* in genetics?

9. What is X chromosome inactivation?
SECTION 7.2 | COMPLEX PATTERNS OF INHERITANCE

Study Guide

KEY CONCEPT
Phenotype is affected by many different factors.

VOCABULARY
<table>
<thead>
<tr>
<th>incomplete dominance</th>
</tr>
</thead>
<tbody>
<tr>
<td>codominance</td>
</tr>
<tr>
<td>polygenic trait</td>
</tr>
</tbody>
</table>

MAIN IDEA: Phenotype can depend on interactions of alleles.

1. How is incomplete dominance different from a dominant and recessive relationship?

2. How is codominance different from a dominant and recessive relationship?

3. What is a multiple-allele trait?

In the table below, describe how phenotypes appear in incomplete dominance and codominance. Then sketch an example of each.

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Phenotype</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete dominance</td>
<td>4.</td>
<td>5.</td>
</tr>
<tr>
<td>Codominance</td>
<td>6.</td>
<td>7.</td>
</tr>
</tbody>
</table>
MAIN IDEA: Many genes may interact to produce one trait.
Use the chart below to take notes on polygenic traits and epistasis.

Many genes may interact to produce one trait.

- Polygenic Traits
- Epistasis

MAIN IDEA: The environment interacts with genotype.

8. Why is genotype not the only factor that affects phenotype?

9. List and explain two examples of how environment and genotype can interact.

Vocabulary Check

10. The prefix in- means “not.” How is the meaning of this prefix related to the meaning of incomplete dominance?

11. The prefix co- means “together.” How is the meaning of this prefix related to the meaning of codominance?

12. The prefix poly- means “many,” and the term genic means “related to genes.” How do these word parts combine to give the meaning of polygenic?
KEY CONCEPT
Genes can be mapped to specific locations on chromosomes.

VOCABULARY
linkage map

MAIN IDEA: Gene linkage was explained through fruit flies.

1. What is gene linkage?

2. Why were fruit flies useful in Morgan’s research?

3. What is the difference between a wild type and a mutant type?

4. What did Morgan conclude from his research on fruit flies?

Complete the sequence below to take notes about the discovery of gene linkage.

Mendel:
Genes assort independently of one another.

Punnett, Bateson:

Morgan:
MAIN IDEA: Linkage maps estimate distances between genes.

5. How is the distance between two genes related to the chance they are inherited together?

6. What hypothesis was the basis of Sturtevant’s research?

7. What is a linkage map?

8. How are cross-over frequencies related to linkage maps?

9. What do linkage maps show about genes on a chromosome?

Use the cross-over frequencies given below to draw a linkage map for the four genes listed. Think about the relationship between cross-over frequency and distance in linkage map units. Use Figure 7.11 to help you make the linkage map. Put gene A on the far left of the map, then work through the distances between the gene pairs.

<table>
<thead>
<tr>
<th>Cross-over Frequencies</th>
<th>Linkage Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-B 20%</td>
<td></td>
</tr>
<tr>
<td>B-C 5%</td>
<td></td>
</tr>
<tr>
<td>A-C 25%</td>
<td></td>
</tr>
<tr>
<td>A-D 7%</td>
<td></td>
</tr>
<tr>
<td>D-B 13%</td>
<td></td>
</tr>
<tr>
<td>D-C 18%</td>
<td></td>
</tr>
</tbody>
</table>
KEY CONCEPT
A combination of methods is used to study human genetics.

VOCABULARY
pedigree
karyotype

MAIN IDEA: Human genetics follows the patterns seen in other organisms.
1. How does genetic inheritance follow similar patterns in all sexually reproducing organisms?

2. How are single-gene traits useful in studying human genetics?

MAIN IDEA: Females can carry sex-linked genetic disorders.
3. Who can be carriers of autosomal disorders?

4. Why can females, but not males, be carriers of sex-linked genetic disorders?

MAIN IDEA: A pedigree is a chart for tracing genes in a family.
5. What is a pedigree?

6. How are phenotypes used in pedigree analysis?

7. What information on a pedigree can tell you whether a gene is on an autosome or on a sex chromosome?
8. Complete the chart to follow the logic necessary to fill out a pedigree for a sex-linked gene. Use $X^D$ and $X^d$ for the dominant and recessive X-linked genes, respectively.

**Tracing Sex-Linked Genes**

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>must have</th>
<th>Genotype</th>
<th>could have</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female, recessive phenotype</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male, recessive phenotype</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parental Phenotype</th>
<th>must have</th>
<th>Parental Genotype</th>
<th>could have</th>
<th>Offspring Genotypes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female carrier, normal male</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female carrier, male with</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>recessive phenotype</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female with recessive phenotype,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>normal male</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female with recessive phenotype,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>male with recessive phenotype</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Several methods help map human chromosomes.

9. What are two methods that are used to directly study human chromosomes?

10. What does a karyotype show about chromosomes?

**Vocabulary Check**

11. What is a karyotype?
SECTION 8.1 IDENTIFYING DNA AS THE GENETIC MATERIAL

Study Guide

KEY CONCEPT
DNA was identified as the genetic material through a series of experiments.

VOCABULARY
bacteriophage

MAIN IDEA: Griffith finds a “transforming principle.”
Write the results of Griffith’s experiments in the boxes below.

<table>
<thead>
<tr>
<th>Experiments</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Injected mice with R bacteria</td>
<td></td>
</tr>
<tr>
<td>2. Injected mice with S bacteria</td>
<td></td>
</tr>
<tr>
<td>3. Killed S bacteria and injected them into mice</td>
<td></td>
</tr>
<tr>
<td>4. Mixed killed S bacteria with R bacteria and injected them into mice</td>
<td>Found live S bacteria in the mice’s blood</td>
</tr>
</tbody>
</table>

5. Which type of bacteria caused disease, the S form or the R form?
   _______________________________________________________________________

6. What conclusions did Griffith make based on his experimental results?
   _______________________________________________________________________
   _______________________________________________________________________
MAIN IDEA: Avery identifies DNA as the transforming principle.

7. Avery and his team isolated Griffith’s transforming principle and performed three tests to learn if it was DNA or protein. In the table below, summarize Avery’s work by writing the question he was asking or the results of his experiment.

<table>
<thead>
<tr>
<th>Avery’s Question</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>What type of molecule does the transforming principle contain?</td>
<td>The ratio of nitrogen to phosphorus in the transforming principle is similar to the ratio found in DNA.</td>
</tr>
<tr>
<td>Which type of enzyme destroys the ability of the transforming principle to function?</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Hershey and Chase confirm that DNA is the genetic material.

8. Proteins contain _______________ but very little _______________.

9. DNA contains _______________ but no _______________.

10. Summarize the two experiments performed by Hershey and Chase by completing the table below. Identify what type of radioactive label was used in the bacteriophage and whether radioactivity was found in the bacteria.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Bacteriophage</th>
<th>Bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check
11. Explain what a bacteriophage is and describe or sketch its structure.
KEY CONCEPT
DNA structure is the same in all organisms.

MAIN IDEA: DNA is composed of four types of nucleotides.
In the space below, draw a nucleotide and label its three parts using words and arrows.

1. How many types of nucleotides are present in DNA?

2. Which parts are the same in all nucleotides? Which part is different?

MAIN IDEA: Watson and Crick developed an accurate model of DNA’s three-dimensional structure.

3. What did Franklin’s data reveal about the structure of DNA?

4. How did Watson and Crick determine the three-dimensional shape of DNA?
5. How does DNA base pairing result in a molecule that has a uniform width?

MAIN IDEA: Nucleotides always pair in the same way.
6. What nucleotide pairs with T? with C?

In the space below, draw a DNA double helix. Label the sugar-phosphate backbone, the nitrogen-containing bases, and the hydrogen bonds.

Vocabulary Check
7. Explain how the DNA double helix is similar to a spiral staircase.

8. How do the base pairing rules relate to Chargaff’s rules?
SECTION 8.3 DNA REPLICATION

Study Guide

KEY CONCEPT
DNA replication copies the genetic information of a cell.

VOCABULARY

| replication | DNA polymerase |

MAIN IDEA: Replication copies the genetic information.

1. What is DNA replication?

2. Where does DNA replication take place in a eukaryotic cell?

3. When is DNA replicated during the cell cycle?

4. Why does DNA replication need to occur?

5. What is a template?

6. If one strand of DNA had the sequence TAGGTAC, what would be the sequence of the complementary DNA strand?

MAIN IDEA: Proteins carry out the process of replication.

7. What roles do proteins play in DNA replication?

8. What must be broken for the DNA strand to separate?

9. Why is DNA replication called semiconservative?
Use words and diagrams to summarize the steps of replication, in order, in the boxes below.

10. _______________
11. _______________
12. _______________
13. _______________
14. _______________

**MAIN IDEA:** Replication is fast and accurate.

13. Human chromosomes have hundreds of ______________, where the DNA is unzipped so replication can begin.

14. DNA polymerase has a ______________ function that enables it to detect errors and correct them.

**Vocabulary Check**

15. Explain what DNA polymerase is by breaking the word into its parts.

16. Write a short analogy to explain what replication is.

**Be Creative**

17. People sometimes like to display bumper stickers that relate to their trade or field of study. For example, a chemist may have a bumper sticker that says “It takes alkynes to make the world.” Then, chemists or other people who know that an alkyne is a molecule that contains carbon atoms joined by a triple bond get a nice little chuckle out of the play on words. Use your knowledge of DNA replication to write a bumper sticker.

______________________________
SECTION 8.4  |  TRANSCRIPTION

Study Guide

KEY CONCEPT
Transcription converts a gene into a single-stranded RNA molecule.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>central dogma</td>
</tr>
<tr>
<td>RNA</td>
</tr>
<tr>
<td>transcription</td>
</tr>
<tr>
<td>RNA polymerase</td>
</tr>
<tr>
<td>messenger RNA (mRNA)</td>
</tr>
<tr>
<td>ribosomal RNA (rRNA)</td>
</tr>
<tr>
<td>transfer RNA (tRNA)</td>
</tr>
</tbody>
</table>

MAIN IDEA: RNA carries DNA’s instructions.
Label each of the processes represented by the arrows in the diagram below. Write where each of these processes takes place in a eukaryotic cell in parentheses.

1. _____________________________________
2. __________________________
3. __________________________

Fill in the table below to contrast DNA and RNA.

<table>
<thead>
<tr>
<th>DNA</th>
<th>RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Contains the sugar deoxyribose</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Has the bases A, C, G, and U</td>
</tr>
<tr>
<td>6. Typically double-stranded</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Transcription makes three types of RNA.
7. What enzyme helps a cell to make a strand of RNA?
8. Summarize the three key steps of transcription.

9. Write the basic function of each type of RNA in the chart below.

<table>
<thead>
<tr>
<th>Type of RNA</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>mRNA</td>
<td></td>
</tr>
<tr>
<td>rRNA</td>
<td></td>
</tr>
<tr>
<td>tRNA</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: The transcription process is similar to replication.

10. List two ways that the processes of transcription and replication are similar.

11. List two ways that the end results of transcription and replication differ.

Vocabulary Check

12. How does the name of each type of RNA tell what it does?

13. What is transcription?
SECTION 8.5
TRANSLATION
Study Guide

KEY CONCEPT
Translation converts an mRNA message into a polypeptide, or protein.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>translation</td>
</tr>
<tr>
<td>codon</td>
</tr>
<tr>
<td>anticodon</td>
</tr>
</tbody>
</table>

MAIN IDEA: Amino acids are coded by mRNA base sequences.
1. What is translation?

2. What is a codon?

3. Would the codons in Figure 8.13 be found in a strand of DNA or RNA?

4. What is a reading frame?

Refer to Figure 8.13 to complete the table below.

<table>
<thead>
<tr>
<th>Codon</th>
<th>Amino Acid or Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. AGA</td>
<td></td>
</tr>
<tr>
<td>6. UAG</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>tryptophan (Trp)</td>
</tr>
<tr>
<td>8. GGA</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Amino acids are linked to become a protein.

9. ____________ and ____________ are the tools that help a cell translate an mRNA message into a polypeptide.

10. The ____________ subunit of a ribosome holds onto the mRNA strand.

11. The ____________ subunit of a ribosome has binding sites for tRNA.
12. A tRNA molecule is attached to an ____________ at one end and has an ____________ at the other end.

Fill in the cycle diagram below to outline the steps of translation.

Ribosome assembles on start codon of mRNA strand.

A.

C.

B.

When the ribosome encounters a stop codon, it falls apart and the protein is released.

Vocabulary Check

13. What are AGG, GCA, and GUU examples of?

14. What is a set of three nucleotides on a tRNA molecule that is complementary to an mRNA codon?

15. What do codons code for in addition to amino acids?
KEY CONCEPT
Gene expression is carefully regulated in both prokaryotic and eukaryotic cells.

VOCABULARY
<table>
<thead>
<tr>
<th>promoter</th>
<th>exon</th>
</tr>
</thead>
<tbody>
<tr>
<td>operon</td>
<td>intron</td>
</tr>
</tbody>
</table>

MAIN IDEA: Prokaryotic cells turn genes on and off by controlling transcription.

1. Why is gene expression regulated in prokaryotic cells?

2. In prokaryotic cells, gene expression is typically regulated at the start of ____________.

3. A ____________ is a segment of DNA that helps RNA polymerase recognize the start of a gene.

4. An ____________ is a region of DNA that includes a ____________, an ____________, and one or more ____________ that code for proteins needed to carry out a task.

Complete the cause-and-effect diagram below about the lac operon.

1. Bacteria growing in culture
2. medium without lactose added
3. The repressor continues to bind to the operator.
4. medium with lactose added
5. ____________
6. ____________
7. ____________
8. ____________
9. The resulting transcript is translated into 3 enzymes.
MAIN IDEA: Eukaryotic cells regulate gene expression at many points.

10. Why do the cells in your body differ from each other?

11. What role do transcription factors play in a cell?

12. What is a TATA box?

13. What is “sonic hedgehog” an example of?

MAIN IDEA: The diagrams below represent unprocessed and processed mRNA in a eukaryotic cell. Using the diagrams as a reference, fill in the legend with the corresponding element: cap, exon, intron, tail.

Vocabulary Check

14. What is the difference between an exon and an intron?

15. Make an analogy to help you remember what a promoter is.
KEY CONCEPT

Mutations are changes in DNA that may or may not affect phenotype.

VOCABULARY

<table>
<thead>
<tr>
<th>mutation</th>
<th>frameshift mutation</th>
</tr>
</thead>
<tbody>
<tr>
<td>point mutation</td>
<td>mutagen</td>
</tr>
</tbody>
</table>

MAIN IDEA: Some mutations affect a single gene, while others affect an entire chromosome.

1. List two types of gene mutations.

2. List two types of chromosomal mutations.

3. Which type of mutation affects more genes, a gene mutation or a chromosomal mutation?

4. What leads to gene duplication?

5. What is a translocation?

Below is a string of nucleotides. (1) Use brackets to indicate the reading frame of the nucleotide sequence. (2) Copy the nucleotide sequence into the first box and make a point mutation. Circle the mutation. (3) Copy the nucleotide sequence into the second box and make a frameshift mutation. Use brackets to indicate how the reading frame would be altered by the mutation.

AGGCGTCCATGA

6.

7.
MAIN IDEA: Mutations may or may not affect phenotype.

Fill in the cause-and-effect diagram below to explain how a point mutation may or may not affect phenotype.

13. For a mutation to be passed to offspring, in what type of cell must it occur?

MAIN IDEA: Mutations can be caused by several factors.

14. Can DNA polymerase catch and correct every replication error?

15. What is a mutagen?

16. How does UV light damage the DNA strand?

Vocabulary Check

17. What is a mutation?

18. If a nucleotide is deleted from a strand of DNA, what type of mutation has occurred?
KEY CONCEPT
Biotechnology relies on cutting DNA at specific places.

VOCABULARY
<table>
<thead>
<tr>
<th>restriction enzyme</th>
<th>restriction map</th>
</tr>
</thead>
<tbody>
<tr>
<td>gel electrophoresis</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Scientists use several techniques to manipulate DNA.

1. List five ways in which scientists study and manipulate DNA.

MAIN IDEA: Restriction enzymes cut DNA.

2. What is a restriction enzyme?

3. What is the nucleotide sequence at which a restriction enzyme cuts DNA called?

4. Why would different restriction enzymes cut the same DNA molecule into different numbers of fragments?

In the space provided below, draw two sketches. Show what happens when a restriction enzyme leaves “blunt ends,” and show what happens when a restriction enzyme leaves “sticky ends.” Label the restriction sites in each sketch.

<table>
<thead>
<tr>
<th>Blunt Ends</th>
<th>Sticky Ends</th>
</tr>
</thead>
</table>

In the space provided below, draw two sketches. Show what happens when a restriction enzyme leaves “blunt ends,” and show what happens when a restriction enzyme leaves “sticky ends.” Label the restriction sites in each sketch.
STUDY GUIDE, CONTINUED

MAIN IDEA:  Restriction maps show the lengths of DNA fragments.

5. After DNA is cut with a restriction enzyme, how is the mixture of DNA fragments sorted?

6. How does gel electrophoresis work?

7. How do different fragments of DNA show up on a gel?

8. What information does a restriction map give about DNA? What information is not given by a restriction map?

9. How are restriction maps used?

Vocabulary Check

10. How does a restriction enzyme limit, or restrict, the effect of a virus on a bacterial cell?

11. The prefix *electro-* means “electricity.” The suffix *-phoresis* comes from a Greek word that means “carrying.” How do these two meanings relate to what happens in gel electrophoresis?
KEY CONCEPT
The polymerase chain reaction rapidly copies segments of DNA.

VOCABULARY
polymerase chain reaction (PCR)
primer

MAIN IDEA: PCR uses polymerases to copy DNA segments.
1. What is PCR?

2. Why is PCR useful?

MAIN IDEA: PCR is a three-step process.
3. What four materials are needed for PCR?

4. Why are primers needed in the PCR process?

Sketch and label the PCR process in the cycle below.
Sketch how the amount of DNA changes during five PCR cycles.

**Vocabulary Check**

5. DNA polymerase is an enzyme that helps put DNA molecules together. A chain reaction is a process in which one event leads to the next event and the effect is stronger over time. How does the combination of these two terms describe what happens during PCR?

6. The verb *to prime* means “to prepare.” How does this meaning tell you what a primer does in PCR?
SECTION 9.3 | DNA FINGERPRINTING

Study Guide

KEY CONCEPT
DNA fingerprints identify people at the molecular level.

VOCABULARY
DNA fingerprint

MAIN IDEA: A DNA fingerprint is a type of restriction map.
Take notes on DNA fingerprinting by filling in the main idea web below.

1. Definition

2. What it shows

DNA fingerprint

3. How it’s made

4. What it’s based on

5. How is a DNA fingerprint a specific type of restriction map?

__________________________________________________________________________

__________________________________________________________________________
MAIN IDEA: DNA fingerprinting is used for identification.

6. How does identification through DNA fingerprinting depend on probability?

________________________________________________________________________

________________________________________________________________________

7. The chance that two people have four repeats in location A is 1 in 100. The chance that two people have eight repeats in location B is 1 in 50. The probability that two people have three repeats in location C is 1 in 200. What is the probability that two people would have matching DNA fingerprints for these three locations by chance?

________________________________________________________________________

________________________________________________________________________

8. Why does using more regions of the genome decrease the probability that two people would have the same DNA fingerprint?

________________________________________________________________________

________________________________________________________________________

9. List two ways in which DNA fingerprinting is used for identification.

________________________________________________________________________

________________________________________________________________________

Vocabulary Check

10. One definition of the term fingerprint is “a distinctive mark or characteristic.” How does this meaning relate to a DNA fingerprint?

________________________________________________________________________

________________________________________________________________________
### 9.4 GENETIC ENGINEERING

#### Study Guide

**KEY CONCEPT**

DNA sequences of organisms can be changed.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>clone</td>
<td>recombinant DNA</td>
<td>transgenic</td>
</tr>
<tr>
<td>genetic engineering</td>
<td>plasmid</td>
<td>gene knockout</td>
</tr>
</tbody>
</table>

### MAIN IDEA:

**Entire organisms can be cloned.**

Fill in the chart below to take notes about cloning.

**Entire organisms can be cloned.**

1. **Definition of clone**

2. **Cloning in nature**

3. **Cloning mammals**

4. **Potential benefits**

5. **Concerns**

### MAIN IDEA:

**New genes can be added to an organism’s DNA.**

6. **What is genetic engineering?**

7. **What is recombinant DNA?**

8. **Why are plasmids used to produce bacteria with recombinant DNA?**
Use the space below to sketch and label the process that scientists use to produce bacteria with recombinant DNA. Use Figure 9.11 to help you with your sketch.

<table>
<thead>
<tr>
<th>Type of Organism</th>
<th>Process Used</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animals</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Genetic engineering produces organisms with new traits.

9. What is a transgenic organism?

10. Complete the table below to take notes on transgenic bacteria, plants, and animals.

11. The term *recombine* means “to combine, or join, again.” How is the meaning of recombine related to the production of recombinant DNA?

12. The prefix *trans-* means “across,” and *genic* means “relating to genes.” How do these two meanings help to explain the meaning of *transgenic*?
**SECTION 9.5  GENOMICS AND BIOINFORMATICS**

**Study Guide**

**KEY CONCEPT**
Entire genomes are sequenced, studied, and compared.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>genomics</td>
</tr>
<tr>
<td>gene sequencing</td>
</tr>
<tr>
<td>DNA microarray</td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Genomics involves the study of genes, gene functions, and entire genomes.
Take notes on concepts in genomics by completing the concept map below.

**MAIN IDEA:** Technology allows the study and comparison of both genes and proteins.

10. What is bioinformatics?

11. Why is bioinformatics important for genomics research?

12. What are DNA microarrays?
13. How can DNA microarrays compare gene expression in different cells?

14. What is proteomics?

15. What are some potential benefits and uses of proteomics?

Vocabulary Check
16. The suffix -ic means “related to.” A genome is all of an organism’s DNA. A proteome is all of an organism’s proteins. What does this information tell you about genomics, proteomics, and bioinformatics?

17. An array is an organized arrangement or a large number of objects. The prefix micro- means “small.” How are these meanings related to the definition of a DNA microarray?
KEY CONCEPT
Genetics provides a basis for new medical treatments.

VOCABULARY
<table>
<thead>
<tr>
<th>genetic screening</th>
</tr>
</thead>
<tbody>
<tr>
<td>gene therapy</td>
</tr>
</tbody>
</table>

MAIN IDEA: Genetic screening can detect genetic disorders.

1. What is the purpose of genetic screening?

2. How is genetic screening used?

MAIN IDEA: Gene therapy is the replacement of faulty genes.

3. What is the goal of gene therapy?

4. What are two technical challenges in gene therapy?

5. What is one experimental method for the treatment of cancer?

Vocabulary Check

6. The verb *to screen* means “to examine.” Explain how this meaning is related to genetic screening.

7. What is gene therapy?
Advertise or Fight Against Genetic Screening

Choose one of the two following situations.

1. Suppose you work for a company that does genetic screening. Draw and write a one-page advertisement that explains genetic screening and what it both can and cannot do.

2. Suppose you are a spokesperson for a group that is against genetic screening. Draw and write a one-page advertisement that focuses on the ethical questions surrounding genetic screening.
**SECTION 10.1 EARLY IDEAS ABOUT EVOLUTION**

**Study Guide**

**KEY CONCEPT**
There were theories of biological and geologic change before Darwin.

**VOCABULARY**
- evolution
- fossil
- gradualism
- species
- catastrophism
- uniformitarianism

**MAIN IDEA:** Early scientists proposed ideas about evolution.

In a phrase, tell what each scientist did to help develop evolutionary theory.

<table>
<thead>
<tr>
<th>Scientist</th>
<th>Contribution to Evolutionary Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Linnaeus</td>
<td></td>
</tr>
<tr>
<td>2. Buffon</td>
<td></td>
</tr>
<tr>
<td>3. E. Darwin</td>
<td></td>
</tr>
<tr>
<td>4. Lamarck</td>
<td></td>
</tr>
</tbody>
</table>

5. What two conditions must be true for a group of animals to be considered the same species?

__________________________________________________

6. Lamarck’s ideas of evolution are known as the inheritance of acquired characteristics. What was incorrect about his theory of how organisms evolve?

__________________________________________________

7. In the 1700s, many people believed that species were fixed and did not change. How did plant hybridization—a type of crossing that could be observed in experiments—help change this view?

__________________________________________________

---

Copyrigh by McDougal Littell, a division of Houghton Mifflin Company
MAIN IDEA: Theories of geologic change set the stage for Darwin’s theory.

8. Write a description of each theory in the space provided.

<table>
<thead>
<tr>
<th>Geologic Theory</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>catastrophism</td>
<td></td>
</tr>
<tr>
<td>gradualism</td>
<td></td>
</tr>
<tr>
<td>uniformitarianism</td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

9. What word refers to traces of an organism that existed in the past?

10. What is the process of biological change by which descendants come to differ from their ancestors?

11. Events such as volcanoes, floods, and earthquakes are the basis of what geologic theory?

12. What geologic theory can be summarized by the phrase “the present is the key to the past”?

Who’s Who

<table>
<thead>
<tr>
<th>Linnaeus</th>
<th>Lamarck</th>
<th>Buffon</th>
<th>E. Darwin</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Charles Darwin’s poetic grandfather</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Thought that a giraffe’s long neck evolved from reaching high in trees</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Grouped living organisms into categories based on what they looked like</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Wrote <em>Histoire Naturelle</em> (Natural History) in 1749</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
KEY CONCEPT
Darwin’s voyage provided insights into evolution.

VOCABULARY
variation
adaptation

MAIN IDEA: Darwin observed differences among island species.
1. What is variation among members of different species called?

2. What is variation among members of the same species called?

3. What island chain in South America was the source of many of Darwin’s insights?

4. Darwin saw populations of various species that seemed well-suited to their environment. What did this suggest?

MAIN IDEA: Darwin observed fossil and geologic evidence supporting an ancient Earth.
5. Darwin observed fossils of huge animals such as Glyptodon, a giant armadillo. Why were these fossils of interest to him?

6. Many people in the 1700s thought that Earth was only about 6000 years old. How did the fossil organisms Darwin saw lead him to think Earth must be much older than that?

7. Darwin also observed fossil shells of marine organisms high up in the Andes mountains, and saw an earthquake move land that was underwater above sea level. How did he apply these insights to the evolution of organisms?

8. Look at Figure 10.4 in your textbook. What differences between the two Galápagos tortoises can you identify from the two pictures?
Vocabulary Check

<table>
<thead>
<tr>
<th>Variation</th>
<th>Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>the difference in the physical traits of an individual from those of other individuals in the group to which it belongs</td>
</tr>
<tr>
<td>10.</td>
<td>a feature that allows an organism to better survive in its environment</td>
</tr>
<tr>
<td>11.</td>
<td>A tortoise population lives in an area with high grass. These tortoises have longer necks than tortoises that live in other areas. The long necks are an example of this.</td>
</tr>
<tr>
<td>12.</td>
<td>One bird in a population has a slightly thicker beak than its relatives. This thicker beak is an example of what in the population.</td>
</tr>
</tbody>
</table>

Be Creative

In the space below, draw a sketch of a bird that may eat the food choice that is given in the left column.

<table>
<thead>
<tr>
<th>Food choice</th>
<th>Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eats large, hard-shelled nuts</td>
<td></td>
</tr>
<tr>
<td>Eats fruit and insects</td>
<td></td>
</tr>
</tbody>
</table>
KEY CONCEPT
Darwin proposed natural selection as a mechanism for evolution.

VOCABULARY
<table>
<thead>
<tr>
<th>artificial selection</th>
<th>natural selection</th>
<th>fitness</th>
</tr>
</thead>
<tbody>
<tr>
<td>heritability</td>
<td>population</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Several key insights led to Darwin’s idea for natural selection.

1. Why did artificial selection interest Darwin?
   __________________________________________________________________________

2. Why must selected traits be heritable?
   __________________________________________________________________________

3. In natural selection, what must be true of traits that are passed down through generations?
   __________________________________________________________________________

4. What important idea from Thomas Malthus inspired Darwin?
   __________________________________________________________________________

MAIN IDEA: Natural selection explains how evolution can occur.

<table>
<thead>
<tr>
<th>variation</th>
<th>overproduction</th>
<th>adaptation</th>
<th>descent with modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>__________</td>
<td>_______________</td>
<td>___________</td>
<td>_________________</td>
</tr>
</tbody>
</table>

5. producing many offspring, some of which may not survive
   __________________________________________________________________________

6. individual differences that may be heritable
   __________________________________________________________________________

7. a structure well-suited for the environment
   __________________________________________________________________________

8. a heritable trait becoming common in a population
   __________________________________________________________________________
Use an organism of your choice to sketch the four principles of natural selection.

<table>
<thead>
<tr>
<th>9. overproduction</th>
<th>10. variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. adaptation</td>
<td>12. descent with modification</td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Natural selection works on existing variation.

13. Peter and Rosemary Grant observed natural selection acting on traits within a population of finches on the Galápagos Islands. A drought reduced the number of small soft seeds but left plenty of large, tough-shelled seeds intact. The next year there was a(n) ____________ (increase, decrease) in the number of large-beaked hatchlings.

14. After several years, the supply of large seeds went down after an unusually wet period. The increase in small, soft seeds brought a(n) ____________ (increase, decrease) in the number of large-beaked hatchlings the following year.

**Vocabulary Check**

15. *Humans* are the selective agent in which type of process, artificial selection or natural selection?

16. *The environment* is the selective agent in which type of process, artificial selection or natural selection?

17. What is the measure of the ability to survive and produce more offspring relative to other members of the population called?

18. What is the ability of a trait to be passed down from one generation to the next called?

19. What are all the individuals of a species that live in an area called?
KEY CONCEPT
Evidence of common ancestry among species comes from many sources.

VOCABULARY
<table>
<thead>
<tr>
<th>biogeography</th>
<th>analogous structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>homologous structure</td>
<td>vestigial structure</td>
</tr>
</tbody>
</table>

MAIN IDEA: Evidence for evolution in Darwin’s time came from several sources.
In the diagram below, give examples of each type of evidence for evolution.

1. Fossils: 
2. Geography:  
3. Embryology: 
4. Anatomy: 

Evidence for evolution in Darwin’s time came from several sources.

MAIN IDEA: Structural patterns are clues to the history of a species.
5. Vestigial structures seem to lack any useful function, or are at least no longer used for their original purpose. Give three examples of vestigial structures.

6. Many modern whale species have vestigial pelvic and leg bones. What does this suggest about the ancestry of modern whales?
Vocabulary Check

<table>
<thead>
<tr>
<th>homologous structure</th>
<th>analogous structure</th>
<th>vestigial structure</th>
</tr>
</thead>
</table>

7. Feature that is similar in structure in different organisms but has different functions

8. Feature that performs a similar function in different organisms but is not similar in origin

9. Is not evidence of a common ancestor

10. Remnant of an organ or structure that had a function in an early ancestor

11. Examples include the wing of a bat and the hand of a human

12. Examples include the wing of a bird and the wing of an insect

13. Examples include the wing of an ostrich and the appendix of a human

Sketch it Out

Use Figure 10.11 to sketch a skeleton of a human hand next to the whale fin skeleton shown below. Draw lines to match the groups of bones that are homologous for these two structures.
SECTION 10.5 | EVOLUTIONARY BIOLOGY TODAY

Study Guide

KEY CONCEPT
New technology is furthering our understanding of evolution.

MAIN IDEA: Fossils provide a record of evolution.
1. What are two reasons that the fossil record is not complete?

2. What is one example of a transitional fossil that has been found?

3. Why are transitional fossils important?

MAIN IDEA: Molecular and genetic evidence support fossil and anatomical evidence.
In a phrase, explain how each of the following contribute to evolutionary theory.

<table>
<thead>
<tr>
<th>Molecular Evidence</th>
<th>Contribution to Evolutionary Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. DNA sequence analysis</td>
<td></td>
</tr>
<tr>
<td>5. Pseudogenes</td>
<td></td>
</tr>
<tr>
<td>6. Homeobox genes</td>
<td></td>
</tr>
<tr>
<td>7. Protein comparisons</td>
<td></td>
</tr>
</tbody>
</table>
STUDY GUIDE, CONTINUED

MAIN IDEA: Evolution unites all fields of biology.

8. What two things combine to make up our modern evolutionary theory?

9. How has molecular evidence helped support fossil evidence in determining the early ancestor of modern-day whales?

10. What is meant by the phrase “Evolution unites all fields of biology”?

Vocabulary Check

11. How does paleontology contribute to evolutionary biology?

Sketch it Out

Look at the fossil evidence of whale evolution shown in Figure 10.16. Sketch one part of the skeletons (such as the skull, forelimbs, hindlimbs, or ribcages) of each of the whale ancestors. Briefly describe their differences and propose how these differences are well-suited for the habitat in which the animals lived.
KEY CONCEPT
A population shares a common gene pool.

VOCABULARY
- gene pool
- allele frequency

MAIN IDEA: Genetic variation in a population increases the chance that some individuals will survive.

1. What kind of variation must exist in a population that has a wide range of phenotypes?

2. How can a wide range of phenotypes increase the chance that some individuals will survive in a changing environment?

Fill in the concept map below.

- Genetic variation is stored in a population’s "which contains" 3.
- Genetic variation is measured with "which are calculated by" 5.

4. 6.
MAIN IDEA: Genetic variation comes from several sources.
In a phrase, describe how each term below provides a source of genetic variation.

<table>
<thead>
<tr>
<th>Source</th>
<th>How It Provides Genetic Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. mutation</td>
<td></td>
</tr>
<tr>
<td>8. recombination</td>
<td></td>
</tr>
<tr>
<td>9. hybridization</td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check
10. How is a gene pool like a pool of genes?
11. What does an allele frequency measure?

Be Creative
In the space below, write a logo advertising the importance of genetic diversity to a population.
SECTION 11.2
NATURAL SELECTION IN POPULATIONS
Study Guide

KEY CONCEPT
Populations, not individuals, evolve.

VOCABULARY
<table>
<thead>
<tr>
<th>normal distribution</th>
<th>stabilizing selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>microevolution</td>
<td>disruptive selection</td>
</tr>
<tr>
<td>directional selection</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Natural selection acts on a distribution of traits.

1. What is a phenotypic distribution?

2. What can you learn from looking at a phenotypic distribution?

3. In a population that is not undergoing natural selection for a certain trait, what does the phenotypic distribution look like?

In the space provided below, draw the phenotypic distribution for a trait that follows a normal distribution. Be sure to label the axes as well as the mean phenotype.
MAIN IDEA: Natural selection can change the distribution of a trait in one of three ways.

In the table below, take notes about the three patterns of natural selection.

<table>
<thead>
<tr>
<th>Type of Selection</th>
<th>How It Works</th>
<th>Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. directional selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. stabilizing selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. disruptive selection</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

7. The observable change in ________________ over time is called microevolution.

8. During ________________ selection, the intermediate phenotype is selected for.

9. During ________________ selection, both extreme phenotypes are selected for.

10. During ________________ selection, the mean phenotype changes.
SECTION 11.3

OTHER MECHANISMS OF EVOLUTION
Study Guide

KEY CONCEPT
Natural selection is not the only mechanism through which populations evolve.

VOCABULARY
<table>
<thead>
<tr>
<th>gene flow</th>
<th>bottleneck effect</th>
<th>sexual selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>genetic drift</td>
<td>founder effect</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Gene flow is the movement of alleles between populations.
Fill in the word or phrase that best completes each statement.

1. When an individual __________________________ from its population, its alleles are no longer part of that population’s gene pool.
2. When an individual __________________________ into a new population, the genetic diversity of this new population increases.
3. Gene flow among neighboring populations helps to keep the __________________________ of these populations similar.

MAIN IDEA: Genetic drift can occur in small populations.
4. How is genetic drift different from natural selection?

Use Y-notes to compare and contrast the bottleneck effect and the founder effect.

<table>
<thead>
<tr>
<th>Bottleneck effect</th>
<th>Founder effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Both
5. Why is genetic drift more likely to occur in smaller populations?

6. What are some problems that can result from genetic drift?

**MAIN IDEA:** Sexual selection is a source of evolutionary change.

7. Why is the cost of reproduction different for males and females?

8. What is sexual selection?

9. ________________ selection involves fighting among males for a female, whereas ________________ selection involves males displaying traits to impress females.

**Vocabulary Check**

In the spaces provided below, draw pictures that help you to remember the definitions of the vocabulary words.

- Gene Flow
- Bottleneck Effect
- Founder Effect
KEY CONCEPT
Hardy-Weinberg equilibrium provides a framework for understanding how populations evolve.

MAIN IDEA: Hardy-Weinberg equilibrium describes populations that are not evolving.

1. What variable remains constant, or in equilibrium, in the Hardy-Weinberg model? 

2. Name the five conditions required for a population to be in Hardy-Weinberg equilibrium.

3. Name two ways that population biologists can use Hardy-Weinberg equilibrium.

MAIN IDEA: The Hardy-Weinberg equation is used to predict genotype frequencies for a population.

4. Write the Hardy-Weinberg equation:

5. Fill in the missing information about the variables involved in the Hardy-Weinberg equation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>What It Represents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>frequency of dominant homozygous genotype</td>
</tr>
<tr>
<td>2pq</td>
<td>frequency of recessive homozygous genotype</td>
</tr>
<tr>
<td>p</td>
<td>frequency of recessive allele</td>
</tr>
</tbody>
</table>
6. In what types of systems can the Hardy-Weinberg equation be used?

7. What variables must be known in order to use the Hardy-Weinberg equation?

8. What can be concluded if real genetic data do not match the frequencies predicted by the equation?

9. Take notes about these five factors in the table below.

<table>
<thead>
<tr>
<th>Factor</th>
<th>How It Can Lead To Evolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>genetic drift</td>
<td></td>
</tr>
<tr>
<td>gene flow</td>
<td></td>
</tr>
<tr>
<td>mutation</td>
<td></td>
</tr>
<tr>
<td>sexual selection</td>
<td></td>
</tr>
<tr>
<td>natural selection</td>
<td></td>
</tr>
</tbody>
</table>

10. A population is said to be in Hardy-Weinberg equilibrium for a trait if ______________________ stay the same from generation to generation.
KEY CONCEPT
New species can arise when populations are isolated.

VOCABULARY
<table>
<thead>
<tr>
<th>reproductive isolation</th>
<th>geographic isolation</th>
</tr>
</thead>
<tbody>
<tr>
<td>speciation</td>
<td>temporal isolation</td>
</tr>
<tr>
<td>behavioral isolation</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: The isolation of populations can lead to speciation.
Fill in the term from the box that best completes each statement.

<table>
<thead>
<tr>
<th>speciation</th>
<th>gene flow</th>
<th>species</th>
<th>gene pools</th>
</tr>
</thead>
<tbody>
<tr>
<td>environments</td>
<td>mutation</td>
<td>mate</td>
<td>genetic drift</td>
</tr>
</tbody>
</table>

1. Two populations are said to be isolated if there is no longer any ____________ between them.

2. Over generations, the ____________ of isolated populations may become more and more different.

3. Isolated populations may become genetically different as they adapt to new ____________, or through random processes such as mutation and ____________.

4. When members of two isolated populations can no longer ____________ successfully, the populations are said to be reproductively isolated.

5. Reproductive isolation is the final step of ____________, which is the rise of new ____________.

6. The experiment illustrated in Figure 11.12 shows how just one ____________ can provide enough genetic difference to result in reproductive isolation.
MAIN IDEA: Populations can become isolated in several ways.

7. Name the three types of barriers that can isolate populations.

8. In the chart below, take notes about the three ways in which populations can become isolated, leading to reproductive isolation.

<table>
<thead>
<tr>
<th>Type of Isolation</th>
<th>How It Works</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>behavioral isolation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>geographic isolation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>temporal isolation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

9. What is speciation?

10. Which type of isolation involves factors of time?

11. Which type of isolation can involve mating or courtship rituals?

12. Which type of isolation can involve physical barriers?
KEY CONCEPT
Evolution occurs in patterns.

VOCABULARY
- convergent evolution
- coevolution
- punctuated equilibrium
- divergent evolution
- extinction
- adaptive radiation

MAIN IDEA: Evolution through natural selection is not random.
Fill in the Main Idea in the center of the Main Idea Web below. Then take notes based on the phrases in the surrounding boxes.

1. Main idea:
2. Natural selection has direction:
3. Its effects are cumulative:
4. Convergent evolution:
5. Divergent evolution:

MAIN IDEA: Species can shape each other over time.
In the table below, take notes about two ways in which species can coevolve.

<table>
<thead>
<tr>
<th>Type of Coevolution</th>
<th>How It Works</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. beneficial relationship</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. evolutionary arms race</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STUDY GUIDE, CONTINUED

MAIN IDEA: Species can become extinct.

In the table below, take notes about background and mass extinctions.

<table>
<thead>
<tr>
<th>Type of Extinction</th>
<th>Possible Causes</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. background extinction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. mass extinction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Speciation often occurs in patterns.

10. The theory of punctuated equilibrium states that relatively brief episodes of _________________ are followed by long periods of little evolutionary _________________.

11. Adaptive radiation is a process in which one ancestral species diversifies into many _________________ species.

12. Adaptive radiation occurred after the extinction of the dinosaurs, because they left a wide range of _________________ into which mammals could diversify.

Vocabulary Check

13. Converge means “to come together” and diverge means “to branch out.” How do these meanings apply to the terms convergent and divergent evolution?

14. The prefix co- means “together.” How does this meaning apply to the term coevolution?

15. Punctuate means “to interrupt periodically.” How does this meaning apply to the term punctuated equilibrium?
KEY CONCEPT
Fossils are a record of life that existed in the past.

VOCABULARY
relative dating  isotope
radiometric dating  half-life

MAIN IDEA: Fossils can form in several ways.
In the spaces provided, write either the type of fossil being described or a brief description of how the fossil type is formed.

<table>
<thead>
<tr>
<th>Type of Fossil</th>
<th>Description of Fossil Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Organism trapped in tree resin that hardens after being buried.</td>
</tr>
<tr>
<td>2.</td>
<td>An impression is left in sediment, and minerals fill the impression in, recreating the original shape of the organism.</td>
</tr>
<tr>
<td>3. Trace fossil</td>
<td></td>
</tr>
<tr>
<td>4. Permineralized fossil</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Organism becomes encased in materials such as ice or volcanic ash, or immersed in a bog.</td>
</tr>
</tbody>
</table>
Use Figure 12.2 to fill in a sequence diagram that describes the process of permineralization.

An organism dies.  →  Sediments quickly cover its body.  →  The fossils may be exposed millions of years after formation.

6. 

7. 

MAIN IDEA: Radiometric dating provides an accurate estimate of a fossil’s age.

8. What is the main purpose of both relative dating and radiometric dating?

9. What is the main difference between relative dating and radiometric dating?

10. How is the radioactive decay of an element used to determine the age of a rock layer?

11. Look at Figure 12.4. After two half-lives, what percentage of carbon-14 remains in a sample?

Vocabulary Check

<table>
<thead>
<tr>
<th>relative dating</th>
<th>radiometric dating</th>
<th>isotope</th>
<th>half-life</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. Measures the actual age of a fossil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Most elements have several of these</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Measure of the release of radiation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Infers order in which groups of organisms existed</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**KEY CONCEPT**
The geologic time scale divides Earth's history based on major past events.

**VOCABULARY**
- index fossil
- era
- epoch
- geologic time scale
- period

**MAIN IDEA:** Index fossils are another tool to determine the age of rock layers.

1. How are index fossils used to determine the age of fossils or rock layers?

2. What four characteristics are best for an index fossil to have?

**MAIN IDEA:** The geologic time scale organizes Earth’s history.

Look at Figure 12.6 to fill in the following classification tree.
STUDY GUIDE, CONTINUED

**Vocabulary Check**

<table>
<thead>
<tr>
<th>era</th>
<th>period</th>
<th>epoch</th>
</tr>
</thead>
</table>

Fill in the blanks below using the terms in the box. You may use some terms more than others.

12. The smallest unit of geologic time
13. Associated with rock systems
14. Consists of two or more periods
15. Lasts tens to hundreds of millions of years
16. Lasts several million years
17. Lasts tens of millions of years
18. Most commonly used units of geologic time
19. Examples include the Paleozoic, Mesozoic, and Cenozoic
20. Examples include the Cambrian, Jurassic, and Quaternary
21. The longest unit of geologic time

The names of eras come from early ideas about life forms preserved as fossils. Provide the meaning of the following names of eras:

22. Paleozoic
23. Mesozoic
24. Cenozoic

25. How is the geologic time scale a representation of the history of Earth?

________________________________________________________________________

________________________________________________________________________
KEY CONCEPT
The origin of life on Earth remains a puzzle.

VOCABULARY
| nebula   | ribozyme |

MAIN IDEA: Earth was very different billions of years ago.
1. Most scientists agree on two points about Earth’s origins. What are they?

 Fill in the Main Idea Web with the descriptions of early Earth.

Heat released by:
2. __________________ and
3. __________________

Atmosphere made of:
4. __________________

Absent in atmosphere:
5. __________________

Eon name:
6. __________________

Energy provided by:
7. __________________ and
8. __________________
**MAIN IDEA:** Several sets of hypotheses propose how life began on Earth. 
In the column on the left labeled “hypothesis,” write the hypothesis from the readings about how life began on Earth. In the column labeled “proof,” list the evidence that supports the hypothesis.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Proof</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. ORGANIC MOLECULE HYPOTHESES</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Demonstrated organic compounds could be made by passing electrical current (to simulate lightning) through a closed system that held a mixture of gases (to simulate the early atmosphere).</td>
</tr>
<tr>
<td>10. Meteorite hypothesis</td>
<td></td>
</tr>
<tr>
<td>II. EARLY CELL STRUCTURE HYPOTHESES</td>
<td></td>
</tr>
<tr>
<td>11. Simulated in the lab, making a chimney structure with compartments that could have acted as the first cell membranes.</td>
<td></td>
</tr>
<tr>
<td>12. Lipid membrane hypothesis</td>
<td></td>
</tr>
<tr>
<td>III. RNA AS EARLY GENETIC MATERIAL</td>
<td></td>
</tr>
<tr>
<td>13. RNA world hypothesis</td>
<td></td>
</tr>
<tr>
<td><strong>Vocabulary Check</strong></td>
<td></td>
</tr>
<tr>
<td>14. A cloud of gas and dust in space</td>
<td></td>
</tr>
<tr>
<td>15. An RNA molecule that can catalyze specific chemical reactions</td>
<td></td>
</tr>
</tbody>
</table>
SECTION 12.4  EARLY SINGLE-CELLED ORGANISMS
Study Guide

KEY CONCEPT
Single-celled organisms existed 3.8 billion years ago.

VOCABULARY
| cyanobacteria | endosymbiosis |

MAIN IDEA: Microbes have changed the physical and chemical composition of Earth.

1. What are two ways that early single-celled organisms changed Earth’s surface?

2. What have scientists inferred from fossil stromatolites?

MAIN IDEA: Eukaryotic cells may have evolved through endosymbiosis.

3. Although prokaryotes existed as long as 3.5 billion years ago, ________________ arose about 1.5 billion years ago.

4. Eukaryotes have a ________________ and membrane-bound organelles.

5. Eukaryotes are ________________, which means they need oxygen to survive.

6. While the first eukaryotes were made of only one ________________, later eukaryotes were made of many.

Use the sequence diagram below to summarize the theory of endosymbiosis.

7. Some of the smaller prokaryotes may have survived.

8. ________________
9. Describe the role that cyanobacteria play in the theory of endosymbiosis.

________________________________________________________________________

________________________________________________________________________

MAIN IDEA: The evolution of sexual reproduction led to increased diversity.

10. What is the main advantage of asexual reproduction?

________________________________________________________________________

11. Sexual reproduction increases genetic variation in a population. Why might this be beneficial to the population?

________________________________________________________________________

Vocabulary Check

12. Bacteria that can carry out photosynthesis are called ________________.

13. The mutually beneficial relationship in which one organism lives within the body of another is called ________________.

14. The term endosymbiosis can be broken down into parts. Endo- means “within.” What is another term you have heard that starts with endo?

________________________________________________________________________

15. The term cyanobacteria can be broken down into parts. Cyan- means “greenish blue,” because cyanobacteria are often blue-green in color. Not too long ago, cyanobacteria were known as blue-green algae. Why do you think they were considered algae?

________________________________________________________________________
KEY CONCEPT
Multicellular life evolved in distinct phases.

VOCABULARY
<table>
<thead>
<tr>
<th>Period</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Paleozoic</td>
<td>Mesozoic</td>
</tr>
<tr>
<td>Cambrian explosion</td>
<td>Cenozoic</td>
</tr>
</tbody>
</table>

MAIN IDEA: Life moved onto land during the Paleozoic era.
Fill in a Main Idea and Supporting Information Diagram describing the Paleozoic era.

Life moved onto land during the Paleozoic era.

- Early plants moved onto land.
- 1.
- 2.

MAIN IDEA: Reptiles radiated during the Mesozoic era.
Fill in a Main Idea and Supporting Information Diagram describing the Mesozoic era.

Reptiles radiated during the Mesozoic era.

- 3.
- 4.
- 5.
MAIN IDEA: Mammals radiated during the Cenozoic era.
Fill in a Main Idea and Supporting Information Diagram describing the Cenozoic era.

6. 

7. 

8. 

9.

Vocabulary Check

<table>
<thead>
<tr>
<th>Paleozoic</th>
<th>Cambrian explosion</th>
<th>Mesozoic</th>
<th>Cenozoic</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>Divided into the Triassic, Jurassic, and Cretaceous periods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Ended with a mass extinction with more than 90 percent of all marine life extinct</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Earliest part of Paleozoic era</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Primates evolved during this era</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Trilobites were abundant then</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Rise of the first marsupial mammals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Divided into Tertiary and Quarternary periods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Life moved onto land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Includes the Carboniferous period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Dinosaurs roamed the earth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Continues today</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SECTION 12.6 PRIMATE EVOLUTION
Study Guide

KEY CONCEPT
Humans appeared late in Earth’s history.

VOCABULARY
- primate
- hominid
- prosimian
- bipedal
- anthropoid

MAIN IDEA: Humans share a common ancestor with other primates.
Use Figure 12.18 to help you fill in the concept map below with the correct primate group.

```
   Primates
     /   \
  1.    2.
     /   \
  3.    4.  5.    6.  7.  8.  9.
     /   \
chimpanzee human
```
MAIN IDEA: There are many fossil of extinct hominids.

10. What are the two groups that most hominid species are classified into?

11. What early hominid was known as “handy man”?

12. What early hominid group may have existed alongside modern humans?

MAIN IDEA: Modern humans arose about 200,000 years ago.

13. What trends can be seen in tools from older to more recent fossil sites of Homo?

14. What evidence supports the hypothesis that primate brains evolved faster than rodent brains in the past?

Vocabulary Check

<table>
<thead>
<tr>
<th>primate</th>
<th>prosimian</th>
<th>anthropoid</th>
<th>hominid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Walks upright, has long lower limbs, opposable thumbs, and large brains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Oldest living primate group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Name means humanlike primate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Has flexible hands and feet, eyes that face forward, and large brains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Small primate that is active at night</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Includes all species in human lineage, both modern and extinct</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>Examples include lemurs, lorises, and tarsiers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Divided into New World monkeys, Old World monkeys, and hominoids</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SECTION 13.1  ECOLOGISTS STUDY RELATIONSHIPS

Study Guide

KEY CONCEPT
Ecology is the study of the relationships among organisms and their environment.

VOCABULARY
<table>
<thead>
<tr>
<th>Ecology</th>
<th>Ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>Biome</td>
</tr>
</tbody>
</table>

MAIN IDEA: Ecologists study environments at different levels of organization. Write a description of each level of organization in the table. Also, provide an example for each level.

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. organism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. community</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. ecosystem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. biome</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Ecological research methods include observation, experimentation, and modeling.

6. What is observation?

7. What is the difference between direct and indirect surveys?
8. Complete the following table with a benefit and drawback of conducting an experiment in the laboratory compared with conducting an experiment in the field.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Benefit</th>
<th>Drawback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. When might a scientist use a model as a research method?

Vocabulary Check

10. What is ecology?

11. Of the three terms, *biome*, *community*, and *ecosystem*, which term contains the other two?
KEY CONCEPT
Every ecosystem includes both living and nonliving factors.

VOCABULARY
<table>
<thead>
<tr>
<th>biotic</th>
<th>biodiversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>abiotic</td>
<td>keystone species</td>
</tr>
</tbody>
</table>

MAIN IDEA: An ecosystem includes both biotic and abiotic factors.

Use a word from the box below to complete the following sentences.

<table>
<thead>
<tr>
<th>abiotic</th>
<th>animals</th>
<th>biotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>living</td>
<td>moisture</td>
<td>nonliving</td>
</tr>
<tr>
<td>plants</td>
<td>temperature</td>
<td>wind</td>
</tr>
</tbody>
</table>

1. All ecosystems are made up of ___________ and ___________ components.
2. ___________ factors are living things, such as ___________ or ___________.
3. ___________ factors are nonliving things, such as ___________, ___________, or ___________.

MAIN IDEA: Changing one factor in an ecosystem can affect many other factors.


5. What is the term for an organism that has an unusually large effect on its ecosystem?

6. List a few reasons why a beaver is an example of a keystone species.
Vocabulary Check

7. What is the difference between a biotic and an abiotic factor?

8. Take another look at the Visual Vocab on page 403. In architecture, a keystone is the stone at the center of an arch that holds the arch together. How does this definition relate to a keystone species?

Be Creative

In the box below, sketch a simple ecosystem and label the abiotic and biotic factors.
KEY CONCEPT
Life in an ecosystem requires a source of energy.

VOCABULARY

<table>
<thead>
<tr>
<th>producer</th>
<th>heterotroph</th>
</tr>
</thead>
<tbody>
<tr>
<td>autotroph</td>
<td>chemosynthesis</td>
</tr>
<tr>
<td>consumer</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Producers provide energy for other organisms in an ecosystem.

Complete the following sentences with the correct term:

<table>
<thead>
<tr>
<th>autotrophs</th>
<th>eating</th>
<th>nonliving</th>
</tr>
</thead>
<tbody>
<tr>
<td>consumers</td>
<td>heterotrophs</td>
<td>producers</td>
</tr>
</tbody>
</table>

1. _________ are organisms that get their energy from _________ resources, meaning they make their own food. These organisms are also called _________.

2. _________ are organisms that get their energy by _________ other organisms. These organisms are also called _________.

3. Why are producers so important to an ecosystem?

4. Why is the Sun important to both producers and consumers?
STUDY GUIDE, CONTINUED

MAIN IDEA: Almost all producers obtain energy from sunlight.

5. Complete the following Y-diagram to outline the similarities and differences between photosynthesis and chemosynthesis.

Photosynthesis

Chemosynthesis

Both

Vocabulary Check

6. Use the above word origins to explain the difference between an autotroph and a heterotroph.

7. The prefix photo- means “light” while the prefix chemo- means “chemical.” How do these word origins relate to the difference between photosynthesis and chemosynthesis?

8. What is the difference between a consumer and a producer?
KEY CONCEPT
Food chains and food webs model the flow of energy in an ecosystem.

VOCABULARY
<table>
<thead>
<tr>
<th>food chain</th>
<th>decomposer</th>
</tr>
</thead>
<tbody>
<tr>
<td>herbivore</td>
<td>specialist</td>
</tr>
<tr>
<td>carnivore</td>
<td>generalist</td>
</tr>
<tr>
<td>omnivore</td>
<td>trophic level</td>
</tr>
<tr>
<td>detritivore</td>
<td>food web</td>
</tr>
</tbody>
</table>

MAIN IDEA:  A food chain is a model that shows a sequence of feeding relationships.
Complete the following sentence with the correct terms.

1. A food chain follows the connection between one __________ and a single chain of __________ within an __________.

Choose the correct term from the box below to fit each description.

| carnivore  | herbivore | secondary consumer |
| detritivore | omnivore  | tertiary consumer  |
| decomposer | primary consumer | trophic levels |

2. I eat only plants. I am a(n) ________________________.
3. I eat only other animals. I am a(n) ____________________.
4. I eat both plants and animals. I am a(n) ____________________.
5. I eat dead organic matter. I am a(n) ____________________.
6. I break down organic matter into simpler compounds. I am a(n) ____________________.
7. I am the first consumer above the producer level. I am a(n) ____________________.
8. I am a carnivore that eats herbivores. I am a(n) ____________________.
9. I am a carnivore that eats other carnivores. I am a(n) ____________________.
10. The levels of nourishment in a food chain are called ____________________.
STUDY GUIDE, CONTINUED

MAIN IDEA: A food web shows a complex network of feeding relationships.

11. How is a food web different from a food chain?

________________________________________________________________________

________________________________________________________________________

12. What happens to energy at each link in a food web?

________________________________________________________________________

13. What type of organism provides the base of a food web?

________________________________________________________________________

Vocabulary Check

14. Use your knowledge of the words *special* and *general* to explain the diets of a specialist and a generalist.

________________________________________________________________________

15. Use the word origins to explain the diets of each of the following consumers: herbivores, carnivores, and omnivores.

<table>
<thead>
<tr>
<th>Word Part</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>herba</td>
<td>vegetation</td>
</tr>
<tr>
<td>carnus</td>
<td>flesh</td>
</tr>
<tr>
<td>omnis</td>
<td>all</td>
</tr>
</tbody>
</table>

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
SECTION 13.5 | CYCLING OF MATTER

Study Guide

KEY CONCEPT
Matter cycles in and out of an ecosystem.

VOCABULARY
| hydrologic cycle |
| biogeochemical cycle |
| nitrogen fixation |

MAIN IDEA: Water cycles through the environment.
Fill in the chart with a description of each process that describes how water moves through an ecosystem in the hydrologic cycle.

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. precipitation</td>
<td></td>
</tr>
<tr>
<td>2. evaporation</td>
<td></td>
</tr>
<tr>
<td>3. transpiration</td>
<td></td>
</tr>
<tr>
<td>4. condensation</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Elements essential for life also cycle through ecosystems.
Complete the following sentences with the proper terms.

5. Plants, animals, and most other organisms need ________________ for cellular ________________.

6. Oxygen is released as a waste product by plants during the process of ________________. Animals take in this oxygen and release it as ________________ during the process of ________________.

7. In the carbon cycle, plants use energy from the Sun to convert ________________ from the air into organic material that becomes a part of the plant’s structure.
8. Carbon is released to the atmosphere as carbon dioxide when you breathe during the process of ________________ or through the ________________ of dead organisms.

9. ________________, or the burning of fossil fuels, also adds carbon dioxide to the atmosphere.

10. What is nitrogen fixation?

   ____________________________________________________________
   ____________________________________________________________

11. List five steps that occur during the phosphorus cycle.

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

**Vocabulary Check**

Use the following word origins to answer the questions below.

<table>
<thead>
<tr>
<th>Word Part</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>bio-</td>
<td>life</td>
</tr>
<tr>
<td>chem-</td>
<td>chemical</td>
</tr>
<tr>
<td>geo-</td>
<td>earth</td>
</tr>
<tr>
<td>hydro-</td>
<td>water</td>
</tr>
</tbody>
</table>

12. What is a biogeochemical cycle?

   ____________________________________________________________
   ____________________________________________________________

13. What is the hydrologic cycle?

   ____________________________________________________________
Section 13.6 | Pyramid Models

Study Guide

**KEY CONCEPT**

Pyramids model the distribution of energy and matter in an ecosystem.

**VOCABULARY**

<table>
<thead>
<tr>
<th>biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>energy pyramid</td>
</tr>
</tbody>
</table>

**MAIN IDEA:** An energy pyramid shows the distribution of energy among trophic levels.

Complete the following sentences with the correct terms.

<table>
<thead>
<tr>
<th>biomass</th>
<th>heat</th>
<th>waste</th>
</tr>
</thead>
</table>

1. The measure of the total dry mass of organisms in a given area is called _____________.

2. When a consumer incorporates the biomass of a producer into its own biomass, a large amount of energy is lost as ____________ and _____________.

3. Label the four tiers of the energy pyramid with the correct trophic level (producers, primary consumers, secondary consumers, tertiary consumers).
STUDY GUIDE, CONTINUED

MAIN IDEA: Other pyramid models illustrate an ecosystem’s biomass and distribution of organisms.
Write a description of each pyramid model.

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. energy pyramid</td>
<td></td>
</tr>
<tr>
<td>5. biomass pyramid</td>
<td></td>
</tr>
<tr>
<td>6. pyramid of numbers</td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check
7. What is biomass?

Make an Energy Pyramid
8. Choose an ecosystem. Research what types of plants and animals live in your chosen ecosystem. Draw an energy pyramid that might exist within that ecosystem.
KEY CONCEPT
Every organism has a habitat and a niche.

VOCABULARY
<table>
<thead>
<tr>
<th>habitat</th>
<th>competitive exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>ecological niche</td>
<td>ecological equivalent</td>
</tr>
</tbody>
</table>

MAIN IDEA: A habitat differs from a niche.
1. What is the difference between an organism’s habitat and its ecological niche?

2. Determine which ecological factors are a part of a lion’s niche and which are a part of a lion’s habitat by placing the above items in the correct column.

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Niche</th>
</tr>
</thead>
<tbody>
<tr>
<td>food</td>
<td>trees</td>
</tr>
<tr>
<td>hunting behavior</td>
<td>watering hole</td>
</tr>
<tr>
<td>other lions</td>
<td>zebra</td>
</tr>
<tr>
<td></td>
<td>sand</td>
</tr>
<tr>
<td></td>
<td>waterhole</td>
</tr>
<tr>
<td></td>
<td>wildebeest</td>
</tr>
<tr>
<td></td>
<td>temperature</td>
</tr>
<tr>
<td></td>
<td>grass</td>
</tr>
<tr>
<td></td>
<td>savanna</td>
</tr>
</tbody>
</table>

MAIN IDEA: Resource availability gives structure to a community.
3. What is competitive exclusion?
4. What are the three possible outcomes of competitive exclusion?

5. What are ecological equivalents?

6. Explain why ecological equivalents do not share the same niche.

Vocabulary Check

7. The term *habitat* comes from a Latin word which means “to dwell.” Explain how this word origin relates to the definition of a habitat.

8. In competitive exclusion, who is competing and who gets excluded?

9. What does *equivalent* mean in math? How does that meaning relate to ecological equivalents?
**KEY CONCEPT**

Organisms interact as individuals and as populations.

**VOCABULARY**

<table>
<thead>
<tr>
<th>competition</th>
<th>symbiosis</th>
<th>commensalism</th>
</tr>
</thead>
<tbody>
<tr>
<td>predation</td>
<td>mutualism</td>
<td>parasitism</td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Competition and predation are two important ways in which organisms interact.

Next to each situation described below, write whether it is an example of *interspecific* competition or *intraspecific* competition.

1. Two squirrels race up a tree to reach a hidden pile of nuts.
2. A hyena chases off a vulture to feast on an antelope carcass.
3. Different species of shrubs and grasses on the forest floor compete for sunlight.
4. Brown bears hunting for fish on a river’s edge fight over space.
5. Male big horn sheep butt heads violently in competition for mates.

6. Draw and label a sketch that represents an example of a predator-prey interaction.
STUDY GUIDE, CONTINUED

MAIN IDEA: Symbiosis is a close relationship between species.

7. For each type of symbiotic relationship, complete the chart with details about how each organism is impacted using the terms “Benefits,” “Harmed,” or “No impact.” For each situation, assume that Organism A initiates the relationship.

<table>
<thead>
<tr>
<th>Symbiotic Relationship</th>
<th>Organism A</th>
<th>Organism B</th>
</tr>
</thead>
<tbody>
<tr>
<td>mutualism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>commensalism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>parasitism</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. How is parasitism similar to and different from predation?

_____________________________________________________________________________________

_____________________________________________________________________________________

9. What is the difference between endoparasites and ectoparasites?

_____________________________________________________________________________________

_____________________________________________________________________________________

Vocabulary Check

10. The term *symbiosis* comes from a Greek term which means “living together.” How does this word origin help to explain the definition of symbiosis?

_____________________________________________________________________________________

11. Use your knowledge of the word “mutual” to write a definition for mutualism.

_____________________________________________________________________________________

_____________________________________________________________________________________

12. The word *commensalism* comes from the Latin *mensa*, meaning “table,” and *com-*, meaning “with.” If I come to your table to eat your food, I benefit but you don’t. Draw a sketch to show this meaning to help you remember it.
SECTION 14.3  POPULATION DENSITY AND DISTRIBUTION

Study Guide

KEY CONCEPT
Each population has a density, a dispersion, and a reproductive strategy.

VOCABULARY
<table>
<thead>
<tr>
<th>population density</th>
<th>survivorship curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>population dispersion</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Population density is the number of individuals that live in a defined area.

1. What is the formula for calculating population density?

2. What might cause the population density of a population of deer to increase?

MAIN IDEA: Geographic dispersion of a population shows how individuals in a population are spaced.

3. In the boxes below, draw and label the three types of population dispersion patterns.

4. List two reasons why a population might live in a clumped dispersion and two reasons why a population might live in a uniform dispersion.
MAIN IDEA: Survivorship curves help to describe the reproductive strategy of a species.

5. What is meant by the term reproductive strategy? What accounts for differences in reproductive strategies?

Take a look at each of the survivorship curves shown above. Next to each type of organism listed below, write in the space provided whether it is an example of Type I, Type II, or Type III survivorship.

6. lion
7. bird
8. reptile
9. small mammal
10. invertebrate
11. fish
12. giraffe
13. human

Vocabulary Check

14. What is the difference between population density and population dispersion?
1. When resources are abundant in a particular area, individuals may move into the population of this area. This movement of individuals into a population from a different population is called ________________.

2. A very cold winter has left many deer in a population hungry and sick. By the end of the winter, this population will likely decrease because of ________________.

3. A deer population experiences growth when the rate of reproduction increases. This change in population size is due to ________________.

4. As humans move into their territory, many members of a deer population move away and join other herds. This movement of individuals out of a population into a new population is called ________________.

5. How does the availability of resources affect population growth?

__________________________________________________

__________________________________________________
MAIN IDEA: Population growth is based on available resources.

6. In the space below, draw and label the two different types of population growth curves. Write a brief description next to each graph.

7. What type of population growth curve shows a carrying capacity?

8. What type of population growth is at risk for a population crash? Explain why.

MAIN IDEA: Ecological factors limit population growth.

8. List three examples of density-dependent limiting factors.

9. List three examples of density-independent limiting factors.

Vocabulary Check
Explain why each pair of words below are opposites.

10. emigrate/immigrate

11. density-dependent limiting factor/density-independent limiting factor

12. exponential growth/logistic growth
KEY CONCEPT
Ecological succession is a process of change in the species that make up a community.

VOCABULARY
<table>
<thead>
<tr>
<th>success</th>
<th>pioneer species</th>
</tr>
</thead>
<tbody>
<tr>
<td>primary succession</td>
<td>secondary succession</td>
</tr>
</tbody>
</table>

MAIN IDEA: Succession occurs following a disturbance in an ecosystem.

1. What is ecological succession?

2. Fill in the chart below with a description and simple sketch of the four main steps of primary succession. Include the amount of time it takes for each stage of this process.
3. Fill in the chart below with a description and simple sketch of the four main steps of secondary succession. Include the amount of time it takes for each stage of this process.

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sketch</td>
<td>Sketch</td>
<td>Sketch</td>
<td>Sketch</td>
</tr>
<tr>
<td>Describe</td>
<td>Describe</td>
<td>Describe</td>
<td>Describe</td>
</tr>
<tr>
<td>Time</td>
<td>Time</td>
<td>Time</td>
<td>Time</td>
</tr>
</tbody>
</table>

**Vocabulary Check**

4. What is the difference between primary and secondary succession?

5. Use your knowledge of the word *pioneer* to write a definition for the term *pioneer species*.
**KEY CONCEPT**
The biosphere is one of Earth’s four interconnected systems.

**VOCABULARY**
<table>
<thead>
<tr>
<th>biosphere</th>
<th>hydrosphere</th>
<th>geosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>biota</td>
<td>atmosphere</td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** The biosphere is the portion of Earth that is inhabited by life.

Write a description of each Earth system in the table below.

<table>
<thead>
<tr>
<th>Earth System</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. biosphere</td>
<td></td>
</tr>
<tr>
<td>2. hydrosphere</td>
<td></td>
</tr>
<tr>
<td>3. atmosphere</td>
<td></td>
</tr>
<tr>
<td>4. geosphere</td>
<td></td>
</tr>
</tbody>
</table>

5. What is the connection between the biota and the biosphere?

_________________________________________________________________
_________________________________________________________________

6. Use an example to explain how the four Earth systems are connected.

_________________________________________________________________
_________________________________________________________________
7. Fill in the following diagram with the correct term (biosphere, biota, hydrosphere, atmosphere, geosphere).

![Diagram with labeled circles]

**MAIN IDEA:** Biotic and abiotic factors interact in the biosphere.

8. In your own words, describe the Gaia hypothesis.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

**Vocabulary Check**

Choose the word from the box below that best matches up with each Earth system.

<table>
<thead>
<tr>
<th>air</th>
<th>water</th>
<th>earth</th>
<th>life</th>
</tr>
</thead>
</table>

9. Atmosphere __________________

10. Biosphere _________________

11. Geosphere _________________

12. Hydrosphere _______________
SECTION 15.2 CLIMATE

KEY CONCEPT
Climate is a key abiotic factor that affects the biosphere.

VOCABULARY
climate  microclimate

MAIN IDEA: Climate is the prevailing weather of a region.
1. What is the difference between an area’s weather and climate?

2. What are four key factors that shape an area’s climate?

MAIN IDEA: Earth has three climate zones.
3. Name the main reason why the surface of Earth is heated unevenly by the Sun.

4. What characteristic of Earth results in different seasons over a period of a year?

Complete the following chart with the location and characteristics of each climate zone.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Location</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. polar zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. tropical zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. temperate zone</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. What effect does the heating of Earth have on air and water movement?

9. Why do areas closer to bodies of water have different climates than do inland areas?

10. How does the presence of mountains affect an area’s climate?

11. What is a rain shadow?

12. What is the difference between a climate and a microclimate?

13. List four characteristics of the climate where you live. Include information on temperature and precipitation.
### KEY CONCEPT
Biomes are land-based, global communities of organisms.

### VOCABULARY
<table>
<thead>
<tr>
<th>Canopy</th>
<th>Coniferous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grassland</td>
<td>Taiga</td>
</tr>
<tr>
<td>Desert</td>
<td>Tundra</td>
</tr>
<tr>
<td>Deciduous</td>
<td>Chaparral</td>
</tr>
</tbody>
</table>

### MAIN IDEA: Earth has six major biomes.
Fill in the chart with details about the six major biomes found on Earth.

<table>
<thead>
<tr>
<th>Biome</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Tropical rain forest</td>
<td></td>
</tr>
<tr>
<td><strong>2.</strong> Grassland</td>
<td></td>
</tr>
<tr>
<td><strong>3.</strong> Desert</td>
<td></td>
</tr>
<tr>
<td><strong>4.</strong> Temperate</td>
<td></td>
</tr>
<tr>
<td><strong>5.</strong> Taiga</td>
<td></td>
</tr>
<tr>
<td><strong>6.</strong> Tundra</td>
<td></td>
</tr>
</tbody>
</table>

7. What is the difference between tropical and temperate grasslands?
   - Tropical grasslands have a high diversity of plants and animals, while temperate grasslands have a lower diversity and are more seasonal.

8. What are the four different types of deserts?
   - Desert, cold desert, arid desert, hot desert
9. How does precipitation differ in a temperate deciduous forest and a temperate rain forest?


10. Why do few plants grow in the tundra?


11. Describe the main characteristics of chaparral.


MAIN IDEA: Polar ice caps and mountains are not considered biomes.

12. Why aren’t polar ice caps and mountains considered biomes?


13. Where are the polar ice caps located?


14. What is a mountain life zone?


Vocabulary Check

15. I lose my leaves in the autumn. I am a ____________________.

16. I retain my needles all year long. I am a ____________________.

17. I am the uppermost branches of a tree. I am called the ____________________.
**KEY CONCEPT**
Marine ecosystems are global.

**VOCABULARY**

<table>
<thead>
<tr>
<th>Zone</th>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>intertidal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>neritic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bathyal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>abyssal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** The ocean can be divided into zones.
Complete the following table with information about ocean zones.

5. What zone has the most biomass? What type of organism makes up most of this biomass?

6. Why are phytoplankton critical to life on Earth?
MAIN IDEA: Coastal waters contain unique habitats.

7. Complete the following Y-diagram to outline the similarities and differences between a coral reef and a kelp forest.

![Y-diagram for coral reef and kelp forest]

8. What is a coral reef made from?

   _____________________________________________________________
   _____________________________________________________________

9. Why are coral reefs considered delicate?

   _____________________________________________________________
   _____________________________________________________________

Vocabulary Check

10. I am a photosynthetic plankton. What am I? ______________________

11. I am an animal plankton. What am I? ______________________
KEY CONCEPT
Freshwater ecosystems include estuaries as well as flowing and standing water.

VOCABULARY
<table>
<thead>
<tr>
<th>estuary</th>
<th>littoral zone</th>
<th>benthic zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>watershed</td>
<td>limnetic zone</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA:
Estuaries are dynamic environments where rivers flow into the ocean.

1. What is an estuary?

2. What is the distinctive feature of an estuary?

3. Describe why estuaries are considered to be highly productive ecosystems.

4. Why are estuaries sometimes called the “nurseries of the sea”?

5. What adaptations are necessary for organisms that live in an estuary?

6. What impact does the removal of an estuary have on surrounding areas?
**MAIN IDEA:** Freshwater ecosystems include moving and standing water.

7. What are the characteristics of a wetland?

________________________________________________________________________

8. What is an important function of wetlands with regard to the water supply?

________________________________________________________________________

**MAIN IDEA:** Ponds and lakes share common features.

9. Complete the following chart with details about the different zones found in a pond or lake.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>littoral zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>limnetic zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>benthic zone</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary Check**

10. What is a watershed?

________________________________________________________________________

11. The term *estuary* comes from the Latin word *aestus*, which means “tide.” How does this meaning relate to the definition of estuary?

________________________________________________________________________
KEY CONCEPT
As the human population grows, the demand for Earth’s resources increases.

VOCABULARY
nonrenewable resource
renewable resource
ecological footprint

MAIN IDEA: Earth’s human population continues to grow.

1. Approximately how big is Earth’s population now?

2. Name and give examples of two technologies that have influenced human population growth since 1700.

MAIN IDEA: The growing human population exerts pressure on Earth’s natural resources.

Determine whether the following resources are renewable or nonrenewable. Explain your answer.

3. sun

4. oil

5. trees

6. water

7. wind

8. corn

9. beef

10. coal
MAIN IDEA: Effective management of Earth’s resources will help meet the needs of the future.

11. The inhabitants of Easter Island made many mistakes in their resource use. Name one resource that was misused and describe two ways that they could have used the resource more effectively.

12. What is an ecological footprint?

13. List the four factors that determine your ecological footprint.

Vocabulary Check

14. What is the difference between a renewable and a nonrenewable resource?

Be Creative

Create a poster that illustrates why it is important to conserve natural resources.
SECTION 16.2 | AIR QUALITY

Study Guide

KEY CONCEPT
Fossil fuel emissions affect the biosphere.

VOCABULARY

<table>
<thead>
<tr>
<th>pollution</th>
<th>acid rain</th>
</tr>
</thead>
<tbody>
<tr>
<td>smog</td>
<td>greenhouse effect</td>
</tr>
<tr>
<td>particulate</td>
<td>global warming</td>
</tr>
</tbody>
</table>

MAIN IDEA: Pollutants accumulate in the air.

1. What is pollution?
   __________________________________________________________
   __________________________________________________________

2. What is smog?
   __________________________________________________________
   __________________________________________________________

3. What are the major components of smog and how does it form?
   __________________________________________________________
   __________________________________________________________

4. What is acid rain?
   __________________________________________________________
   __________________________________________________________

5. How does acid rain affect ecosystems?
   __________________________________________________________
   __________________________________________________________
**MAIN IDEA:** Air pollution is changing Earth's biosphere.

Complete the concept map with information about the greenhouse effect.

**Vocabulary Check**

11. How is a gardener's greenhouse a miniature version of the greenhouse effect?

12. The word *particulate* comes from the Latin word *partícula*, which means "a small part." How is this word origin related to the definition of a particulate?
KEY CONCEPT
Pollution of Earth’s freshwater supply threatens habitat and health.

VOCABULARY
- indicator species
- biomagnification

MAIN IDEA: Water pollution affects ecosystems.
1. List three examples of water pollution.

2. Why are indicator species important to scientists?

MAIN IDEA: Biomagnification causes accumulation of toxins in the food chain.
3. What is biomagnification?

4. Illustrate an ecosystem’s food chain and describe what will happen to the concentration of pollutants as they move up the food chain.
Vocabulary Check

5. Use your knowledge of the prefix bio- and the term magnification to explain the meaning of biomagnification.

Be Creative

6. Design a poster that explains the importance of keeping sources of fresh water free from pollution.
SECTION 16.4
THREATS TO BIODIVERSITY
Study Guide

KEY CONCEPT
The impact of a growing human population threatens biodiversity.

VOCABULARY

<table>
<thead>
<tr>
<th>Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>habitat fragmentation</td>
</tr>
<tr>
<td>introduced species</td>
</tr>
</tbody>
</table>

MAIN IDEA: Preserving biodiversity is important to the future of the biosphere.

1. What is biodiversity?

2. Why is it important to preserve biodiversity?

3. Where are the highest levels of biodiversity on our planet? Explain why this is so.

MAIN IDEA: Loss of habitat eliminates species.

4. List three ways in which humans cause habitat fragmentation.

MAIN IDEA: Introduced species can disrupt stable relationships in an ecosystem.

5. What is an introduced species?
6. Complete the chart below with examples of introduced species and describe how they are disrupting the ecosystem in which they live.

<table>
<thead>
<tr>
<th>Species</th>
<th>Impact on Ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burmese python</td>
<td></td>
</tr>
<tr>
<td>(Everglades)</td>
<td></td>
</tr>
<tr>
<td>Kudzu</td>
<td></td>
</tr>
<tr>
<td>(United States)</td>
<td></td>
</tr>
<tr>
<td>Mice</td>
<td></td>
</tr>
<tr>
<td>(Australia)</td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary Check**

7. A fragment is defined as “a small part broken off or detached.” How does this definition relate to the meaning of habitat fragmentation?

---

**Be Creative**

8. Think of an area where you live that is an example of habitat fragmentation. Design a poster that both illustrates the problem and proposes a solution.
**KEY CONCEPT**

Conservation methods can help protect and restore ecosystems.

**VOCABULARY**

<table>
<thead>
<tr>
<th>sustainable development</th>
</tr>
</thead>
<tbody>
<tr>
<td>umbrella species</td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Sustainable development manages resources for present and future generations.

1. How can sustainable development help Earth’s human population?

2. Complete the following chart with two examples of sustainable development and explain how they benefit humans.

<table>
<thead>
<tr>
<th>Resource</th>
<th>How Is It managed?</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Conservation practices focus on a few species but benefit entire ecosystems.

3. What is an umbrella species?

<table>
<thead>
<tr>
<th>Resource</th>
<th>How Is It managed?</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Complete the concept map with information about the manatee and its role as an umbrella species.

**West Indian manatee**

is an

is protected by

helps to

4. 

5. 

6.

**MAIN IDEA:** Protecting Earth’s resources helps to protect our future.

7. What are three laws that have been developed to help protect natural resources?

8. What can humans do to reduce their impact on Earth’s ecosystems?

**Vocabulary Check**

9. The word *sustain* means “to keep in existence, maintain.” How does this meaning relate to the idea of sustainable development?
SECTION 17.1  THE LINNAEAN SYSTEM OF CLASSIFICATION

Study Guide

KEY CONCEPT
Organisms can be classified based on physical similarities.

VOCABULARY

<table>
<thead>
<tr>
<th>taxonomy</th>
<th>binomial nomenclature</th>
</tr>
</thead>
<tbody>
<tr>
<td>taxon</td>
<td>genus</td>
</tr>
</tbody>
</table>

MAIN IDEA: Linnaeus developed the scientific naming system still used today.
Fill in the concept map with details about Linnaean taxonomy.

1. Linnaean taxonomy
   classifies
   based on
   into groups called
   2.

2. using a system called
   which gives each species a
   4.

MAIN IDEA: Linnaeus’ classification system has seven levels.
7. How are the seven levels of Linnaeus’ classification system organized?

8. Describe the trend in the levels, or taxa, as you move down from kingdom to species.
Fill in the seven taxa of the Linnaean classification system into the appropriate boxes below.

**MAIN IDEA:** The Linnaean classification system has limitations.

9. Why did Linnaeus base his system of classification on physical similarities alone, as opposed to including molecular and genetic similarities?

10. Why are physical similarities among species not always the result of being closely related?

11. Why do scientists today rely on molecular and genetic similarities to classify organisms?

**Vocabulary Check**

12. Taxonomy is the science of ____________ and ____________ organisms.

13. Words from the ________ language are used in binomial nomenclature.

14. In the binomial nomenclature naming system, each species is given a unique scientific name that includes a ________________ name and a ________________ descriptor.
SECTION 17.2
CLASSIFICATION BASED ON EVOLUTIONARY RELATIONSHIPS

Study Guide

KEY CONCEPT
Modern classification is based on evolutionary relationships.

VOCABULARY
<table>
<thead>
<tr>
<th>phylogeny</th>
<th>cladogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>cladistics</td>
<td>derived character</td>
</tr>
</tbody>
</table>

MAIN IDEA: Cladistics is classification based on common ancestry.

1. What is a phylogeny?

2. How can a phylogeny be shown?

3. Describe the main goal of cladistics.

Use the word box below to label the main features of a cladogram.

<table>
<thead>
<tr>
<th>clade</th>
<th>node</th>
<th>taxon being classified</th>
<th>derived character</th>
</tr>
</thead>
</table>

4. 

5. 

6. 

7.
8. What is a clade?

9. How are derived characters used in making a cladogram?

10. On a cladogram, what is a node and what does it represent?

MAIN IDEA: Molecular evidence reveals species’ relatedness.

11. Give two examples of molecular evidence that can be used to help determine species’ relatedness.

12. Why are evolutionary trees often changed?

13. What can be concluded if the genes of two species are found to be nearly identical?

Vocabulary Check

14. Phylo- comes from the Greek word meaning “class,” and the suffix -geny means “origin.” How do these meanings apply to the term phylogeny?

15. How are the words cladistics and cladogram related?

16. Traits that are shared by some species of a group being studied, which other species in that group do not have, are called __________ characters.
SECTION 17.3
MOLECULAR CLOCKS
Study Guide

KEY CONCEPT
Molecular clocks provide clues to evolutionary history

VOCABULARY
molecular clock
ribosomal RNA
mitochondrial DNA

MAIN IDEA: Molecular clocks use mutations to estimate evolutionary time.

1. What are molecular clocks?

2. Explain how species become more and more different at the molecular level, after they have diverged from a common ancestor.

3. Using Figure 17.8 as a reference, draw your own set of DNA sequences that illustrate molecular evolution.

4. How can scientists estimate mutation rates for use in developing a molecular clock?

MAIN IDEA: Mitochondrial DNA and ribosomal RNA provide two types of molecular clocks.

5. Depending on how closely related species are, scientists must choose a molecule with an appropriate __________________ rate to use as a molecular clock.
6. In the table below, take notes about two commonly used molecular clocks.

<table>
<thead>
<tr>
<th>Molecular Clock</th>
<th>Description of Molecule</th>
<th>Why It's Unique</th>
<th>How It's Useful as a Molecular Clock</th>
</tr>
</thead>
<tbody>
<tr>
<td>mtDNA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rRNA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary Check**

<table>
<thead>
<tr>
<th>molecular clock</th>
<th>mitochondrial DNA</th>
<th>ribosomal RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Useful for studying closely related species</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Model that uses mutation rates to measure evolutionary time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Useful for studying species in different kingdoms or phyla</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
17.4 | DOMAINS AND KINGDOMS

Study Guide

KEY CONCEPT
The current tree of life has three domains.

VOCABULARY
<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Eukarya</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archaea</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Classification is always a work in progress.

1. Why is classification considered a work in progress?

2. How has the kingdom system changed over the last three hundred years?

3. Describe Woese’s discovery and the impact it had on the tree of life.

On the timeline below, fill in the major changes to the kingdom system that have occurred over the past three hundred years.

1753: 1886: 1938: 1977:

1700 1800 1900 2000

Copyright © McDougal Littell/Houghton Mifflin Company.
**MAIN IDEA:** The three domains in the tree of life are Bacteria, Archaea, and Eukarya.

Fill in the table below with notes about the three-domain system.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Characteristics</th>
<th>Kingdoms Included</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Archaea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Eukarya</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Why is it difficult to classify bacteria and archaea down to the species level?

8. Have cells with distinct nucleus and membrane-bound organelles

9. Known for their ability to live in extreme environments

10. Classified by their shape, need for oxygen, and whether they cause disease
KEY CONCEPT
Infections can be caused in several ways.

VOCABULARY

<table>
<thead>
<tr>
<th>Virus</th>
<th>Viroid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathogen</td>
<td>Prion</td>
</tr>
</tbody>
</table>

MAIN IDEA: Viruses, bacteria, viroids, and prions can all cause infection.

1. In the top left side of the Y shape below, write the characteristics of bacteria.

2. In the top right side of the Y shape below, write the characteristics of viruses.

3. At the bottom of the Y shape below, write the characteristics that both bacteria and viruses share. Then lightly cross out those characteristics at the top of the Y.

4. All living things share four characteristics of life. What are they?
5. Write the description for each of the infectious particles in the spaces provided on the chart below. Include what they are made of and their range of sizes in your descriptions.

<table>
<thead>
<tr>
<th>Infectious Particle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virus</td>
<td></td>
</tr>
<tr>
<td>Viroid</td>
<td></td>
</tr>
<tr>
<td>Prion</td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary Check**

<table>
<thead>
<tr>
<th>virus</th>
<th>pathogen</th>
<th>viroid</th>
<th>prion</th>
</tr>
</thead>
</table>

6. Does not have genes
7. Includes infectious bacteria
8. Made of only RNA
9. Any living thing or particle that can cause infectious disease
10. Made only of protein
11. Infects plants
12. Made of genetic material surrounded by a protein coat
13. Can contain RNA or DNA but is not living
KEY CONCEPT
Viruses exist in a variety of shapes and sizes.

VOCABULARY
<table>
<thead>
<tr>
<th>capsid</th>
<th>lytic infection</th>
<th>prophage</th>
</tr>
</thead>
<tbody>
<tr>
<td>bacteriophage</td>
<td>lysogenic infection</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Viruses differ in shape and in ways of entering host cells.

1. Sketch the three common shapes of viruses, and give an example of a virus that exists in each shape.

2. Name the three parts of the structure of a typical enveloped virus.

3. What must viruses do before they can reproduce?

4. How does a virus identify its host?

5. How do the structures of bacteriophages help them infect host cells?

6. What are two ways that viruses that infect eukaryotes enter their host cells?
MAIN IDEA: Viruses cause two types of infections.

7. In the top left side of the Y shape below, write the characteristics of a lytic infection.

8. In the top right side of the Y shape below, write the characteristics of a lysogenic infection.

9. At the bottom of the Y shape below, write the characteristics that both types of infections have in common. Then lightly cross out those characteristics at the top of the Y.

Vocabulary Check

<table>
<thead>
<tr>
<th>capsid</th>
<th>bacteriophage</th>
<th>lytic infection</th>
<th>lysogenic infection</th>
<th>prophage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. Virus that infects bacteria
11. Viral DNA plus host cell DNA
12. Protein shell of a virus
13. Infection where virus combines its DNA with host cell’s DNA
14. Infection where host cell bursts, releasing viral offspring
SECTION 18.3 | VIRAL DISEASES

Study Guide

KEY CONCEPT
Some viral diseases can be prevented with vaccines.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>epidemic</td>
</tr>
<tr>
<td>vaccine</td>
</tr>
<tr>
<td>retrovirus</td>
</tr>
</tbody>
</table>

MAIN IDEA: Viruses cause many infectious diseases.

1. What is the body’s first defense against infection?

2. What are two ways viruses enter the body?

3. How do some viruses trick cells into letting them in?

4. Why is it not easy to find a cure for the common cold?

5. Why must a new flu vaccine be made every year?

6. Why might a person who has AIDS have a hard time fighting off normally harmless microorganisms?

MAIN IDEA: Vaccines are made from weakened pathogens.

7. Describe how a vaccine works to protect people against infection.
STUDY GUIDE, CONTINUED

Vocabulary Check

<table>
<thead>
<tr>
<th>epidemic</th>
<th>vaccine</th>
<th>retrovirus</th>
</tr>
</thead>
</table>

8. Contains RNA and uses a special enzyme to make a DNA copy
9. Rapid outbreak of an infection that affects many people
10. Stimulates the body’s own immune response against invading microbes

Identify the Infection
Use Figure 18.10 to determine what infection is being described.

11. Disease caused by the bite of an infected animal
   
12. Disease caused by the bite of an infected insect
   
13. Disease caused by contact with a particular rash
   
14. Disease that causes swelling in glands under a person’s jaw
   
15. Disease caused by contact with contaminated feces.
SECTION 18.4  BACTERIA AND ARCHAEA

Study Guide

KEY CONCEPT
Bacteria and archaea are both single-celled prokaryotes.

VOCABULARY

<table>
<thead>
<tr>
<th>obligate anaerobe</th>
<th>plasmid</th>
<th>endospore</th>
</tr>
</thead>
<tbody>
<tr>
<td>obligate aerobe</td>
<td>flagellum</td>
<td></td>
</tr>
<tr>
<td>facultative aerobe</td>
<td>conjugation</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Prokaryotes are widespread on Earth.

1. What two groups of organisms include all prokaryotes on Earth?

2. Some prokaryotes don’t need oxygen to live. Where are three environments where methane-producing archaea have been found?

MAIN IDEA: Bacteria and archaea are structurally similar but have different molecular characteristics.

In the top left of the Y shape, write the characteristics of bacteria. In the top right, write the characteristics of archaea. At the bottom, write the characteristics bacteria and archaea have in common. Then lightly cross out those characteristics at the top of the Y.
STUDY GUIDE, CONTINUED

MAIN IDEA: Bacteria have various strategies for survival.

3. What is binary fission?

4. Describe one way that prokaryotes exchange genetic material.

5. How do some bacteria survive unfavorable conditions?

6. How is an endospore formed?

Vocabulary Check

<table>
<thead>
<tr>
<th>obligate anaerobe</th>
<th>facultative aerobe</th>
<th>flagellum</th>
<th>endospore</th>
</tr>
</thead>
<tbody>
<tr>
<td>obligate aerobe</td>
<td>plasmid</td>
<td>conjugation</td>
<td></td>
</tr>
</tbody>
</table>

7. Can survive whether oxygen is present or not

8. Long whiplike structure used for movement

9. Needs oxygen to survive

10. Specialized prokaryotic cell that can withstand harsh conditions

11. Prokaryotic method of gene exchange

12. Cannot live in the presence of oxygen

13. Separate circular piece of a prokaryote’s genetic material
**SECTION 18.5 \ BENEFICIAL ROLES OF PROKARYOTES \ Study Guide**

**KEY CONCEPT**
Prokaryotes perform important functions for organisms and ecosystems.

**VOCABULARY**
bioremediation

**MAIN IDEA:** Prokaryotes provide nutrients to humans and other animals.

1. Some prokaryotes live in animal digestive systems. What are three ways these prokaryotes are helpful to the animals they live inside?

2. What are two ways animals help the prokaryotes that live in their digestive tracts?

3. What are examples of types of food we eat that are fermented by bacteria?

**MAIN IDEA:** Prokaryotes play important roles in ecosystems.
Write the details about some of the roles prokaryotes play in an ecosystem.

<table>
<thead>
<tr>
<th>Role</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Atmosphere composition</td>
<td></td>
</tr>
<tr>
<td>5. Element cycling</td>
<td></td>
</tr>
<tr>
<td>6. Nitrogen fixation</td>
<td></td>
</tr>
</tbody>
</table>
7. Peas, beans, and other legumes have a mutualistic relationship with bacteria. Where do the bacteria associated with these plants live?

__________________________________________________________________________

8. The bacteria associated with legumes provide nitrogen to the plant in a usable form. Describe how they do this.

__________________________________________________________________________

9. Some bacteria can digest oil. How are these bacteria helpful?

__________________________________________________________________________

10. What does the term biodegradable mean?

__________________________________________________________________________

11. What is a type of human-made material that is not biodegradable?

__________________________________________________________________________

Vocabulary Check

12. The term bioremediation can be broken into parts. Bio- means “life, or living organism.” Remediation, or remedy, means “the act or process of correcting a fault.” How do these word parts relate to what you have learned about bioremediation?

__________________________________________________________________________
KEY CONCEPT
Understanding bacteria is necessary to prevent and treat disease.

VOCABULARY
- toxin
- antibiotic

MAIN IDEA: Some bacteria cause disease.

1. What are two ways that bacteria can cause illness?

2. Why are people often unaware of the presence of potentially disease-causing bacteria in their bodies?

3. What are two ways that people can get food poisoning?

MAIN IDEA: Antibiotics are used to fight bacterial disease.

4. Why can’t antibiotics be used to cure infections caused by viruses?

5. What are two types of organisms that produce antibiotics naturally?

6. What can you do to help prevent getting a bacterial infection?
MAIN IDEA:  Bacteria can evolve resistance to antibiotics.
In the chart below, use your own words to describe the factors that have led to widespread antibiotic resistance.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>Overuse</td>
</tr>
<tr>
<td>8.</td>
<td>Underuse</td>
</tr>
<tr>
<td>9.</td>
<td>Misuse</td>
</tr>
</tbody>
</table>

Vocabulary Check
10. A poison released by a living thing

11. Medicine that helps you fight bacterial infection

Identify the Infection
Use Figure 18.18 to help you identify the infection when given the causes.
12. an open wound that gets dirty

13. breathing in this bacteria’s endospores

14. skin making excess oil

15. getting bitten by an infected wood tick

16. many bacteria on teeth and gums
SECTION 19.1 | DIVERSITY OF PROTISTS

Study Guide

KEY CONCEPT
Kingdom Protista is the most diverse of all the kingdoms.

VOCABULARY
protist

MAIN IDEA: Protists can be animal-like, plantlike, or funguslike.

1. Are protists eukaryotes or prokaryotes?


3. Are all protists microscopic? Explain.

4. How do protists reproduce?

Write how each category of protists get their food, and whether they are single-celled, colonial, or multicellular in the table below.

<table>
<thead>
<tr>
<th>Protist Category</th>
<th>How They Get Their Food</th>
<th>Body Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal-like protist</td>
<td>5.</td>
<td>6.</td>
</tr>
<tr>
<td>7.</td>
<td>8.</td>
<td>single-celled, colonial, or multicellular</td>
</tr>
<tr>
<td>9.</td>
<td>decomposer (heterotroph)</td>
<td>multicellular</td>
</tr>
</tbody>
</table>
STUDY GUIDE, CONTINUED

MAIN IDEA: Protists are difficult to classify.

10. What kingdom are protists placed in?

11. What domain are protists placed in?

12. Are protists more closely related to animals or to bacteria? Explain.

13. Look at Figure 19.3. What type of protist is more closely related to animals: algae or slime molds?

14. Look again at Figure 19.3. What type of protist is more closely related to plants: algae or slime molds?

Vocabulary Check

15. In the 1860s, the scientist Ernst Haeckel first used the term Protista to categorize all single-celled organisms. How has the meaning of protist changed since then?
KEY CONCEPT
Animal-like protists are single-celled heterotrophs that can move.

VOCABULARY
protozoa

cilia
pseudopod

MAIN IDEA: Animal-like protists move in various ways.
1. What are protists?

Fill in the table below with characteristics of animal-like protists.

<table>
<thead>
<tr>
<th>Structure Used for Movement</th>
<th>Way of Life</th>
<th>Example (sketch and label)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flagella</td>
<td>free-living, parasites, and mutualists</td>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
<td>free-living, parasites</td>
<td>4. amoeba or foraminifera (draw sketch and label)</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>7.</td>
</tr>
</tbody>
</table>
MAIN IDEA: Some animal-like protists cause disease.

8. What is the disease caused by the protist *Plasmodium*?

9. How is the disease caused by *Plasmodium* passed to humans?

10. One protist causes sleeping sickness. What structure does that protist use to move around?

11. What protist is common in natural streams and other bodies of water near wild animal habitats?

Vocabulary Check

12. A common name that refers to all animal-like protists

13. Shorter and more numerous than flagella

14. Means “fake foot”

Sketch it Out

Use Figure 19.5 and the text to sketch and describe how an amoeba gets its food.
### KEY CONCEPT
Algae are plantlike protists.

### VOCABULARY
| algae |

### MAIN IDEA:
Plantlike protists can be single-celled or multicellular.

Fill in the table below with characteristics of plantlike protists.

<table>
<thead>
<tr>
<th>Plantlike Protist</th>
<th>Where Found</th>
<th>Identifying Characteristic</th>
<th>Single-celled or Multicellular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euglenoids</td>
<td>fresh water, salt water</td>
<td>1–2 flagella</td>
<td>1.</td>
</tr>
<tr>
<td>Dinoflagellates</td>
<td>salt water, fresh water, snow</td>
<td>2.</td>
<td>3.</td>
</tr>
<tr>
<td>Diatoms</td>
<td>4.</td>
<td>5.</td>
<td>single-celled</td>
</tr>
<tr>
<td>Green algae</td>
<td>6.</td>
<td>chlorophyll a and b, carotenoids</td>
<td>7.</td>
</tr>
<tr>
<td>Brown algae</td>
<td>8.</td>
<td>9.</td>
<td>10.</td>
</tr>
<tr>
<td>Red algae</td>
<td>11.</td>
<td>chlorophyll a, phycoerythrin</td>
<td>12.</td>
</tr>
</tbody>
</table>
STUDY GUIDE, CONTINUED

MAIN IDEA: Many plantlike protists can reproduce both sexually and asexually. Choose whether the phrase below best describes asexual reproduction or sexual reproduction of algae.

<table>
<thead>
<tr>
<th>asexual reproduction</th>
<th>sexual reproduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. All algae can reproduce this way.</td>
<td></td>
</tr>
<tr>
<td>14. In <em>Chlamydomonas</em>, the entire cycle is haploid (1n).</td>
<td></td>
</tr>
<tr>
<td>15. Simple fragmenting.</td>
<td></td>
</tr>
<tr>
<td>16. In <em>Chlamydomonas</em>, this is triggered by environmental stress.</td>
<td></td>
</tr>
<tr>
<td>17. Gametes are formed.</td>
<td></td>
</tr>
<tr>
<td>18. In <em>Chlamydomonas</em>, it has both haploid (1n) and diploid (2n) stages.</td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary Check**

19. Are algae plants or protists? Explain.

**Sketch it Out**

Use Figure 19.15 to sketch the life cycle of a single-celled green algae. Make sure to label asexual and sexual reproduction.
SECTION 19.4  FUNGUSLIKE PROTISTS

Study Guide

KEY CONCEPT
Funguslike protists decompose organic matter.

VOCABULARY
| slime mold | water mold |

MAIN IDEA: Slime molds and water molds are funguslike protists.

1. How are funguslike protists different from fungi?

2. What are the two types of slime molds?

3. The protist that causes malaria is called *Plasmodium*. How is a funguslike protist plasmodium different than this disease-causing *Plasmodium*?

4. What happens to a plasmodial slime mold when it is under environmental stress?

5. What is unusual about the spores released by a slime mold?

6. A cellular slime mold produces a pseudoplasmodium, which means “fake plasmodium.” How is a pseudoplasmodium of a cellular slime mold different from a plasmodium of a plasmodial slime mold?

7. What was the cause of the Great Potato Famine in Ireland in the 1800s?
STUDY GUIDE, CONTINUED

Write where the different funguslike protists can be found, their ecological roles, and their possible body forms in the table below.

<table>
<thead>
<tr>
<th>Funguslike Protist</th>
<th>Where Found</th>
<th>Ecological Role</th>
<th>Body Forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasmodial slime mold</td>
<td>8.</td>
<td>decomposer</td>
<td>plasmodium, spore producing structure, spores that can move</td>
</tr>
<tr>
<td>Cellular slime mold</td>
<td>9. 10. 11.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

slime mold water mold

15. can grow as large as a meter or more
16. has a resistant, resting stage
17. can have a cottony appearance
18. releases chemical signals that cause the cells to swarm together
SECTION 19.5 | DIVERSITY OF FUNGI

Study Guide

KEY CONCEPT

Fungi are heterotrophs that absorb their food.

VOCABULARY

<table>
<thead>
<tr>
<th>chitin</th>
<th>fruiting body</th>
</tr>
</thead>
<tbody>
<tr>
<td>hyphae</td>
<td>mycorrhizae</td>
</tr>
<tr>
<td>mycelium</td>
<td>sporangia</td>
</tr>
</tbody>
</table>

MAIN IDEA: Fungi are adapted to absorb their food from the environment

1. What are the three informal groups that fungi can be divided into?

2. What is one way that fungi are similar to insects?

In the chart below, compare fungi and plants.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Fungi</th>
<th>Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do they get their food?</td>
<td>3. hyphae, mycelium, fruiting body</td>
<td>4.</td>
</tr>
<tr>
<td>What structures make up their bodies?</td>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>What makes up their cell walls?</td>
<td>6.</td>
<td>7.</td>
</tr>
</tbody>
</table>
MAIN IDEA: Fungi come in many shapes and sizes.
Sketch and label an example of each of the following: sac fungi, bread mold, and club fungi. Pick figures throughout the chapter as examples for your sketches.


MAIN IDEA: Fungi reproduce sexually and asexually.

11. List the three ways that yeast can reproduce.

12. Why are single-celled yeasts classified as sac fungi?

13. Where can the reproductive structures of a club fungi, called basidia, be found on a mushroom?

Vocabulary Check
14. spore-forming structures of fungi
15. aboveground reproductive structure of a fungus
16. a tough polysaccharide that makes up the cell walls of fungi
17. symbiotic relationship between plant roots and fungi
18. long strands that make up the bodies of multicellular fungi
19. a tangled mass of hyphae
SECTION 19.6 ECOLOGY OF FUNGI

Study Guide

KEY CONCEPT
Fungi recycle nutrients in the environment.

VOCABULARY
lichen

MAIN IDEA: Fungi may be decomposers, pathogens, or mutualists.

1. How does the decomposing activity of fungi help ecosystems?

2. How are fungi well adapted as decomposers?

3. Fungi are the main decomposers of what two tough plant materials?

4. What negative effect to human industry may fungi decomposers have?

5. What are organisms that always cause disease called?

6. How does overuse or incorrect use of antibiotics contribute to infection by fungi?

7. What are two fairly mild infections to humans that are caused by fungi?

8. What are three diseases of plants that are caused by fungi?

9. What is usually the source of the chemicals used in antifungal medicines?

10. Use Figure 19.27 to sketch and label the structure of a lichen in the space provided.
11. What does an associated alga provide to a lichen?

12. What two roles do lichens play in an ecosystem?

13. Mycorrhizae are mutualistic associations between plant roots and fungi. What does the fungi provide in this relationship?

14. How does the fungus benefit by being associated with plant roots as mycorrhizae?

15. What are two ways mycorrhizae are beneficial to a plant?

**MAIN IDEA:** Fungi are studied for many purposes.

Fill in the concept map below with details of how humans use fungi for different purposes.

**Vocabulary Check**

21. A lichen is a mutualistic relationship between what two types of organisms?
SECTION 20.1 | ORIGINS OF PLANT LIFE

Study Guide

**KEY CONCEPT**
Plant life began in the water and became adapted to land.

**VOCABULARY**

<table>
<thead>
<tr>
<th>plant</th>
<th>vascular system</th>
<th>seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>cuticle</td>
<td>lignin</td>
<td></td>
</tr>
<tr>
<td>stomata</td>
<td>pollen grain</td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Land plants evolved from green algae.

1. Name five characteristics that green algae and land plants share.

2. The common ancestor of all plants would be classified in what class if it were alive today?

3. What plant characteristics probably originated in charophyceans?

**MAIN IDEA:** Plants have adaptations that allow them to live on land.

In the table below, take notes about the challenges that plants face on land and adaptations to these challenges.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Description</th>
<th>Adaptations</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. retaining moisture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. transporting resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. growing upright</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. reproducing on land</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STUDY GUIDE, CONTINUED

MAIN IDEA: Plants evolve with other organisms in their environment.

8. Give two examples of mutualisms that have evolved between plants and other types of organisms.

_________________________________________________________________________
_________________________________________________________________________

9. Give two examples of how plants have evolved with the animals that eat them.

_________________________________________________________________________

Vocabulary Check
In the spaces provided below, draw pictures that help you to remember the definitions of the vocabulary words.

Plant  Vascular system

Cuticle and stomata  Seed
SECTION 20.2  |  CLASSIFICATION OF PLANTS
Study Guide

KEY CONCEPT
Plants can be classified into nine phyla.

VOCABULARY
| pollination | angiosperm | flower       |
| gymnosperm  | cone       | fruit        |

MAIN IDEA: Mosses and their relatives are seedless nonvascular plants.
1. What is required in order for seedless plants to reproduce?

2. How do nonvascular plants obtain water and nutrients?

3. Take notes about seedless nonvascular plants in the table below.

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Phylum Name</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>liverworts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hornworts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mosses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Club mosses and ferns are seedless vascular plants.
4. How does having a vascular system affect how seedless vascular plants grow?

5. Take notes about seedless vascular plants in the table below.

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Phylum Name</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>club mosses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ferns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MAIN IDEA: Seed plants include cone-bearing plants and flowering plants.

6. What are three advantages that seed plants have over their seedless relatives?

__________________________________________________________________________

7. Name and describe the two broad categories of seed plants.

__________________________________________________________________________

8. Take notes about seed plants in the table below.

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Phylum Name</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>cycads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ginkgo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>conifers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>flowering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>plants</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pollination</td>
<td>mature ovary of flower</td>
</tr>
<tr>
<td>cone</td>
<td>process in which pollen meets female parts of same plant species</td>
</tr>
<tr>
<td>flower</td>
<td>reproductive structure of most gymnosperms</td>
</tr>
<tr>
<td>fruit</td>
<td>reproductive structure of angiosperms</td>
</tr>
</tbody>
</table>
SECTION 20.3 | DIVERSITY OF FLOWERING PLANTS

**Study Guide**

**KEY CONCEPT**
The largest phylum in the plant kingdom is the flowering plants.

**VOCABULARY**
cotyledon   dicot
monocot     wood

**MAIN IDEA:** Flowering plants have unique adaptations that allow them to dominate in today’s world.

Fill in the concept map below about the adaptations of flowering plants.

1. **Flowing plants** have
   - which can allow for more efficient

2. **Flowing plants** have
   - which plays a role in

3. **Flowing plants**

4. **Flowing plants**

**MAIN IDEA:** Botanists classify flowering plants into two groups based on seed type.

Take notes about monocots and dicots in the table below.

<table>
<thead>
<tr>
<th>Type of Flowering Plant</th>
<th>Number of Cotyledons</th>
<th>Other Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. monocot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. dicot</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STUDY GUIDE, CONTINUED

MAIN IDEA: Flowering plants are also categorized by stem type and lifespan.

7. Why is it helpful to categorize flowering plants in ways other than by seed type?

8. Describe the two major stem types of flowering plants.

9. Take notes about the three lifespan types of flowering plants.

<table>
<thead>
<tr>
<th>Lifespan</th>
<th>Characteristics</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>annual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>biennial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>perennial</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

10. What is a cotyledon?

11. How does the prefix mono-, meaning “one,” relate to the meaning of monocot?

12. How does the prefix di-, meaning “two,” relate to the meaning of dicot?

13. What is wood made up of?
**SECTION 20.4 | PLANTS IN HUMAN CULTURE**

**Study Guide**

**KEY CONCEPT**
Humans rely on plants in many ways.

**VOCABULARY**
- botany
- pharmacology
- ethnobotany
- alkaloid

**MAIN IDEA:** Agriculture provides stable food supplies for people in permanent settlements.

1. How have people obtained food for the majority of human history?

2. How have farmers “tamed” wild crop species over the past 10,000 years?

3. How has farming become part of a culture’s economy?

Take notes about the requirements and benefits of the following methods of obtaining food.

<table>
<thead>
<tr>
<th>Method</th>
<th>Requirements</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. hunting and gathering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. agriculture</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MAIN IDEA: Plant products are important economic resources.

6. How were plants involved in the great seafaring expeditions of the 1400s and 1500s?

7. Name three plant products that are important to the global economy today.

MAIN IDEA: Plant compounds are essential to modern medicine.

Fill in the main idea web below with notes about the role of plants in modern medicine.

Pharmacology: ____________________  Alkaloids: ____________________

Main Idea: Plant compounds are essential to modern medicine.

Role of plants: ____________________ Synthetic drugs: ____________________

Vocabulary Check

botany  ethnobotany  pharmacology

8. study of plants

9. study of drugs and their effects on the body

10. study of how people use plants
### KEY CONCEPT
Plants have specialized cells and tissue systems.

### VOCABULARY
<table>
<thead>
<tr>
<th>Parenchyma cell</th>
<th>Dermal tissue</th>
<th>Xylem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collenchyma cell</td>
<td>Ground tissue</td>
<td>Phloem</td>
</tr>
<tr>
<td>Sclerenchyma cell</td>
<td>Vascular tissue</td>
<td></td>
</tr>
</tbody>
</table>

### MAIN IDEA:
Plant tissues are made of three basic cell types. Write the functions of each of the three basic cell types, and sketch or describe their appearance in the chart below.

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Function</th>
<th>Sketch or Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Parenchyma cell</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Collenchyma cell</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Sclerenchyma cell</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MAIN IDEA: Plant organs are made of three tissue systems.
Fill in the concept map below with supporting details about the three tissue systems of plants.

Vocabulary Check

<table>
<thead>
<tr>
<th>parenchyma cell</th>
<th>sclerenchyma cell</th>
<th>ground tissue</th>
<th>xylem</th>
<th>phloem</th>
</tr>
</thead>
<tbody>
<tr>
<td>collenchyma cell</td>
<td>dermal tissue</td>
<td>vascular tissue</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14. Outer covering of a plant
15. Includes xylem and phloem
16. Tissue that makes up the majority of a plant
17. Supporting cell type that makes up celery strands
18. Vascular tissue that carries sugars
19. Strongest cell type that makes up fruit pits
20. Most common cell type that can help plants heal from injury
21. Vascular tissue that carries water and dissolved minerals
KEY CONCEPT
The vascular system allows for the transport of water, minerals, and sugars.

VOCABULARY
- cohesion-tension theory
- transpiration
- pressure-flow model

MAIN IDEA: Water and dissolved minerals move through xylem.
The cohesion-tension theory proposes that the physical properties of water allow the rise of water through a plant. Sketch and describe cohesion and adhesion of water molecules.

1. **Cohesion**
   - Sketch:
   - Description:

2. **Adhesion**
   - Sketch:
   - Description:

Fill in the sequence diagram below to explain how water moves through the roots, stems, and leaves of a plant within xylem. Use the text and Figure 21.4 to help fill in the diagram.

3. **Roots**
4. **Stems**
5. **Leaves**
STUDY GUIDE, CONTINUED

MAIN IDEA: Phloem carries sugars from photosynthesis throughout the plant.
6. Phloem sap moves from a sugar source to a sugar sink. What are two plant parts that might be sources of sugars?

7. What is a sugar sink in a plant?

8. The pressure changes between sugar sources and sinks keeps sap flowing through phloem. Is there a higher concentration of sugars at a sugar source or a sugar sink?

9. In the movement of sap through phloem, what two events require energy on the part of the plant?

10. Water moves into the phloem due to the high sugar concentration there. It requires no energy. What is this process called?

Vocabulary Check

<table>
<thead>
<tr>
<th>cohesion-tension theory</th>
<th>pressure-flow model</th>
<th>transpiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Well-supported theory that describes how sugars move through a plant within phloem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Well-supported theory that describes how water and dissolved minerals move through a plant within xylem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Term that describes how water moves through a plant within xylem by evaporation from leaves</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
KEY CONCEPT
Roots and stems form the support system of vascular plants.

VOCABULARY
<table>
<thead>
<tr>
<th>term</th>
<th>definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>vascular cylinder</td>
<td></td>
</tr>
<tr>
<td>meristem</td>
<td></td>
</tr>
<tr>
<td>primary growth</td>
<td></td>
</tr>
<tr>
<td>root hair</td>
<td></td>
</tr>
<tr>
<td>fibrous root</td>
<td></td>
</tr>
<tr>
<td>secondary growth</td>
<td></td>
</tr>
<tr>
<td>root cap</td>
<td></td>
</tr>
<tr>
<td>taproot</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Roots anchor plants and absorb mineral nutrients from soil.
In the space provided, sketch a root tip. Draw lines from the terms to label the sketch, and describe the function for each of the parts. Use Figure 21.7 and the text to fill in the diagram.

Sketch:

1. Vascular cylinder
2. Apical meristem
3. Root cap

4. How do root hairs help a plant?

5. What are root systems made of fine branches of about the same size called?

6. What are root systems that have one main root and can sometimes store food called?

7. Plants are not just soaking up water. They use energy to absorb ______________ .

8. The increased concentration of ions in root cells causes ______________ to move into the root.

9. An example of a mineral needed in large amounts is ______________ .

10. Other minerals, such as ______________ , are needed in small amounts.
MAIN IDEA: Stems support plants, transport materials, and provide storage.

11. What are three functions of most stems?

12. Look at Figure 21.10. What are two plants whose stems store water?

13. What special adaptation do strawberry plant stems have?

14. What are two stems that grow underground?

15. What are four characteristics of herbaceous stems?

16. What is growth that makes stems grow taller or roots grow longer called?

17. What is growth that makes stems and roots of woody plants grow wider called?

18. What represents one year of growth on a tree ring?

Vocabulary Check

19. Tough covering on root tip
20. Unspecialized tissue of dividing cells
21. Houses xylem and phloem
22. Root system made of equal-sized roots
23. Growth pattern that increases height and length
24. Increases surface area of a root
25. Root system that reaches deep into the ground
26. Growth pattern that increases width
KEY CONCEPT
Leaves absorb light and carry out photosynthesis.

VOCABULARY
<table>
<thead>
<tr>
<th>blade</th>
<th>mesophyll</th>
</tr>
</thead>
<tbody>
<tr>
<td>petiole</td>
<td>guard cell</td>
</tr>
</tbody>
</table>

MAIN IDEA: Most leaves share similar structures.
1. Sketch a leaf attached to a stem. Label the blade, petiole, stem, and axillary bud.

Use a sequence diagram to fill in the steps describing how stomata regulate gas exchange.

During the day stomata are _____________.

________ enters.  

________ occurs.

________________ in leaves overtakes water absorption in roots.

________________ close the stomata.

Low ____________ will slow photosynthesis.

2. What are three leaf characteristics that can be used for plant identification?

3. How can you tell the difference between a leaf and a leaflet?
2. What are three leaf characteristics that can be used for plant identification?

3. How can you tell the difference between a leaf and a leaflet?

**MAIN IDEA:** Most leaves are specialized systems for photosynthesis.

4. What is the photosynthetic tissue of a leaf?

5. How are the two types of mesophyll found in a leaf specialized for photosynthesis?

6. What are three adaptations of plants that help reduce water loss in a desert or cold environment?

7. Use the following terms and stack them like you were building a sandwich in the order they are found within a leaf: mesophyll, dermal tissue, dermal tissue, cuticle, cuticle.

**Vocabulary Check**

8. Like the part of a knife with the same name, this is the widest part of a leaf.

9. “Guards” the exchange of gases through stomata

10. This term means “stalk” or “leafstalk.”

11. This term means “middle leaf,” which is where it is found.
KEY CONCEPT
All plants alternate between two phases in their life cycles.

VOCABULARY
<table>
<thead>
<tr>
<th>alternation of generations</th>
<th>gametophyte</th>
</tr>
</thead>
<tbody>
<tr>
<td>sporophyte</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Plant life cycles alternate between producing spores and gametes.

1. What is the alternation of generations?

2. What are the characteristics of a sporophyte and a gametophyte?

3. At what point is meiosis involved in the plant life cycle?

4. Use Figure 22.1 to draw a diagram illustrating the alternation of generations in plants. Be sure to use all of the words in the word box above as labels in your diagram.
**MAIN IDEA:** Life cycle phases look different among various plant groups.
Fill in the table below with notes about alternation of generations in different plant groups.

<table>
<thead>
<tr>
<th>Plant Group</th>
<th>Example</th>
<th>Sporophyte</th>
<th>Gametophyte</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.</strong> nonvascular plants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6.</strong> seedless vascular plants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>7.</strong> seed plants</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary Check**

8. What two phases alternate, or pass back and forth, in the alternation of generations?

9. How is the word part *sporo* related to the meaning of *sporophyte*?

10. How is the word part *gameto* related to the meaning of *gametophyte*?


**KEY CONCEPT**

Reproduction of flowering plants takes place within flowers.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>sepal</td>
</tr>
<tr>
<td>carpel</td>
</tr>
<tr>
<td>double</td>
</tr>
<tr>
<td>petal</td>
</tr>
<tr>
<td>stamen</td>
</tr>
<tr>
<td>ovary</td>
</tr>
<tr>
<td>endosperm</td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Flowers contain reproductive organs protected by specialized leaves.

1. Use Figure 22.5 to draw a diagram of a flower. Be sure to use all of the words in the word box below as labels in your diagram. Write the functions of the sepal, petal, stamen, and carpel next to their labels.

- **sepal**: stamen: filament, anther
- **petal**: carpel: stigma, style, ovary

**MAIN IDEA:** Flowering plants can be pollinated by wind or animals.

2. What needs to happen for a flowering plant to be pollinated?

3. Why is animal pollination more efficient than wind pollination?
**MAIN IDEA:** Fertilization takes place within the flower.

Take notes about the processes involved in the reproduction of flowering plants.

<table>
<thead>
<tr>
<th>Process</th>
<th>How It Works</th>
<th>Products/Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>production of male gametes</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>production of female gametes</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>double fertilization</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>development of fruit and seeds</td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary Check**

8. *Ovum* is the Latin word meaning “egg.” How is this meaning related to the words *ovary* and *ovule*?

9. What two structures are “fertilized” during double fertilization?
SECTION 22.3 | SEED DISPERSAL AND GERMINATION

Study Guide

KEY CONCEPT
Seeds disperse and begin to grow when conditions are favorable.

VOCABULARY
| dormancy | germination |

MAIN IDEA: Animals, wind, and water can spread seeds.

1. What is the function of fruit in flowering plants?

2. Why is seed dispersal important?

3. Describe two ways that seeds can be spread by animals.

4. What fruit forms can allow seeds to be spread by wind and water?

MAIN IDEA: Seeds begin to grow when environmental conditions are favorable.

5. When a seed is ________________, the embryo has stopped growing.

6. Seed dormancy allows the next generation of plants to grow under ________________ conditions.

7. What types of conditions can end dormancy for many plant species?
8. Take notes about germination in this cause-and-effect chart.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Effect(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>embryo takes up water</td>
<td></td>
</tr>
<tr>
<td>water activates enzymes</td>
<td></td>
</tr>
<tr>
<td>sugars are moved to embryo</td>
<td></td>
</tr>
</tbody>
</table>

9. Describe the order in which seedling structures emerge during germination.

10. At what stage in development is a young plant considered a seedling?

**Vocabulary Check**

11. Hibernation is to an animal as ______________________ is to a seed.

12. How does the Latin word *germen*, meaning “seed,” relate to the meaning of *germination*?
SECTION 22.4  |  ASEXUAL REPRODUCTION

**Study Guide**

**KEY CONCEPT**
Plants can produce genetic clones of themselves through asexual reproduction.

**VOCABULARY**

| **regeneration** |
| **vegetative reproduction** |

**MAIN IDEA:** Plants can reproduce asexually with stems, leaves, or roots.

1. What is asexual reproduction?

2. How can the ability to reproduce asexually help plants to populate a variety of environments?

Take notes about plant reproduction in the concept map below.

[Concept map image]

3. which involves

4. by

5. which involves

6. by

7. which involves

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STUDY GUIDE, CONTINUED

Fill in the chart with notes about structures adapted for vegetative reproduction.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description</th>
<th>How It Works</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. stolon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. rhizome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. tuber</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. bulb</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Humans can produce plants with desirable traits using vegetative structures.

12. How can cuttings be used to produce new plants?

________________________________________________________________________

________________________________________________________________________

13. How can grafting be used to produce plants with several desirable traits?

________________________________________________________________________

________________________________________________________________________

**Vocabulary Check**

14. The prefix re- means “again; anew” and the word generate means “to bring into being.” How do these word parts apply to the meaning of regeneration?

________________________________________________________________________

15. One definition of vegetative is “relating to processes such as growth and nutrition rather than sexual reproduction.” How does this meaning apply to the terms vegetative structure and vegetative reproduction?

________________________________________________________________________
SECTION 22.5 | PLANT HORMONES AND RESPONSES

Study Guide

KEY CONCEPT
Plant hormones guide plant growth and development.

VOCABULARY

<table>
<thead>
<tr>
<th>hormone</th>
<th>auxin</th>
<th>gravitropism</th>
</tr>
</thead>
<tbody>
<tr>
<td>gibberellin</td>
<td>tropism</td>
<td>photoperiodism</td>
</tr>
<tr>
<td>ethylene</td>
<td>phototropism</td>
<td></td>
</tr>
<tr>
<td>cytokinin</td>
<td>thigmotropism</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Plant hormones regulate plant functions.

1. What is a hormone?

2. Give two reasons why plant hormones may be released.

Take notes about the four main groups of plant hormones in the chart below.

<table>
<thead>
<tr>
<th>Plant Hormone</th>
<th>Processes Involved In</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. gibberellins</td>
<td></td>
</tr>
<tr>
<td>4. ethylene</td>
<td></td>
</tr>
<tr>
<td>5. cytokinins</td>
<td></td>
</tr>
<tr>
<td>6. auxins</td>
<td></td>
</tr>
</tbody>
</table>
STUDY GUIDE, CONTINUED

MAIN IDEA: Plants can respond to light, touch, gravity, and seasonal changes.

Match the term from the word box with the correct description.

<table>
<thead>
<tr>
<th>phototropism</th>
<th>thigmotropism</th>
<th>gravitropism</th>
<th>rapid response</th>
<th>photoperiodism</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Growth in response to being touched</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Response to being touched not involving growth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Growth in response to gravity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Response to changing lengths of day and night</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Growth in response to light</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

12. The prefixes photo-, thigmo-, and gravi- refer to light, touch, and gravity, and the Greek word trope means “a turning.” How do these word parts relate to the meanings of phototropism, thigmotropism, and gravitropism?

13. In the space provided below, illustrate the process of phototropism as it occurs at the cellular level. Use Figure 22.16 as a reference. Be sure to label areas of high auxin concentration.
SECTION 23.1  ANIMAL CHARACTERISTICS

Study Guide

KEY CONCEPT
Animals are diverse but share common characteristics.

VOCABULARY
- collagen
- homeotic
- homeobox

MAIN IDEA: Animals are the most physically diverse kingdom of organisms.
1. Give three examples that support the statement that animals are a remarkably diverse group of organisms.

MAIN IDEA: All animals share a common set of characteristics.
2. Complete the following main idea web with details about the common characteristics shared by all animals.

Animal characteristics

[Diagram with branches leading to empty boxes for additional details]
3. How are animal cells different from plant cells?

4. Explain how Hox genes influence animal development.

Vocabulary Check
5. What is collagen?

6. What is the connection between homeotic and homeobox (Hox) genes?

Be Creative
7. In the box below, design a poster that celebrates animal diversity.
SECTION 23.2 | ANIMAL DIVERSITY

Study Guide

KEY CONCEPT
More than 95 percent of all animal species are invertebrates.

VOCABULARY

<table>
<thead>
<tr>
<th>vertebrate</th>
<th>radial symmetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>invertebrate</td>
<td>protostome</td>
</tr>
<tr>
<td>phylum</td>
<td>deuterostome</td>
</tr>
<tr>
<td>bilateral symmetry</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Each animal phylum has a unique body plan.

Use your textbook to fill in the missing words in the following sentences.

1. A vertebrate is an animal with an internal segmented _____________. Vertebrates make up less than ____________ percent of all known animal species.

2. Invertebrates are animals without ________________. Invertebrates make up over ____________ percent of all known animal species.

3. Animals are divided into more than 30 major groups, which are called _____________. Each group of animals is defined by ____________ and ____________ characteristics.

4. Differences in body plans result from differences in the expression of ____________ genes.

5. What is the function of a homeobox gene?

6. What is the connection between Hox genes and the diversity of animal body plans?

7. What factor might account for the development of so many unique body plans during the Cambrian explosion?
MAIN IDEA: Animals are grouped using a variety of criteria. For each type of symmetry, write a short description, and sketch a picture of an animal that exhibits each type of symmetry.

<table>
<thead>
<tr>
<th>Symmetry</th>
<th>Description</th>
<th>Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. bilateral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. radial</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. What are three differences in the developmental patterns of protostomes and deuterostomes?

________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

Vocabulary Check

11. What is a phylum?

________________________________________________________________________________________

12. If stoma means “mouth,” what do you think proto- and deutero- mean?

________________________________________________________________________________________
SECTION 23.3 SPONGES AND CNIDARIANS Study Guide

KEY CONCEPT
Sponges and cnidarians are the simplest animals.

VOCABULARY
<table>
<thead>
<tr>
<th>sessile</th>
<th>medusa</th>
<th>gastrovascular cavity</th>
</tr>
</thead>
<tbody>
<tr>
<td>filter feeder</td>
<td>mesoglea</td>
<td>polyp</td>
</tr>
</tbody>
</table>

MAIN IDEA: Sponges have specialized cells but no tissues.
Choose the correct term or terms from the box below to complete the following sentences.

- muscle
- nerve
- sessile
- hard
- toxic
- growing
- predators
- growing
- parasites

1. Sponges lack _______ and _______ cells. They are ________, meaning they are unable to move from where they are attached.

2. Sponges attach to _______ surfaces. They secrete _______ substances that keep other sponges from _______ into their area and also protect them from _______ and _______.

3. Explain the difference between sexual and asexual reproduction in sponges.

4. How does a sponge filter feed?

5. Describe the anatomy of a sponge.

6. List and describe the three types of cells that make up a sponge.
STUDY GUIDE, CONTINUED

MAIN IDEA:  Cnidarians are the oldest existing animals that have specialized tissues.
Complete the following chart with a description and simple sketch of the two types of cnidarian body types.

<table>
<thead>
<tr>
<th>Body Form</th>
<th>Description</th>
<th>Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. polyp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. medusa</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. How do cnidarians reproduce asexually?


Choose the correct term from the box to fit each definition of a part of a cnidarian’s anatomy.

<table>
<thead>
<tr>
<th>cnidocytes</th>
<th>contracting cells</th>
<th>mesoglea</th>
<th>nerve cells</th>
</tr>
</thead>
</table>

10. These cells interconnect and form a network over the entire animal. They send sensory information around the animal and coordinate muscular contractions.

11. This is a non-cellular jellylike material.

12. These cells cover the surface of a cnidarian and contain muscle fibers.

13. These cells contain stinging structures used for defense and capturing prey.

Vocabulary Check

14. What is a nematocyst?


15. What is the function of the gastrovascular cavity?
SECTION 23.4 | FLATWORMS, MOLLUSKS, AND ANNELIDS

Study Guide

KEY CONCEPT
Flatworms, mollusks, and annelids belong to closely related phyla.

VOCABULARY
<table>
<thead>
<tr>
<th>complete digestive tract</th>
<th>hemocoel</th>
</tr>
</thead>
<tbody>
<tr>
<td>radula</td>
<td>coelom</td>
</tr>
<tr>
<td>segmentation</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Flatworms are simple bilateral animals.

1. Flatworms, mollusks, and annelids are members of which phylum?

2. Describe the basic body plan of a flatworm.

3. Why are flatworms flat?

4. What are the three classes of flatworms?

5. What is schistosomiasis?

6. Describe the life cycle of a tapeworm.
STUDY GUIDE, CONTINUED

MAIN IDEA: Mollusks are diverse animals.

7. What is a complete digestive tract?

8. What is a benefit of having a complete digestive tract?

9. Complete the following chart with a description of each of the three shared anatomical features of mollusks.

<table>
<thead>
<tr>
<th>Anatomical Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>radula</td>
<td></td>
</tr>
<tr>
<td>mantle</td>
<td></td>
</tr>
<tr>
<td>ctenidia</td>
<td></td>
</tr>
</tbody>
</table>

10. What is a hemocoel?

MAIN IDEA: Annelids have segmented bodies.

11. What are the three groups of annelids?

Vocabulary Check

12. The word *coelom* comes from a Greek word that means “cavity.” How does this word origin relate to the definition of a coelom?
KEY CONCEPT
Roundworms have bilateral symmetry and shed their outer skeleton to grow.

VOCABULARY
<table>
<thead>
<tr>
<th>cuticle</th>
</tr>
</thead>
<tbody>
<tr>
<td>pseudocoelom</td>
</tr>
</tbody>
</table>

MAIN IDEA: Roundworms shed their stiff outer skeleton as they grow.
Use words from the box below to complete the following sentences.

<table>
<thead>
<tr>
<th>bilateral</th>
<th>cuticle</th>
<th>nematodes</th>
<th>protostomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>chitin</td>
<td>diversity</td>
<td>numbers</td>
<td>shed</td>
</tr>
<tr>
<td>exoskeleton</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Roundworms, or ____________, are one of the most numerous kinds of animals, both in terms of ____________ and in terms of species ________________.

2. Members of the Ecdysozoa are ____________ (meaning their gut cavity forms mouth-first) and they have ________________ symmetry.

3. All Ecdysozoans have a tough ________________ called a ________________.

4. The cuticle is made of ________________ and must be ________________ whenever the animal grows larger.

5. Describe the anatomy of a roundworm.

   ____________________________________________________________________

   ____________________________________________________________________

   ____________________________________________________________________

MAIN IDEA: Many roundworms are parasites.
Complete the following chart with information about parasitic roundworms.

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Where Found?</th>
<th>Infections Occur By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. hookworm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Invertebrate Diversity

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Vocabulary Check

9. The prefix *pseudo-* comes from a Greek word which means “false.” For example, the term *pseudoscience* refers to a theory, method, or practice that is considered to lack a foundation in scientific principles; it is false science. How does the meaning of *pseudo* relate to the definition of a pseudocoelom?

---

Be Creative

Design a poster that tells people how to avoid parasitic roundworm infections. Your design can focus on just one type of roundworm or more if you choose.
KEY CONCEPT
Echinoderms are on the same evolutionary branch as vertebrates.

VOCABULARY
- ossicle
- water vascular system

MAIN IDEA: Echinoderms have radial symmetry.

Use words from the box below to complete the following sentences.

<table>
<thead>
<tr>
<th>arm</th>
<th>flexible</th>
<th>ossicles</th>
<th>stiff</th>
</tr>
</thead>
<tbody>
<tr>
<td>catch</td>
<td>connective</td>
<td>internal</td>
<td>ring canal</td>
</tr>
</tbody>
</table>

1. All echinoderms have an ____________ skeleton made up of many tiny interlocking calcium-based plates called ____________.

2. The plates are joined together by a unique ____________ ____________ tissue with adjustable stiffness.

3. This tissue lets echinoderms change their consistency, going from very ____________ to very ____________ in a matter of seconds.

4. A water vascular system is a series of ____________-filled canals that extend along each ____________ from the ____________ ____________ surrounding the central disk.

5. What is the function of the water vascular system?

   __________________________________________________________

   __________________________________________________________

   __________________________________________________________

6. Describe how a sea star eats a clam.

   __________________________________________________________

   __________________________________________________________

   __________________________________________________________
MAIN IDEA: There are five classes of Echinoderms.
Complete the following chart with information about each Echinoderm class.

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Crinoidea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Asteroidea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Ophiurioidea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Echinoidea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Holothuroidea</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check
12. The term *ossicle* comes from a Latin word meaning “bone.” How does this word origin relate to the definition of an ossicle?

Be Creative
Create an informative brochure for a tide pool. Include information about all the different kinds of echinoderms a visitor would find there.
KEY CONCEPT
Arthropods are the most diverse of all animals.

VOCABULARY
<table>
<thead>
<tr>
<th>arthropod</th>
<th>chitin</th>
<th>segmentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>exoskeleton</td>
<td>appendage</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Arthropod features are highly adapted.

1. What are the three main features of an arthropod’s body?

2. What is chitin?

3. Why are jointed appendages considered an important adaptation during the evolution of arthropods?

4. Complete the following chart with a description of and example animal for each group of arthropods.

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>trilobites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>crustaceans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chelicerates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>myriapods</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STUDY GUIDE, CONTINUED

MAIN IDEA: Arthropod exoskeletons serve a variety of functions.

5. What three important body functions are made difficult by the presence of an exoskeleton?

6. Why must an arthropod molt?

7. List the three steps of the molting process.

8. How is an arthropod’s circulatory system different from a vertebrate’s circulatory system?

9. What body parts allow an arthropod to sense its surrounding environment?

10. How is an arthropod’s eye different from a mammal’s eye?

MAIN IDEA: Arthropod diversity evolved over millions of years.

11. What two species do scientists think are the closest relatives to arthropods?

Vocabulary Check

12. The word appendage comes from the Latin word appendere, which means “to hang upon.” How does this meaning relate to the definition of appendage?

13. What word within segmentation helps you remember it as something made of separate parts?
SECTION 24.2  CRUSTACEANS

**Study Guide**

**KEY CONCEPT**

Crustaceans are a diverse group of ancient arthropods.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>crustacean</td>
</tr>
<tr>
<td>abdomen</td>
</tr>
<tr>
<td>cephalothorax</td>
</tr>
<tr>
<td>carapace</td>
</tr>
<tr>
<td>mandible</td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Crustaceans evolved as marine arthropods.

1. What are the four main features of a crustacean’s body?

Choose a word from the box below that best fits each of the following descriptions.

<table>
<thead>
<tr>
<th>abdomen</th>
<th>carapace</th>
<th>cephalothorax</th>
</tr>
</thead>
</table>

2. This body section is the region of an organism in which the head and trunk region are combined into one long section.

3. This body section refers to the rear portion of the organism.

4. This shieldlike section of cuticle covers the sides of the body and protects the gills.

**MAIN IDEA:** Crustacean appendages can take many forms.

5. List three functions of a crustacean claw.

6. What is the function of a crustacean’s antennae?

7. What are mandibles?

8. What two body parts are used by a crustacean to move?
9. In the space below, draw a simple sketch of a crustacean and label its parts.

![Sketch of a crustacean]

**MAIN IDEA:** There are many different types of crustaceans.

10. Complete the following chart with a description of each crustacean group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>decapod</td>
<td></td>
</tr>
<tr>
<td>barnacle</td>
<td></td>
</tr>
<tr>
<td>isopod</td>
<td></td>
</tr>
<tr>
<td>tongue worm</td>
<td></td>
</tr>
</tbody>
</table>

11. What evidence helped to determine that barnacles and tongue worms are crustaceans?

12. **Vocabulary Check**

   The word *mandible* comes from the Latin word *mandere*, which means “to chew.” How does this meaning relate to the definition of mandibles?
**SECTION 24.3  ARACHNIDS**

**Study Guide**

**KEY CONCEPT**
Arachnids include spiders and their relatives.

**VOCABULARY**

<table>
<thead>
<tr>
<th>chelicerate</th>
<th>book lung</th>
<th>trachea</th>
</tr>
</thead>
<tbody>
<tr>
<td>arachnid</td>
<td>spiracle</td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Arachnids are the largest group of chelicerates.

1. What is a chelicerate?

2. What are three characteristics of arachnids?

Choose a word from the word box below that best fits each of the following descriptions.

<table>
<thead>
<tr>
<th>book lungs</th>
<th>Malpighian tubules</th>
<th>spiracles</th>
<th>tracheae</th>
</tr>
</thead>
</table>

3. tiny holes on the abdomen that open and close to allow oxygen to enter

4. structures built of many thin, hollow sheets of tissue

5. tubes that carry oxygen directly to the arachnid’s tissues

6. excretory structures that allow spiders to minimize loss of water while excreting metabolic wastes

7. In the space below, draw a simple picture of a spider and label its parts.
STUDY GUIDE, CONTINUED

MAIN IDEA:  Arachnids have evolved into a diverse group.
8. Where is silk produced in a spider’s body?

9. List four uses of a spider’s silk.

10. What is the function of a spider’s venom?

11. List one positive and one negative aspect of an arachnid’s role as a predator.

Vocabulary Check
12. The word spiracle comes from the Latin word spirare, which means “to breathe.” Explain how this meaning relates to the definition of a spiracle.

Be Creative
13. Draw a cartoon that illustrates the importance of spiders as predators.
SECTION 24.4 INSECT ADAPTATIONS
Study Guide

KEY CONCEPT
Insects show an amazing range of adaptations.

VOCABULARY
| incomplete metamorphosis |
| complete metamorphosis |
| pupa |

MAIN IDEA: Insects are the dominant terrestrial arthropods.

1. Explain why insects are considered an incredible success story.

2. Draw a picture of an insect and label the following parts: head, thorax, abdomen, legs, wings, antennae, and compound eyes.

MAIN IDEA: Insects undergo metamorphosis.

3. Describe incomplete metamorphosis.
4. Complete the following process diagram with details about the complete metamorphosis of a butterfly.

**Egg**
____________________
____________________
____________________

**Larva**
____________________
____________________
____________________

**Adult**
____________________
____________________
____________________

**Pupa**
____________________
____________________
____________________

**MAIN IDEA:** Insects have adapted to life on land.
For each type of insect, indicate whether it uses a proboscis or mandibles to eat.

5. butterfly
6. ant
7. beetle
8. moth

**Vocabulary Check**

9. What happens during a metamorphosis?

10. What is the difference between complete and incomplete metamorphosis?
KEY CONCEPT
Arthropods and humans interact in many ways.

VOCABULARY

insecticide
vector

MAIN IDEA:  Arthropods and humans share many of the same resources.

1. In what way do arthropods compete with humans for resources?

2. What is an insecticide?

3. What are three negative aspects of insecticide use?

4. List and describe three safer methods scientists have developed to control insects.

MAIN IDEA:  Some arthropods can spread human diseases.

5. What is a vector?
6. Complete the following chart with details about the following diseases transmitted to humans by arthropods.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Vector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>bubonic plague</td>
<td></td>
<td></td>
</tr>
<tr>
<td>yellow fever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>malaria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West Nile virus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

7. The suffix *-cide* comes from the Latin word *caedere*, which means “to strike, kill.” How does this meaning relate to the meaning of the word *insecticide*?

---

8. *Vector* comes from the Latin word *vectus*, which means “to carry.” Explain how this meaning relates to the definition of a vector.

---

Be Creative

9. Draw a cartoon that illustrates the world through an insect’s eyes. How might an insect see the world differently than you do?
KEY CONCEPT
All vertebrates share common characteristics.

VOCABULARY
- chordate
- notochord
- endoskeleton

MAIN IDEA: The phylum Chordata contains all vertebrates and some invertebrates.
1. What three groups make up the phylum Chordata?

Choose the correct term from the box below to fit each description.

notochord  hollow nerve cord  pharyngeal slits  tail

2. extends beyond the anal opening, and contains segments of muscle tissue used for movement

3. runs along the animal’s back, forms from a section of ectoderm

4. slits through the body wall in the pharynx

5. flexible skeletal support rod embedded in the animal’s back

MAIN IDEA: All vertebrates share common features.
6. What is an endoskeleton?

7. How does the growth of an animal with an endoskeleton differ from the growth of an animal with an exoskeleton?
Complete the following chart with the missing information for each vertebrate class.

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td>Agnatha</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Chondrichthyes</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Osteichthyes</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Amphibia</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Reptilia</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Aves</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Mammalia</td>
<td></td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Fossil evidence sheds light on the origins of vertebrates.

15. Where has most of the early vertebrate fossil evidence been found?

16. Which animals are recognized as the first vertebrates?

17. Which two groups of jawless fish still exist today?

**Vocabulary Check**

18. The prefix *endo-* means “inside,” while the prefix *exo-* means “outside.” How does this help you to distinguish between an endoskeleton and an exoskeleton?
**KEY CONCEPT**
The dominant aquatic vertebrates are fish.

**VOCABULARY**

<table>
<thead>
<tr>
<th>gill</th>
<th>lateral line</th>
</tr>
</thead>
<tbody>
<tr>
<td>countercurrent flow</td>
<td>operculum</td>
</tr>
</tbody>
</table>

**MAIN IDEA:** Fish are vertebrates with gills and paired fins.

Choose a word or words from the box below to complete the following sentences.

<table>
<thead>
<tr>
<th>blood</th>
<th>circulatory</th>
<th>gills</th>
<th>tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>capillaries</td>
<td>countercurrent flow</td>
<td>opposite</td>
<td></td>
</tr>
</tbody>
</table>

1. Fish use specialized organs called ____________ to take in oxygen dissolved in water.  
   Gills are large sheets of frilly ____________ filled with ____________.

2. Fish ____________ systems pump blood in a single loop through a heart with two main chambers.

3. ____________ ____________ is the ____________ movement of water against the flow of ____________ in the fish’s gills.

4. Explain how countercurrent flow works.

   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________

5. Draw a simple sketch of a fish and label the five main types of fins on its body.
STUDY GUIDE, CONTINUED

MAIN IDEA: **Jaws evolved from gill supports.**

6. What are gill arches?

7. What is an advantage of having jaws?

---

MAIN IDEA: **Only two groups of jawed fish still exist.**

Use the box below to choose the correct word or words to complete the following sentences.

<table>
<thead>
<tr>
<th>cartilage</th>
<th>electroreceptive</th>
<th>lateral line</th>
<th>sensory</th>
</tr>
</thead>
<tbody>
<tr>
<td>chimeras</td>
<td>Holocephali</td>
<td>muscular</td>
<td>sharks</td>
</tr>
<tr>
<td>Elasmobranchs</td>
<td>internal</td>
<td>rays</td>
<td>skates</td>
</tr>
</tbody>
</table>

8. Members of phylum Chondrichthyes have skeletons made of ____________.

9. The two groups within phylum Chondrichthyes are the ____________ and the ____________. The Holocephali include ____________, also called ratfish. The Elasmobranchs include ____________, ____________, and ____________.

10. While the cartilaginous fish as a group may be ancient, they have many advanced features. They have ____________ fertilization, and many species give birth to live young.

11. Fish can sense their prey’s movements at a distance with a sensory system called the ____________.

12. Many fish also have ____________ organs that detect the electrical currents made by ____________ contractions in other animals. These sensory organs are called ____________ cells because they receive electrical signals.

---

**Vocabulary Check**

13. The term *operculum* comes from a Latin word which means “to cover.” Explain how this meaning is related to the definition of an operculum.
KEY CONCEPT
Bony fish include ray-finned and lobe-finned fish.

VOCABULARY
<table>
<thead>
<tr>
<th>ray-fin</th>
<th>lobe-fin</th>
</tr>
</thead>
<tbody>
<tr>
<td>swim bladder</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Ray-finned fish have a fan of bones in their fins.

1. Describe the shape of a ray-fin and list three reasons why its shape helps a ray-finned fish move.

2. Describe the diversity of ray-finned fish. How does the number of species of ray-finned fish compare to the total number of vertebrate species?

3. What is the function of the swim bladder?

MAIN IDEA: Lobe-finned fish have paired rounded fins supported by a single bone.

4. What is the evolutionary significance of lobe-finned fish?

5. Describe the structure of a lobe-fin.
6. Complete the following Y-diagram to outline the similarities and differences between ray-fins and lobe-fins.

```
Ray-fin
___________
|            |
|___________|
|            |
|___________|
|            |
Lobe-fin
___________
|            |
|___________|
|            |
|___________|
|            |
Both
___________
|            |
|___________|
|            |
|___________|
```

7. Name two types of lobe-finned fish that still exist today.


Vocabulary Check

8. Use a comparison (for example, consider how a scuba diver travels to lower and higher depths) to describe how a swim bladder works.


KEY CONCEPT
Amphibians evolved from lobe-finned fish.

VOCABULARY
- tetrapod
- tadpole
- amphibian

MAIN IDEA: Amphibians were the first animals with four limbs.
Choose a word or words from the box below to complete the following sentences.

| amphibians | four | land | water | vertebrate |

1. A tetrapod is a ___________ that has ___________ limbs.
2. ___________ are animals that can live both on ___________ and in ___________.
3. Complete the following concept map with information about amphibian adaptations.

Amphibians

- have
  - to support
  - to capture
  - to hear
4. What are the different methods amphibians use to breathe?

5. Why can’t amphibians travel too far away from a source of water?

6. List three strategies used by amphibians to keep their eggs moist.

7. Describe the changes a tadpole goes through during metamorphosis into an adult frog.

8. Write a short phrase to describe each amphibian group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>salamander</td>
<td></td>
</tr>
<tr>
<td>frog</td>
<td></td>
</tr>
<tr>
<td>caecilian</td>
<td></td>
</tr>
</tbody>
</table>

9. If the suffix -pod means “foot,” then what does the term tetrapod mean?

10. How is an amphibious vehicle different than a normal vehicle driven on the road?
SECTION 25.5
VERTEBRATES ON LAND
Study Guide

KEY CONCEPT
Reptiles, birds, and mammals are adapted for life on land.

VOCABULARY
| amniote | amniotic egg
| keratin | placenta |

MAIN IDEA: Amniotes can retain moisture.
1. What is an amniote?

2. List three examples of familiar animals that are amniotes. Are humans amniotes? Explain why or why not.

3. What is keratin used for?

4. How do an amniote’s kidneys and intestines help it to retain moisture?

MAIN IDEA: Amniotes do not need to return to water to reproduce.
5. How does the amniotic egg allow amniotes to live permanently on land?

6. What is the advantage for rattlesnakes to retain their eggs until they hatch?

7. What is the function of placenta?
Vocabulary Check
Choose a term from the box below that best fits each description.

<table>
<thead>
<tr>
<th>amniote</th>
<th>amniotic egg</th>
<th>keratin</th>
<th>placenta</th>
</tr>
</thead>
</table>

8. I am a vertebrate that has a thin, tough, membranous sac that encloses the embryo or fetus during development.

9. I am a protein that binds to lipids inside a skin cell, forming a water-repellent layer that keeps water from escaping.

10. I am an almost completely waterproof container that keeps the embryo within from drying out.

11. I am a membranous organ that develops in female mammals during pregnancy.

Be Creative
12. Draw a cartoon that illustrates the benefits of the amniotic egg.
SECTION 26.1 AMNIOTES
Study Guide

KEY CONCEPT
Reptiles, birds, and mammals are amniotes.

VOCABULARY

<table>
<thead>
<tr>
<th>pulmonary circuit</th>
<th>ectotherm</th>
</tr>
</thead>
<tbody>
<tr>
<td>systemic circuit</td>
<td>endotherm</td>
</tr>
</tbody>
</table>

MAIN IDEA: Amniote embryos develop in a fluid-filled sac.

1. Why is it important that an amniotic egg shell is semi-permeable?

2. Complete the following chart with a description of each type of membrane found within an amniotic egg. Use Figure 26.1 to help you.

<table>
<thead>
<tr>
<th>Membrane</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>allantois</td>
<td></td>
</tr>
<tr>
<td>amnion</td>
<td></td>
</tr>
<tr>
<td>chorion</td>
<td></td>
</tr>
<tr>
<td>yolk sac</td>
<td></td>
</tr>
</tbody>
</table>

3. Why was the development of the amniotic egg an important adaptation for amniotes?

MAIN IDEA: Anatomy and circulation differ among amniotes.

4. What are three characteristics of a sprawling stance?

5. What are three characteristics of an upright stance?

6. What is the difference between the pulmonary circuit and the systemic circuit?
7. Use the Venn diagram below to list the differences between the circulatory system of a reptile and the circulatory system of a mammal.

![Venn diagram showing reptile circulatory system and mammal circulatory system with both and both]

**MAIN IDEA:** Amniotes can be ectothermic or endothermic.

8. What is the difference between an ectotherm and an endotherm?

For each type of amniote, indicate whether it is an **ectotherm** or an **endotherm**.

9. garter snake
10. peregrine falcon
11. your biology teacher

**Vocabulary Check**

12. What word in the term *systemic* can help you to remember the difference between the systemic circuit and the pulmonary circuit? Explain why.

13. The prefix *endo-* means inner and the prefix *ecto-* means outer. Relate these two meanings to the definition of endotherm and ectotherm.
SECTION 26.2 | REPTILES

Study Guide

KEY CONCEPT
Reptiles were the first amniotes.

VOCABULARY
<table>
<thead>
<tr>
<th>reptile</th>
<th>viviparous</th>
</tr>
</thead>
<tbody>
<tr>
<td>oviparous</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Reptiles are a diverse group of amniotes.

1. What are three characteristics of a reptile?

2. What is the difference between oviparous and viviparous reptiles?

3. How do reptiles regulate their body temperature?

MAIN IDEA: Reptiles have been evolving for millions of years.

Choose the word from the box below that best fits each description.

<table>
<thead>
<tr>
<th>anapsid</th>
<th>diapsid</th>
<th>synapsid</th>
</tr>
</thead>
</table>

4. Reptiles with one hole in each temporal region have this type of skull.

5. Reptiles that have two holes in each temporal region, one above the other, have this type of skull.

6. Reptiles that do not have any temporal holes have this type of skull.

7. When do dinosaurs first appear in the fossil record? When did all walking dinosaurs go extinct?

8. What were the first vertebrates to evolve powered flight?
MAIN IDEA: There are four modern groups of reptiles.

9. Complete the following chart with details about the four modern groups of reptiles.

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>turtles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sphenodons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>snakes and lizards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>crocodilians</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

10. Word Part | Meaning
              | to give birth
-parous       | egg
-ovi-         | alive
-vivi-        |

Use the word parts in the table above to explain the difference between oviparous and viviparous reptiles.

Be Creative

11. Draw a cartoon that illustrates the importance of a reptilian adaptation (for example, consider the function of a reptile’s dry scales or plates, such as the hard shell of a turtle.)
SECTION 26.3 | BIRDS
Study Guide

KEY CONCEPT
Birds have many adaptations for flight.

VOCABULARY
| airfoil   | air sac |
| sternum   |         |

MAIN IDEA: Birds evolved from theropod dinosaurs.

1. List the five anatomical characteristics shared by both birds and theropod dinosaurs.

2. What species is recognized as the oldest fossilized bird? How long ago did it live?

3. What is the difference between the “trees-down” hypothesis and the “ground-up” hypothesis for the origin of flight in birds?

MAIN IDEA: A bird’s body is specialized for flight.

4. In the box below, draw an airfoil. Next to your picture, write a description of how the curved shape of a bird’s wings helps it to fly.
5. Complete the table below with details about the specialized adaptations of a bird’s body that allow it to fly.

<table>
<thead>
<tr>
<th>Adaptation</th>
<th>How It Helps with Flight</th>
</tr>
</thead>
<tbody>
<tr>
<td>wing shape</td>
<td></td>
</tr>
<tr>
<td>chest muscles</td>
<td></td>
</tr>
<tr>
<td>air sacs</td>
<td></td>
</tr>
<tr>
<td>hollow bones</td>
<td></td>
</tr>
<tr>
<td>reproductive organs</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Birds have spread to many ecological niches.

6. List three ways in which birds have adapted to different habitats and methods of feeding.

Vocabulary Check

7. What is an air sac?

8. How does a bird’s sternum compare to yours? What is another name for it?
**SECTION 26.4 | MAMMALS**

**Study Guide**

**KEY CONCEPT**
Evolutionary adaptations allowed mammals to succeed dinosaurs as a dominant terrestrial vertebrate.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>mammal</td>
</tr>
<tr>
<td>marsupial</td>
</tr>
<tr>
<td>mammary gland</td>
</tr>
<tr>
<td>eutherian</td>
</tr>
<tr>
<td>monotreme</td>
</tr>
</tbody>
</table>

**MAIN IDEA:** All mammals share several common characteristics.

1. What is a mammal?

2. List the four characteristics shared by all mammals.

3. What important adaptation gives mammals a distinct advantage over reptiles?

4. What is hair made out of and what is its function?

5. What are mammary glands?

6. What important nutrients does milk provide to a newborn?

Complete the following process diagram with details about how a mammal detects sound.

- Sounds in ear canal vibrate ear drum.
- Nerve impulses interpreted by brain.
7. How is a mammal able to chew and breathe at the same time?

**MAIN IDEA:** Modern mammals are divided into three main groups.

8. Complete the following chart with details about the three main groups of modern mammals.

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>monotremes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>marsupials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>eutherian mammals</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary Check**

9. The word *marsupial* comes from the Greek word *marsuppos*, which means “purse.” Draw a picture of this word origin to help you remember the meaning of marsupial.
SECTION 27.1 | ADAPTIVE VALUE OF BEHAVIOR

Study Guide

KEY CONCEPT
Behavior lets organisms respond rapidly and adaptively to their environment.

VOCABULARY
- stimulus
- taxis
- biological clock
- kinesis
- circadian rhythm

MAIN IDEA: Behavioral responses to stimuli may be adaptive.
Choose a term or terms from the word box below to complete the following sentences.

behavior body
external internal stimulus surroundings

1. A ___________ is a type of information that can make an organism change its ___________.
2. ___________ stimuli tell an animal what is occurring in its own ___________.
3. ___________ stimuli give an animal information about its ___________.

Complete the cause-and-effect diagram to explain how a stimulus results in a behavior.

Stimulus → Information sent to nervous system → No response
4. Homeostasis refers to the maintenance of constant internal conditions. How might an animal’s behavior help to maintain homeostasis?

5. What is the difference between kinesis and taxis?

MAIN IDEA: Internal and external stimuli usually interact to trigger specific behaviors.
Choose a term or terms from the word box below to complete the following sentences.

| external | internal | hormones | physiological |

6. Some behaviors can be triggered by a single stimulus, but most behaviors occur in response to a variety of _____________ and _____________ stimuli.

7. An external stimulus, such as a change in day length, might cause an animal to secrete specific _____________.

8. These hormones act as internal signals that cause other ______________ changes. These changes, in turn, cause the animal to be more likely to respond to another external stimulus.

MAIN IDEA: Some behaviors occur in cycles.

9. What is a circadian rhythm?

10. List and describe two cyclical behaviors.

Vocabulary Check

11. The word circadian comes from a Latin word that means “circle.” Explain the connection between these two words.
SECTION 27.2 | INSTINCT AND LEARNING

Study Guide

KEY CONCEPT
Both genes and environment affect an animal’s behavior.

VOCABULARY

<table>
<thead>
<tr>
<th>instinct</th>
<th>habituation</th>
<th>classical conditioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>innate</td>
<td>imprinting</td>
<td>operant conditioning</td>
</tr>
<tr>
<td>releaser</td>
<td>imitation</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Innate behaviors are triggered by specific internal and external stimuli.

1. What are two characteristics of instinctive behavior?

2. Why are innate behaviors important for a newborn?

3. Consider the “nature versus nurture” debate. What factors influence innate behaviors?

MAIN IDEA: Many behaviors have both innate and learned components.
Choose the correct term from the box below that best fits each description.

<table>
<thead>
<tr>
<th>habituation</th>
<th>imprinting</th>
<th>imitation</th>
</tr>
</thead>
</table>

4. rapid and irreversible learning process that only occurs during a short time in an animal’s life

5. a type of learning in which animals learn by observing the behavior of other animals

6. a type of learning in which an animal learns to ignore a repeated stimulus
MAIN IDEA: Learning is adaptive.

7. What is associative learning?

8. Complete the following concept map with details about classical and operant conditioning.

Vocabulary Check

9. What is a releaser?

10. Use your knowledge of the words “habit,” “imitate,” and “imprint” to write definitions for the vocabulary terms habituation, imitation, and imprinting.
SECTION 27.3 | EVOLUTION OF BEHAVIOR
Study Guide

KEY CONCEPT
Every beneficial behavior has costs and benefits.

VOCABULARY
survivorship
territoriality
optimal foraging

MAIN IDEA: Even beneficial behaviors have associated costs.
1. What are the two most important benefits of behavior?

2. Complete the following table with information about the three types of behavioral costs.

<table>
<thead>
<tr>
<th>Cost of Behavior</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Animals perform behaviors that outweigh their costs.
3. What is territoriality?

4. What are the costs and benefits of territorial behavior?

5. What are the costs and benefits of foraging?
6. What is the theory of optimal foraging?


Vocabulary Check

7. Use your knowledge of the words “survive” and “territory” to write definitions for the vocabulary words **survivorship** and **territoriality**.


Be Creative

8. In the box below, draw a cartoon that illustrates the costs and benefits of either territoriality or optimal foraging.
SECTION 27.4 SOCIAL BEHAVIOR

Study Guide

KEY CONCEPT
Social behaviors enhance the benefits of living in a group.

VOCABULARY
- pheromone
- inclusive fitness
- eusocial
- altruism
- kin selection

MAIN IDEA: Living in groups also has benefits and costs.

1. Complete the following table with three costs and three benefits of living in a group.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(1)</td>
</tr>
<tr>
<td>(2)</td>
<td>(2)</td>
</tr>
<tr>
<td>(3)</td>
<td>(3)</td>
</tr>
</tbody>
</table>

MAIN IDEA: Social behaviors are interactions between members of the same or different species.

2. Describe the four main types of communication signals.

<table>
<thead>
<tr>
<th>Communication Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>visual</td>
<td></td>
</tr>
<tr>
<td>sound</td>
<td></td>
</tr>
<tr>
<td>touch</td>
<td></td>
</tr>
<tr>
<td>chemical</td>
<td></td>
</tr>
</tbody>
</table>

3. What are courtship displays?

4. What do scientists think might be the evolutionary function of a courtship display?
5. Explain what defensive behaviors are and give an example.


**MAIN IDEA:** Some behaviors benefit other group members at a cost to the individual performing them.

Choose the correct term from the box below that best fits each description.

<table>
<thead>
<tr>
<th>altruism</th>
<th>inclusive fitness</th>
<th>reciprocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>cooperation</td>
<td>kin selection</td>
<td></td>
</tr>
</tbody>
</table>

6. behavior in which individuals help other group members so they will be helped in return

7. the total number of genes an animal and its relatives contribute to the next generation

8. behavior that helps both individuals

9. type of natural selection acting on alleles that favor the survival of close relatives

10. type of behavior in which an animal risks its life to help other group members

**MAIN IDEA:** Eusocial behavior is an example of extreme altruism.

11. List three characteristics of a eusocial species.

12. What is meant by the term *haplodiploid*?

**Vocabulary Check**

13. What is a pheromone?

14. Give an example of an altruistic behavior that might be performed by a human.
SECTION 27.5 | ANIMAL COGNITION

Study Guide

KEY CONCEPT
Some animals other than humans exhibit behaviors requiring complex cognitive abilities.

VOCABULARY
<table>
<thead>
<tr>
<th>cognition</th>
<th>cultural behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>insight</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Animal intelligence is difficult to define.

1. What are the characteristics of cognitive behavior?

2. Why is it easier to measure an animal’s cognitive abilities rather than its level of intelligence?

MAIN IDEA: Some animals can solve problems.

3. What is insight?

4. What does tool use suggest about an animal’s cognitive abilities?

MAIN IDEA: Cognitive ability may provide an adaptive advantage for living in social groups.

5. What are two characteristics of animals considered to be most “intelligent”?

6. What is cultural behavior?
Vocabulary Check

7. What is cognition?

8. What does it mean to solve a problem by using insight? What is the opposite of using insight?

Be Creative

9. Draw a four-panel cartoon that illustrates how an animal might use a tool to solve a problem.
KEY CONCEPT
The human body has five levels of organization.

VOCABULARY
- determination
- organ
- differentiation
- organ system
- tissue

MAIN IDEA: Specialized cells develop from a single zygote.
Fill in the main idea and supporting information for cell development.

1. Stem cells:

2. Determination

3. Differentiation

4. What are the characteristics of stem cells?

5. Look at Figure 28.2. Describe some of the shapes and structures that the cells in this figure acquired during differentiation.

6. Give two examples of how cell structures relate to cell functions.
STUDY GUIDE, CONTINUED

MAIN IDEA: Specialized cells function together in tissues, organs, organ systems, and the whole organism.

7. Write a description of each level of organization and draw a sketch to help you remember it.

<table>
<thead>
<tr>
<th>Level of Organization</th>
<th>Description</th>
<th>Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

8. There is an easy way to remember the difference between determination and differentiation. Look at the first part of each word. Explain how these word parts can help you remember the meaning of each term.

________________________________________________________________________

________________________________________________________________________
KEY CONCEPT
Homeostasis is the regulation and maintenance of the internal environment.

VOCABULARY
<table>
<thead>
<tr>
<th>term</th>
<th>type</th>
</tr>
</thead>
<tbody>
<tr>
<td>homeostasis</td>
<td>negative feedback</td>
</tr>
<tr>
<td>feedback</td>
<td>positive feedback</td>
</tr>
</tbody>
</table>

MAIN IDEA: Conditions within the body must remain within a narrow range.

1. Give two reasons why it is so important that the internal environment of the body remains stable.

______________________________________________________________________________

______________________________________________________________________________

2. Homeostasis is maintained by control systems. Fill in the name and function of the parts of the control system in the cycle diagram below.

   Sensors → Control center → Targets → Communication system

3. What might happen if a target organ cannot respond?

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________
MAIN IDEA: Negative feedback loops are necessary for homeostasis.

4. Study the following line drawings. Which of the following diagrams represents negative feedback and which represents positive feedback? Explain your answer.

A.  

B.  

5. It’s a hot day and you’re sweating. Is this response an example of a positive or negative feedback loop? Explain your answer.

6. When you run, your muscles require more oxygen as their level of activity increases. Explain briefly how your control systems act to bring more oxygen into your body.

Vocabulary Check

7. What is the difference between positive and negative feedback loops?

8. Think of an analogy that would illustrate the process of feedback for someone who does not know what the word means.
KEY CONCEPT
Systems interact to maintain homeostasis.

VOCABULARY
thermoregulation

MAIN IDEA: Each organ affects other organ systems.
1. The organs in the body work together like members of a pit crew servicing a race car. What other analogies can you think of to illustrate organ systems working together?

2. Fill in the table below to explain what each organ does to help produce vitamin D in your body.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td></td>
</tr>
<tr>
<td>Kidneys</td>
<td></td>
</tr>
</tbody>
</table>

3. What role does the hypothalamus play to help regulate body temperature?

MAIN IDEA: A disruption of homeostasis can be harmful.
4. List three reasons why homeostasis in the body might be disrupted.
5. Why is a long-term disruption of homeostasis usually more serious than a short-term disruption?

Fill in the concept map to help you remember what you know about long-term and short-term disruption of homeostasis.

**Vocabulary Check**

11. Think of a diagram that might illustrate the term *thermoregulation* for someone unfamiliar with the word. Use the space below to sketch your diagram.
SECTION 29.1  HOW ORGAN SYSTEMS COMMUNICATE

Study Guide

KEY CONCEPT
The nervous system and the endocrine system provide the means by which organ systems communicate.

VOCABULARY

<table>
<thead>
<tr>
<th>nervous system</th>
<th>central nervous system (CNS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>endocrine system</td>
<td>peripheral nervous system (PNS)</td>
</tr>
<tr>
<td>stimulus</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: The body’s communication systems help maintain homeostasis.

1. What is homeostasis?

2. How do communication systems allow the body to maintain homeostasis?

You work for a new kind of textbook company, one whose textbooks are actually comic books! Using the boxes provided, create a comic strip that shows an example of how a stimulus causes the human body to respond. (If you can’t come up with an example, use the one in the text that describes how your eyes respond to bright sunlight.)
MAIN IDEA: The nervous and endocrine systems have different methods and rates of communication.

Fill out the Y diagram below. In the top left, write the characteristics of the nervous system. In the top right, write the characteristics of the endocrine system. At the bottom, write the characteristics the two systems have in common. Then, lightly cross out those characteristics at the top.

Vocabulary Check

Use the vocabulary terms from this section to complete the following sentences.

3. When you stand on a street corner, you jump when you hear a nearby truck honk its horn. In this example, the honking horn is the _________________.

4. The ________________ sends chemical signals through the bloodstream.

5. When your brain wants to make your legs move so that you can run, the ________________ carries the message from your spinal cord to your leg muscles.

6. Your ________________ is the communication system that sends its signals through a highly connected network of specialized cells and tissues.
KEY CONCEPT
The nervous system is composed of highly specialized cells.

VOCABULARY
- neuron
- action potential
- dendrite
- synapse
- axon
- terminal
- resting potential
- neurotransmitter
- sodium-potassium pump

MAIN IDEA: Neurons are highly specialized cells.
Use the concept map to organize your notes on neurons.

7. What is the difference between the function of an axon and a dendrite?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
STUDY GUIDE, CONTINUED

MAIN IDEA: Neurons receive and transmit signals.

8. What is the role of the sodium-potassium pump?

9. Draw a picture to match each of the captions in the table. In the third column, write additional details about what is happening in each of your drawings.

<table>
<thead>
<tr>
<th>Caption</th>
<th>Drawing</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The neuron is stimulated and Na⁺ ions flow into the axon.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The action potential travels down the axon as more Na⁺ ions enter and K⁺ ions leave.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurotransmitters enter the synapse and bind to receptors on another neuron, stimulating Na⁺ ions to enter that cell.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. What happens after neurotransmitters bind to the other neuron’s receptors?

Vocabulary Check

11. the molecule that transmits a signal from one neuron to another
12. a gap between neurons
13. end of an axon
14. moving electrical impulse
KEY CONCEPT
The senses detect the internal and external environments.

VOCABULARY
| rod cell | cone cell | hair cell |

MAIN IDEA: The senses help to maintain homeostasis.
1. What do you rely on your senses to do?

2. Give an example of how your sensory organs work with your brain to help you to maintain homeostasis.

MAIN IDEA: The senses detect physical and chemical stimuli.
Use the chart below to organize your notes on the senses. For each of the senses shown in the first column, write the types of receptors that contribute to this sense. In the third column, write what kind of stimuli that the receptor detects. Include any additional notes or important details about that sense in the last column.

<table>
<thead>
<tr>
<th>Sense</th>
<th>Receptor</th>
<th>Stimuli It Detects</th>
<th>Additional Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Vision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Hearing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Smell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Taste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Touch</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. What part of the eye contains the receptors?

9. Explain how sound waves interact with the structures of the middle ear and, eventually, generate impulses that cause hearing.

10. Before chemicals can be detected by the tongue or nose, what must happen to them?

11. What types of receptors will be activated when you get a paper cut on your finger?

Vocabulary Check
12. Fill in the chart below.

<table>
<thead>
<tr>
<th>Rod Cell</th>
<th>Cone Cell</th>
<th>Hair Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>What does it do?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where is it found?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Activity
Pick one of the five senses, and design a bumper sticker that has a catchy slogan that explains a little bit about the function of the sense you picked.
KEY CONCEPT
The central nervous system interprets information, and the peripheral nervous system gathers and transmits information.

VOCABULARY
| cerebrum   | brain stem              | autonomic nervous system |
| cerebellum | reflex arc              | sympathetic nervous system |
| cerebral cortex | somatic nervous system | parasympathetic nervous system |

MAIN IDEA: The nervous system’s two parts work together.

1. What organs make up the central nervous system?

2. What types of neurons make up the peripheral nervous system?

On the first page of this section, you read about how the nerves, brain, and spinal cord work together to produce a response. Use the cause-and-effect diagram below to trace how the nervous system produces a response to a stimulus.

PNS detects ____________________________ .

A sensory neuron passes signal to ____________________________ .

___________________________ passes signal to the ________________ .

The ________________interprets the signal and passes it to the PNS.

A motor neuron ____________________________ .
MAIN IDEA: The CNS processes information.

3. What is the role of the cerebrum?

4. What are the three main structures of the brain?

MAIN IDEA: The PNS links the CNS to the muscles and other organs.

5. Use the chart to take notes on the peripheral nervous system.

<table>
<thead>
<tr>
<th>Division of the PNS</th>
<th>Voluntary or Involuntary?</th>
<th>Examples of Tissues It Stimulates</th>
</tr>
</thead>
<tbody>
<tr>
<td>somatic nervous system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>autonomic nervous system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sympathetic nervous system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>parasympathetic nervous system</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

Explain how the clue can help you to remember the word’s definition.

6. word: reflex arc; clue: An arc is movement that is in the shape of an arch.

7. word: autonomic nervous system; clue: Autonomic looks similar to the word automatic.

8. word: cerebral cortex; clue: A cortex is an outermost layer.

9. word: sympathetic nervous system; clue: Consider how something that is sympathetic might affect homeostasis.
SECTION 29.5 BRAIN FUNCTION AND CHEMISTRY

Study Guide

KEY CONCEPT
Scientists study the functions and chemistry of the brain.

VOCABULARY

<table>
<thead>
<tr>
<th>addiction</th>
<th>tolerance</th>
<th>stimulant</th>
</tr>
</thead>
<tbody>
<tr>
<td>desensitization</td>
<td>sensitization</td>
<td>depressant</td>
</tr>
</tbody>
</table>

MAIN IDEA: New techniques improve our understanding of the brain.
Organize your notes on technologies used to study the brain in this three-column chart.

<table>
<thead>
<tr>
<th>Imaging Technology</th>
<th>What scans the brain?</th>
<th>What is shown in the image?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Computerized tomography (CT)</td>
<td>x-rays</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>activity in the brain</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Changes in brain chemistry can cause illness.
Write the word(s) that completes each sentence.

4. Chemicals called _______________ allow neurons in the brain to communicate with one another.

5. The _______________ of neurotransmitter in an area of the brain affects how stimulated that area will be.

6. The PET scans in Figure 29.15 show what areas of the brain are _______________.

7. Depression and Alzheimer’s disease are examples of mental illness linked to _______________ in the brain.

8. Drugs that treat mental illness affect the _______________ that neurons generate.
MAIN IDEA: Drugs alter brain chemistry.

9. What are some of the effects drugs can have on a person’s behavior?

10. What are the two ways that drugs affect the brain’s chemistry?

11. What in the brain do drugs have an effect on?

12. How does the brain’s ability to adapt when it experiences long periods of too much or too little neurotransmitter help it maintain homeostasis?

13. How does a stimulant affect brain function?

14. How does a depressant affect brain function?

Vocabulary Check
For each of the word pairs, write a sentence or two that explains how the two terms are different from one another.

15. Addiction, Tolerance

16. Desensitization, Sensitization

17. Stimulant, Depressant
KEY CONCEPT
The endocrine system produces hormones that affect growth, development, and homeostasis.

VOCABULARY
- hormone
- hypothalamus
- releasing hormone
- gland
- pituitary gland

MAIN IDEA: Hormones influence a cell’s activities by entering the cell or binding to its membrane.

1. How do hormones get from the gland that produced them to the cells they will affect?

2. What determines whether or not a hormone will affect a cell?

3. How are steroid hormones different from nonsteroid hormones?

MAIN IDEA: Endocrine glands secrete hormones that act throughout the body.
Use the text and Figure 29.20 to fill in the chart.

<table>
<thead>
<tr>
<th>Gland</th>
<th>Location</th>
<th>Secretes Hormones that Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. hypothalamus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>brain</td>
<td>metabolism, growth, and development</td>
</tr>
<tr>
<td>6.</td>
<td>chest</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>blood pressure, breathing rate, fight-or-flight response</td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td>digestion and glucose metabolism</td>
</tr>
<tr>
<td>10. gonads</td>
<td>pelvis</td>
<td></td>
</tr>
</tbody>
</table>
MAIN IDEA: The hypothalamus interacts with the nervous system and endocrine system.
Draw the diagram of a hormone feedback loop on p. 900, and answer the following questions.

11. Which of the hormones in your diagram are releasing hormones?

12. What stimulates the hypothalamus to stop producing TRH?

13. Explain why the thyroid gland will stop producing thyroxine when the body warms.

MAIN IDEA: Hormonal imbalances can cause severe illness.
14. How do hormone imbalances cause illness in many different body systems?

Vocabulary Check
For each term, write a clue that helps you to remember the word’s definition.
15. Hormone

16. Pituitary gland

17. Hypothalamus
SECTION 30.1 | RESPIRATORY AND CIRCULATORY FUNCTIONS

Study Guide

KEY CONCEPT
The respiratory and circulatory systems bring oxygen and nutrients to the cells.

VOCABULARY
- circulatory system
- alveoli
- vein
- respiratory system
- diaphragm
- capillary
- trachea
- heart
- lung
- artery

MAIN IDEA: The respiratory and circulatory systems work together to maintain homeostasis.

Fill in the Q and A chart below about the circulatory and respiratory systems.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What are the main functions of the circulatory system?</td>
<td></td>
</tr>
<tr>
<td>2. What are the main functions of the respiratory system?</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: The respiratory system moves gases into and out of the blood.

3. What pathway does air follow after it enters the nose and mouth?

4. Explain why so much surface area is needed in the lungs.

5. As shown in Figure 30.2, when you inhale, the muscles of the rib cage contract, expanding the rib cage. The diaphragm flattens and moves downward, and air flows into the lungs. What happens when you exhale?
MAIN IDEA: The circulatory system moves blood to all parts of the body.

6. Fill in the chart to help you remember the parts of the circulatory system and their functions.

<table>
<thead>
<tr>
<th>Part</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>heart</td>
<td></td>
</tr>
<tr>
<td>arteries</td>
<td></td>
</tr>
<tr>
<td>veins</td>
<td></td>
</tr>
<tr>
<td>capillaries</td>
<td></td>
</tr>
</tbody>
</table>

7. How do the heart and blood vessels maintain a stable body temperature in hot and cold weather?

________________________________________________________________________

________________________________________________________________________

Vocabulary Check

8. The word *diaphragm* is based on the Latin word *diaphragma*, which means “midriff.” How does this term relate to the meaning of *diaphragm*?

________________________________________________________________________

________________________________________________________________________

9. The trachea, bronchi, and bronchioles have been compared to the trunk, branches, and twigs of a tree. What other analogy can you think of to describe these structures?

________________________________________________________________________

________________________________________________________________________
KEY CONCEPT
The respiratory system exchanges oxygen and carbon dioxide.

VOCABULARY
| red blood cell | emphysema |
| hemoglobin     | asthma    |

MAIN IDEA: Gas exchange occurs in the alveoli of the lungs.

1. What are the three principles of gas exchange?

2. What is the advantage of having so many clusters of alveoli in the lungs?

Fill in diagram A about oxygen diffusion and diagram B about carbon dioxide diffusion. Add arrows to show the direction in which the gases move.

A
Alveolus
$O_2$ concentrations are higher than in the capillary.

Capillary and alveolus walls

Capillary

B
Alveolus

Capillary and alveolus walls

Capillary
$CO_2$ and water vapor concentrations are higher than in alveolus.
3. What is the function of hemoglobin in red blood cells?

4. When CO₂ levels in the blood increase, how does the nervous system respond?

MAIN IDEA: Respiratory diseases interfere with gas exchange.

5. In the chart below, summarize how each activity or disease affects the lungs’ ability to exchange gases.

<table>
<thead>
<tr>
<th>Activity or Disease</th>
<th>Effect on Lungs</th>
</tr>
</thead>
<tbody>
<tr>
<td>smoking</td>
<td></td>
</tr>
<tr>
<td>emphysema</td>
<td></td>
</tr>
<tr>
<td>asthma</td>
<td></td>
</tr>
<tr>
<td>cystic fibrosis</td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

6. Asthma comes from the Greek word 
   asthma, which means “to pant.” How does this meaning relate to the definition of asthma?

7. What is the definition of hemoglobin? Why does it give blood its reddish color?
KEY CONCEPT
The heart is a muscular pump that moves the blood through two pathways.

**VOCABULARY**
- atrium
- ventricle
- valve
- pacemaker
- pulmonary circulation
- systemic circulation

**MAIN IDEA:** The tissues and structures of the heart make it an efficient pump.
Fill in the pattern notes with the main chambers and valves of the heart. Use Figure 30.7 to help you.

**RIGHT**
1. right atrium
2. ______ valve
3. ______ valve

**LEFT**
4. ______ valve
5. Explain what makes the heart such an efficient, self-regulating pump.

6. After the SA node stimulates the atria to contract, what happens next in the heartbeat cycle?
Fill in the process diagram below to summarize the blood flow in the heart.

**Oxygen-poor blood flows into right atrium, then is pumped into the right ventricle.**

**MAIN IDEA:** The heart pumps blood through two main pathways.

7. What are the main functions of the pulmonary circulation and the systemic circulation?

________________________________________________________________________

________________________________________________________________________

**Vocabulary Check**

8. An atrium in a building is the first room or area that people enter before going into the rest of the building. How does this meaning relate to the location and function of an atrium in the heart?

________________________________________________________________________

9. Systemic means “related to a an entire system,” while pulmonary is based on the Latin pulmo, which means “lung.” Make up a table or draw a diagram using these clues to help you remember the difference between pulmonary and systemic circulations.

________________________________________________________________________
KEY CONCEPT
The circulatory system transports materials throughout the body.

VOCABULARY
<table>
<thead>
<tr>
<th>blood pressure</th>
<th>diastolic pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>systolic pressure</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Arteries, veins, and capillaries transport blood to all parts of the body.

Fill in the Y diagram to summarize what you know about the differences and similarities between arteries and veins.

1. Describe how capillaries differ from arteries and veins.

2. When a doctor takes your blood pressure, what is he or she measuring?
3. What is the difference between systolic pressure and diastolic pressure?

4. Why is hypertension, or high blood pressure, a serious health risk?

MAIN IDEA: Lifestyle plays a key role in circulatory diseases.
Complete the following concept web to show how lifestyle choices can affect circulatory health.

Vocabulary Check
11. Systolic is based on the Greek word *sustellein*, which means “to contract.” Diastolic is based on the Greek word *diastellein*, which means “to expand.” How can the meaning of these Greek words help you remember the difference between systolic and diastolic pressure?
KEY CONCEPT
Blood is a complex tissue that transports materials.

VOCABULARY
<table>
<thead>
<tr>
<th>platelet</th>
<th>ABO blood group</th>
<th>white blood cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>plasma</td>
<td>Rh factor</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Blood is composed mainly of cells, cell fragments, and plasma.
Complete the following concept web to help you remember the components in blood.

1. __________ 2. __________ 3. __________

Whole blood is composed mainly of

4. plasma which is composed of

5. 90% water 6. minerals

7. __________ such as

8. __________ 9. __________

10. immune proteins

11. Summarize how plasma proteins and the water in plasma help to maintain homeostasis in the body.

_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
MAIN IDEA: Platelets and different types of cells have different functions.

12. Complete the chart below to describe the structures and functions of blood cells and platelets.

<table>
<thead>
<tr>
<th>Blood Component</th>
<th>Structure</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red blood cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White blood cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platelets</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. Why is it important for a person to receive a blood type and Rh factor that is compatible with his or her own blood?

__________________________________________________________________________

__________________________________________________________________________

14. Describe two ways that platelets act to help heal a torn or injured blood vessel.

__________________________________________________________________________

__________________________________________________________________________

15. In what way can clots and the inability to form clots be life-threatening?

__________________________________________________________________________

Vocabulary Check

16. What does the term ABO blood group stand for?

__________________________________________________________________________

17. To keep from getting plasma and platelet confused, remember that the suffix -let means “small.” Platelet is a small part of a cell. Draw and label a sketch of a platelet and plasma to help you remember the difference between these two terms.
KEY CONCEPT
The lymphatic system provides another type of circulation in the body.

VOCABULARY
<table>
<thead>
<tr>
<th>lymphatic system</th>
<th>node</th>
</tr>
</thead>
<tbody>
<tr>
<td>lymph</td>
<td>lymphocyte</td>
</tr>
</tbody>
</table>

MAIN IDEA: Lymph is collected from tissues and returned to the circulatory system.

1. What are the main functions of the lymphatic system?

2. The lymphatic system, unlike the circulatory system, has no pump that moves the fluid. What keeps lymph moving in the lymph vessels?

Fill in the cycle diagram below that traces the pathway of lymphatic circulation.

- Blood leaves the heart and circulates to the rest of the body.
- Excess fluid leaks out of the capillaries into the area between cells.
- [Diagram to be filled in]
3. Suppose the lymphatic system was unable to function in one area of the body. What would you expect to happen in that area?

   _______________________________________________________________________
   _______________________________________________________________________

MAIN IDEA: The lymphatic system is a major part of the immune system.

4. Complete the question and answer note taking chart below.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do the tonsils help fight disease?</td>
<td></td>
</tr>
<tr>
<td>What role does the thymus play in the immune system?</td>
<td></td>
</tr>
<tr>
<td>How does the spleen help fight disease?</td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

5. The suffix -cyte means “cell.” What then is a lymphocyte?
   _______________________________________________________________________
   _______________________________________________________________________

6. The doctor checks the lymph nodes in your neck and tells you that you have lymphadenitis. Adeno- means “gland” and -itis means “inflammation.” What does lymphadenitis mean, and what does it indicate about your health?
   _______________________________________________________________________
   _______________________________________________________________________
**SECTION 31.1 | PATHOGENS AND HUMAN ILLNESS**

**Study Guide**

**KEY CONCEPT**
Germs cause many diseases in humans.

**VOCABULARY**
- germ theory
- pathogen
- vector

**MAIN IDEA:** Germ theory states that microscopic particles cause certain diseases. Use the concept map below to take notes on early research about infectious diseases.

![Concept Map](concept-map-image)

1. Louis Pasteur theorized that
2. theory called
3. hypothesized that
   - cleaning his surgical tools would prevent infection
   - practice called
4. used to develop which states
5. found that
6. used to develop
7. which states
8. 9. 10. 11.
MAIN IDEA: There are different types of pathogens.
Fill in the chart to take notes on the different types of pathogens.

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Causes Disease By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. bacteria</td>
<td></td>
</tr>
<tr>
<td>13. viruses</td>
<td></td>
</tr>
<tr>
<td>14. fungi</td>
<td></td>
</tr>
<tr>
<td>15. protozoa</td>
<td></td>
</tr>
<tr>
<td>16. parasites</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Pathogens can enter the body in different ways.
Use the concept map to take notes on how pathogens spread.

Vocabulary Check
21. Something that causes disease is called a __________________________.
22. A vector is something that ____________________________
KEY CONCEPT
The immune system consists of organs, cells, and molecules that fight infections.

VOCABULARY
<table>
<thead>
<tr>
<th>immune system</th>
<th>B cell</th>
<th>passive immunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>phagocyte</td>
<td>antibody</td>
<td>active immunity</td>
</tr>
<tr>
<td>T cell</td>
<td>interferon</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Many body systems protect you from pathogens.

1. What is the immune system?

2. For each, describe how it helps the immune system by protecting the body from pathogens.

<table>
<thead>
<tr>
<th>Tissue or Body System</th>
<th>How It Protects the Body from Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>skin</td>
<td></td>
</tr>
<tr>
<td>mucus membrane</td>
<td></td>
</tr>
<tr>
<td>circulatory system</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Cells and proteins fight the body’s infections.

3. How do your basophil cells react when a pathogen enters the body?

4. What are three ways that antibodies help fight infection?
MAIN IDEA: Immunity prevents a person from getting sick from a pathogen.
Fill in the blanks in the concept map to take notes on the differences between active and passive immunity.

**Vocabulary Check**
13. Come up with a way to remember the difference between B cells and T cells.

14. The word *phagocyte* comes from two Greek words: *phago-* means “to eat” and *-cyte* means cell. How can this help you remember the definition of the word *phagocyte*?

15. *Interferon* is similar to the word *interference*. How can this clue help you remember what *interferon* means?
KEY CONCEPT
The immune system has many responses to pathogens and foreign cells.

VOCABULARY
<table>
<thead>
<tr>
<th>inflammation</th>
<th>memory cell</th>
<th>humoral immunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>antigen</td>
<td>cellular immunity</td>
<td>tissue rejection</td>
</tr>
</tbody>
</table>

MAIN IDEA: Many body systems work to produce nonspecific responses.
1. What is the difference between a specific immune response and a nonspecific immune response?

In the table, write the characteristics of each of the nonspecific immune responses. Then, in the third column, explain how this nonspecific response helps the immune system to fight off infections.

<table>
<thead>
<tr>
<th>Nonspecific Response</th>
<th>Characteristics</th>
<th>How It Helps the Immune System</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. inflammation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. fever</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Cells of the immune system produce specific responses.
4. How does the immune system know if a foreign particle has infected the body?

5. What is the role of memory cells in providing acquired immunity?
Using Figures 31.10 and 31.11, write the differences for each type of immunity on the right or left side of the Y diagram below. Then, write the similarities on the bottom of the Y.

**Humoral Immunity**

[Blank lines for differences]

**Cellular Immunity**

[Blank lines for differences]

**Both**

[Blank lines for similarities]

**MAIN IDEA:** The immune system rejects foreign tissues.

6. Donors and recipients should have ________________ differing antigens.

7. An organ recipient takes drugs that ________________ the immune system.

**Vocabulary Check**

8. What do memory cells remember?

9. How does the word rejection help you to remember what tissue rejection means?

10. The prefix anti- means “destroying” and, the suffix -gen means “something that produces or lives.” How can this help you remember the definition for the word antigen?
KEY CONCEPT
Living in a clean environment and building immunity helps to keep a person healthy.

MAIN IDEA: Many methods are used to control pathogens.
Use the concept map to take notes on the different technologies that have been developed to destroy pathogens.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>antiseptic</td>
</tr>
<tr>
<td>antibiotic resistance</td>
</tr>
<tr>
<td>vaccine</td>
</tr>
</tbody>
</table>

![Concept Map]

1. examples
2. types
3. kills pathogens found
4. kills pathogens found
5. antibiotics
6. overuse can cause
7. which is
8. antiseptics
9. antibiotics
STUDY GUIDE, CONTINUED

MAIN IDEA: Vaccines artificially produce acquired immunity.

9. What is a vaccine?

10. What do vaccines do that allow the body to gain immunity without ever getting sick?

11. Why does a person who has memory cells for a pathogen not get sick, while a person without memory cells for a pathogen will get sick?

12. What are four different things vaccines can be made of?

Vocabulary Check

13. The word antiseptic comes from the prefix anti-, which means “destroying,” and the word septic, which means “disease-causing.” How can these words help you to remember what an antiseptic is?

14. How can the meaning of the word resistance help you remember what an antibiotic resistant bacterium is?
OVERREACTIONS OF THE IMMUNE SYSTEM

Study Guide

KEY CONCEPT
An overactive immune system can make the body very unhealthy.

VOCABULARY

<table>
<thead>
<tr>
<th>Allergy</th>
<th>Allergen</th>
<th>Anaphylaxis</th>
</tr>
</thead>
</table>

MAIN IDEA: Allergies occur when the immune system responds to harmless antigens.

1. What triggers an allergic reaction?

2. What do white blood cells do that causes an allergic reaction?

3. Use the chart to take notes on the types of allergens.

<table>
<thead>
<tr>
<th>Allergen Category</th>
<th>Symptoms of Allergic Reaction</th>
<th>Examples of Allergen</th>
</tr>
</thead>
<tbody>
<tr>
<td>food allergen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>airborne allergen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chemical allergen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MAIN IDEA: In autoimmune diseases, white blood cells attack the body’s healthy cells.

4. What are two things that occur when a person has Type 1 diabetes?

5. How do medications help people with autoimmune diseases?

Vocabulary Check

6. The suffix auto- means “self.” How can this help you to remember what an autoimmune disease is?

7. What is the difference between the word allergy and the word allergen?

8. What symptoms does a person have if they are experiencing anaphylaxis?
SECTION 31.6 | DISEASES THAT WEaken THE IMMUNE SYSTEM

KEY CONCEPT
When the immune system is weakened, the body cannot fight off diseases.

VOCABULARY

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>leukemia</td>
<td>human immunodeficiency virus (HIV)</td>
</tr>
<tr>
<td>opportunistic infection</td>
<td>acquired immune deficiency syndrome (AIDS)</td>
</tr>
</tbody>
</table>

MAIN IDEA: Leukemia is characterized by abnormal white blood cells.
Fill in the boxes of the flow chart to show how leukemia can lead to opportunistic diseases.

Leukemia → Bone marrow produces... → White blood cells...

Bone marrow stops... → Immune system cannot... → opportunistic diseases

MAIN IDEA: HIV targets the immune system.

1. What are three examples of the ways HIV can be passed from person to person?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Study Guide 111
Use the flow chart to explain how HIV infection leads to AIDS.

**Vocabulary Check**

2. HIV stands for *human immunodeficiency virus*. The second word contains the root words *immune* and *deficiency*. How can these two words help you to remember the definition of HIV?

3. What does AIDS stand for, and how does the last word, beginning with “s,” help you to remember that it is a disease and not a virus?

4. How does the word *opportunity* help you remember the definition of *opportunistic infection*?
KEY CONCEPT
Cells require many different nutrients.

**VOCABULARY**
- mineral
- Calorie
- vitamin

**MAIN IDEA:** Six types of nutrients help to maintain homeostasis.
Fill in the concept map to summarize what you know about the six nutrients.

1. **water**
   - needed for... 
   - energy

2. **needed for...**

3. **needed for...**
   - growth, repair, enzymes, hormones

4. **needed for...**

5. **needed for...**
   - regulate cell functions, growth, development

6. **needed for...**
   - vitamins, water- and fat-soluble

7. Many dietary experts recommend drinking about 8 glasses of water a day. Why do you need this much fluid to maintain homeostasis?

8. Explain why vegans, who eat no animal products, might have difficulty obtaining all 8 essential amino acids from their diet.
STUDY GUIDE, CONTINUED

9. What is the difference between saturated and unsaturated fats?

10. Which of the six nutrients supply the body with energy?

MAIN IDEA: Meeting nutritional needs supports good health.

11. Why is eating a balanced diet particularly important during pre-teen and teen years?

12. Why do most dietary experts recommend that you obtain most of your Calories from whole grains, vegetables, and fruits?

13. You are checking the number of Calories and Calories from fat on a food label. What other information do you need to know to get accurate Calorie counts?

14. How can the information on a food label help you make good eating choices?

Vocabulary Check

15. The words calorie and Calorie both refer to a unit of energy. What is the difference in meaning between these two words?

16. The Latin term vita means “life.” How does this meaning relate to the function of vitamins?
KEY CONCEPT
The digestive system breaks down food into simpler molecules.

VOCABULARY
- digestion
- esophagus
- chyme
- digestive system
- peristalsis
- small intestine
- sphincter
- stomach
- bile

MAIN IDEA: Several digestive organs work together to break down food.

1. What is the main function of digestion?

2. Give an example of mechanical and chemical digestion.

3. How do smooth muscles and sphincters keep food moving in one direction throughout the digestive system?

4. What happens after digestion is completed?

MAIN IDEA: Digestion begins in the mouth and continues in the stomach.

5. Fill in the chart below to help you remember facts about key digestive enzymes.

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>salivary amylase, amylase</td>
<td></td>
</tr>
<tr>
<td>pepsin, peptides</td>
<td></td>
</tr>
<tr>
<td>lipase</td>
<td></td>
</tr>
</tbody>
</table>
MAIN IDEA: Digestion is completed in part of the small intestine.

Fill in the process diagram below to summarize the digestion of food as it moves through the mouth, stomach, and small intestine. Use Figure 32.11 to help you.

Mouth
- Food is chewed and shredded.
- Food is swallowed.

Stomach
- Smooth muscles churn and mix food.

Small Intestine
- Smooth muscles churn and mix food.
- Protein digestion finished.

6. What keeps the stomach from digesting itself?

Vocabulary Check

7. The word *esophagus* is based on the Greek terms *ois*-, which refers to “carrying something,” and *phagos*, which means “food.” How can these Greek terms help you remember the meaning of *esophagus*?

8. Think of an analogy that might help you to explain the meaning of *peristalsis* to someone who does not know the word.
SECTION 32.3 | ABSORPTION OF NUTRIENTS
Study Guide

KEY CONCEPT
Nutrients are absorbed and solid wastes eliminated after digestion.

VOCABULARY
| absorption | microvilli |
| villi |

MAIN IDEA: Most absorption of nutrients occurs in the small intestine.

1. What is absorption, and why is it important to your body?

2. Name the three structures in the small intestine that absorb most of the nutrients from chyme.

3. How do these three structures increase the surface area of the small intestine?

4. Why is it important that food move slowly through the small intestine?

5. Fill in the chart summarizing absorption in the three parts of the small intestine.

<table>
<thead>
<tr>
<th>Part of Small Intestine</th>
<th>Materials Absorbed</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>duodenum</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>circulatory system</td>
</tr>
<tr>
<td></td>
<td>fat-soluble vitamins, vitamin B₁₂, fatty acid, cholesterol, some water</td>
<td></td>
</tr>
</tbody>
</table>
6. What happens when nutrient-rich blood leaves the small intestine and enters the liver?

MAIN IDEA: Water is absorbed and solid wastes are eliminated from the large intestine.

7. How does the large intestine help to maintain the body’s fluid balance, or homeostasis?

8. What materials make up the feces?

9. In what ways can bacteria in the large intestine be helpful or harmful?

10. How is solid waste eliminated from the body?

Vocabulary Check

11. The Latin word villus means “shaggy hair,” and micro refers to something that is unusually small. How can these two terms help you remember the meaning of microvilli?

12. Draw a sketch or think of an analogy to illustrate the meaning of absorption. Think of times you have watched water or other liquids being absorbed by something.
KEY CONCEPT
The excretory system removes wastes and helps maintain homeostasis.

VOCABULARY
<table>
<thead>
<tr>
<th>term</th>
</tr>
</thead>
<tbody>
<tr>
<td>excretory system</td>
</tr>
<tr>
<td>urinary bladder</td>
</tr>
<tr>
<td>dialysis</td>
</tr>
<tr>
<td>kidney</td>
</tr>
<tr>
<td>nephron</td>
</tr>
<tr>
<td>ureter</td>
</tr>
<tr>
<td>glomerulus</td>
</tr>
</tbody>
</table>

MAIN IDEA: The excretory system eliminates nonsolid wastes and helps maintain homeostasis.

1. What are the main organs of the excretory system?

2. Name three ways that the excretory system eliminates nonsolid wastes.

3. What are the waste products removed by the lungs?

MAIN IDEA: The kidneys help to maintain homeostasis by filtering the blood.

4. What are the main parts of the kidney?

5. The kidneys release key hormones to help maintain homeostasis. In what other ways do the kidneys help to maintain homeostasis?

MAIN IDEA: Nephrons clean the blood and produce urine.

6. What are the main functions of the glomerulus and Bowman’s capsule?
Fill in the process diagram to summarize the three steps in which blood is filtered and urine is formed in the nephron.

**Filtration**
- Blood enters glomerulus
- Small molecules diffuse into Bowman’s capsule, forming filtrate

**Reabsorption**

**Excretion**

**MAIN IDEA:** Injury and disease can damage the kidneys.

7. How can diabetes and high blood pressure affect the kidneys?

8. How is the process of dialysis similar to the function of the kidneys?

**Vocabulary Check**

9. Which vocabulary words are based on the verbs *excrete* and *urinate*?

10. *Dialysis* is based on the Greek word *dialuein*, which means “to break apart.” What “breaking apart” does a dialysis machine do?
SECTION 33.1  SKELETAL SYSTEM Study Guide

KEY CONCEPT
The skeletal system includes bones and tissues that are important for supporting, protecting, and moving your body.

<table>
<thead>
<tr>
<th>VOCABULARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>skeletal system</td>
</tr>
<tr>
<td>appendicular skeleton</td>
</tr>
<tr>
<td>axial skeleton</td>
</tr>
</tbody>
</table>

MAIN IDEA: Your skeletal system is made up of the appendicular and axial skeletons.

1. What does the skeletal system do?

Fill in the concept map to take notes on the parts of the skeletal system.

8. What is the function of the vertebrae?

9. How is cartilage different from bone?

MAIN IDEA: Bones connect to form joints.

10. What is a joint?

11. What two places in the body are cartilaginous joints found?

12. How do ligaments work to allow synovial joints to move?

13. What are the five types of synovial joints?
MAIN IDEA: Bones are living tissue.

14. What are the two types of bone?

15. How do Haversian canals and red bone marrow link the skeletal system to the circulatory system?

16. How do bones help to maintain chemical homeostasis in the body?

Vocabulary Check

17. The word appendicular contains the word appendages. How can this help you to remember the definition of the appendicular skeleton?

18. The word axial contains the word axis. Knowing this, define what the axial skeleton is.

19. The prefix calci-, which means “calcium,” is found in the vocabulary word calcification. How can this clue help you to remember the definition of calcification?

20. What are two things that cartilage, joints, and ligaments all have in common?
SECTION 33.2 | MUSCULAR SYSTEM

Study Guide

KEY CONCEPT
Muscles are tissues that can contract, enabling movement.

VOCABULARY
- muscular system
- tendon
- myofibril
- myosin
- muscle fiber
- smooth muscle
- sarcomere
- skeletal muscle
- cardiac muscle
- actin

MAIN IDEA: Humans have three types of muscle. Use the chart, and Figure 33.7 in your book, to organize your notes on the three different types of muscle.

<table>
<thead>
<tr>
<th>Type of Muscle</th>
<th>Attaches to/Found in</th>
<th>Moves</th>
<th>Voluntary or Involuntary?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Skeletal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Smooth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Cardiac</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: Muscles contract when the nervous system causes muscle filaments to move.

4. What shortens when a muscle is contracted?

5. Which filament is anchored to the middle of the sarcomere?

6. Which filament is anchored to the Z line?

7. Where is the Z line located?
8. What stimulates a muscle contraction?

9. How is calcium ion (Ca\(^{2+}\)) important for muscle contraction?

In the space below, draw two diagrams: one of a relaxed sarcomere, and the second of a contracted sarcomere. Label actin, myosin, Z line, M line, and sarcomere in your drawings.

10. What happens to actin and myosin when muscles relax?

**Vocabulary Check**

11. On each of the lines below, write one of the three types of muscles and say where that type is found.

12. Write two sentences or clues, one for each word, that will help you remember the difference between actin and myosin. (Example: Actin is actively pulled.)
KEY CONCEPT
The integumentary system has many tissues that protect the body.

VOCABULARY
<table>
<thead>
<tr>
<th>integumentary system</th>
<th>epidermis</th>
<th>hair follicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>keratin</td>
<td>dermis</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: The integumentary system helps maintain homeostasis.

1. What is the integumentary system?

2. What are the two main functions of the integumentary system?

3. How does the integumentary system prevent infection?

MAIN IDEA: The integumentary system consists of many different tissues.
In the space below, draw and label all of the important structures within the skin.
4. epidermis

5. dermis

6. subcutaneous fat

7. What are the functions of keratin and melanin?

8. What in the dermis gives the skin structure and flexibility?

Vocabulary Check

9. The prefix *epi-* means above. How does this help you to remember the difference between the dermis and the epidermis?

10. Write a clue to help you remember what keratin is. It could be a rhyme, an analogy, or something entirely different.

11. Hair and hair follicles are different structures. The word *follicle* means “cavity of cells.” How can knowing this help you to remember what a hair follicle is?
KEY CONCEPT
Female and male reproductive organs fully develop during puberty.

VOCABULARY

<table>
<thead>
<tr>
<th>Reproductive System</th>
<th>Uterus</th>
<th>Testosterone</th>
<th>Semen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puberty</td>
<td>Estrogen</td>
<td>Scrotum</td>
<td></td>
</tr>
<tr>
<td>Ovum</td>
<td>Fallopian Tube</td>
<td>Epididymis</td>
<td></td>
</tr>
<tr>
<td>Ovary</td>
<td>Testis</td>
<td>Vas Deferens</td>
<td></td>
</tr>
</tbody>
</table>

MAIN IDEA: The female reproductive system produces ova.

1. What is the reproductive system?

2. What hormones begin the process of puberty?

3. What are the main functions of the female reproductive system?

4. Name the three roles of the hormone estrogen in the female reproductive system.

5. Describe the function of each part of the female reproductive system listed below.

<table>
<thead>
<tr>
<th>Part of Reproductive System</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ovaries</td>
<td></td>
</tr>
<tr>
<td>Fallopian Tube</td>
<td></td>
</tr>
<tr>
<td>Uterus</td>
<td></td>
</tr>
</tbody>
</table>
STUDY GUIDE, CONTINUED

MAIN IDEA: The male reproductive system produces sperm.

6. What are the main functions of the male reproductive system?

__________________________________________________________________________

7. Name the two roles of the hormone testosterone in the male reproductive system.

__________________________________________________________________________

8. Describe the function of each part of the male reproductive system listed below.

<table>
<thead>
<tr>
<th>Part of Reproductive System</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>testes</td>
<td></td>
</tr>
<tr>
<td>epididymus</td>
<td></td>
</tr>
<tr>
<td>vas deferens</td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Check

<table>
<thead>
<tr>
<th>epididymis</th>
<th>vas deferens</th>
<th>fallopian tube</th>
</tr>
</thead>
</table>

9. Each of the terms listed above refer to tubes found in the human reproductive system. Come up with a clue that will help you to remember each word’s definition and how the definition is different from the other two.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
### KEY CONCEPT

Human reproductive processes depend on cycles of hormones.

### VOCABULARY

<table>
<thead>
<tr>
<th>Term</th>
<th>Term</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>follicle</td>
<td>endometrium</td>
<td>zygote</td>
</tr>
<tr>
<td>ovulation</td>
<td>corpus luteum</td>
<td>infertility</td>
</tr>
<tr>
<td>menstrual cycle</td>
<td>menopause</td>
<td>sexually transmitted disease</td>
</tr>
</tbody>
</table>

### MAIN IDEAS:

Eggs mature and are released according to hormonal cycles. Sperm production in the testes is controlled by hormones.

Answer the questions in the chart regarding both female and male reproductive cycles.

<table>
<thead>
<tr>
<th>Question</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>What type of cell division produces mature eggs and sperm?</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>At what stage of life does egg or sperm production begin?</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>What hormones stimulate the cycle of egg or sperm production?</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>What is the menstrual cycle?</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>How does the endometrium change during the three phases of the menstrual cycle?</td>
<td></td>
</tr>
</tbody>
</table>

### MAIN IDEA:

Fertilization occurs when a sperm cell joins an egg cell.

6. Out of millions of sperm, usually only one can fertilize an egg. Explain why.

7. What happens genetically to produce a zygote?

8. What is the difference between identical and fraternal twins?
9. List three reasons a person might become infertile.

**MAIN IDEA:** Sexually transmitted diseases affect fertility and overall health.

10. What characteristic must a disease have for it to be a sexually transmitted disease?

11. Use the table below to describe the different types of STDs, their effects on health, and their treatment.

<table>
<thead>
<tr>
<th>Type of STD</th>
<th>Examples</th>
<th>Effects</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>bacterial infections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>viral infections</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Vocabulary Check**

12. The prefix *meno-* means “relating to menstruation,” and *pause* means “to stop.” How does this help you to remember the definition for the word *menopause*?

13. How does knowing the definition of the word *transmitted* help you to remember what a *sexually transmitted disease* is?

14. The prefix *in-* means “not.” How can this be a clue to the meaning of the word *infertility*?
KEY CONCEPT
Development progresses in stages from zygote to fetus.

VOCABULARY

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>blastocyst</td>
<td></td>
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<tr>
<td>embryo</td>
<td></td>
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<tr>
<td>amniotic sac</td>
<td></td>
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<tr>
<td>placenta</td>
<td></td>
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<tr>
<td>umbilical cord</td>
<td></td>
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<tr>
<td>trimester</td>
<td></td>
</tr>
<tr>
<td>fetus</td>
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</table>

MAIN IDEA: The fertilized egg implants into the uterus and is nourished by the placenta.

1. What is the difference between a blastocyst and an embryo?

2. Fill in the following chart to summarize what you know about the structures that nourish and protect the growing embryo.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description and Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>amniotic sac</td>
<td></td>
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<tr>
<td>chorion</td>
<td></td>
</tr>
<tr>
<td>placenta</td>
<td></td>
</tr>
<tr>
<td>umbilical cord</td>
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</table>

3. Why must the blood flows of the mother and the embryo be kept separate?
MAIN IDEA: A zygote develops into a fully formed fetus in about 38 weeks.

4. In the first trimester of human life, what are some of the major organs that are forming and beginning to function?

5. Would a mother be more likely to feel the fetus moving in the first trimester or in the second trimester? Explain your answer.

6. Why would a fetus who is born at the beginning of the third trimester have a difficult time surviving?

MAIN IDEA: The mother affects the fetus and the pregnancy affects the mother.

7. Why is the quality of the mother’s diet so important to the developing fetus?

8. Besides proper diet, what else can the mother do to help ensure a healthy pregnancy for herself and her baby?

9. How can fluctuating hormone levels affect the mother’s health during and just after a pregnancy?

Vocabulary Check

10. In the space below, draw a sketch that illustrates the terms amniotic sac, placenta, and umbilical cord. You can use Figure 34.10 as a reference or think up your own example, such as an astronaut’s suit.
SECTION 34.4 | BIRTH AND DEVELOPMENT

Study Guide

KEY CONCEPT
Physical development continues through adolescence and declines with age.

VOCABULARY

| Physical development continues through adolescence and declines with age.

MAIN IDEA: Birth occurs in three stages.

Fill in the cause-and-effect chart about the birth process, showing that one cause can have multiple effects.

<table>
<thead>
<tr>
<th>EFFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Dilation of the cervix</td>
</tr>
<tr>
<td>• Amniotic sac usually breaks.</td>
</tr>
<tr>
<td>3. Emergence of the baby</td>
</tr>
<tr>
<td>4. Expulsion of the placenta</td>
</tr>
</tbody>
</table>

5. If the cervix does not dilate enough, how is the baby removed from the mother?

6. What happens to the umbilical cord after the baby is born?
MAIN IDEA: Human growth and aging also occur in stages.

7. What is the effect of the human growth hormone (hGH) on the body?

8. What are the main stages of development in human life after birth?

9. Why might an infant’s heart rate, breathing rate, and body temperature vary more than they do in older children?

10. During which two stages of development does the greatest growth rate occur?

11. What might be one reason that most children learn to walk around the end of infancy or the beginning of childhood?

12. List some of the major changes that occur in adolescence.

13. What are some of the activities that can help to slow down or counteract the effects of aging?

Vocabulary Check

14. The suffix -hood refers to “a group sharing a specific state or quality.” How does this meaning relate to the terms childhood and adulthood?

15. The word adolescence is based on the Latin verb adolescere, which means “to grow up.” How does this help you understand the definition of adolescence?