SECTION 1-1 REVIEW

THE WORLD OF BIOLOGY

VOCABULARY REVIEW Define the following terms.

1. development ____________________________

2. reproduction ____________________________

3. organ ____________________________

4. tissue ____________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. Biology is the study of
   a. animals.
   b. plants and animals.
   c. all living things.
   d. energy transfer.

2. A short segment of DNA that contains instructions for the development of a single trait of an organism is known as a
   a. DNA loop.
   b. gene.
   c. library.
   d. membrane.

3. As the cells in a multicellular organism multiply, they become specialized for different functions in a process called
   a. sexual reproduction.
   b. descent with modification.
   c. photosynthesis.
   d. cell differentiation.

4. Homeostasis refers to the
   a. organization of cellular structures.
   b. stable level of internal conditions in organisms.
   c. organized structure of crystals.
   d. destruction of tropical rain forests.

5. Photosynthesis is part of a plant’s
   a. metabolism.
   b. homeostasis.
   c. development.
   d. response to stimuli.
SHORT ANSWER Answer the questions in the space provided.

1. Explain why the cell is called the basic unit of life.

2. Give a specific example of homeostasis.

3. Why is it important to study biology?

4. Contrast the reproduction of bacteria with that of frogs.

5. Critical Thinking The organization of a rock is much simpler than that of living things.
   By what other criteria can a rock be distinguished from living things?

STRUCTURES AND FUNCTIONS Explain how the drawing below illustrates the characteristics of life.
THEMES IN BIOLOGY

VOCABULARY REVIEW  Distinguish between the terms in each of the following groups of terms.

1. domain, kingdom

2. diversity of life, unity of life

3. adaptations, evolution

4. ecosystem, ecology

MULTIPLE CHOICE  Write the correct letter in the blank.

1. A “tree of life” explains
   a. how organisms are related to each other.
   b. how organisms differ from each other.
   c. the lineages of various organisms.
   d. All of the above

2. Which of the following is NOT an important unifying theme in biology?
   a. the diversity and unity of life
   b. the relationship between organisms and society
   c. the interdependence of living organisms
   d. the evolution of life

3. An example of a domain is
   a. Animalia.
   b. Protista.
   c. Fungi.
   d. Eukarya.

4. A trait that improves an individual’s ability to survive and reproduce is a(n)
   a. mutation.
   b. natural selection
   c. adaptation.
   d. domain.

5. Which of the following statements is true?
   a. Destruction of rain forests has no effect on living things.
   b. Destruction of rain forests increases the rate of evolution of rainforest organisms.
   c. Humans have had no impact on the world’s environment.
   d. Humans have had a large impact on the world’s environment.
SHORT ANSWER Answer the questions in the space provided.

1. Give an example of how two organisms are interdependent. ____________________________

2. Why must an adaptation be inheritable if it is to cause a population to evolve? ________________

3. What is natural selection? ____________________________

4. If two organisms share the same kingdom, must they also share the same domain? Explain. ____________________________

5. **Critical Thinking** A female frog has a genetic trait that prevents it from producing eggs. How likely is it that this trait will spread through the frog population? Explain your answer. ____________________________

**STRUCTURES AND FUNCTIONS** Briefly describe the interactions among the panther, the deer, and the grass in the drawing below.
SECTION 1-3 REVIEW

THE STUDY OF BIOLOGY

VOCABULARY REVIEW  Define the following terms.

1. prediction _____________________________________________________________

2. control group _________________________________________________________

3. dependent variable ____________________________________________________

4. independent variable __________________________________________________

5. theory ______________________________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

____  1. A field biologist who studies the behavior of birds in a rain forest most likely collects data through
   a. experimenting.  b. modeling.  c. observing.  d. inferring.

____  2. Constructing a graph is an example of
   a. measuring.  b. organizing data.  c. observing.  d. predicting.

____  3. Of the following steps in a scientific investigation, the last to be done is usually
   a. experimenting.  b. observing.  c. producing a model.  d. hypothesizing.

____  4. A statement that explains observations and can be tested is called
   a. a hypothesis.  b. an inference.  c. a theory.  d. a model.

____  5. A visual, verbal, or mathematical explanation that is supported by data is called
   a. a hypothesis.  b. an inference.  c. a theory.  d. a model.
SHORT ANSWER Answer the questions in the space provided.

1. What are quantitative data? Give two examples of quantitative data. 

2. What is an advantage of a peer review of a scientific paper? 

3. How are a hypothesis, a prediction, and an experiment related? 

4. What are some of the things scientists might do to analyze data? 

5. Critical Thinking A scientist wanted to study the effect of a drug on the blood pressure of rats. She set up an experiment in which the experimental group consisted of rats that were injected with a salt solution containing the drug. What should the control group have consisted of?

   What were the dependent and independent variables in her experiment?

STRUCTURES AND FUNCTIONS Examine the drawing of the owl. In each space below, provide an observation that would support the inference given or provide an inference that could be derived from the observation given.

<table>
<thead>
<tr>
<th>Observations</th>
<th>Inferences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owls live in trees.</td>
<td>The owl has wings.</td>
</tr>
<tr>
<td>Owls feed on mice.</td>
<td>Owls kill prey with their talons.</td>
</tr>
<tr>
<td>It is night.</td>
<td>Both of the owl’s eyes face forward.</td>
</tr>
</tbody>
</table>
**SECTION 1-4 REVIEW**

**TOOLS AND TECHNIQUES**

**VOCABULARY REVIEW** Circle the term that does not belong in each of the following groups, and briefly explain why it does not belong.

1. compound light, transmission electron, light electron, scanning electron

2. base unit, stage, nosepiece, objective lens

3. magnification, power of magnification, resolution, mass density

4. second, minute, meter, kilogram

5. meter, square meter, cubic meter, kilogram per cubic meter

**MULTIPLE CHOICE** Write the correct letter in the blank.

1. The ability of a microscope to show details clearly is called
   a. enlargement.  b. magnification.  c. reduction.  d. resolution.

2. One limitation of the scanning electron microscope is that it cannot be used to
   a. examine specimens smaller than cells.
   b. view living specimens.
   c. produce an enlarged image of a specimen.
   d. produce an image of the surface of a specimen.

3. A microscope with a 10× ocular lens and a 25× objective lens has a total power of magnification equal to
   a. 2.5×.  b. 35×.  c. 250×.  d. 2,500×.

4. The SI base unit for time is the
   a. second.  b. minute.  c. hour.  d. day.

5. The SI prefix that represents 1,000 times the base unit is
   a. deci.  b. centi.  c. kilo.  d. micro.
SHORT ANSWER Answer the questions in the space provided.

1. Arrange the following parts in the order that matches the light path through a light microscope: specimen, ocular lens, objective lens, light source. 

2. What are the maximum magnifications of the LM, TEM, and SEM?

3. Write the abbreviation for each of the following units: meter, kilometer, centimeter, millimeter, micrometer. What is the mathematical relationship between these units?

4. **Critical Thinking** A group of scientists want to determine whether the bacteria they are studying have viruses inside them. Which type of microscope should they use? Explain your answer.

STRUCTURES AND FUNCTIONS Label each part of the figure in the spaces provided.
SECTION 2-1 REVIEW

COMPOSITION OF MATTER

VOCABULARY REVIEW Define the following terms.

1. atom ____________________________________________

2. neutron __________________________________________

3. compound _________________________________________

4. covalent bond ______________________________________

5. ion ______________________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. The atomic number of carbon is 6. Therefore, the number of protons in a carbon atom equals
   a. 3.  b. 6.  c. 7.  d. 12.

_____ 2. One of the kinds of particles found in the nucleus of an atom is the
   a. proton.  b. electron.  c. ion.  d. boron.

_____ 3. The maximum number of electrons that can be held in the orbitals in an atom’s second
   energy level is
   a. 2.  b. 4.  c. 6.  d. 8.

_____ 4. Of the following elements, the one that is most likely to form ionic bonds is
   a. hydrogen.  b. carbon.  c. sodium.  d. oxygen.

_____ 5. An example of a compound is
   a. water.  b. hydrogen gas.  c. oxygen gas.  d. chloride ion.
SHORT ANSWER Answer the questions in the space provided.

1. What is the difference between mass and weight?

2. Identify the elements and the number of atoms of each element in each of the following compounds:
   \( \text{BO}_2 \) .................................................................
   \( \text{KCl} \) .................................................................
   \( \text{C}_6\text{H}_{12}\text{O}_6 \) ..................................................
   \( \text{NH}_3 \) .................................................................

3. How many pairs of electrons do the two oxygen atoms in an oxygen molecule share with each other? Explain your answer.

4. Critical Thinking The atomic number of argon is 18. Will argon tend to form bonds with other elements? Explain your answer.

STRUCTURES AND FUNCTIONS Use the figure to answer the following questions.

The diagram below shows bonding of a hydrogen atom with a chlorine atom. The atomic number of hydrogen is 1. The atomic number of chlorine is 17. The orbitals corresponding to the third energy level can hold up to 8 electrons.

1. What kind of bond is formed between hydrogen and chlorine atoms?

2. Describe the formation of this bond and the total number of electrons in the orbitals of each energy level.
SECTION 2-2 REVIEW

ENERGY

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. reactant, product ________________________________________________________________

2. catalyst, enzyme ________________________________________________________________

3. oxidation reaction, reduction reaction ______________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

1. The state of matter in which particles move most rapidly is
   a. liquid.  b. gas.  c. solid.  d. heat.

2. Every chemical reaction involves a
   a. change in the state of the matter in the reactants.
   b. net release of energy.
   c. transfer of energy.
   d. transfer of electrons between atoms.

3. Enzymes
   a. increase the amount of energy released in a reaction.
   b. decrease the amount of energy released in a reaction.
   c. catalyze only redox reactions.
   d. reduce the activation energy needed for a reaction.

4. In chemical reactions, the number of each kind of atom in the reactants is
   a. the same as in the products.
   b. less than in the products.
   c. more than in the products.
   d. b or c, depending on the kind of chemical reaction.

5. Redox reactions
   a. involve either reduction or oxidation, but not both.
   b. involve the transfer of electrons between atoms.
   c. do not occur in living things.
   d. always involve oxygen.
**SHORT ANSWER** Answer the questions in the space provided.

1. In the chemical reaction shown below, write *R* over the reactants and *P* over the products:
   \[ \text{C}_{12}\text{H}_{22}\text{O}_{11} + \text{H}_{2}\text{O} \rightarrow \text{C}_{6}\text{H}_{12}\text{O}_{6} + \text{C}_{6}\text{H}_{12}\text{O}_{6} \]

2. What role do catalysts play in chemical reactions?

3. What does a two-direction arrow indicate in a chemical equation?

4. In the chemical reaction shown below, write *R* over the substance that is reduced and *O* over the substance that is oxidized:
   \[ \text{Na} + \text{Cl} \rightarrow \text{Na}^+ + \text{Cl}^- \]

5. **Critical Thinking** Sucrose, or table sugar, can react with water to form two other compounds, glucose and fructose. However, when you add sugar to a glass of water, this reaction proceeds extremely slowly. Why does it proceed slowly, and what else is needed to speed up the reaction?

**STRUCTURES AND FUNCTIONS** Use the figure to answer the following questions.

The graph below represents the energy changes that occur as a chemical reaction progresses.

1. What is represented by arrow *A*?
2. What is represented by arrow *B*?
3. Is energy absorbed or released in this reaction? Explain your answer.
SECTION 2-3 REVIEW

WATER AND SOLUTIONS

VOCABULARY REVIEW Define the following terms.

1. solvent ____________________________

2. aqueous solution ____________________________

3. hydroxide ion ____________________________

4. base ____________________________

5. buffer ____________________________

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. The concentration of a solution is the measurement of the amount of
   a. acid dissolved in a fixed amount of base.
   b. solvent dissolved in a fixed amount of the solution.
   c. solute dissolved in a fixed amount of the solution.
   d. solvent dissolved in a fixed amount of the solute.

_____ 2. When water dissociates, it forms
   a. H\(^+\) ions and H\(_2\)O.
   b. H\(^+\) ions and OH\(^-\) ions.
   c. H\(^+\) ions and H\(_2\)O\(^+\) ions.
   d. OH\(^-\) ions and H\(_2\)O\(^-\) ions.

_____ 3. An acid is a solution with more
   a. hydronium ions than hydroxide ions.
   b. hydroxide ions than hydronium ions.
   c. sodium ions than hydroxide ions.
   d. hydroxide ions than sodium ions.

_____ 4. An example of a base is
   a. pure water.  b. vinegar.  c. ammonia.  d. urine.

_____ 5. A solution with a pH above 7 is
   a. logarithmic.  b. neutral.  c. acidic.  d. alkaline.
SHORT ANSWER Answer the questions in the space provided.

1. What property of water allows it to stick to the sides of a vertical glass tube?

2. What states of matter can solutions be composed of?

3. How much sugar is there in 100 mL of a 10 percent aqueous sugar solution?

   What is the solvent in this solution?

4. What are the relative numbers of H$_3$O$^+$ and OH$^-$ ions in an acidic, an alkaline, and a neutral solution?

5. How many times more hydroxide ions are there in a solution with a pH of 9 than in a solution with a pH of 3?

6. How are buffers important to the functioning of living systems?

7. **Critical Thinking** If a solution has a pH of 7.5, what would its new pH be if the concentration of H$_3$O$^+$ ions in the solution were increased by 100 times? Explain your reasoning.

**STRUCTURES AND FUNCTIONS** The diagram below represents a single water molecule. Draw three other water molecules near it, and use dashed lines to indicate where hydrogen bonds would form between the molecule shown below and the ones you drew.
SECTION 3-1 REVIEW

CARBON COMPOUNDS

VOCABULARY REVIEW Define the following terms and provide one example for each.

1. organic compound ____________________________________________________________

2. functional group _____________________________________________________________

3. alcohol _________________________________________________________________

4. monomer _________________________________________________________________

5. polymer _________________________________________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. Organic compounds contain
   a. carbon and usually other elements.   b. many kinds of elements except carbon.
   c. only carbon.   d. only carbon and hydrogen.

2. The number of covalent bonds a carbon atom can form with other atoms is
   a. 1.   b. 2.   c. 4.   d. 8.

3. A covalent bond formed when two atoms share two pairs of electrons is called a

4. The breakdown of a polymer involves
   a. hydrolysis.   b. a condensation reaction.   c. the breaking of hydrogen bonds.
   d. the breaking of ionic bonds.

5. ATP releases energy when
   a. it undergoes a condensation reaction.   b. a hydroxyl group is added to it.
   c. a phosphate group is added to it.   d. a phosphate group is removed from it.
SHORT ANSWER Answer the questions in the space provided.

1. Give an example of how a functional group can affect the properties of an organic compound.

2. Arrange the following in order of size, from smallest to largest: polymer, monomer, carbon atom, macromolecule.

3. Explain how a water molecule is produced when glucose and fructose undergo a condensation reaction.

4. What are the products of the hydrolysis of ATP? What else is released during this reaction?

5. Critical Thinking How would the variety of organic compounds be different if carbon had seven electrons in its outermost energy level instead of four?

STRUCTURES AND FUNCTIONS Use the figure to answer the following questions.

The formation of sucrose from glucose and fructose is represented by the chemical reaction shown below. Notice that this reaction can proceed in either direction.

1. What are the reactants and products of the forward (left-to-right) reaction?

2. Is the forward reaction a condensation reaction or hydrolysis?

3. What are the reactants and products of the reverse (right-to-left) reaction?

4. Is the reverse reaction a condensation reaction or hydrolysis?
SECTION 3-2 REVIEW

MOLECULES OF LIFE

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. monosaccharide, polysaccharide

2. amino acid, protein

3. nucleotide, nucleic acid

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Glycogen, starch, and cellulose are
   a. monosaccharides.  b. disaccharides.  c. polysaccharides.  d. simple sugars.

2. The different shapes and functions of different proteins are determined by
   a. the R groups of the amino acids they contain.
   b. the amino groups of the amino acids they contain.
   c. the carboxyl groups of the amino acids they contain.
   d. whether or not they contain any amino acids.

3. Most enzymes
   a. are changed by the reactions they catalyze.
   b. increase the activation energy of the reactions they catalyze.
   c. strengthen the chemical bonds in their substrate.
   d. are sensitive to changes in temperature or pH.

4. The large numbers of carbon-hydrogen bonds in lipids
   a. make lipids polar.
   b. store more energy than the carbon-oxygen bonds in other organic compounds.
   c. allow lipids to dissolve in water.
   d. are found in the carboxyl group at the end of the lipid.

5. The most important function of nucleic acids is
   a. catalyzing chemical reactions.
   b. forming a barrier between the inside and outside of a cell.
   c. storing energy.
   d. storing information related to heredity and protein synthesis.
SHORT ANSWER Answer the questions in the space provided.

1. What are the storage and quick-energy forms of carbohydrates found in animals, and how are these forms structurally related to each other?

2. How many different kinds of monomers are there in starch? How many different kinds of monomers are there in proteins?

3. What compound composes most of the cell membrane? How is this compound suited to the function of the membrane?

4. Steroids are made up of what type of molecule? Give two examples of steroids.

5. Critical Thinking Insects that live on land have a coating of wax on the outer surface of their body. What function might the wax serve for these animals?

STRUCTURES AND FUNCTIONS Label each part of the figure in the spaces provided.

The diagram below shows the interaction of an enzyme and its substrate during a chemical reaction.
SECTION 4-1 REVIEW

THE HISTORY OF CELL BIOLOGY

VOCABULARY REVIEW Define the following terms.

1. cell
   ____________________________
   ____________________________

2. cell theory
   ____________________________
   ____________________________

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. One early piece of evidence supporting the cell theory was the observation that
   
   a. only plants are composed of cells.  
   b. only animals are composed of cells.  
   c. cells come from other cells.  
   d. animal cells come from plant cells.

_____ 2. The scientist who described cells as “many little boxes” was
   
   a. Robert Hooke.  
   b. Anton van Leeuwenhoek.  
   c. Theodor Schwann.  
   d. Rudolf Virchow.

_____ 3. Living and nonliving things are different in that only
   
   a. nonliving things are made of cells.  
   b. nonliving things are made of atoms.  
   c. living things are made of cells.  
   d. living things are made of atoms.

_____ 4. Microscopes were used to study cells beginning in the
   
   a. 16th century.  
   b. 17th century.  
   c. 18th century.  
   d. 19th century.

_____ 5. The advantage of van Leeuwenhoek’s microscopes was that
   
   a. they were simple.  
   b. they had two lenses.  
   c. the lenses could be moved.  
   d. the lenses were ground very precisely.

_____ 6. Which of the following was a major event in the history of cell biology?
   
   a. cloning animals  
   b. growing bone tissue for transplant  
   c. discovery of cell parts  
   d. All of the above

_____ 7. A light microscope uses optical lenses to magnify objects by
   
   a. bending light rays.  
   b. bending electron beams.  
   c. reflecting beams of light.  
   d. reflecting beams of electrons.
SHORT ANSWER Answer the questions in the space provided.

1. State the three parts of the cell theory.

2. Why did it take 150 years for the cell theory to be developed after microscopes were invented?

3. Why did Hooke’s cork cells appear to be empty?

4. Critical Thinking If you read that a new organism had been discovered, what would you know about the organism without examining it in terms of cells?

STRUCTURES AND FUNCTIONS Use the figure to answer the following questions.

Timeline—History of Cell Biology

- Robert Hooke observes cork cells. 1665
- Karl Von Baer discovers the mammalian egg. 1827
- Rudolf Virchow adds to the cell theory. 1855
- Kolliker describes mitochondria in muscle. 1857
- Camillo Golgi discovers the Golgi apparatus in cells. 1897
- Tissue engineering used to grow new skin and bone for transplant. 1996
- Researchers in Scotland clone a sheep from an adult sheep cell. 2004

1. Approximately how many years elapsed between the time cells were discovered and the observation of cell parts in muscle cells?

2. When was the third part of the cell theory added? What was the time interval between this event and the discovery of cells?
SECTION 4-2 REVIEW

INTRODUCTION TO CELLS

VOCABULARY REVIEW Define the following terms.

1. **organelle**

2. **nucleus**

3. **eukaryote**

4. **prokaryote**

MULTIPLE CHOICE Write the correct letter in the blank.

1. Cells are limited in size by the
   a. rate at which substances needed by the cell can enter the cell through its surface.
   b. rate at which the cell can manufacture genetic information.
   c. amount of material the cell can collect to fill itself.
   d. amount of cell membrane the cell can produce.

2. The diameter of most plant and animal cells is about
   a. 0.1 to 0.2 µm.
   b. 10 to 50 µm.
   c. 1 to 2 mm.
   d. 10 to 50 mm.

3. The characteristic of a nerve cell that relates directly to its function in receiving and transmitting nerve impulses is its
   a. long extensions.
   b. flat shape.
   c. ability to change shape.
   d. ability to engulf and destroy bacteria.

4. One difference between eukaryotic and prokaryotic cells is that only
   a. prokaryotic cells are surrounded by a cell membrane.
   b. prokaryotic cells have a nucleus.
   c. eukaryotic cells have genetic information.
   d. eukaryotic cells have membrane-bound organelles.
SHORT ANSWER Answer the questions in the space provided.

1. How is the shape of a skin cell suited to its function? ____________________________
   ____________________________
   ____________________________
   ____________________________

2. How are the organelles of a single cell like the organs of a multicellular organism? ______
   ____________________________

3. Name two features of eukaryotic cells that prokaryotic cells lack. ____________________________
   ____________________________

4. Critical Thinking When a spherical cell increases in diameter from 2 µm to 20 µm, by what factor does its surface area change? By what factor does its volume change? (The surface area of a sphere = $4\pi r^2$, and the volume of a sphere = $\frac{4}{3}\pi r^3$. Remember that diameter = $2 \times$ radius.)
   ____________________________
   ____________________________

STRUCTURES AND FUNCTIONS

1. These figures represent a eukaryotic cell and a prokaryotic cell. In the spaces below the diagrams, indicate which type of cell each diagram represents.
   a ____________________________
   b ____________________________

2. List two features that formed the basis for your identification of these cells.
   ____________________________
   ____________________________
   ____________________________

3. Identify the structures labeled X and Y. ____________________________
SECTION 4-3 REVIEW

CELL ORGANELLES AND FEATURES

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. nucleoplasm, nuclear envelope

2. cytoskeleton, microtubule

3. cilia, flagella

MULTIPLE CHOICE  Write the correct letter in the blank.

____  1. The plasma membrane

a. allows all substances to pass into and out of the cell.
b. prevents all substances from passing into and out of the cell.
c. is composed mainly of a protein bilayer.
d. is composed mainly of a lipid bilayer.

____  2. Substances produced in a cell and exported outside of the cell would pass through the

a. endoplasmic reticulum and Golgi apparatus.
b. mitochondria and Golgi apparatus.
c. nucleus and lysosomes.
d. vacuoles and lysosomes.

____  3. Cells that have a high energy requirement generally have many

a. nuclei.
b. flagella.
c. mitochondria.
d. microfilaments.

____  4. Viruses, bacteria, and old organelles that a cell ingests are broken down in

a. ribosomes.
b. lysosomes.
c. the rough endoplasmic reticulum.
d. the smooth endoplasmic reticulum.

____  5. Organelles that are surrounded by two membranes and contain DNA are the

a. nucleus, the endoplasmic reticulum, and lysosomes.
b. nucleus, the endoplasmic reticulum, and chloroplasts.
c. nucleus and mitochondria.
d. endoplasmic reticulum and the Golgi apparatus.
**SHORT ANSWER** Answer the questions in the space provided.

1. What roles do membrane proteins play in transporting only certain substances into a cell?

   2. What are ribosomes made of? What cellular function are they involved in?

3. What is the cytoskeleton, and what are three of its major components?

4. Describe the structural organization shared by cilia and flagella.

5. **Critical Thinking** When lipid is added to a solution of a detergent in water, the detergent breaks up large globules of the lipid into much smaller globules. What effect do you think a detergent would have on the integrity of cells? Explain your answer.

**STRUCTURES AND FUNCTIONS** This diagram represents a typical animal cell. Label each part of the figure in the spaces provided.

- a.
- b.
- c.
- d.
- e.
- f.
SECTION 4-4 REVIEW

UNIQUE FEATURES OF PLANT CELLS

VOCABULARY REVIEW  Define the following terms.

1. cell wall  

2. plastid  

3. thylakoids  

4. chlorophyll  

5. central vacuole  

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Which of the following organelles is found in plant cells but not in animal cells?
   a. nucleus  
   b. chloroplast  
   c. mitochondrion  
   d. Golgi apparatus

2. The end products of photosynthesis include
   a. carbon dioxide and water.  
   b. sugars.  
   c. carbon dioxide and oxygen.  
   d. oxygen and water.

3. A cell that contains a cell wall, chloroplasts, and a central vacuole is a
   a. plant cell.  
   b. animal cell.  
   c. prokaryotic cell.  
   d. bacterial cell.

4. A central vacuole forms from
   a. chloroplasts.  
   b. fusion of amyloplasts.  
   c. the fusion of smaller vacuoles.  
   d. the products of photosynthesis.

5. Thylakoids are located
   a. between the two membranes of a chloroplast.  
   b. outside the outer membrane of a chloroplast.  
   c. inside the inner membrane of a chloroplast.  
   d. in chromoplasts.
**SHORT ANSWER** Answer the questions in the space provided.

1. How are secondary cell walls different from primary cell walls? ____________________________
   ____________________________
   ____________________________
   ____________________________

2. What are plant cell walls made of? ____________________________
   ____________________________

What is the function of cell walls? ____________________________
   ____________________________

3. What is the appearance of a plant cell when water is plentiful? ____________________________
   ____________________________

4. **Critical Thinking** Bacteria have a region called a nucleoid, in which their genetic material is located. Why, then, are bacteria classified as prokaryotes?
   ____________________________
   ____________________________

**STRUCTURES AND FUNCTIONS** Label each part of the figure in the spaces provided.

This diagram represents a typical plant cell.
SECTION 5-1 REVIEW

PASSIVE TRANSPORT

VOCABULARY REVIEW Explain the relationship between the terms in each of the following pairs of terms.

1. concentration gradient, diffusion

2. osmosis, turgor pressure

3. hypertonic, plasmolysis

MULTIPLE CHOICE Write the correct letter in the blank.

1. Substances that can pass through cell membranes by diffusion include
   a. Na\(^+\) ions.  
   b. Cl\(^-\) ions.  
   c. glucose.  
   d. oxygen.

2. The contractile vacuole of a paramecium should be active when the paramecium is in
   a. an isotonic environment.  
   b. a hypotonic environment.  
   c. a hypertonic environment.  
   d. any environment.

3. When a human red blood cell is placed in a hypotonic environment, it will
   a. undergo cytolysis.  
   b. undergo plasmolysis.  
   c. experience a decrease in turgor pressure.  
   d. be at equilibrium.

4. Facilitated diffusion is often used to transport
   a. ions.  
   b. water.  
   c. molecules that are not soluble in lipids.  
   d. molecules that are too small to diffuse across the membrane.

5. Na\(^+\) ions enter cells by
   a. diffusing across the lipid bilayer without assistance.  
   b. diffusing through Na\(^+\) ion channels.  
   c. binding to Na\(^+\) carrier proteins.  
   d. binding to Cl\(^-\) ions.
SHORT ANSWER Answer the questions in the space provided.

1. What happens to the movement of molecules at equilibrium?

2. How do carrier proteins transport substances across cell membranes?

3. What types of stimuli can cause the gates on ion channels to open or close?

4. Critical Thinking How does the interaction between a carrier protein and the substance it transports resemble the interaction between an enzyme and its substrate?

STRUCTURES AND FUNCTIONS The drawings below show the appearance of a red blood cell and a plant cell in isotonic, hypotonic, and hypertonic environments. Label each environment in the spaces provided.

RED BLOOD CELL

a b c

PLANT CELL

d e f
SECTION 5-2 REVIEW

ACTIVE TRANSPORT

VOCABULARY REVIEW  Define the following terms.

1. active transport

2. endocytosis

3. vesicle

4. phagocytosis

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Facilitated-diffusion carrier proteins and cell-membrane pumps both
   a. require an input of energy.
   b. are specific for the kinds of substances they transport.
   c. transport substances up their concentration gradients.
   d. carry out active transport.

2. The sodium-potassium pump transports
   a. Na\(^+\) out of the cell and K\(^+\) into the cell.
   b. Na\(^+\) and K\(^+\) in both directions across the cell membrane.
   c. K\(^+\) out of the cell and Na\(^+\) into the cell.
   d. Na\(^+\) during some cycles and K\(^+\) during other cycles.

3. The energy needed to power the sodium-potassium pump is provided by the
   a. binding of ATP to the pump.
   b. transport of ATP by the pump.
   c. removal of a phosphate group from ATP.
   d. formation of ATP.

4. Pinocytosis involves the transport of
   a. large particles out of a cell.
   b. fluids into a cell.
   c. whole cells into another cell.
   d. lysosomes out of a cell.

5. Exocytosis is a
   a. type of passive transport.
   b. mechanism by which cells ingest other cells.
   c. transport process in which vesicles are formed from pouches in the cell membrane.
   d. way for cells to release large molecules, such as proteins.
SHORT ANSWER Answer the questions in the space provided.

1. Why is the sodium-potassium transport mechanism called a “pump”? 

2. Explain how a phagocyte destroys bacteria. 

3. Describe how a cell produces and releases proteins. 

4. Critical Thinking Why is it important that ions being transported across a cell membrane be shielded from the interior of the lipid bilayer? 

STRUCTURES AND FUNCTIONS Use the figure to answer the following questions.

1. The diagrams below represent the six steps in one cycle of the sodium-potassium pump. The order of the steps has been scrambled. Beginning with diagram d (numbered 1), sequence the remaining diagrams by writing the appropriate numeral in each blank.

2. On which side of the membrane are Na\(^+\) ions released from the pump? 

3. On which side of the membrane are K\(^+\) ions released from the pump? 

SECTION 6-1 REVIEW

THE LIGHT REACTIONS

VOCABULARY REVIEW Explain the relationship between the terms in each of the following pairs of terms.

1. granum, stroma
   
2. chlorophyll a, carotenoids
   
3. chemiosmosis, ATP synthase

MULTIPLE CHOICE Write the correct letter in the blank.

   1. Chlorophyll a
      a. absorbs mostly orange-red and blue-violet light.
      b. absorbs mostly green light.
      c. is an accessory pigment.
      d. is responsible for the red color of many autumn leaves.

   2. The photosystems and electron transport chains are located in the
      a. outer chloroplast membrane.
      b. inner chloroplast membrane.
      c. thylakoid membrane.
      d. stroma.

   3. Both photosystem I and photosystem II
      a. receive electrons from other photosystems.
      b. donate electrons to a transport chain that generates NADPH.
      c. donate protons to each other.
      d. contain chlorophyll a molecules.

   4. Water participates directly in the light reactions of photosynthesis by
      a. donating electrons to NADPH.
      b. donating electrons to photosystem II.
      c. accepting electrons from the electron transport chains.
      d. accepting electrons from ADP.

   5. The energy that is used to establish the proton gradient across the thylakoid membrane comes from the
      a. synthesis of ATP.
      b. synthesis of NADPH.
      c. passage of electrons along the electron transport chain of photosystem II.
      d. splitting of water.
**SHORT ANSWER** Answer the questions in the space provided.

1. Why is photosynthesis referred to as a biochemical pathway?

2. How does the structure of a chloroplast enable it to build up a concentration gradient of protons?

3. What are the energy-carrying end products of the light harvesting reactions?

4. Explain the function of accessory pigments.

5. **Critical Thinking** Which photosystem—I or II—most likely evolved first? Explain your reasoning.

**STRUCTURES AND FUNCTIONS** Label the substances represented by the letters a–d below.

The diagram below summarizes the light reactions of photosynthesis.

![Diagram of photosynthesis light reactions]

- **a**
- **b**
- **c**
- **d**

**STRONG INSIDE OF THYLAKOID**
SECTION 6-2 REVIEW

THE CALVIN CYCLE

VOCABULARY REVIEW Define the following terms.

1. Calvin cycle

2. carbon fixation

3. stoma

4. C₄ pathway

5. CAM pathway

MULTIPLE CHOICE Write the correct letter in the blank.

1. The Calvin cycle begins when CO₂ combines with a five-carbon carbohydrate called
   a. RuBP.  
   b. PGA.  
   c. 3-G3P.  
   d. NADPH.

2. For every three molecules of CO₂ that enter the Calvin cycle, the cycle produces six molecules of
   a. RuBP.  
   b. ATP.  
   c. 3-PGA.  
   d. NADPH.

3. Organic compounds that can be made from the products of the Calvin cycle include
   a. only carbohydrates.  
   b. only amino acids.  
   c. only lipids.  
   d. carbohydrates, amino acids, and lipids.

4. C₃ and C₄ plants differ in terms of the number of
   a. steps in the Calvin cycle.  
   b. carbon atoms in the compound that CO₂ is initially incorporated into.  
   c. carbon atoms in the end product of the Calvin cycle.  
   d. ATP molecules used in the Calvin cycle.

5. As light intensity increases, the rate of photosynthesis
   a. continues to decrease.  
   b. continues to increase.  
   c. initially decreases and then levels off.  
   d. initially increases and then levels off.
**SHORT ANSWER** Answer the questions in the space provided.

1. How many molecules of ATP and NADPH are used in a single turn of the Calvin cycle?

2. Using \((\text{CH}_2\text{O})\) as the general formula for a carbohydrate, write the simplest overall equation for photosynthesis.

3. How do CAM plants differ from both C₂ and C₄ plants?

4. Why does the rate of photosynthesis increase, peak, and then decrease as temperature increases?

5. **Critical Thinking** Stomata can open and close in response to changes in the CO₂ concentration inside the leaf. Would you expect stomata to open or close if the CO₂ concentration decreased? Explain.

**STRUCTURES AND FUNCTIONS** In the blank spaces provided in the diagram, indicate the number of molecules of each substance that are involved when three CO₂ molecules enter the cycle.

The diagram below summarizes the Calvin cycle.

![Calvin cycle diagram]
SECTION 7-1 REVIEW

GLYCOLYSIS AND FERMENTATION

VOCABULARY REVIEW Define the following terms.

1. cellular respiration

2. glycolysis

3. lactic acid fermentation

4. alcoholic fermentation

MULTIPLE CHOICE Write the correct letter in the blank.

1. Glycolysis takes place
   a. in the cytosol.
   b. in the mitochondria.
   c. only if oxygen is present.
   d. only if oxygen is absent.

2. During glycolysis, glucose is
   a. produced from two molecules of pyruvic acid.
   b. converted into two molecules of ATP.
   c. partially broken down and some of its stored energy is released.
   d. partially broken down and its stored energy is increased.

3. Both lactic acid fermentation and alcoholic fermentation produce
   a. a two-carbon molecule from a six-carbon molecule.
   b. CO₂ from a three-carbon molecule.
   c. ATP from ADP and phosphate.
   d. NAD⁺ from NADH and H⁺.

4. The efficiency of glycolysis is approximately
   a. 0.2%.
   b. 2%.
   c. 20%.
   d. 200%.

5. The anaerobic pathways provide enough energy to meet all of the energy needs of
   a. all organisms.
   b. all unicellular and most multicellular organisms.
   c. many unicellular and some multicellular organisms.
   d. no organisms.
SHORT ANSWER Answer the questions in the space provided.

1. Why are the fermentation pathways referred to as “anaerobic” pathways? ____________________________

2. What are the energy-containing products of glycolysis? ____________________________

3. Of what importance are lactic acid fermentation and alcoholic fermentation to the cells that use these pathways? ____________________________

4. Critical Thinking The vitamin niacin is an essential component of NAD⁺. Niacin can be consumed in food or manufactured in the body from tryptophan, an amino acid. How would a person’s ability to break down glucose through glycolysis be affected if the person’s diet were deficient in both niacin and tryptophan? Explain your answer. ____________________________

STRUCTURES AND FUNCTIONS The diagram below depicts the stages of fermentation. Complete the diagram by writing the names of the pathways in the ovals and the names of the molecules in the boxes.

```
O2 absent

a

b

c

2

O2 absent

<table>
<thead>
<tr>
<th>d</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>f</td>
<td>g</td>
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```
SECTION 7-2 REVIEW

AEROBIC RESPIRATION

VOCABULARY REVIEW  Define the following terms.

1. aerobic respiration ________________________________

2. mitochondrial matrix ________________________________

3. Krebs cycle ________________________________

4. FAD ________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

1. The breakdown product of glucose that diffuses into the mitochondrial matrix for further breakdown is
   a. acetyl CoA.   b. pyruvic acid.   c. oxaloacetic acid.   d. citric acid.

2. The starting substance of the Krebs cycle, which is regenerated at the end of the cycle, is
   a. acetyl CoA.   b. pyruvic acid.   c. oxaloacetic acid.   d. citric acid.

3. The Krebs cycle
   a. produces two molecules of CO₂.   c. produces NAD⁺ from NADH and H⁺.
   b. produces a six-carbon molecule from six molecules of CO₂.   d. generates most of the ATP produced in aerobic respiration.

4. The electron transport chain of aerobic respiration
   a. generates O₂ from H₂O.
   b. produces NADH by chemiosmosis.
   c. pumps electrons into the mitochondrial matrix.
   d. pumps protons into the space between the inner and outer mitochondrial membranes.

5. The maximum efficiency of aerobic respiration is approximately
   a. 0.39%.   b. 3.9%.   c. 39%.   d. 390%.
**SHORT ANSWER** Answer the questions in the space provided.

1. In the Krebs cycle, what molecule acquires most of the energy that is released by the oxidation of acetyl CoA, and how many of these molecules are produced during each turn of the cycle?

2. Which reactions of aerobic respiration occur in the inner mitochondrial membrane?

3. Write the equation for the complete oxidation of glucose in aerobic respiration.

4. **Critical Thinking** How is the structure of a mitochondrion well adapted for the activities it carries out?

**STRUCTURES AND FUNCTIONS** Use the diagram to answer the following questions.

The diagram below summarizes the electron transport chain and chemiosmosis in aerobic respiration. Label the substances that are transported along the arrows labeled a–d in the spaces provided. Label the reactants or products that are represented by e–g in the spaces provided.
SECTION 8-1 REVIEW

CHROMOSOMES

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. histone, nonhistone protein ______________________________________________________

2. chromatid, centromere __________________________________________________________

3. sex chromosome, autosome ______________________________________________________

4. diploid cell, haploid cell _________________________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

_____  1. During cell division, the DNA in a eukaryotic cell is tightly packed and coiled into structures called
     a. centromeres.  b. histones.  c. haploids.  d. chromosomes.

_____  2. Between cell divisions, the DNA in a eukaryotic cell is uncoiled and spread out; in this form it is called
     a. chromatid.  b. chromatin.  c. histone.  d. nonhistone.

_____  3. The chromosomes of most prokaryotes consist of proteins and
     a. a single circular DNA molecule.
     b. a single linear DNA molecule.
     c. a pair of linear DNA molecules joined in the center.
     d. a pair of homologous, circular DNA molecules.

_____  4. Humans have 46 chromosomes in all cells except sperm and egg cells. How many of these chromosomes are autosomes?
     a. 2  b. 23  c. 44  d. 46

_____  5. If an organism has a diploid, or 2n, number of 16, how many chromosomes do its sperm cells or eggs cells contain?
     a. 8  b. 16  c. 32  d. 64
**SHORT ANSWER** Answer the questions in the space provided.

1. What role do proteins play in enabling the enormous amount of DNA in a eukaryotic cell to fit into the nucleus, and what are those proteins called? __________________________

2. In what ways are homologous chromosomes similar? __________________________

3. What is the picture below called, and how is it used to determine the sex of a person?

   ![Karyotype Diagram]

   __________________________

4. **Critical Thinking** Some relatively simple eukaryotes, such as the adder’s tongue fern, may have many more chromosomes than a more complex eukaryote, such as a mammal. What might this suggest about the size and organization of chromosomes in different species?

   __________________________

   __________________________

**STRUCTURES AND FUNCTIONS** The diagram below shows structures isolated from the nucleus of a dividing eukaryotic cell. Label each structure or pair of structures in the space provided.

![Diagram of Chromosomes]

   a __________________________

   b __________________________

   c __________________________

   d __________________________

---

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VOCABULARY REVIEW  Circle the term that does not belong in each of the following groups, and briefly explain why it does not belong.

1. G₁ phase, G₂ phase, S phase, telophase

2. anaphase, interphase, metaphase, prophase

3. binary fission, mitosis, meiosis, cytokinesis

4. cleavage furrow, cytokinesis, spindle fiber, cell plate

5. centrioles, vesicles, kinetochore fibers, polar fibers

MULTIPLE CHOICE  Write the correct letter in the blank.

___  1. Prokaryotic cells reproduce by a process called
   a. mitosis.  b. meiosis.  c. binary fission.  d. binary fusion.

___  2. In eukaryotic cells, DNA is copied during a phase of the cell cycle called

___  3. The cytoplasm of a eukaryotic cell divides by a process called
   a. mitosis.  b. meiosis.  c. replication.  d. cytokinesis.

___  4. The fibers that extend from centrosome to centrosome during mitosis are
   a. polar fibers.  b. spindle fibers.  c. kinetochore fibers.  d. binary fibers.

___  5. In the G₀ phase, cells
   a. synthesize DNA.  c. exit from the cell cycle.
   b. prepare for cell division.  d. move their chromosomes to the
   cell equator.
SHORT ANSWER  Answer the questions in the space provided.

1. List the five main phases of the cell cycle, and briefly explain what occurs during each phase.

2. List the four phases of mitosis, and briefly explain what occurs during each phase.

3. Describe cytokinesis in a plant cell.

4. Critical Thinking  What would happen to a cell and its offspring if the cells did not go through a G1 phase during their cell cycle? Explain.

STRUCTURES AND FUNCTIONS  In the spaces provided below, label each figure with the phase of mitosis that it represents.

a  b  c  d
SECTION 8–3 REVIEW

MEIOSIS

VOCABULARY REVIEW Define the following terms.

1. oogenesis

2. tetrad

3. independent assortment

4. polar bodies

MULTIPLE CHOICE Write the correct letter in the blank.

1. During synapsis, the
   a. DNA in each chromosome is copied.
   b. spindle fibers disappear.
   c. cytoplasm divides.
   d. chromosomes line up next to their homologues.

2. During crossing-over, portions of chromatids
   a. double the amount of DNA in each chromosome.
   b. move from autosomes to sex chromosomes.
   c. break off and attach to adjacent chromatids on the homologous chromosome.
   d. separate from each other and move to opposite poles of the cell.

3. In which phase of meiosis do tetrads form?
   a. prophase I  
   b. telophase I  
   c. metaphase II  
   d. anaphase II

4. Meiosis II
   a. is preceded by the copying of DNA.
   b. separates chromatids into opposite poles of the cell.
   c. separates homologous chromosomes into opposite poles of the cell.
   d. produces diploid offspring cells.

5. In oogenesis, a diploid reproductive cell divides meiotically to produce
   a. one diploid gamete.
   b. four diploid gametes.
   c. one haploid gamete.
   d. four haploid gametes.
**SHORT ANSWER** Answer the questions in the space provided.

1. Describe two ways in which genetic recombination occurs during meiosis.

   
   

2. List the four phases of meiosis I, and briefly explain what occurs during each phase.

   
   

3. How do the products of meiosis I differ from those of meiosis II?

   
   

4. **Critical Thinking** What are one advantage and one disadvantage of asexual reproduction compared with sexual reproduction?

   
   

**STRUCTURES AND FUNCTIONS** In the spaces provided below, label each figure with the phase of meiosis that it represents.

- [ ] a
- [ ] b
- [ ] c
- [ ] d
SECTION 9-1 REVIEW

MENDEL’S LEGACY

VOCABULARY REVIEW Distinguish between the terms in each of the following pairs of terms.

1. F<sub>1</sub> generation, F<sub>2</sub> generation

2. dominant, recessive

3. self-pollination, cross-pollination

MULTIPLE CHOICE Write the correct letter in the blank.

1. Mendel obtained plants that were true-breeding for particular traits by
   a. growing plants from the seeds of other plants that showed that trait.
   b. discarding plants that showed other traits.
   c. allowing plants to self-pollinate for several generations.
   d. allowing plants to cross-pollinate for one generation.

2. When Mendel crossed a strain of tall pea plants with a strain of short pea plants, he observed that all of the plants in the F<sub>1</sub> generation were tall. This suggests that
   a. the tall trait was controlled by a dominant factor.
   b. the short trait was controlled by a dominant factor.
   c. both traits were controlled by a recessive factor.
   d. the strain of short plants was not capable of pollinating the strain of tall plants.

3. A cross between true-breeding green-podded pea plants and true-breeding yellow-podded pea plants produces only green-podded plants. When the F<sub>1</sub> generation is allowed to self-pollinate, the F<sub>2</sub> generation consists of
   a. only green-podded plants.
   b. only yellow-podded plants.
   c. about three-quarters yellow-podded plants and one-quarter green-podded plants.
   d. about three-quarters green-podded plants and one-quarter yellow-podded plants.

4. When alleles for different characteristics are on separate chromosomes, they are distributed to gametes independently. This observation is summarized by the law of
   a. cross-pollination.
   b. independent assortment.
   c. segregation.
   d. molecular genetics.
**SHORT ANSWER** Answer the questions in the space provided.

1. What does the term *allele* mean as it is used in genetic crosses?

2. Explain how the events of meiosis account for the law of segregation and the law of independent assortment.

3. If orange flower color in a plant is controlled by an allele *F* and red flower color is controlled by an allele *f*, which flower color is dominant? If true-breeding orange-flowered plants are crossed with true-breeding red-flowered plants, what will be the flower color(s) of the F₁ plants?

4. **Critical Thinking** How would Mendel’s observations and conclusions have been different if many of the characteristics he studied, such as seed color and seed texture, had been controlled by genes located close together on the same chromosome?

**STRUCTURES AND FUNCTIONS** In the spaces inside each gamete, indicate the four possible combinations of alleles the gametes could receive.

The diagram below shows the assortment of two pairs of homologous chromosomes during meiosis. One pair has a gene for flower color (*R* allele = red, *r* allele = white). The other pair has a gene for seed color (*B* allele = brown, *b* allele = gray).
SECTION 9–2 REVIEW

GENETIC CROSSES

VOCABULARY REVIEW Define the following terms, and provide one example for each.

1. complete dominance

2. incomplete dominance

3. codominance

MULTIPLE CHOICE Write the correct letter in the blank.

1. The appearance of an organism is its
   a. genotype.       b. phenotype.       c. genotypic ratio.       d. phenotypic ratio.

2. A genetic cross performed many times produces 798 long-stemmed plants and 266 short-stemmed plants. The probability of obtaining a short-stemmed plant in a similar cross is
   a. 266/1,064.       b. 266/798.       c. 798/266.       d. 798/1,064.

3. A monohybrid cross of two individuals that are heterozygous for a trait exhibiting complete dominance would probably result in a phenotypic ratio of
   a. 4 dominant:0 recessive.       b. 1 dominant:3 recessive.       c. 3 dominant:1 recessive.       d. 1 dominant:1 recessive.

4. To determine the genotype of an individual that shows the dominant phenotype, you would cross that individual with one that is
   a. heterozygous dominant.       b. heterozygous recessive.       c. homozygous dominant.       d. homozygous recessive.

5. In a dihybrid cross between an individual with the genotype RRYY and an individual with the genotype rryy, all of the offspring will have the genotype
   a. RRYY.       b. RrYY.       c. RrYy.       d. rryy.
**SHORT ANSWER** Answer the questions in the space provided.

1. What is the difference between a homozygous individual and a heterozygous individual?

2. If the probability that a specific trait will appear in the F2 generation is 0.25, how many individuals would be expected to show that trait in an F2 generation consisting of 80 individuals?

3. A homozygous dominant individual (AA) is crossed with an individual that is heterozygous for the same trait (Aa). What are the possible genotypes of the offspring, and what percentage of the offspring is likely to show the dominant phenotype?

4. **Critical Thinking** Some animals, such as cows, normally produce only one offspring from each mating. If a cow showed a dominant phenotype, why would a typical testcross be a difficult way to determine the genotype of that animal?

**STRUCTURES AND FUNCTIONS** Write the possible genotypes of the offspring in the Punnett square below. Then answer the questions in the spaces provided.

A plant with the genotype WwRr is crossed with another plant with the same genotype.

```
WwRr

WwRr
```

1. What proportion of the offspring will be dominant for both traits?

2. What proportion of the offspring will have the same genotype as their parents?

3. What proportion of the offspring will be homozygous dominant for both traits?

4. What proportion of the offspring will be homozygous recessive for both traits?
SECTION 10-1 REVIEW

DISCOVERY OF DNA

VOCABULARY REVIEW
Define the following terms.

1. **virulent**

2. **transformation**

3. **bacteriophage**

MULTIPLE CHOICE
Write the correct letter in the blank.

1. The virulent strain of the bacterium *S. pneumoniae* causes disease because it
   a. has a capsule.      c. undergoes transformation.
   b. lacks a capsule.    d. does not undergo transformation.

2. Oswald Avery and his colleagues showed that the transforming agent in Griffith’s experiments was
   a. RNA.    b. protein.       c. DNA.       d. an enzyme.

3. Hershey’s and Chase’s experiment led to the conclusion that
   a. protein is the hereditary molecule in viruses.
   b. DNA is responsible for transformation in bacteria.
   c. hereditary material can pass from cell to cell.
   d. DNA is the hereditary molecule in viruses.

4. Hershey and Chase used what organism in their experiments?
   a. *E. coli*    b. *S. pneumoniae*    c. *S. aureus*    d. *B. transformis*

5. The *S* strain and the *R* strain of *S. pneumoniae* are different in that
   a. the *R* strain produces a capsule but the *S* strain does not.
   b. the *S* strain produces a capsule but the *R* strain does not.
   c. the *R* strain is virulent but the *S* strain is not.
   d. the *R* strain contains protein but the *S* strain does not.
**SHORT ANSWER** Answer the questions in the space provided.

1. What was the purpose of Griffith’s experiment 1, in which he injected a mouse with live R cells?

2. What was the purpose of Griffith’s experiment 2, in which he injected a mouse with live S cells?

3. What was the purpose of Griffith’s experiment 3, in which he injected a mouse with heat-killed S cells?

4. What was the purpose of Griffith’s experiment 4, in which he injected a mouse with a mixture of heat-killed S cells and live R cells?

5. **Critical Thinking** Why is an S strain of bacteria able to cause disease in mammals but a R strain is not?

---

**STRUCTURES AND FUNCTIONS** In the spaces provided, write the number of the experiment that resulted in the following conclusions.

**Hershey-Chase’s Experiments**

<table>
<thead>
<tr>
<th>Experiment Number</th>
<th>Preparation</th>
<th>Action</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 1</td>
<td>radioactive sulfur used to label protein in phage</td>
<td>infect <em>E. Coli</em> with sulfur-labeled phage</td>
<td>radioactive sulfur did not enter bacterial cell</td>
</tr>
<tr>
<td>Experiment 2</td>
<td>radioactive phosphorous used to label DNA in phage</td>
<td>infect <em>E. Coli</em> with phosphorous-labeled phage</td>
<td>radioactive phosphorous entered bacterial cell</td>
</tr>
</tbody>
</table>

1. DNA is the hereditary material.
2. Protein is not the hereditary material.
VOCABULARY REVIEW Define the following terms and provide one example for each.

1. purine
   
   

2. pyrimidine
   
   

3. complementary base pair
   
   

4. nitrogenous base
   
   

MULTIPLE CHOICE Write the correct letter in the blank.

1. The primary function of DNA in cells is to
   
   a. serve as a storage form for unused nucleotides.
   b. occupy space in the nucleus to keep the nucleus from collapsing.
   c. store information that tells the cells which proteins to make.
   d. serve as a template for making long, spiral carbohydrates.

2. The two strands of a DNA molecule are held together by
   
   a. ionic bonds.
   b. covalent bonds.
   c. peptide bonds.
   d. hydrogen bonds.

3. According to the base-pairing rules, guanine binds with
   
   a. cytosine.
   b. adenine.
   c. thymine.
   d. guanine.

4. Which of the following is NOT a correct structure of a nucleotide?
   
   a. adenine—deoxyribose—phosphate
   b. adenine—ribose—phosphate
   c. cytosine—deoxyribose—phosphate
   d. guanine—deoxyribose—phosphate

5. The percentage of adenine in DNA is
   
   a. equal to the percentage of cytosine.
   b. equal to the percentage of thymine.
   c. not related to the percentage of thymine.
   d. equal to the percentage of guanine.
SHORT ANSWER Answer the questions in the space provided.

1. What are the three parts of a DNA nucleotide, and how are they connected to each other?

2. If 15% of the nucleotides in a DNA molecule contain guanine, what percentage of the nucleotides contain each of the other three bases? Explain your reasoning.

3. Why is complementary base pairing important in DNA structure?

4. Critical Thinking How did X-ray diffraction photographs help Watson and Crick determine the structure of DNA?

STRUCTURES AND FUNCTIONS Label each part of the figure in the spaces provided.

The diagram below shows two nucleotide base pairs in a segment of a DNA molecule.
SECTION 10-3 REVIEW

DNA REPLICATION

VOCABULARY REVIEW  Define the following terms.

1. replication fork ____________________________
   __________________________________________

2. helicase ____________________________
   __________________________________________

3. semi-conservative replication ____________________________
   __________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Before replication can take place,
   a. DNA polymerases must add complementary nucleotides to the DNA.
   b. the two strands of DNA must separate.
   c. the covalent bonds in DNA must break.
   d. helicases must break the bonds in the nucleotides.

2. Replication of the two DNA strands takes place
   a. in two different directions.
   b. in the same direction of the replication fork.
   c. in a direction opposite to that of the replication fork.
   d. at right angles to the direction of the replication fork.

3. In replication in prokaryotes,
   a. there are two origins.
   b. two replication forks move in opposite directions.
   c. replication proceeds in one direction.
   d. there are no replication forks.

4. A mutation is a
   a. change in the direction of a replication fork.
   b. form of cancer.
   c. kind of DNA replication.
   d. change in the nucleotide sequence of DNA.

5. Which of the following enzymes is involved with breaking hydrogen bonds?
   a. DNA polymerase  c. DNA helicase
   b. DNA ligase  d. Both a and b
SHORT ANSWER Answer the questions in the space provided.

1. How does replication occur so quickly in eukaryotes?

2. Why is it important that exact copies of DNA are produced during replication?

3. How is DNA replication related to cancer?

4. Critical Thinking Why is it advantageous to have weak hydrogen bonds between complementary bases and strong covalent bonds between phosphate and deoxyribose groups in a DNA molecule?

STRUCTURES AND FUNCTIONS The figure below shows DNA replicating. In the space provided, describe what is occurring at each lettered section of the figure.
**SECTION 10-4 REVIEW**

**PROTEIN SYNTHESIS**

**VOCABULARY REVIEW** Define the following terms.

1. **Codon**
2. **Translation**
3. **Anticodon**

**MULTIPLE CHOICE** Write the correct letter in the blank.

1. A protein is a polymer consisting of a specific sequence of
   - a. amino acids.
   - b. fatty acids.
   - c. RNA nucleotides.
   - d. DNA nucleotides.

2. The genetic code specifies the correlation between
   - a. a DNA-nucleotide sequence and an RNA-nucleotide sequence.
   - b. an mRNA-nucleotide sequence and a tRNA-nucleotide sequence.
   - c. an mRNA-nucleotide sequence and an rRNA-nucleotide sequence.
   - d. an RNA-nucleotide sequence and an amino-acid sequence.

3. During translation, one end of a tRNA molecule pairs with a complementary
   - a. nucleotide sequence in DNA.
   - b. mRNA codon.
   - c. tRNA molecule.
   - d. protein molecule.

4. In eukaryotic cells, RNA is copied from DNA in the
   - a. ribosomes.
   - b. nucleus.
   - c. nuclear membrane.
   - d. cytosol.

5. Two amino acids are linked by a peptide bond when
   - a. two ribosomes attach simultaneously to the same mRNA transcript.
   - b. two tRNAs pair with neighboring codons on an mRNA transcript.
   - c. two codons on an mRNA transcript bind to each other.
   - d. a ribosome attaches to two codons on an mRNA transcript.
SHORT ANSWER  Answer the questions in the space provided.

1. List, in order, the tRNA anticodons that are complementary to the mRNA sequence
   AUGCAUGCAAGUUAG. ____________________________________________________________
   How many amino acids will be in the polypeptide that is initially formed when this mRNA
   sequence is translated? _________________________________________________________

2. Explain why methionine is the first amino acid in every growing polypeptide. ________________
   _____________________________________________________________________________

3. Describe three ways that RNA differs from DNA. _________________________________________
   _____________________________________________________________________________
   _____________________________________________________________________________
   _____________________________________________________________________________

4. Critical Thinking  How would a deletion of one nucleotide in the middle of an mRNA transcript
   affect the polypeptide specified by that transcript? _________________________________
   _____________________________________________________________________________
   _____________________________________________________________________________
   _____________________________________________________________________________

STRUCTURES AND FUNCTIONS  Label each part of the figure in the spaces provided.

The diagram below summarizes the events that occur during translation.

[Diagram of translation process with labeled parts: a, b, c, d, e, f, g, h]
SECTION 11-1 REVIEW

CONTROL OF GENE EXPRESSION

VOCABULARY REVIEW  Explain the relationship between the terms in each of the following pairs of terms.

1. regulator gene, repressor protein

2. operator, operon

3. intron, exon

4. transcription factor, enhancer

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. A gene is expressed when it is
a. present in the genome of an individual.
b. prevented from interacting with RNA polymerase.
c. transcribed into mRNA.
d. duplicated during the replication of DNA.

_____ 2. In the lac operon of E. coli, lactose functions as
a. a promoter.  b. an operator.  c. a repressor protein  d. an inducer.

_____ 3. In eukaryotic cells, transcription occurs
a. on parts of the DNA that are uncoiled.  c. only on exons.
b. only on introns.  d. on all parts of the DNA.

_____ 4. Unlike gene expression in prokaryotes, gene expression in eukaryotes
a. cannot be regulated before transcription has occurred.
b. can be regulated after transcription has occurred.
c. does not involve promoters.
d. involves the transcription of groups of genes called operons.

_____ 5. Enhancers
a. code for proteins called inducers.
b. must be located close to the genes they activate.
c. are found only in prokaryotic genomes.
d. facilitate transcription by binding to transcription factors.
SHORT ANSWER  Answer the questions in the space provided.

1. What is an operon, and in what type of organism are operons found?

2. Describe what occurs during activation of the lac operon.

3. Describe what occurs during repression of the lac operon.

4. Critical Thinking  How does the absence of a nuclear envelope in prokaryotes prevent prokaryotes from controlling gene expression by modifying RNA after transcription?

STRUCTURES AND FUNCTIONS  Use the figure to answer the following questions.

1. The diagram below represents the lac operon in the presence of lactose. Label each part of the diagram in the space provided.

2. If the regulator gene were deleted, how would this affect expression of the structural genes?

   Explain your answer.

3. Is transcription of the structural genes activated or repressed under the conditions shown above? Explain your answer.
SECTION 11-2 REVIEW

GENE EXPRESSION IN DEVELOPMENT AND CELL DIVISION

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. homeobox, homeotic gene
   - Homeobox is a DNA sequence found in the development of many organisms, including humans. It is involved in the regulation of gene expression during embryonic development. A homeotic gene is a type of gene that controls the identity of a group of body segments. Homeotic genes are found in insects and plants, where they play a crucial role in the development of body segments. In vertebrates, homeotic genes are involved in the development of the nervous system and the axial skeleton.

2. proto-oncogene, oncogene
   - Proto-oncogenes are normal genes that can become oncogenes when they are mutated. Proto-oncogenes can be activated by external factors such as viruses, chemicals, or radiation. Oncogenes are mutations of proto-oncogenes that cause cells to divide uncontrollably, leading to cancer.

3. sarcoma, lymphoma
   - Sarcoma is a type of cancer that arises from mesenchymal tissues, such as muscle, bone, or fat. Sarcomas are classified by the type of tissue they originate from. Lymphoma is a type of cancer that develops in the lymphatic system and can affect the lymph nodes, spleen, and other organs. Lymphoma is classified as either Hodgkin lymphoma or non-Hodgkin lymphoma.

4. oncogene, tumor-suppressor gene
   - Oncogenes are genes that, when activated, can cause cancer by promoting cell growth and division. Tumor-suppressor genes are genes that, when mutated, can lead to cancer by preventing the growth and division of cells.

MULTIPLE CHOICE  Write the correct letter in the blank.

     1. The expression of different genes in different cells of a multicellular organism

       a. contributes to the development of form in an organism.

       b. causes the uncontrolled proliferation of cells.

       c. is caused by the transfer of cells from one organism to another.

       d. results from mutations that destroy normal gene functioning.

     2. homeoboxes are

       a. found only in prokaryotes.

       b. found only in Drosophila.

       c. mutations that can have devastating consequences on development.

       d. DNA sequences that regulate patterns of development.

     3. The major distinguishing characteristic of cancer is

       a. uncontrolled cell division.

       b. production of viruses.

       c. metastasis.

       d. tumor formation.

     4. More than 85 percent of all lung cancers are caused by

       a. asbestos.

       b. tobacco smoke.

       c. X rays.

       d. ultraviolet light.
5. A gene whose normal function is to prevent uncontrolled cell division is
a. an oncogene.

b. a cancer gene.
c. a homeotic gene.
d. a tumor-suppressor gene.

**SHORT ANSWER** Answer the questions in the space provided.

1. How do homeotic genes regulate development in *Drosophila*?

2. What factors influence whether a person will develop cancer?

3. How can viruses induce cancer?

4. What are two key characteristics of cancer cells?

5. **Critical Thinking** A great deal of research on the causes of and a possible cure for cancer focuses on the genes that control the cell cycle. Why?

**STRUCTURES AND FUNCTIONS** Complete the flowchart below by filling in the three boxes at the bottom.

- **Proto-oncogenes**
  - Normal
  - Effect:
  - Effect:
  - Effect:

- **Tumor-suppressor genes**
  - Normal
  - Effect:
  - Effect:
  - Effect:
SECTION 12-1 REVIEW

CHROMOSOMES AND INHERITANCE

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. sex chromosome, autosome

2. germ-cell mutation, somatic-cell mutation

3. translocation, nondisjunction

4. deletion, inversion

5. substitution, frameshift mutation

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Genes that belong to the same linkage group tend to be
   a. located on different chromosomes.  
   b. inherited together.  
   c. found only in males.  
   d. found only in somatic cells.

2. Two genes that are one map unit apart are separated by crossing-over
   a. 1% of the time.  
   b. 20% of the time.  
   c. 50% of the time.  
   d. 100% of the time.

3. Mutations that can be inherited arise in
   a. somatic cells.  
   b. body cells.  
   c. germ cells.  
   d. skin cells.

4. Which of the following sequences could result from an inversion of the sequence GAGACATT?
   a. GAGCATT  
   b. GTGACATT  
   c. CTCTGATT  
   d. GATACAGT

5. Which of the following is a point mutation that does not produce a frameshift?
   a. substitution  
   b. insertion  
   c. deletion  
   d. inversion
SHORT ANSWER  Answer the questions in the space provided.

1. In humans and fruit flies, which parent determines the sex of the offspring? Explain why. ____________
   _______________________________________________________________________________________
   _______________________________________________________________________________________

2. How did Morgan determine that red-eye color in Drosophila is an X-linked trait? ________________
   _______________________________________________________________________________________
   _______________________________________________________________________________________

3. Explain why traits that are controlled by genes on the same chromosome do not always appear in the expected ratio in offspring. _______________________________________________________________________________________
   _______________________________________________________________________________________

4. Critical Thinking  Would a frameshift mutation have a more serious effect if it occurred near the beginning of a gene or the end of a gene? Explain your answer. _______________________________________________________________________________________
   _______________________________________________________________________________________
   _______________________________________________________________________________________

STRUCTURES AND FUNCTIONS  Use the data in the table below to indicate the position of these genes on the chromosome map shown below. Assuming that the gene for white eyes has a chromosome map unit number of 1, write the map unit numbers above each gene’s position on the chromosome map.

The Drosophila genes for white eyes, vermilion eyes, and miniature wings are located on the same chromosome. The table shows how often these genes are separated by crossing-over.

<table>
<thead>
<tr>
<th>Genes</th>
<th>Frequency of crossing-over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vermilion eyes and miniature wings</td>
<td>3%</td>
</tr>
<tr>
<td>White eyes and vermilion eyes</td>
<td>30%</td>
</tr>
<tr>
<td>White eyes and miniature wings</td>
<td>33%</td>
</tr>
</tbody>
</table>

0 40
HUMAN GENETICS

VOCABULARY REVIEW Name a trait or genetic disorder that is caused by each of the following patterns of inheritance.

1. polygenic inheritance __________
2. multiple alleles __________
3. autosomal dominant __________
4. sex-influenced trait __________
5. incomplete dominance __________

MULTIPLE CHOICE Write the correct letter in the blank.

1. Which individual(s) in the pedigree shown below must be a carrier?
   a. 1 only
   b. 4 only
   c. 3 only
   d. both 1 and 4

2. Since the ABO blood group alleles are codominant, an individual with the genotype \( I^A I^B \) will have blood type
   a. A.  
   b. B.  
   c. AB. 
   d. O.

3. Which of the following human traits is not a polygenic trait?
   a. skin color  
   b. eye color  
   c. height  
   d. ABO blood type

4. A trait whose expression is affected by the presence of sex hormones is said to be
   a. sex-influenced.  
   b. sex-linked.  
   c. X-linked.  
   d. Y-linked.

5. In humans, PKU can be treated by
   a. insulin injections.  
   b. diet.  
   c. gene therapy.  
   d. surgery.
SHORT ANSWER  Answer the questions in the space provided.

1. Why is pattern baldness more common in men than in women? ____________________________
______________________________
______________________________
______________________________

2. Briefly describe how amniocentesis and chorionic villi sampling are used in genetic screening.
______________________________
______________________________
______________________________
______________________________

3. Explain the difference between a sex-linked trait and a sex-influenced trait.
______________________________
______________________________
______________________________

4. Critical Thinking  A couple has four children, and each child has a different ABO blood type.
What are the blood types and genotypes of the children and the parents? ____________________________
______________________________

STRUCTURES AND FUNCTIONS  In the two pedigrees below, indicate all possible offspring in generation II by correctly filling in the male and female symbols for generation II. Use a completely filled symbol to represent an individual who displays the trait and a half-filled symbol to represent a carrier.

X-linked recessive trait

Autosomal recessive trait
SECTION 13-1 REVIEW

DNA TECHNOLOGY

VOCABULARY REVIEW  Define the following terms.

1. DNA fingerprint

2. gel electrophoresis

3. probe

4. primer

MULTIPLE CHOICE  Write the correct letter in the blank.

_____  1. To cut DNA molecules into pieces at specific sequences of nucleotides, genetic engineers use
   a. cloning vectors.  
   b. insulin.  
   c. bacteria.  
   d. restriction enzymes.

_____  2. In gel electrophoresis, DNA fragments migrate toward one end of a gel because they are
   a. pulled toward that end by gravity.  
   b. attracted to complementary DNA fragments at that end of the gel.  
   c. attracted to the positively charged end of the gel.  
   d. repelled by hydrophobic molecules at the other end of the gel.

_____  3. The accuracy of DNA fingerprinting can be increased by comparing
   a. segments of DNA that tend to vary the least from person to person.  
   b. noncoding segments from several loci.  
   c. DNA from identical twins.  
   d. repeat patterns at only one or two sites in the genome.

_____  4. In addition to DNA polymerase and primers, the polymerase chain reaction also requires
   a. a large amount of DNA.  
   b. restriction enzymes.  
   c. a supply of the four DNA nucleotides.  
   d. complementary sequences of RNA.

_____  5. To obtain bacteria that produce insulin, genetic engineers
   a. remove repressor proteins that inhibit the expression of the bacterial insulin gene.  
   b. insert a vector containing the human gene for insulin into bacteria.  
   c. search for bacteria that can grow in a medium that lacks insulin.  
   d. grow normal bacteria in a nutrient medium that contains a large amount of sugar.
SHORT ANSWER Answer the questions in the space provided.

1. How are radioactive probes useful in DNA fingerprinting?

2. How is the polymerase chain reaction useful in DNA fingerprinting?

3. Critical Thinking Why is it necessary to use the same restriction enzyme to cut two pieces of DNA that are to be joined together?

4. List three ways that DNA technology could be used to improve the lives of humans.

STRUCTURES AND FUNCTIONS In the spaces provided, write the names for the objects labeled a–f.

The diagram below summarizes the procedure for transferring a human gene into a bacterium.

[Diagram of gene transfer process]
SECTION 13-2 REVIEW

THE HUMAN GENOME PROJECT

VOCABULARY REVIEW Define the following terms.

1. proteomics ____________________________________________

2. bioinformatics __________________________________________

3. single nucleotide polymorphisms (SNP) ____________________________

4. Human Genome Project ______________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. One of the goals of the Human Genome Project is to
    a. increase the number of genes in the human genome.
    b. map the location of only the most important genes on each chromosome.
    c. clone the entire human genome in bacteria.
    d. determine the nucleotide sequence of the entire human genome.

_____ 2. One of the surprising discoveries of the Human Genome Project was that
    a. the human genome consists of only about 30,000 to 40,000 genes.
    b. 98 percent of the human genome codes for proteins.
    c. each gene encodes only a single protein.
    d. the human genome contains no transposons.

_____ 3. An understanding of the human genome is aided by an understanding of
    a. mathematics.  c. DNA fingerprints.
    b. computer science.  d. the genomes of model species.

_____ 4. What percentage of the human genome codes for proteins?
    a. 98 percent  
    b. 10 percent  
    c. 25 percent  
    d. 2 percent

_____ 5. A DNA microarray is an important tool because it
    a. can cure cancer.  c. identifies an individual.
    b. shows which genes are active in a cell.  d. dyes tumor cells to kill them.
SHORT ANSWER  Answer the questions in the space provided.

1. Why did scientists want to map the human genome? 

2. List three important discoveries that resulted from the Human Genome Project.

3. Critical Thinking  Why is it more important to understand the human proteome than the human genome?

STRUCTURES AND FUNCTIONS  Use the table to answer the following questions in the spaces provided.

1. What is the relationship, if any, between the complexity of an organism and the size of its genome?

2. What might explain why there is not a direct relationship between the size of an organism’s genome and the number of genes it contains?

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Organism (common name)</th>
<th>Genome size (million bases)</th>
<th>Number of genes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archaebacteria</td>
<td>Pyrococcus</td>
<td>1.9</td>
<td>2,065</td>
</tr>
<tr>
<td>Eubacteria</td>
<td>Chlamydia</td>
<td>1.0</td>
<td>894</td>
</tr>
<tr>
<td></td>
<td>E. coli</td>
<td>4.6</td>
<td>4,289</td>
</tr>
<tr>
<td>Protista</td>
<td>Amoeba</td>
<td>34</td>
<td>~9,000</td>
</tr>
<tr>
<td>Fungi</td>
<td>Yeast</td>
<td>12</td>
<td>6,000</td>
</tr>
<tr>
<td>Plantae</td>
<td>Mustard</td>
<td>125</td>
<td>23,174</td>
</tr>
<tr>
<td></td>
<td>Easter lily</td>
<td>100,000</td>
<td>~25,000</td>
</tr>
<tr>
<td>Animalia</td>
<td>Fruitfly</td>
<td>120</td>
<td>13,600</td>
</tr>
<tr>
<td></td>
<td>Roundworm</td>
<td>97</td>
<td>19,049</td>
</tr>
<tr>
<td></td>
<td>Frog</td>
<td>1,700</td>
<td>~30,000</td>
</tr>
<tr>
<td></td>
<td>Human</td>
<td>3,300</td>
<td>35,000</td>
</tr>
<tr>
<td></td>
<td>Mouse</td>
<td>3,630</td>
<td>~30,000</td>
</tr>
<tr>
<td></td>
<td>Zebrafish</td>
<td>1,700</td>
<td>~3,000</td>
</tr>
</tbody>
</table>
SECTION 13-3 REVIEW

GENETIC ENGINEERING

VOCABULARY REVIEW  Define the following terms.

1. DNA vaccine  

2. telomere  

3. bioethics  

4. gene therapy  

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Many of the pharmaceutical products being produced by DNA technology are
   a. carbohydrates.  b. lipids.  c. proteins.  d. polysaccharides.

2. When the human body mobilizes its defenses against a pathogen, the body recognizes the pathogen’s
   a. surface proteins.  b. DNA.  c. RNA.  d. genome.

3. DNA technology is being used to develop crop plants that are
   a. less toxic to the pests that normally feed on them.  c. unable to fix nitrogen in the atmosphere.
   b. more susceptible to herbicides.  d. resistant to some diseases.

4. Scientists have inserted genes into rice plants that
   a. code for enzymes that cause rice to ripen quickly.
   b. increase the iron and beta carotene levels.
   c. code for substances that cause allergies in people.
   d. increase the thickness of the seed coat.

5. Some people are concerned that genetically engineered crop plants could
   a. transmit their new genes to wild plant species, producing “superweeds.”
   b. transmit their new genes to the animals that eat the plants, producing “superanimals.”
   c. exchange genes with animals, producing plant-animal hybrids.
   d. be wiped out by native plant species.
SHORT ANSWER Answer the questions in the space provided.

1. How does a DNA vaccine prevent future disease?

2. If Dolly’s cloning was successful, why was her lifespan shorter than normal?

3. Why doesn’t gene therapy cure cystic fibrosis?

4. Describe a potential problem that could arise from genetic engineering.

5. Critical Thinking What is a possible beneficial change besides those mentioned in the text that could be made to crop plants using DNA technology?

STRUCTURES AND FUNCTIONS The flowchart below summarizes some of the successes of genetic engineering. Complete the chart by filling in the blanks.

Genetic engineering

- of animals has produced
- of plants has produced

- a
- b
- c
- d
- e
SECTION 14-1 REVIEW

BIOGENESIS

VOCABULARY REVIEW Define the following terms.

1. biogenesis ____________________________________________

2. spontaneous generation __________________________________

3. vital force ____________________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

____  1. One of the observations that led people to think that life could arise from nonliving things was that
   a. maggots turned into oval cases from which flies eventually emerged.
   b. fish appeared in ponds that had been dry the previous season.
   c. large fish developed from smaller fish, which hatched from fish eggs.
   d. fish grew larger by eating other living things, such as flies.

____  2. The purpose of the netting in Redi’s experiment was to prevent
   a. maggots from leaving the jar.
   b. air from leaving the jar.
   c. adult flies from entering the jar.
   d. bacteria from entering the jar.

____  3. In the experimental group in Spallanzani’s experiment, the
   a. broth remained clear.
   b. flask contained no broth.
   c. broth was not boiled.
   d. flask was not sealed.

____  4. Spallanzani’s opponents disagreed with his conclusion that microorganisms from the air contaminated the boiled meat broth. They argued that Spallanzani
   a. heated the flasks too long, killing the microorganisms in the broth.
   b. heated the flasks too long, destroying the “vital force” in the air inside the flasks.
   c. waited too long before he sealed the flasks after heating them.
   d. accidentally contaminated the broth when he sealed the flasks.

____  5. In Pasteur’s experiment, the function of the curved neck on the flask was to prevent
   a. air from entering the body of the flask.
   b. air from leaving the body of the flask.
   c. solid particles from entering the body of the flask.
   d. broth from spilling out of the flask.
**SHORT ANSWER** Answer the questions in the space provided.

1. What observations made in the 1600s and 1700s led some people to believe that there was a “vital force” in the air? ____________________________

   ____________________________

   ____________________________

2. Why did Spallanzani boil the broth in his experiment? ____________________________

   ____________________________

   ____________________________

3. How did Pasteur’s experiment differ from Spallanzani’s experiment? ____________________________

   ____________________________

   ____________________________

4. How did Pasteur’s experiment answer the objections raised by supporters of the “vital force” hypothesis? ____________________________

   ____________________________

   ____________________________

5. **Critical Thinking** How might the believers in spontaneous generation have disputed Redi’s conclusion if Redi had not used a control group? ____________________________

   ____________________________

   ____________________________

**STRUCTURES AND FUNCTIONS** The diagrams below illustrate steps in the control and experimental groups of Spallanzani’s experiment. In the spaces provided, list the steps in each group in their proper order. A step may be used in more than one group.

- Broth becomes cloudy.
- Flask is sealed.
- Broth is boiled.
- Broth remains clear.
- Flask is open.

Control group: ____________________________

Experimental group: ____________________________
SECTION 14-2 REVIEW

EARTH’S HISTORY

VOCABULARY REVIEW  Explain the relationship between the terms in each of the following pairs of terms.

1. radioactive isotope, radioactive dating

2. radioactive decay, half-life

3. microsphere, coacervate

MULTIPLE CHOICE  Write the correct letter in the blank.

1. The age of Earth is estimated to be
   a. about 700,000 years.  
   b. about 50 million years.  
   c. about 400 million years.  
   d. more than 4 billion years.

2. Sulfur has an atomic number of 16. Therefore, the isotope sulfur-35 has
   a. 19 protons and 16 neutrons.  
   b. 35 protons and 16 neutrons.  
   c. 16 protons and 19 neutrons.  
   d. 16 protons and 35 neutrons.

3. When performing radioactive dating, scientists measure the
   a. number of protons and neutrons in the nucleus of a radioactive isotope.  
   b. amount of a particular radioactive isotope contained in a material.  
   c. age of a living organism that is exposed to radioactive isotopes.  
   d. rate at which the mass of an object decreases over time.

4. Carbon-14 dating is useful for estimating the age of
   a. relatively young organic material.  
   b. old rocks.  
   c. Earth.  
   d. the solar system.

5. Researchers using the technique of Miller and Urey have been able to produce
   a. amino acids and nucleotides.  
   b. proteins and DNA.  
   c. ATP and mitochondria.  
   d. cell membranes and simple cells.
SHORT ANSWER Answer the questions in the space provided.

1. Explain how the half-life of a radioactive isotope affects the usefulness of that isotope in dating specific types of rocks.

2. Why do some scientists think that areas protected from the atmosphere might have favored the production of organic compounds on early Earth?

3. Why was the discovery of microspheres and coacervates an important contribution to the understanding of how life might have originated on Earth?

4. Critical Thinking Does radioactive dating with isotopes of uranium and thorium provide an estimate of the beginning, middle, or end of the period of Earth’s formation? Explain your answer.

STRUCTURES AND FUNCTIONS Use the figure to answer the following question.

The graph below represents the radioactive decay of an isotope. If the half-life of thorium-230 is 75,000 years, how old is a rock that contains only 1/16th of its original thorium-230? Show your calculations in the space below.
SECTION 14-3 REVIEW

THE FIRST LIFE-FORMS

VOCABULARY REVIEW Define the following terms.

1. ribozyme

2. chemosynthesis

3. cyanobacteria

4. endosymbiosis

MULTIPLE CHOICE Write the correct letter in the blank.

____ 1. The idea that life may have started with self-replicating molecules of RNA is based on the observation that RNA can

   a. take on a great variety of shapes and act as an enzyme.
   b. link nucleotides together to form proteins.
   c. create proteins that have the ability to replicate themselves.
   d. produce ribozymes that have the ability to produce other ribozymes.

____ 2. The first organisms on Earth were probably

   a. autotrophic, aerobic eukaryotes.
   b. heterotrophic, aerobic eukaryotes.
   c. autotrophic, aerobic prokaryotes.
   d. heterotrophic, anaerobic prokaryotes.

____ 3. The main difference between chemosynthetic autotrophs and photosynthetic autotrophs is that only

   a. photosynthetic autotrophs use CO₂ as a carbon source.
   b. chemosynthetic autotrophs use CO₂ as a carbon source.
   c. chemosynthetic autotrophs obtain energy from inorganic molecules.
   d. photosynthetic autotrophs synthesize organic compounds.

____ 4. An early function of aerobic respiration may have been to

   a. increase the amount of oxygen in the upper atmosphere.
   b. prevent the destruction of essential organic compounds by oxygen.
   c. provide more oxygen for photosynthesis.
   d. enable land animals to breathe.

____ 5. The eukaryotic organelle that is thought to have evolved from aerobic prokaryotes is the

   a. chloroplast.
   b. nucleus.
   c. ribosome.
   d. mitochondrion.
SHORT ANSWER Answer the questions in the space provided.

1. Explain how early RNA molecules might have been able to respond to natural selection. 

2. What role did the appearance of the ozone layer play in the evolution of early life on Earth? 

3. Name three characteristics of mitochondria and chloroplasts that support the endosymbiotic hypothesis of eukaryotic evolution. 

4. Critical Thinking How would endosymbiosis have been mutually beneficial for pre-eukaryotic cells and for the small prokaryotes that invaded them? 

STRUCTURES AND FUNCTIONS Arrange the organisms listed below in the order in which they are thought to have originated on Earth by writing their names in the spaces provided in the figure.

photosynthetic prokaryotes
photosynthetic eukaryotes
chemosynthetic prokaryotes
aerobic eukaryotes
heterotrophic prokaryotes
SECTION 15-1 REVIEW

HISTORY OF EVOLUTIONARY THOUGHT

VOCABULARY REVIEW  Define the following terms.

1. evolution

2. natural selection

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. If Lamarck's hypothesis of species modification were true, the children of a person who developed large muscles by lifting weights would be born with
   a. smaller-than-average muscles.
   b. normal-sized muscles.
   c. normal-sized muscles that would become larger only if the children also lifted weights.
   d. larger-than-average muscles.

_____ 2. What is the idea developed by Charles Lyell stating that the geologic processes that shaped Earth in the past continue to operate today?
   a. inheritance of acquired characteristics
   b. catastrophism
   c. uniformitarianism
   d. descent with modification

_____ 3. Darwin used the phrase "descent with modification" to mean that
   a. new species descended from preexisting species, and species must be able to change over time.
   b. organisms that descend from high elevations are modified as they acquire new traits.
   c. all living things descended from a recent common ancestor on the Galápagos Islands.
   d. individuals modify their behavior to survive and then pass those modifications on to their descendants.

_____ 4. According to Darwin's theory of natural selection,
   a. individuals are modified by adverse environmental conditions.
   b. the environment affects all organisms in a population in the same way.
   c. populations of all organisms grow unchecked under natural conditions.
   d. organisms that have more favorable traits tend to leave more offspring.

_____ 5. In an evolutionary sense, an individual organism has high fitness if it
   a. has a large number of acquired traits.
   b. can run long distances without becoming exhausted.
   c. reproduces more successfully than other individuals.
   d. evolves into another organism rather than becoming extinct.
SHORT ANSWER Answer the questions in the space provided.

1. Why are acquired traits not directly related to the process of evolution?

2. How did the ideas of Thomas Malthus influence Darwin’s thinking about evolution?

3. What is the relationship between evolution and natural selection?

4. Critical Thinking If Lamarck and Darwin had debated why giraffes have such long necks, how would their explanations have differed?

STRUCTURES AND FUNCTIONS Use the figure to answer the following question.

Which of the parent birds shown below (A or B) appears to have greater fitness? Explain your answer.
SECTION 15-2 REVIEW

EVIDENCE OF EVOLUTION

VOCABULARY REVIEW  Explain the relationship between the terms in each of the following pairs of terms.

1. homologous structure, analogous structure

2. fossil, principle of superposition

3. relative age, absolute age

MULTIPLE CHOICE  Write the correct letter in the blank.

(__) 1. The wing of a bat and the foreleg of an alligator are
   a. analogous features.  c. vestigial features.
   b. homologous features.  d. artificially selected features.

(__) 2. Features that were useful to an ancestral organism but are not useful to a modern organism that inherited them are said to be
   a. analogous.  b. homologous.  c. vestigial.  d. artificially selected.

(__) 3. According to the principle of superposition, the lowest layer in a cross section of a rock sequence
   a. is the most recent.  b. is the oldest.
   c. has the fewest fossils.  d. contains only the fossils of burrowing animals.

(__) 4. Embryological comparisons reveal that
   a. many vertebrate embryos look similar at early stages of development.
   b. embryos of different vertebrates look more similar as development proceeds.
   c. rabbit embryos look like adult fish.
   d. gorillas begin life as fish and then develop into gorillas during an embryonic stage.

(__) 5. Fossils are
   a. remains or traces of preexisting organisms.
   b. all extinct organisms.
   c. deeply buried sedimentary rock strata.
   d. from animals but not plants.
SHORT ANSWER Answer the questions in the space provided.

1. When trying to determine the evolutionary relationship between two species, would a biologist concentrate on homologous features or analogous features? Explain why. ________________________________

2. If an animal has a vestigial structure, what might a biologist infer about the animal's evolutionary history? ________________________________

3. How does biogeography contribute to an understanding of evolution? ________________________________

4. Explain the evidence that indicates that species evolve over time.

________________________________________

________________________________________

5. Critical Thinking Why do vestigial structures persist in modern organisms? ________________________________

________________________________________

STRUCTURES AND FUNCTIONS Indicate the relative ages of the fossilized organisms listed below by placing them in a strata on the diagram of a cross section of sedimentary rock below.

trilobites, mammal fossils, oldest fossil, youngest fossil, first land plants, first dinosaurs

a

b

c

d

e

f
SECTION 15-3 REVIEW

EVOLUTION IN ACTION

VOCABULARY REVIEW Provide one example for each of the following terms.

1. adaptive radiation

2. artificial selection

3. coevolution

4. convergent evolution

5. divergent evolution

6. resistance

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. What is the process called by which different species evolve similar traits?
   a. coevolution.  
   b. convergent evolution.  
   c. divergent evolution.  
   d. adaptive radiation.

_____ 2. The evolutionary pattern illustrated by the finch species on the Galápagos Islands is an example of
   a. coevolution.  
   b. convergent evolution.  
   c. divergent evolution.  
   d. artificial selection.

_____ 3. Divergent evolution would be most likely in which of the following situations?
   a. A group of organisms is isolated from the main population on three isolated islands with different environmental conditions.
   b. Individuals in a large population experience the same environmental conditions.
   c. Individuals in a small population experience the same environmental conditions.
   d. A group of organisms which are well adapted to the environment live on a remote island.

_____ 4. The corresponding changes of two or more species that are closely associated with each other, such as a plant and an animal that pollinates it, are called
   a. adaptive radiation.  
   b. divergent evolution.  
   c. convergent evolution.  
   d. coevolution.

_____ 5. In artificial selection, humans select for
   a. a desirable trait.
   b. an undesirable trait.
   c. a vestigial trait.
   d. a trait that makes the organisms less fit.
SHORT ANSWER Answer the questions in the space provided.

1. What is adaptive radiation?

2. What could happen to a tree-dwelling species of lizard if all the trees in an area died?

3. Give three examples of artificial selection. Include examples of both animals and plants.

4. Critical Thinking Would a species that lives a long time, but has few offspring, be more or less likely to become extinct after a sudden change in its environment than a species that has a short life, but produces large numbers of offspring? Explain.

STRUCTURES AND FUNCTIONS

The diagram shows several groups of primates and a hypothesis of how they are related based on differences in DNA. What pattern of evolution does the diagram represent? According to this hypothesis, when did the rhesus monkey and the green monkey diverge? Which group of primates existed before the others?
SECTION 16-1 REVIEW

GENETIC EQUILIBRIUM

VOCABULARY REVIEW Define the following terms.

1. population genetics ____________________________

2. gene pool ____________________________

3. allele frequency ____________________________

4. phenotype frequency ____________________________

5. Hardy-Weinberg genetic equilibrium ____________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. The smallest unit in which evolution occurs is
   a. an individual organism.            c. a species.
   b. a population.                    d. a kingdom.

2. Length, weight, and many other quantitative traits in a population tend to show variation that, when plotted on a graph, looks like
   a. a population wave.       c. a bell curve.
   b. a gene pool.             d. an equilibrium plot.

3. If a population of four o’clock flowers consists of five RR plants (red flowers), two Rr plants (pink flowers), and one rr plant (white flowers), the phenotype frequency of plants with pink flowers is
   a. 0.125.                  b. 0.25.        c. 0.5.        d. 0.75.

4. In the population described in question 3, the frequency of the R allele is
   a. 0.125.                  b. 0.25.        c. 0.5.        d. 0.75.

5. For a population to be in genetic equilibrium,
   a. individuals must not enter or leave the population.
   b. the population must be evolving.
   c. the population must be small.
   d. selection must occur.
SHORT ANSWER Answer the questions in the space provided.

1. What types of individuals in a population are represented by the two ends of a bell curve?
   
   __________________________________________________________
   _____________________________
   __________________________________________________________
   __________________________________________________________

2. What are the three main ways that variations in genotype arise in a population? ______________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

3. What five assumptions must be made for the Hardy-Weinberg genetic equilibrium to apply to a population?
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

4. Critical Thinking Does a gene pool include the genes of individuals that cannot reproduce?
   Explain your answer. ________________________________________
   __________________________________________________________
   __________________________________________________________

STRUCTURES AND FUNCTIONS The drawing below shows a population of four o’clock flowers. Using the information given in the table below the drawing, predict the phenotype frequencies and allele frequencies in the offspring of this population. Write your answers in the table below. Show your calculations.

<table>
<thead>
<tr>
<th>PARENTS</th>
<th>OFFSPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenotype frequency</td>
<td>Allele frequency</td>
</tr>
<tr>
<td>Red: 0.5</td>
<td>R: 0.625</td>
</tr>
<tr>
<td>White: 0.25</td>
<td>r: 0.375</td>
</tr>
<tr>
<td>Pink: 0.25</td>
<td></td>
</tr>
</tbody>
</table>
SECTION 16-2 REVIEW

DISRUPTION OF GENETIC EQUILIBRIUM

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. immigration, emigration

2. gene flow, genetic drift

3. random mating, assortative mating

4. stabilizing selection, directional selection

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Any violation of the conditions necessary for Hardy-Weinberg equilibrium can result in
   a. independent assortment.
   b. disorganizing selection.
   c. evolution.
   d. eventual extinction.

2. The movement of reproductive individuals from one population to another results in
   a. infertile offspring.
   b. spontaneous mutation.
   c. genetic drift.
   d. gene flow.

3. Genetic drift is most likely to occur in
   a. small populations.
   b. large populations.
   c. populations that migrate.
   d. populations that have a low frequency of mutation.

4. Assortative mating occurs when
   a. one animal mates with a variety of other individuals during its lifetime.
   b. males choose to mate with females that are the most fertile.
   c. an individual chooses mates that are similar to itself.
   d. females choose to mate with males that are from other populations.

5. Starlings produce an average of five eggs in each clutch. If there are more than five, the parents cannot adequately feed the young. If there are fewer than five, predators may destroy the entire clutch. This is an example of
   a. disruptive selection.
   b. stabilizing selection.
   c. directional selection.
   d. sexual selection.
**SHORT ANSWER** Answer the questions in the space provided.

1. List five conditions that can cause evolution to take place.

2. Explain how a Hardy-Weinberg genetic equilibrium is affected by mutations.

3. What is one potential negative consequence of nonrandom mating based on geographic proximity?

4. How might being brightly colored increase the fitness of the males of some bird species?

5. Why is genetic homozygosity dangerous to a nearly extinct species?

6. **Critical Thinking** If a cow develops a preference for eating white four o’clock flowers and ignoring pink and red four o’clock flowers, what type of selection is being demonstrated? Would the cow eventually eliminate all white four o’clock flowers from the population on which it feeds?

**STRUCTURES AND FUNCTIONS** Label the three types of selection illustrated by the graphs below.

![Graphs a, b, c]
SECTION 16-3 REVIEW

FORMATION OF SPECIES

VOCABULARY REVIEW Define the following terms.

1. morphology
   ____________________________

2. geographic isolation
   ____________________________

3. punctuated equilibrium
   ____________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. One limitation of the morphological species concept is that
   a. morphological characteristics are not easy to observe.
   b. it cannot be applied to extinct organisms.
   c. members of different species often appear quite different.
   d. there can be morphological differences among individuals in a single population.

2. According to the biological species concept, a species is a population of organisms that
   a. can successfully interbreed but cannot breed with other groups.
   b. have a similar structure and appearance.
   c. are physically separated from other organisms with a similar appearance.
   d. can hybridize with each other to produce infertile offspring.

3. Fish populations that do not interbreed because they live in different ponds may evolve into separate species due to
   a. ecological isolation.
   b. geographic isolation.
   c. prezygotic isolation.
   d. postzygotic isolation.

4. Bird populations that do not interbreed because they cannot recognize each other’s mating calls may evolve into separate species due to
   a. ecological isolation.
   b. geographic isolation.
   c. prezygotic isolation.
   d. postzygotic isolation.

5. A pattern of rapid evolutionary changes followed by long periods of no change is described as
   a. gradual evolution.
   b. punctuated equilibrium.
   c. reproductive isolation.
   d. continuous speciation.
SHORT ANSWER Answer the questions in the space provided.

1. What are two limitations of the biological species concept? ________________________________

2. What is one advantage of prezygotic isolation over postzygotic isolation? __________________

3. Describe two pieces of evidence indicating that speciation does not always occur at the same rate.
   ________________________________________________________________
   ________________________________________________________________

4. Critical Thinking Some scientists predict that if global warming continues over the next few centuries, melting of the polar ice caps will raise the level of the oceans, causing some peninsulas to become islands. How might this change eventually affect the species that live on these peninsulas?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

STRUCTURES AND FUNCTIONS The graph below shows the mating seasons of several species of frogs. On the basis of the information shown in the graph, do the peeper frog and the leopard frog likely have barriers to reproduction in addition to slightly different mating seasons? What other barriers might be in operation? Explain your answers.

![Graph showing mating seasons of various frog species](image-url)
SECTION 17-1 REVIEW

Biodiversity

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. taxonomy, taxon

2. kingdom, species

3. phylum, division

4. species name, species identifier

5. species, subspecies

MULTIPLE CHOICE  Write the correct letter in the blank.

_____  1. Aristotle classified animals on the basis of
        a. their size.  
        b. their evolutionary history.  
        c. where they lived.  
        d. what they ate.

_____  2. The main criterion used in Linnaeus’s system of classification is an organism’s
        a. evolutionary history.  
        b. morphology.  
        c. taxonomy.  
        d. hierarchy.

_____  3. Each subset within a class of organisms is called a(n)
        a. order.  
        b. family.  
        c. genus.  
        d. phylum.

_____  4. In the scientific name of an organism, the first part is the
        a. species identifier.  
        b. variety.  
        c. subspecies.  
        d. genus.

_____  5. The species name of the pangolin is
        a. Manis temminckii.  
        b. manis temminckii.  
        c. Manis temminckii.  
        d. Manis Temminckii.
SHORT ANSWER Answer the questions in the space provided.

1. How were the classification systems of Aristotle and Linnaeus similar? _________________
   _________________
   _________________

2. The word part bi- means “two,” and the word part nomen means “name.” Explain how these word
   parts relate to the system scientists use to identify organisms. _________________
   _________________

3. How does the classification process used by modern taxonomists differ from that used by Linnaeus?
   _________________
   _________________
   _________________

4. Critical Thinking Explain why Aristotle’s system of classifying animals is no longer used by
   biologists. Use examples from the animal kingdom to support your answer. _________________
   _________________
   _________________
   _________________

STRUCTURES AND FUNCTIONS Use the figure to fill in the names of the seven levels of
organization in the modern Linnaean system of classifying organisms, with a representing
the smallest category and h the largest category.

a
b
c
d
e
f
g
h
SECTION 17-2 REVIEW

SYSTEMATICS

VOCABULARY REVIEW  Define the following terms.

1. **systematics**

2. **phylogenetic diagram**

3. **cladistics**

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. The scales of snakes and the scales of pangolins
   a. are shared derived characters.  c. suggest descent from a common ancestor.
   b. are homologous structures.  d. evolved independently in the two groups.

_____ 2. In cladistics, what term is used for a group of organisms that includes an ancestor and all of its descendants?
   a. class  c. phylum
   b. clade  d. species

_____ 3. The molecular-clock model of evolutionary relationships is based on the assumption that changes in macromolecule sequences
   a. are not random.
   b. are affected by natural selection.
   c. are greater in species with more-distant common ancestors.
   d. occur at different rates in different organisms.

_____ 4. One example of a derived character is provided by the
   a. feathers of birds.  c. scales of pangolins.
   b. scales of snakes.  d. chromosomes of chimpanzees.

_____ 5. Which of the following do cladistic taxonomists NOT compare when hypothesizing evolutionary relationships among organisms?
   a. morphological similarities  c. homologous chromosomes
   b. analogous structures  d. shared derived characters
SHORT ANSWER Answer the questions in the space provided.

1. List three types of evidence used by systematic taxonomists to construct phylogenetic diagrams.

2. What is an out-group in cladistic analysis?

3. How do derived characters help cladistic taxonomists determine phylogenetic relationships?

4. Critical Thinking A paleontologist studying two modern species finds a 7-million-year-old fossil organism with a morphology similar to the modern species and concludes that it is an ancestor of both. A molecular biologist studying the amino acid sequence of a particular protein in both modern species concludes that the two species last shared a common ancestor 12.5 million years ago. Suggest possible reasons for the discrepancy in the two conclusions.

4 The phylogenetic diagram shown below indicates the evolutionary relationships for a hypothetical group of modern organisms, labeled 1–5, and their ancestors, labeled A–G.

1. Which two modern organisms are likely to be most closely related?

2. What was the most recent common ancestor of organisms 2 and 3?

3. What was the most recent common ancestor of organisms 1 and 5?
SECTION 17-3 REVIEW

MODERN CLASSIFICATION

VOCABULARY REVIEW  For each of the kingdoms listed below, state the cell type (prokaryotic or eukaryotic), number of cells (unicellular, multicellular, or both), and form of nutrition (autotrophy, heterotrophy, or both).

1. Archaebacteria
2. Eubacteria
3. Protista
4. Fungi
5. Plantae
6. Animalia

MULTIPLE CHOICE  Write the correct letter in the blank.

1. The organisms that live in hostile environments that cannot support other forms of life are members of the domain
   a. Bacteria.  b. Archaea.  c. Eukarya.  d. None of the above

2. Amoebas and paramecia belong to the kingdom

3. Mushrooms, puffballs, mildews, and some molds belong to the kingdom

4. The domain that includes the oldest known fossil cells is called

5. The domain that includes organisms with true nuclei and membrane-bound organelles is called

6. The domain Eukarya includes
   a. archaea, protists, fungi, and plants.
   b. protists, fungi, plants, and animals.
   c. protists, fungi, eubacteria, and archaea.
   d. fungi, eubacteria, plants, and animals.
SHORT ANSWER Answer the questions in the space provided.

1. What characteristics distinguish archaea from bacteria?

2. What characteristics distinguish fungi from plants?

3. Which kingdoms include multicellular heterotrophic organisms?

4. What evidence led scientists to develop the three-domain system of classification?

5. Critical Thinking Another possible way to classify organisms would be to separate them into unicellular and multicellular organisms. Explain why this is not a useful classification system.

STRUCTURES AND FUNCTIONS The diagram below represents the relationship between the three-domain system and the six-kingdom system of classifying organisms. Label each box in the diagram with the correct domain or kingdom name.
SECTION 18-1 REVIEW

INTRODUCTION TO ECOLOGY

VOCABULARY REVIEW Define the following terms.

1. ecology _______________________________________________________________________

2. interdependence __________________________________________________________________

3. biosphere _______________________________________________________________________

4. ecosystem _______________________________________________________________________

5. community _______________________________________________________________________

6. population _______________________________________________________________________ 

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. All the robins in an area would be an example of a(n)
  a. community.  b. population.  c. ecosystem.  d. biosphere.

_____ 2. The broadest, most inclusive level of ecological organization is the
  a. population.  b. community.  c. biosphere.  d. ecosystem.

_____ 3. A pond is an example of
  a. a population.  b. a community.  c. a biosphere.  d. an ecosystem.

_____ 4. Ecologists use models to
  a. make predictions about the future behavior of an ecosystem.
  b. substitute for observations from the natural world.
  c. increase the complexity of simple ecosystems.
  d. account for the influence of every variable in a real environment.
SHORT ANSWER  Answer the questions in the space provided.

1. How does the production of acorns by oak trees affect Lyme disease in humans?  

2. Why do ecological models commonly have limited applications?  

3. How does a population differ from a community?  

4. Critical Thinking  How might the destruction of large areas of tropical rain forest have worldwide consequences?  

STRUCTURES AND FUNCTIONS  The drawings below represent five levels of ecological organization. In the spaces provided, label the levels and number them from 1 to 5, with 1 being the most inclusive.

[Diagrams of different ecological levels]
SECTION 18-2 REVIEW

ECOLOGY OF ORGANISMS

VOCABULARY REVIEW Distinguish between the terms in each of the following pairs of terms.

1. habitat, resource

2. biotic factor, abiotic factor

3. conformer, regulator

4. dormancy, migration

5. generalist, specialist

MULTIPLE CHOICE Write the correct letter in the blank.

1. One biotic factor that could influence a plant might be
   a. the amount of sunlight.  b. soil pH.  c. carbon dioxide concentration.  d. a pollinating insect.

2. People who spend time at high elevations develop more red blood cells, which helps them obtain oxygen from the “thin air.” This phenomenon is an example of
   a. acclimation.  b. adaptation.  c. migration.  d. dormancy.

3. An animal that maintains its body temperature within a narrow range even when the environmental temperature varies is an example of a
   a. specialist.  b. generalist.  c. regulator.  d. conformer.

4. The role a species plays in its environment is called the species’
   a. habitat.  b. niche.  c. resources.  d. tolerance curve.

5. An animal that feeds on leaves from only a few species of plants is an example of a
   a. specialist.  b. generalist.  c. regulator.  d. conformer.
SHORT ANSWER Answer the questions in the space provided.

1. Give three examples of abiotic factors and explain how they interact.

2. What are two ways that some organisms can escape from unfavorable environmental conditions?

3. Explain why the Virginia opossum is considered a generalist and the koala is considered a specialist.

4. Explain how a species’ habitat differs from its niche.

5. Critical Thinking How could knowledge of a pest organism’s tolerance limits be used in pest control?

STRUCTURES AND FUNCTIONS Label the curves in the graph below according to the type of organism they represent, and give a specific example of each type of organism.
SECTION 18-3 REVIEW

ENERGY TRANSFER

VOCABULARY REVIEW  Distinguish between the terms in each of the following groups of terms.

1. producer, consumer

2. gross primary productivity, net primary productivity

3. food chain, food web

MULTIPLE CHOICE  Write the correct letter in the blank.

1. The term biomass refers to the
   a. weight of the biosphere.
   b. volume of plants in a community.
   c. organic material in an ecosystem.
   d. amount of energy produced through chemosynthesis.

2. A detritivore is an organism that
   a. feeds on both producers and consumers.
   b. feeds on the “garbage” of an ecosystem.
   c. converts biomass into “garbage” in an ecosystem.
   d. produces carbohydrates by using energy from inorganic molecules.

3. An organism’s position in the sequence of energy transfers in an ecosystem is known as its
   a. trophic level.
   b. energy level.
   c. net productivity.
   d. feeding location.

4. The percentage of energy transferred from one level to another in a food chain is usually
   a. greater than 90 percent.
   b. about 75 percent.
   c. about 50 percent.
   d. less than 20 percent.

5. Compared to the lowest trophic level, the highest trophic level contains
   a. more individuals.
   b. less energy.
   c. more producers.
   d. fewer carnivores.
SHORT ANSWER  Answer the questions in the space provided.

1. Rank the following ecosystems in order of their net primary productivity, from lowest to highest:
   open ocean, tropical rain forest, desert, lake. ________________________________
   ________________________________

2. Why are producers the first trophic level to benefit from the activity of decomposers? ________
   ________________________________

3. Give three reasons why energy transfer between trophic levels is not 100 percent. ___________
   ________________________________
   ________________________________
   ________________________________

4. Why are food chains short? ________________________________

5. Critical Thinking  What would happen to the energy flow through an ecosystem if the decomposers were eliminated? ________________________________

STRUCTURES AND FUNCTIONS  The diagram below shows part of a food web. Each arrow indicates energy passing from one member (the food) to another (the consumer). Only some of the indicated relationships are possible. Write yes in the spaces corresponding to the possible relationships and no in the spaces corresponding to the relationships that are not possible.

Diagram:
- Herbivores
- Omnivores
- Carnivores
- Detritivores
- a
- b
- c
- d
- e
- f
SECTION 18-4 REVIEW

ECOSYSTEM RECYCLING

VOCABULARY REVIEW Explain the relationship between the terms in each of the following groups of terms.

1. water cycle, carbon cycle, nitrogen cycle

2. nitrogen fixation, nitrification, denitrification

MULTIPLE CHOICE Write the correct letter in the blank.

1. The term groundwater refers to water that
   a. exists in lakes or ponds.
   b. is found in soil or in underground formations.
   c. has fallen to sea level.
   d. lies on the surface of the ground after a heavy rain.

2. At least 90 percent of the water that returns to the atmosphere from terrestrial ecosystems does so through
   a. transpiration in plants.
   b. excretion in animals.
   c. sweating in animals.
   d. precipitation.

3. Two sources of carbon dioxide released into the atmosphere in the carbon cycle are
   a. photosynthesis and decomposition.
   b. cellular respiration and photosynthesis.
   c. combustion and transpiration.
   d. cellular respiration and combustion.

4. Two components of the nitrogen cycle that produce ammonia are
   a. nitrification and denitrification.
   b. nitrogen fixation and nitrification.
   c. nitrogen fixation and ammonification.
   d. ammonification and denitrification.

5. Animals obtain nitrogen
   a. through a mutualistic relationship with nitrogen-fixing bacteria.
   b. from the proteins and nucleic acids in the organisms they consume.
   c. by absorbing nitrates and ammonia from the soil.
   d. by absorbing nitrogen gas from the atmosphere.
SHORT ANSWER  Answer the questions in the space provided.

1. Name three processes in the water cycle, and state whether each process removes water from the atmosphere or returns it to the atmosphere. ___________________________________________
   ___________________________________________
   ___________________________________________

2. Describe the cycling of carbon in the carbon cycle. ___________________________________________
   ___________________________________________
   ___________________________________________

3. Where are nitrogen-fixing bacteria found? How do these bacteria benefit plants? ________________
   ___________________________________________
   ___________________________________________

4. Critical Thinking  If a crop, such as corn, is grown in the same field year after year, a nitrogen-containing fertilizer must be added to the soil each time a new crop is planted. Why isn’t a single application of fertilizer sufficient? ___________________________________________
   ___________________________________________

STRUCTURES AND FUNCTIONS  The diagram below represents the effect of the water, carbon, and nitrogen cycles on the life of a plant. Identify the process indicated in the three cycles.

[Diagram of water, carbon, and nitrogen cycles with labels and arrows indicating processes]
SECTION 19-1 REVIEW

UNDERSTANDING POPULATIONS

VOCABULARY REVIEW Contrast the following terms.

1. population density, dispersion
2. death rate, life expectancy

MULTIPLE CHOICE Write the correct letter in the blank.

1. One can estimate a population’s size by counting individuals in a sample of the population if the
   a. distribution of individuals in the sample is the same as that in the population.
   b. density in the sample is greater than the population density.
   c. dispersion in the sample is less than that in the population.
   d. sample size is larger than the population size.

2. A random distribution of individuals in a population would be most likely to result from
   a. clumped food resources.
   b. territorial behavior by the individuals in the population.
   c. herding behavior by the individuals in the population.
   d. the dispersal of seeds by the wind.

3. Although the United States has a larger total population than Japan, population density is greater in Japan because the
   a. people in the United States have less education and medical care.
   b. people in Japan all live in the cities.
   c. geographical area is greater in the United States.
   d. birth rate is lower than the death rate in Japan.

4. A population is likely to grow most rapidly if it has
   a. a high percentage of old individuals.
   b. a high percentage of young individuals.
   c. about the same percentage of individuals in each age range.
   d. individuals with a low birth rate.

5. In a population with a Type I survivorship curve, the likelihood of dying is
   a. low until late in life, when it increases rapidly.
   b. high early in life and much lower in older individuals.
   c. high early in life and late in life, but much lower in middle-aged individuals.
   d. fairly constant throughout life.
SHORT ANSWER Answer the questions in the space provided.

1. How do the three main patterns of population dispersion differ from one another?

2. Give an example of a social behavior that can produce a clumped distribution.

3. Give an example of a social behavior that can produce a uniform distribution.

4. Critical Thinking What would the survivorship curve for humans look like if there were a worldwide epidemic of a fatal disease that affected only children under five years of age?

STRUCTURES AND FUNCTIONS Use the figure to answer the following questions.

The graph below shows three different types of survivorship curves.

1. Which curve corresponds to a species in which 0.3% of the individuals are alive after one-quarter of their lifespan has passed and 0.1% are alive after one-half of their lifespan has passed?

2. Which curve corresponds to a species in which 95% of the individuals are alive after one-quarter of their lifespan has passed and 90% are alive after one-half of their lifespan has passed?

3. Which curve corresponds to a species in which 10% of the individuals are alive after one-third of their lifespan has passed and 1% are alive after two-thirds of their lifespan has passed?

4. Give an example of a species that would have each type of survivorship curve.

X ______________________ Y ______________________ Z ______________________
SECTION 19-2 REVIEW

Measuring Populations

Vocabulary Review Explain the relationship between the terms in each of the following groups of terms.

1. growth rate, birth rate, death rate

2. exponential growth, limiting factor

Multiple Choice Write the correct letter in the blank.

1. If a country’s per capita growth rate is 0.01 and its present population is 50,000,000, what will the population be one year from now?
   a. 500,000
   b. 50,500,000
   c. 60,000,000
   d. 500,000,000

2. The exponential model of population growth applies
   a. when there are no limiting factors.
   b. if the birth rate increases as the population grows.
   c. when the population size exceeds the carrying capacity.
   d. to all real populations that exist in nature.

3. The logistic model of population growth
   a. reflects the fact that the carrying capacity fluctuates with environmental changes.
   b. does not accommodate the influence of limiting factors.
   c. reflects the fact that the birth rate decreases as the population grows.
   d. applies to all real populations that exist in nature.

4. One example of a density-dependent limiting factor is a
   a. forest fire.
   b. flood.
   c. period of very severe weather.
   d. shortage of nesting sites.

5. Which of the following is not a threat to the survival of small populations?
   a. breeding in captivity
   b. inbreeding
   c. habitat destruction
   d. disease outbreaks
SHORT ANSWER Answer the questions in the space provided.

1. In 1996 in the United States, the number of live births was 4 million, the number of deaths was 2.4 million, and the population was 265 million. Calculate the per capita birth rate, death rate, and growth rate. Show your calculations. 

2. What evidence did Charles Elton collect that suggested that fluctuations in hare and lynx populations were related? 

What other evidence indicates that these fluctuations may not have been related? 

3. Name three effects that inbreeding can have on a population. 

4. Critical Thinking If a population’s per capita growth rate is 0.02 and its population is 100,000,000, how large will the population be in five years? Show your calculations. 

STRUCTURES AND FUNCTIONS Use the figure to answer the following questions.

The graph below shows the growth of a population over time.

1. Describe the birth rate and death rate in region A. 

2. Describe the birth rate and death rate in region C. 

3. Identify the line labeled K. 

4. What model best describes the growth of this population?
SECTION 19-3 REVIEW

HUMAN POPULATION GROWTH

VOCABULARY REVIEW  Define the following terms.

1. hunter-gatherer lifestyle

2. agricultural revolution

3. developed country

4. developing country

MULTIPLE CHOICE  Write the correct letter in the blank.

1. The hunter-gatherer lifestyle is associated with
   a. large populations.
   b. ancient human populations but is not found in human populations today.
   c. high mortality rates among infants and young children.
   d. high rates of population growth.

2. About 10,000 to 12,000 years ago, the human population began to grow more rapidly due to
   a. improvements in sanitation.
   b. control of disease.
   c. improved economic conditions.
   d. the agricultural revolution.

3. The global growth rate of the human population is
   a. no longer increasing.
   b. not important to people in developed countries.
   c. increasing but at a slower rate than in the mid-1960s.
   d. decreasing each year.

4. The current population growth rates of developed countries
   a. are lower than those of developing countries.
   b. are high because the death rate is low.
   c. are increasing because the fertility rate is increasing.
   d. are low because the death rate is high.

5. A country may have a negative growth rate if its
   a. population is mostly young people.
   b. birth rate is higher than its death rate.
   c. death rate is higher than its birth rate.
   d. population has access to health care.
SHORT ANSWER Answer the questions in the space provided.

1. Why did the development of agriculture have a major impact on the human population growth rate? 

2. What factors caused human population growth to accelerate after 1650? 

3. What features characterize most developing countries? 

4. Why did population growth rates change after World War II? 

5. Critical Thinking Under what conditions might the per capita birth and death rates not be enough to accurately predict future human population size? 

STRUCTURES AND FUNCTIONS Use the figure to answer the following questions.

The graph below represents the hypothetical growth of a population over time. You may express a time interval, for example, as “from A to B,” or “from B to E.”

1. Which time interval best depicts human population growth over all of human history? 

2. Which time interval best depicts human population growth until about 1650? 

3. In which time interval is the birth rate approximately equal to the death rate? 

4. In which time interval does the birth rate greatly exceed the death rate? 

VOCABULARY REVIEW  Explain the relationship between the terms in each of the following pairs of terms.

1. predator, prey _______________________________________________________________
   _______________________________________________________________

2. herbivore, secondary compound ______________________________________________
   _______________________________________________________________

3. parasite, host _______________________________________________________________
   _______________________________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

1. An example of mimicry that is important in anti-predator defenses is when
   a. a harmless species resembles a dangerous species.
   b. two harmless species look similar.
   c. a species resembles an inedible object.
   d. one individual uses bright colors to warn others of danger.

2. One difference between predators and parasites is that parasites
   a. usually do not cause the immediate death of the organism they feed on.
   b. feed only on the inside of other organisms.
   c. are always microorganisms.
   d. are not anatomically or physiologically specialized.

3. Magpies and crows are scavenger birds that feed on the same food sources and cannot
   live in the same community. This is an example of
   a. character displacement.  c. symbiosis.
   b. resource partitioning. d. competitive exclusion.

4. A change in anatomy that results when two species compete for the same resource is called
   a. mutualism.  c. competitive exclusion.
   b. character displacement. d. resource partitioning.

5. A symbiotic relationship in which one species benefits and the other is not affected is called
   a. commensalism. b. mutualism.  c. parasitism.  d. competition.
SHORT ANSWER Answer the questions in the space provided.

1. How are secondary compounds useful to plants?

2. What is the difference between the fundamental niche of a species and the realized niche of the species?

3. How do ectoparasites differ from endoparasites?

4. Explain how Darwin’s finches illustrate the principle of character displacement.

5. Critical Thinking A biologist finds that when two species of paramecia are grown together in the laboratory, one species always outcompetes and eliminates the other. In ponds and other natural environments, however, the two species coexist. Suggest a hypothesis to explain this phenomenon.

STRUCTURES AND FUNCTIONS Label each drawing below with the most appropriate term from the following list: pollinator, physical defense, secondary compound, endoparasite, ectoparasite, mimicry.

1. Tapeworm

2. Thorns

3. Kingsnake

4. Poison ivy

5. Deer tick

6. Butterfly
VOCABULARY REVIEW  Define the following terms.

1. species richness

2. primary succession

3. species-area effect

MULTIPLE CHOICE  Write the correct letter in the blank.

1. A community that has great species richness contains
   a. many different species.
   b. many individuals in each species.
   c. a few species whose members control most of the community’s resources.
   d. species that are of great economic value.

2. The measure that relates the number of species in a community to the relative abundance of each species is called
   a. species richness.
   b. species evenness.
   c. community stability.
   d. community interaction.

3. Species that predominate early in the development of a community are called
   a. pioneer species.
   b. climax species.
   c. dominant species.
   d. succession species.

4. One explanation for the greater number of species in the Tropics than in temperate zones is that
   a. tropical habitats are younger than temperate habitats.
   b. there is more energy available to support more organisms in the Tropics.
   c. people have been cultivating species for much longer periods in the Tropics.
   d. the climate is more stable in temperate habitats.

5. The stable end point of succession is called
   a. staged community.
   b. climax community.
   c. climatic change.
   d. community development.
SHORT ANSWER Answer the questions in the space provided.

1. Why does primary succession often proceed very slowly?

2. How does species richness vary with latitude?

3. Why are agricultural fields often less stable than natural communities in the same area?

4. Critical Thinking A volcanic eruption removes all plant life from a valley below the volcano. Explain why succession following the eruption is likely to occur more quickly on the valley floor than on the steep slopes that form the valley walls.

STRUCTURES AND FUNCTIONS The map below shows four hypothetical islands: A, B, C, and D. Rank the islands from 1 to 4 in terms of the species richness you would expect them to have, with the island that has the greatest richness as 1 and the island with the least richness as 4.
SECTION 21-1 REVIEW

TERRESTRIAL BIOMES

VOCABULARY REVIEW Define the following terms.

1. biome

2. tundra

3. taiga

4. savanna

5. canopy

MULTIPLE CHOICE Write the correct letter in the blank.

____ 1. The biome that is characterized by the presence of permafrost is called
   a. savanna.        b. desert.        c. taiga.        d. tundra.

____ 2. Plants living in the taiga are adapted for
   a. long, cold winters.        c. nutrient-rich soil.
   b. long summers.              d. very small amounts of precipitation.

____ 3. Prairie, steppe, and veldt are different names for the biome known as
   a. tundra.        b. grassland.        c. temperate deciduous forest.
   d. taiga.

____ 4. Which of the following is not an adaptation that limits water loss in desert plants?
   a. protective spines
   b. a waxy coating
   c. broad, thin leaves
   d. opening of stomata only at night

____ 5. The amount of light that reaches the floor of a tropical rain forest is limited by the
   a. short growing season in the tropics.
   b. forest canopy.
   c. dense growth of short vegetation that covers most of the floor.
   d. dense fog that exists within the forest.
**SHORT ANSWER** Answer the questions in the space provided.

1. Name two factors that limit tree growth in the tundra. __________________________________________
   __________________________________________
   __________________________________________

2. What characteristic of grasses enables these plants to survive occasional fires and continuous grazing by animals? __________________________________________
   __________________________________________

3. How are the plants of savannas adapted to the rainfall patterns of this biome? ________________
   __________________________________________

4. Describe three adaptations of desert organisms that conserve water. __________________________
   __________________________________________
   __________________________________________

5. **Critical Thinking** Why aren’t the forests of the taiga cut down and converted into farmland as often as temperate deciduous forests? __________________________________________
   __________________________________________

6. **Critical Thinking** Why are vines so common in rain forests? ________________________________
   __________________________________________

**STRUCTURES AND FUNCTIONS** The bar graphs below summarize the typical temperature range, annual precipitation, and soil-nutrient level of four biomes. Label each graph according to the biome it represents.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Precipitation</th>
<th>Soil/nutrient content</th>
</tr>
</thead>
</table>

a. High | Medium | Low |

b. High | Low | Medium |

c. Low | Medium | High |

d. Medium | Low | High |
SECTION 21-2 REVIEW

AQUATIC ECOSYSTEMS

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. **photic zone**, **aphotic zone**

   

2. **neritic zone**, **oceanic zone**

   

3. **pelagic zone**, **benthic zone**

   

4. **eutrophic lake**, **oligotrophic lake**

   

MULTIPLE CHOICE  Write the correct letter in the blank.

   ____  1. Which of the following is not an environmental factor that organisms in the intertidal zone must cope with?
   
   a. periodic exposure to the air  
   b. the force of crashing waves  
   c. constant darkness  
   d. the possibility of dehydration

   ____  2. Coral reefs form in the
   
   a. neritic zone.  
   b. intertidal zone.  
   c. pelagic zone.  
   d. aphotic zone.

   ____  3. There are fewer species in the oceanic zone than in the neritic zone because the oceanic zone
   
   a. receives very little sunlight.  
   b. has low nutrient levels.  
   c. is very cold.  
   d. is under very high pressure.

   ____  4. A salt marsh is an example of a(n)
   
   a. pelagic zone.  
   b. species-poor community.  
   c. estuary community.  
   d. oligotrophic zone.

   ____  5. Eutrophic lakes
   
   a. have very clear water.  
   b. generally do not contain fish.  
   c. contain little organic matter.  
   d. are rich in vegetation.
SHORT ANSWER  Answer the questions in the space provided.

1. What are some adaptations of intertidal organisms that enable them to survive in this zone?

2. Why is plankton important to aquatic ecosystems?

3. Explain why the productivity of the oceanic zone is high, even though nutrient levels are low.

4. Explain how producers near deep-sea vents obtain energy.

5. Critical Thinking  Water that drains from agricultural fields during heavy rains or over-irrigation may contain high levels of nitrogen, phosphorus, and other nutrients. What effect might this water have if it is allowed to enter an oligotrophic lake?

STRUCTURES AND FUNCTIONS  Identify the ocean zones labeled a–g in the diagram below.
SECTION 22-1 REVIEW

AN INTERCONNECTED PLANET

VOCABULARY REVIEW Define the following terms.

1. biodiversity

2. species evenness

3. genetic diversity

MULTIPLE CHOICE Write the correct letter in the blank.

___ 1. Which of the following is NOT a measure of biodiversity?
   a. species evenness
   b. genetic recombination
   c. genetic diversity
   d. species richness

___ 2. Of the following groups, which contains the greatest number of species?
   a. crustaceans
   b. mammals
   c. plants
   d. insects

___ 3. The mass extinction currently under way is different from previous mass extinctions because it
   a. is being caused largely by humans.
   b. involves the loss of fewer species.
   c. is occurring at a time when biodiversity is already low.
   d. is actually causing an increase in biodiversity.

___ 4. The portion of Earth that includes all rivers, lakes, and the oceans is the
   a. geosphere.
   b. atmosphere.
   c. hydrosphere.
   d. biosphere.

___ 5. The ozone layer in the upper atmosphere is important because it
   a. causes Earth to heat up.
   b. absorbs most of the sun’s ultraviolet radiation.
   c. causes the greenhouse effect.
   d. causes Earth to cool.
SHORT ANSWER Answer the questions in the space provided.

1. Explain what makes up Earth’s three major layers and the biosphere.

2. Why could a disease be more serious in a population with a low genetic diversity?

3. What is the greenhouse effect?

4. Critical Thinking Why might botanists store the seeds of newly discovered plant species or varieties in dry, refrigerated seed banks?

STRUCTURES AND FUNCTIONS Use the drawings below to answer the following questions. The drawings show the number of individuals of four plant species found at three sites. Each leaf represents one plant.

1. Which site has the greatest species richness?

2. Which site has the lowest species richness?

3. Which site has the greatest species evenness?

4. Which site has the lowest species evenness?

5. Which site has the greatest species diversity?

6. Which site has the lowest species diversity?
SECTION 22-2 REVIEW

ENVIRONMENTAL ISSUES

VOCABULARY REVIEW Define the following terms.

1. smog

2. extinction

3. keystone species

4. chlorofluorocarbon

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. The increase in the concentration of pesticides in organisms at the top of the food chain is an example of
   a. extinction.
   b. biological magnification.
   c. a keystone species.
   d. pollution.

_____ 2. The ozone “hole” is a
   a. clearing in the smoggy air over a large city.
   b. zone of very low ozone concentration in the upper atmosphere over Antarctica.
   c. zone of very high ozone concentration in the lower atmosphere over Antarctica.
   d. circular patch of ozone in the upper atmosphere over the Arctic Ocean.

_____ 3. One of the likely effects of damage to the ozone layer is a(n)
   a. decrease in global temperatures.
   b. shift in wind patterns over North America.
   c. decrease in the amount of ultraviolet radiation that reaches Earth’s surface.
   d. increase in the incidence of skin cancer in humans.

_____ 4. Since the 1960s the levels of atmospheric carbon dioxide have
   a. stayed the same.
   b. increased rapidly.
   c. decreased rapidly.
   d. increased slightly.

_____ 5. Doubling of the human population might
   a. hasten global warming.
   b. decrease the amount of undeveloped land.
   c. All of the above
   d. None of the above
SHORT ANSWER Answer the questions in the space provided.

1. What causes acid precipitation? ______________________________________________________
   ______________________________________________________
   ______________________________________________________

2. Identify three possible consequences of doubling Earth’s human population. ______________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

3. What is sustainability? ______________________________________________________________
   ______________________________________________________
   ______________________________________________________

4. Critical Thinking Increased CO₂ levels in the atmosphere are correlated with rising global temperatures, leading many scientists to believe that the first phenomenon has caused the second. What would it take to be certain that this correlation represents a cause-and-effect relationship?
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

STRUCTURES AND FUNCTIONS The flowcharts below represent some of the effects of human activity on the environment. Each arrow indicates a known or suspected cause-and-effect relationship. Complete the flowcharts by writing an appropriate response in the space corresponding to each box.

- burning of fossil fuels
- decreased levels of ozone in the upper atmosphere
- harmful mutations in plants and animals
- increased global temperatures
SECTION 22-3 REVIEW

ENVIRONMENTAL SOLUTIONS

VOCABULARY REVIEW Define the following terms.

1. conservation biology

2. restoration biology

MULTIPLE CHOICE Write the correct letter in the blank.

1. A species that is extremely sensitive to ecological changes is known as a(n)
   a. conservation species.
   b. bioindicator.
   c. keystone species.
   d. hotspot species.

2. In a debt-for-nature swap,
   a. developing countries destroy their natural ecosystems to build their economies.
   b. countries go into debt to pay for the conservation of their natural resources.
   c. richer countries pay off some of the debts of developing countries that take steps to
      preserve biodiversity.
   d. richer countries pay developing countries to convert their rain forests into farms.

3. Why are small aircraft used in captive breeding programs of whooping cranes?
   a. to teach young cranes their migration route
   b. to monitor whooping crane habitat
   c. to monitor the breeding habits of released cranes
   d. to scare off predators

4. Negative consequences of ecosystem alteration in southern Florida include
   a. the extinction of the melaleuca tree.
   b. water shortages.
   c. overgrowth of sea grass in Florida Bay.
   d. an increase in the populations of wading birds.

5. The plan for restoring the Everglades ecosystem involves
   a. building new drainage canals.
   b. planting more melaleuca trees.
   c. restoring the Kissimmee River to its original channel.
   d. adding fertilizer to the Everglades to increase its productivity.
**SHORT ANSWER** Answer the questions in the space provided.

1. **What is a biodiversity hotspot?**

2. **Why must efforts to protect migratory bird populations be international?**

3. **What is ecotourism, and how can it be used to preserve biodiversity?**

4. **What human actions lead to the disappearance of much of the wetlands in the Everglades ecosystem?**

5. **Critical Thinking** What might be the value of the Everglade restoration plan?

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**STRUCTURES AND FUNCTIONS** The flowcharts below represent some aspects of conservation and restoration biology. Complete the flowcharts by writing an appropriate response in each box.

- Conservation biology strategies include
  - saving critical habitats in the form of
  - for organisms such as
- Restoration biology strategies include
  - reintroducing endangered species such as
  - which involves
  - restoring critical habitats such as
  - which involves
**SECTION 23-1 REVIEW**

**PROKARYOTES**

**VOCABULARY REVIEW** Distinguish between the terms in each of the following groups of terms.

1. halophile, thermoacidophile

2. bacillus, coccus, spirillum

3. staphylococcus, streptococcus

4. Gram-positive bacterium, Gram-negative bacterium

**MULTIPLE CHOICE** Write the correct letter in the blank.

1. Fossil evidence indicates that the earliest prokaryotes on Earth lived about
   - a. 1 billion years ago.
   - b. 5 billion years ago.
   - c. 2.5 billion years ago.
   - d. None of the above

2. Which of the following types of bacteria would you be most likely to find in very salty water?
   - a. chemoautotroph
   - b. halophile
   - c. cyanobacterium
   - d. thermoacidophile

3. Archaea and Bacteria are placed in separate domains because
   - a. Bacteria lack cell membranes.
   - b. Archaea have cells walls that contain peptidoglycan.
   - c. proteins of Bacteria have no amino acids.
   - d. their rRNA sequences are different.

4. Actinomycetes are
   - a. archaea that are spiral-shaped.
   - b. proteobacteria that cause tooth decay.
   - c. Gram-positive bacteria that form branching filaments.
   - d. Gram-negative bacteria that are photosynthetic.

5. Which of the following types of bacteria would you be most likely to find in the human intestinal tract?
   - a. spirochete
   - b. cyanobacterium
   - c. thermoacidophile
   - d. enteric bacterium
SHORT ANSWER  Answer the questions in the space provided.

1. Why do some bacteria retain the Gram stain while others do not? ____________________________

2. Why are nitrogen-fixing bacteria important to plants? ____________________________

3. Identify two ecologically important characteristics of cyanobacteria. ____________________________

4. Identify one beneficial and one harmful role of Gram-negative enteric bacteria found in the human body.

5. Explain how the evolution of aerobic organisms depended on a metabolic product of cyanobacteria. ____________________________

6. Critical Thinking  How have explorations of saltwater lakes and hydrothermal vents on the ocean floor led biologists to revise their ideas about the origin of eukaryotes? ____________________________

STRUCTURES AND FUNCTIONS  Label each drawing below with the most appropriate term from the following list: coccus, streptococcus, spirochete, bacillus.

1. ____________________________  2. ____________________________  3. ____________________________  4. ____________________________
SECTION 23-2 REVIEW

BIOLOGY OF PROKARYOTES

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. capsule, endospore

2. pilus, conjugation

3. obligate anaerobe, facultative anaerobe

4. transformation, transduction

MULTIPLE CHOICE  Write the correct letter in the blank.

1. One structure you would not find in a bacterial cell is a
   a. cell wall.  b. cell membrane.  c. mitochondrion.  d. chromosome.

2. Which of the following is not a method of movement used by bacteria?
   a. gliding through a layer of slime
   b. forceful expulsion of water from contractile vacuoles
   c. producing a corkscrew-like motion
   d. propulsion by flagella

3. Photoautotrophic bacteria obtain energy
   a. from the sun.  b. by oxidizing inorganic compounds.  c. by feeding on living organisms.  d. by feeding on dead and decaying material.

4. Which types of bacteria can live in the presence of oxygen?
   a. only obligate anaerobes  b. only obligate aerobes  c. only obligate aerobes and facultative anaerobes  d. all bacteria

5. The process by which two living bacteria bind together and transfer genetic information is called
   a. conjugation.  b. transformation.  c. transduction.  d. encapsulation.
SHORT ANSWER  Answer the questions in the space provided.

1. Where does photosynthesis take place in a photoautotrophic bacterium?  

2. What is a glycocalyx, and what function does it serve?  

3. Name three environmental factors that affect the growth of bacteria.  

4. What type of genetic recombination in bacteria involves DNA transfer by viruses?  

5. Critical Thinking  Why are bacterial transformation, conjugation, and transduction not considered to be methods of reproduction?  

STRUCTURES AND FUNCTIONS  Briefly describe the function of each labeled structure in the drawing of a bacterial cell shown below.

1. Pilus  
2. Capsule  
3. Cell wall  
4. Cell membrane  
5. Chromosome  
6. Plasmid  
7. Flagellum
SECTION 23-3 REVIEW

BACTERIA AND HUMANS

VOCABULARY REVIEW  Define the following terms.

1. pathology

2. exotoxin

3. endotoxin

4. zoonosis

5. bioremediation

MULTIPLE CHOICE  Write the correct letter in the blank.

1. One bacterial disease that is transmitted by contaminated drinking water is

2. A poison that is released from the outer membrane of dead Gram-negative bacteria is called
   a. a pathogen.  b. an exotoxin.  c. an endotoxin.  d. a broad-spectrum toxin.

3. Which of the following is not a way that bacteria cause disease in humans?
   a. destroying body tissues  b. conjugating with human cells  c. damaging blood vessels  d. dissolving blood clots

4. Bacteria can become resistant to antibiotics by
   a. secreting antibiotics.  b. assisting the passage of antibiotics through the cell wall.  c. acquiring an R-plasmid for resistance.  d. growing only on Petri dishes.

5. One of the positive ways bacteria affect our lives is by
   a. producing dental caries.  b. consuming improperly preserved foods.  c. preventing the decomposition of dead plants and animals.  d. helping to clean up oil spills.
SHORT ANSWER Answer the questions in the space provided.

1. Identify three ways that bacteria can be transmitted from person to person.

2. Name one bacterial disease that affects nerves, one that affects the intestine, and one that affects the skin.

3. Describe two ways that antibiotics work.

4. List four foods that are produced with the assistance of bacteria.

5. Critical Thinking Why are broad-spectrum antibiotics often used to treat infections caused by unidentified pathogens? What is the danger associated with overusing such antibiotics?

STRUCTURES AND FUNCTIONS The diagram below shows a Petri dish containing a bacterial culture and four paper disks (labeled A–D) treated with different antibiotics. The concentrations of all four antibiotics are the same. Dark areas on the dish indicate bacterial growth, and clear areas indicate inhibition of bacterial growth. State whether the bacteria in this culture are very sensitive, moderately sensitive, or insensitive to each antibiotic, and explain your reasoning.

A. 

B. 

C. 

D.
SECTION 24-1 REVIEW

VIRAL STRUCTURE AND REPLICATION

VOCABULARY REVIEW  Define the following terms.

1. virus ____________________________

2. capsid ___________________________

3. retrovirus ________________________

4. lytic cycle ________________________

5. lysogenic cycle ____________________

MULTIPLE CHOICE  Write the correct letter in the blank.

____ 1. Viruses are not alive because they
   a. do not grow.  b. lack cell parts.  c. do not metabolize.  d. All of the above

____ 2. Viruses can reproduce
   a. independently of host cells.
   b. independently of host cells if they first take up organelles from the host cells.
   c. only within host cells.
   d. only with the assistance of other viruses.

____ 3. The enzyme reverse transcriptase uses
   a. DNA as a template to make more DNA.
   b. DNA as a template to make RNA.
   c. RNA as a template to make more RNA.
   d. RNA as a template to make DNA.

____ 4. The grouping of viruses is based partly on the
   a. presence or absence of an envelope.
   b. presence or absence of nucleic acid.
   c. type of organism they infect.
   d. structure of their organelles.

____ 5. Phage DNA that is integrated into a host cell’s chromosome is a
   a. coronavirus.  b. retrovirus.  c. prophage.  d. capsid.
SHORT ANSWER Answer the questions in the space provided.

1. What did Wendell Stanley’s work suggest about the nature of viruses?

2. What kinds of factors can cause a prophage to become virulent?

3. How does an RNA virus get viral DNA into a host cell’s genome?

4. Why must a person receive a different flu vaccine each year to be protected against the flu?

5. Critical Thinking How does the structure and function of bacteriophages make these viruses useful tools for genetic engineering?

STRUCTURES AND FUNCTIONS The diagrams below represent five steps in the lytic cycle of a bacteriophage. The order of the steps has been scrambled. Arrange the steps in their correct order by writing the letter of each step, and briefly describe what is happening in each step.

a b c d e
SECTION 24-2 REVIEW

VIRAL DISEASES

VOCABULARY REVIEW  Define the following terms.

1. inactivated virus

2. attenuated virus

3. oncogene

4. proto-oncogene

5. protease inhibitor

MULTIPLE CHOICE  Write the correct letter in the blank.

1. One viral disease that can occur in childhood and then reappear in adulthood in a more serious form is
   a. chickenpox.  b. smallpox.  c. rabies.  d. hepatitis.

2. The most successful approach to controlling viral diseases has been the use of
   a. antibiotics.  b. antiviral drugs.  c. viroids.  d. vaccines.

3. Which of the following viral diseases is now considered to be eradicated?
   a. chickenpox  b. smallpox  c. rabies  d. hepatitis.

4. An emerging virus is one that arises
   a. from a host cell when the cell undergoes lysis.
   b. from a lysogenic cycle and enters a lytic cycle.
   c. when isolated habitats are developed by humans.
   d. on the skin after hiding inside nerve cells.

5. A disease-causing particle made of RNA without a capsid is called
   a. a viroid.  c. a prion.
   b. a retrovirus.  d. an envelope.
SHORT ANSWER  Answer the questions in the space provided.

1. Name four viruses that can cause diseases that are often fatal.

2. Explain the relationship between shingles and chickenpox.

3. Name two methods, other than vaccination, for controlling viral diseases.

4. How are some viruses thought to cause cancer?

5. Explain how an emerging virus might suddenly appear in a human population.

6. Critical Thinking Why would a drug that blocks DNA transcription not be a desirable method for treating a viral disease?

STRUCTURES AND FUNCTIONS  Identify the structures labeled a–e in the diagram of the human immunodeficiency virus shown below.

a

b

c

d

e
SECTION 25-1 REVIEW

CHARACTERISTICS OF PROTISTS

VOCABULARY REVIEW Define the following terms.

1. protist ________________________________

2. binary fission ________________________________

3. multiple fission ________________________________

4. conjugation ________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. Protozoans are members of the kingdom

2. One characteristic that is not found in any protozoan is
   a. heterotrophy.       b. multicellularity.       c. motility.       d. parasitism.

3. All protists are capable of
   a. asexual reproduction.   b. sexual reproduction.   c. either asexual or sexual reproduction.   d. conjugation.

4. All of the following are structures used for protist movement except
   a. cilia.   b. flagella.   c. zoospores.   d. pseudopodia.

5. Protists are thought to have evolved from
   a. early viruses.   b. early eukaryotes.   c. ancient prokaryotes.   d. modern fungi.
SHORT ANSWER Answer the questions in the space provided.

1. Describe the two major ways by which protists obtain energy.

2. How are protists classified?

3. What is endosymbiosis

4. Critical Thinking Bacteria and protists both can undergo conjugation. Why is this process more complex in protists than in bacteria?

STRUCTURES AND FUNCTIONS The diagram below represents asexual reproduction and sexual reproduction in Chlamydomonas. Label the two types of reproduction in the spaces provided.
SECTION 25-2 REVIEW

ANIMAL-LIKE PROTISTS

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. cilia, flagella

2. mouth pore, anal pore

3. macronucleus, micronucleus

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Amoebas move by means of a process known as
   a. vacuolar contracting.  
   b. cytoplasmic streaming.  
   c. flagellar whipping.  
   d. ciliary beating.

2. Which of the following is formed from the tests of dead sarcodines?
   a. granite  
   b. limestone  
   c. sandstone  
   d. pearls

3. Sexual reproduction in ciliates involves
   a. binary fission and the formation of two identical offspring.  
   b. the exchange of diploid macronuclei between two individuals.  
   c. the exchange of haploid micronuclei between two individuals.  
   d. the exchange of macronuclei and micronuclei between two individuals.

4. One disease caused by a mastigophoran is
   a. amebic dysentery.  
   b. malaria.  
   c. sleeping sickness.  
   d. toxoplasmosis.

5. Most species in the phylum Apicomplexa are
   a. aquatic and move by using cilia.  
   b. terrestrial and move by extending pseudopodia.  
   c. parasitic and have complex life cycles.  
   d. free-living and reproduce only asexually.
SHORT ANSWER  Answer the questions in the space provided.

1. How have foraminifera and radiolarians contributed to the formation of sedimentary layers on the ocean floor?

2. Describe the processes of feeding and digestion in a paramecium.

3. Describe how protozoans use pseudopodia to move and to capture food.

4. Critical Thinking Although the protozoans that cause malaria are nonmotile, they parasitize two hosts during their life cycle. How do they accomplish this?

STRUCTURES AND FUNCTIONS  Label each structure of the paramecium in the space indicated.
SECTION 25-3 REVIEW

PLANTLIKE AND FUNGUSLIKE PROTISTS

VOCABULARY REVIEW  Define the following terms.

1. fruiting body ________________________________

2. gametangium ________________________________

3. euglenoid ________________________________

4. accessory pigment ________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Algae differ from protozoans in that algae are
   a. heterotrophic.  c. always multicellular.
   b. photosynthetic.  d. always unicellular.

2. The body portion of a seaweed is called a
   a. pyrenoid.  b. holdfast.  c. sporophyte.  d. thallus.

3. Algae are classified into phyla based on all of the following except their
   a. type of photosynthetic pigment.  c. presence or absence of flagella.
   b. form of food storage.  d. cell wall composition.

4. A plasmodial slime mold will generally form a fruiting body when
   a. its host dies.
   b. the number of cells in the plasmodium becomes too large.
   c. the environment becomes too cold.
   d. food or water is scarce.

5. Separate sperm-containing and egg-containing structures are produced by
   a. cellular slime molds.  c. water molds.
   b. plasmodial slime molds.  d. chytrids.
SHORT ANSWER  Answer the questions in the space provided.

1. Describe two differences between green algae and plants. 
   ________________________________________________________
   ________________________________________________________

2. Why is phytoplankton important to other organisms? 
   ________________________________________________________
   ________________________________________________________

3. List the four body forms that algae can have. 
   ________________________________________________________
   ________________________________________________________

4. What structural features distinguish dinoflagellates from other algae? 
   ________________________________________________________
   ________________________________________________________

5. List two plantlike and two animal-like characteristics of euglenoids. 
   ________________________________________________________
   ________________________________________________________

6. Critical Thinking  Some biologists prefer to classify brown, red, and some green algae as plants rather than protists. What characteristics of these algae support such a classification? 
   ________________________________________________________
   ________________________________________________________

STRUCTURES AND FUNCTIONS  Name the phylum of funguslike protists represented by each of the drawings below.

- Mass of cytoplasm with many nuclei
- Long filamentous bodies
- Flagellated gametes and zoospores
- Sluglike colony of many cells
- Fertilization tubes between reproductive structures

a  b  c  d
VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. sporozoite, merozoite

2. giardiasis, trichomoniasis

3. alginate, agar

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. Diatomaceous earth is valuable because it
   a. produces much of the Earth’s oxygen.
   b. provides nutrients for many aquatic organisms.
   c. can be used to produce detergents, paint removers, and toothpaste.
   d. can be used as a source of petroleum.

_____ 2. Which of the following is NOT an environmental role of protists?
   a. Protists produce large amounts of atmospheric oxygen.
   b. Photosynthetic protists are at the base of many food webs.
   c. Protists form important symbiotic relationships with other organisms.
   d. Protists form large amounts of cellulose.

_____ 3. Algal blooms are caused by
   a. high nutrient concentrations.
   b. low nutrient concentrations.
   c. low water temperature.
   d. large numbers of fish.

_____ 4. Malaria is characterized by
   a. severe chills, headache, fever, and fatigue.
   b. nerve damage.
   c. severe diarrhea, fever, and gastrointestinal hemorrhage.
   d. skin sores and swollen glands.

_____ 5. Which of the following pathogens causes an intestinal tract disease?
   a. Trypanosoma sp.
   b. Plasmodium sp.
   c. Entamoeba sp.
   d. Anopheles sp.
SHORT ANSWER Answer the questions in the space provided.

1. Describe two symbiotic relationships between a protist and another organism.

2. Why is carrageenan added to many commercial food products?

3. Why are scientists studying chemotaxis in cellular slime molds?

4. Critical Thinking Why are humans affected by red tides if they do not eat dinoflagellates?

STRUCTURES AND FUNCTIONS Identify the structures labeled a–f in the diagram of the life cycle of Plasmodium shown below.
SECTION 26-1 REVIEW

OVERVIEW OF FUNGI

VOCABULARY REVIEW Define the following terms.

1. hypha
2. mycelium
3. coenocyte
4. sporangiophore
5. conidium
6. budding

MULTIPLE CHOICE Write the correct letter in the blank.

1. All fungi are
   a. multicellular and prokaryotic.
   b. prokaryotic and photosynthetic.
   c. eukaryotic and nonphotosynthetic.
   d. unicellular and photosynthetic.

2. Unlike animals, fungi
   a. ingest their nutrients before digesting them.
   b. secrete enzymes and then absorb the digested nutrients through their cell wall.
   c. have cell walls made of cellulose without chitin.
   d. do not store energy in the form of glycogen.

3. Which of the following is NOT an asexual reproductive structure of a fungus?
   a. septum
   b. sporangium
   c. conidiophore
   d. sporangiospore

4. Throughout most of their life cycle, most fungi are
   a. male.
   b. female.
   c. diploid.
   d. haploid.

5. Biologists think that the first fungi on Earth arose from
   a. prokaryotes.
   b. algae.
   c. plants.
   d. animals.
SHORT ANSWER  Answer the questions in the space provided.

1. How do the cell walls of fungi differ from those of plants? __________________________________________

2. Describe an example of dimorphism in fungi. __________________________________________

3. Explain how a fungus reproduces through fragmentation. __________________________________________

4. What do “plus” and “minus” mean when used in reference to fungi? ________________________________

5. What characteristic do fungi share with animals? __________________________________________

6. In what way are fungi resource recyclers? __________________________________________

7. Critical Thinking  In what ways are most fungi similar to unicellular protists? ______________

STRUCTURES AND FUNCTIONS  Identify the structures labeled a–c. In the spaces below the drawings, name the type of hyphae each drawing represents.

The drawings below depict two types of fungal hyphae.
SECTION 26-2 REVIEW

CLASSIFICATION OF FUNGI

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. rhizoid, stolon  

2. basidium, basidiocarp  

3. ascogonium, antheridium  

4. ascocarp, ascus  

5. lichen, mycorrhiza  

MULTIPLE CHOICE  Write the correct letter in the blank.

___  1. Fungi that have coenocytic hyphae and reproduce sexually through conjugation belong to the phylum  

___  2. A mushroom is an example of a  
   a. rhizoid.  b. ascogonium.  c. zygosporangium.  d. basidiocarp.

___  3. Fungi that produce spores inside saclike compartments belong to the phylum  

___  4. In the life cycle of an ascomycete, haploid nuclei fuse when  
   a. conidia germinate.  b. asci develop.  c. a tube forms between the ascogonium and the antheridium.  d. ascospores germinate.

___  5. One of the functions of the fungus in a mycorrhizal relationship is to  
   a. perform photosynthesis.  b. store sugars for the plant.  c. absorb phosphate and other ions.  d. decompose rock to form soil.
SHORT ANSWER Answer the questions in the space provided.

1. How do the above-ground, sexual reproductive structures of basidiomycetes differ in appearance from those of ascomycetes?

2. How are fungi imperfecti different from other fungi?

3. Explain the difference between a mycorrhiza and a lichen.

4. What effect do lichens have on their physical environment?

5. Explain why mushrooms cannot be grouped with deuteromycetes.

6. What would be more beneficial to a growing plant, a mycorrhiza or a lichen? Explain your answer.

7. Critical Thinking Why are fungi classified according to the sexual reproductive structures they form?

STRUCTURES AND FUNCTIONS Label each structure or process in the spaces provided.

The diagram below illustrates asexual and sexual reproduction in zygomycetes.

[Diagram with labeled structures: a, b, c, d, e, f, Germination]
SECTION 26-3 REVIEW

Fungi and Humans

VOCABULARY REVIEW  Answer the questions in the space provided.

1. What are aflatoxins?

2. What effect do aflatoxins have on humans?

3. Where are the organisms that produce aflatoxins found?

4. What is a wheat rust?

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Sniffing, sneezing, and respiratory distress may be symptoms of an allergic reaction to
   a. cortisone.  b. the Amanita mushroom.  c. the yeast Candida albicans.  d. mold spores.

2. Which of the following is not a condition or disease that can be caused by fungi?
   a. athlete’s foot   b. AIDS   c. ringworm   d. candidiasis

3. Fungal diseases that affect human internal organs are often caused by
   a. dimorphic fungi.  b. deuteromycetes.  c. truffles.  d. morels.

4. The yeast Saccharomyces cerevisiae is used to make all of the following except
   a. bread.  b. vaccines.  c. ethanol.  d. penicillin.

5. Fungi of the genus Cephalosporium are used to produce
   a. mushrooms.  b. cheese.  c. antibiotics.  d. soy products.

6. Which of the following is not a fungal product of importance to the food-processing industry?
   a. vitamin B2   b. wheat rust   c. citric acid   d. gluconic acid

7. The automobile fuel gasohol is made in part with
   a. aflatoxins produced by Amanita.
   b. gluconic acid produced by Saccharomyces cerevisiae.
   c. ethanol produced by yeast.
   d. citric acid produced by yeast.
**SHORT ANSWER** Answer the questions in the space provided.

1. What conditions can cause *Candida albicans* to flourish? ________________________________

2. Name four specific medical products that are produced by or with the use of fungi. ____________

3. Name four types of foods that are produced by or with the use of fungi. ________________________

4. How is *Saccharomyces cerevisiae* induced to manufacture substances that it does not normally make? ________________________________

5. **Critical Thinking** Some fungi produce substances with attractive odors or flavors. These substances are often concentrated in the reproductive structures of the fungi. Why might it be adaptive for a fungus to produce such substances? ________________________________

**STRUCTURES AND FUNCTIONS** This flowchart illustrates the effects that fungi can have on humans. Fill in the blanks to complete the chart.

- Fungi
  - can produce foods such as a, b, c
  - can produce nonfood items such as d, e, f
  - can cause disease through mechanisms such as g, h, i
VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. botany, agriculture

2. cereal, root crop

3. legume, nut

4. fruit, vegetable

MULTIPLE CHOICE  Write the correct letter in the blank.

1. In cultivating wheat, early farmers selected wheat plants
   a. whose seeds were easily dispersed.
   b. whose stalks did not break easily in the wind.
   c. that produced the fewest grains.
   d. that had the largest seed pods.

2. Legumes are valuable crops because they have protein-rich seeds and because
   a. they improve the nitrogen content of soil.
   b. their leaves are used as herbs.
   c. their leaves are fed to livestock.
   d. their bark is a source of quinine.

3. Black pepper is the ground-up seed of a pepper plant, which makes pepper
   a. a fruit.
   b. a flavoring.
   c. an herb.
   d. a spice.

4. All of the following plants are used for their medicinal value except the
   a. cinchona tree.
   b. white willow.
   c. coconut.
   d. foxglove.

5. The artificial fabric rayon is made from
   a. rayon grass.
   b. processed wood fibers.
   c. coal.
   d. petroleum.
SHORT ANSWER  Answer the questions in the space provided.

1. What is a cultivar?  

Give two examples of cultivars.  

2. What nutrients are usually deficient in diets consisting of cereals and root crops?  

How can people supplement such diets to overcome this deficiency?  

3. Explain how grains can be used to produce fuel.  

4. Critical Thinking  Why do you think root crops rather than cereals make up the major part of the diet of people living in many parts of the world?  

STRUCTURES AND FUNCTIONS  Label each of the food plants shown below according to one of the following food categories: cereal, root crop, legume, fruit, vegetable, nut, spice, herb.
SECTION 27-2 REVIEW

PLANTS AND THE ENVIRONMENT

VOCABULARY REVIEW Define the following terms.

1. plant ecology

2. weed

3. hay fever

MULTIPLE CHOICE Write the correct letter in the blank.

1. One of the inorganic nutrients recycled by plants is
   a. sugar.  b. starch.  c. phosphorus.  d. cellulose.

2. Which of the following is not a reason why animals help pollinate plants?
   a. The animals want to help the plants reproduce successfully.
   b. The shape and color of the plants’ flowers attract the animals.
   c. The animals obtain nectar as they pollinate the plants.
   d. The plants’ flowers resemble females of the animals’ species.

3. Mycorrhizal fungi
   a. cause plant diseases that may result in major crop losses.
   b. infect plant roots without harming the roots.
   c. decrease a plant’s ability to absorb water and inorganic nutrients.
   d. supply plants with energy in exchange for water.

4. Plants that are harmful when eaten or touched include
   a. poison oak.  c. American mistletoe.
   b. holly.  d. All of the above

5. Most of the problems associated with hay fever are caused by
   a. airborne pollen.  c. skin contact with weeds.
   b. ingested fruits and berries.  d. cotton clothing.

6. Which of the following is not likely to cause hay fever?
   a. deciduous trees  b. wild grasses  c. cereal crops  d. large flowers
**SHORT ANSWER** Answer the questions in the space provided.

1. How do plants participate in the cycling of oxygen and carbon dioxide on Earth? 
   
   
   
2. How do plants contribute to the formation and maintenance of soil? 
   
   
   
3. What caused the near elimination of American chestnut trees in the early 1900s? 
   
   
   
4. What kinds of flowers usually produce allergy-inducing pollen? 
   
   
   
5. **Critical Thinking** Why have plants such as the water hyacinth and kudzu become so widespread in some areas where they have been introduced by humans? 
   
   
   
**STRUCTURES AND FUNCTIONS** The diagram below represents the cycling of inorganic nutrients in the environment. Complete the diagram by filling in each space with one of the following terms: inorganic nutrients, death, consumers, decomposers.

   
   
   
1. Which term describes the role of plants in the cycle? 
   
   
   
2. Provide an example of a nutrient that could be recycled in this manner. 
   
   
   
SECTION 28-1 REVIEW

OVERVIEW OF PLANTS

VOCABULARY REVIEW Distinguish between the terms in each of the following pairs of terms.

1. sporophyte, gametophyte

2. spore, seed

3. xylem, phloem

4. vascular plant, nonvascular plant

5. angiosperm, gymnosperm

MULTIPLE CHOICE Write the correct letter in the blank.

1. Each of the following is a part of a seed except the
   a. embryo.   b. endosperm.   c. seed coat.   d. gametophyte.

2. The plant tissue that transports water from the roots to the leaves is the
   a. phloem.   b. xylem.   c. endosperm.   d. woody tissue.

3. Ferns are a type of
   a. vascular plant.   b. seed plant.   c. angiosperm.   d. gymnosperm.

4. Pine trees are a type of
   a. nonvascular plant.   b. angiosperm.   c. gymnosperm.   d. herbaceous plant.

5. The life cycle of a vascular plant is characterized by
   a. a large gametophyte and a small sporophyte.
   b. a large sporophyte and a small gametophyte.
   c. the absence of a sporophyte.
   d. the absence of a gametophyte.
SHORT ANSWER  Answer the questions in the space provided.

1. Name two adaptations plants have made to life on land, and briefly describe the advantage of each adaptation.  
   
   
   
2. Describe three similarities between modern green algae and plants.  
   
   
   
3. What structures or stages in the life cycle of a plant are haploid?  
   
   
   
4. Critical Thinking  In what two ways are the spores of land plants different from the spores of algae, which you learned about in an earlier chapter?  
   
   
   
STRUCTURES AND FUNCTIONS  The diagram below is a phylogenetic diagram of plants and their algal ancestors. In the spaces provided, name the important adaptation(s) that evolved at each of the positions indicated on the phylogenetic diagram.

Nonvascular plants  
Seedless vascular plants  
Gymnosperms  
Angiosperms  
Algal ancestors 

a  
b  
c  
d
SECTION 28-2 REVIEW

NONVASCULAR PLANTS

VOCABULARY REVIEW  Define the following terms.

1. bryophyte __________________________________________
   __________________________________________

2. liverwort __________________________________________
   __________________________________________

3. hornwort __________________________________________
   __________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Bryophytes have
   a. true roots, stems, and leaves.  c. vascular tissue.
   b. an alternation-of-generations life cycle.  d. seeds.

2. Bryophytes include all of the following plants except
   a. ferns.  b. hornworts.  c. liverworts.  d. mosses.

3. Mosses are called pioneer plants because they
   a. are more closely related to algae than to plants.
   b. were the first plants to be cultivated by European settlers in North America.
   c. are often the first species to inhabit a barren area.
   d. gradually remove organic and inorganic matter from the surface of rocks.

4. Peat bogs
   a. decompose rapidly.
   b. are composed mainly of algae and ferns.
   c. are found mostly in the southern hemisphere.
   d. are used as a source of fuel in many countries.

5. The body forms of liverworts may include all of the following except
   a. thin leaflike structures arranged along a stemlike axis.
   b. clusters of leaves and flowers at the end of a woody stem.
   c. a flat body with distinguishable upper and lower surfaces.
   d. an umbrella-shaped structure that holds reproductive cells.
SHORT ANSWER Answer the questions in the space provided.

1. What phase of the bryophyte life cycle is dominant? ________________________________

2. Why do bryophytes require a moist environment for sexual reproduction? ________________

3. Describe three ways that humans use peat moss. ________________________________

4. How are hornworts similar to algae and different from other plants? ________________

5. Explain how mosses benefit an environmentally disturbed area. ________________

6. Critical Thinking In what type of environment would you expect to find liverworts with a thalloid body form? Explain your answer. ________________

STRUCTURES AND FUNCTIONS The drawing below illustrates the main parts of a moss. Identify the phases of the moss life cycle represented by a and b, and name the structure labeled c.
SECTION 28-3 REVIEW

VASCULAR PLANTS

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. fiddlehead, frond________________________________________________________

2. monocot, dicot___________________________________________________________

3. parallel venation, net venation____________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. The mobile sexual reproductive parts of all seedless plants are
a. rhizomes.  b. cones.  c. spores.  d. epiphytes.

_____ 2. One of the adaptive advantages of seeds is that seeds
a. do not remain inactive for long periods of time.
b. can germinate without water.
c. lack a tough outer coat.
d. contain a nutrient supply.

_____ 3. Naked seeds are produced by plants in the phylum

_____ 4. One of the differences between angiosperms and gymnosperms is that
a. most gymnosperms can reach maturity in a single growing season.
b. angiosperms have a more efficient vascular system.
c. gymnosperms are more likely to be associated with mycorrhizae.
d. angiosperms are less diverse than gymnosperms.

_____ 5. Most monocots
a. bear their seeds in cones.
b. have vascular bundles that are arranged in a circle.
c. do not produce flowers.
d. have parallel venation.
SHORT ANSWER  Answer the questions in the space provided.

1. Identify two ways that vascular plants differ from nonvascular plants. ____________________________________________________________

2. Briefly describe the distinguishing characteristics of gymnosperms in the phyla Cycadophyta, Ginkgophyta, and Coniferophyta. ____________________________________________________________

3. How do the reproductive structures of angiosperms differ from those of gymnosperms? ____________________________________________________________

4. Critical Thinking  There are many more species of ferns (phylum Pteridoophyta) than there are species in the other three phyla of seedless vascular plants. Propose a hypothesis to explain this fact. ____________________________________________________________

STRUCTURES AND FUNCTIONS  Write the phylum name of the type of vascular plant represented by each of the drawings. Choose the name from the list of phylum names below.

<table>
<thead>
<tr>
<th>Lycophyta</th>
<th>Pteridoophyta</th>
<th>Coniferophyta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psilophyta</td>
<td>Cycadophyta</td>
<td>Gnetophyta</td>
</tr>
<tr>
<td>Sphenophyta</td>
<td>Ginkgophyta</td>
<td>Anthophyta</td>
</tr>
</tbody>
</table>

- Ginkgo
- Whisk fern
- Cycad
- Pine

a  b  c  d
**SECTION 29-1 REVIEW**

**PLANT CELLS AND TISSUES**

**VOCABULARY REVIEW** Distinguish between the terms in each of the following groups of terms.

1. parenchyma cells, collenchyma cells, sclerenchyma cells ____________________________  
   ____________________________________________
   ____________________________________________

2. dermal tissue system, ground tissue system, vascular tissue system ____________________  
   ____________________________________________
   ____________________________________________

3. apical meristems, intercalary meristems, lateral meristems __________________________  
   ____________________________________________
   ____________________________________________

**MULTIPLE CHOICE** Write the correct letter in the blank.

1. Which of the following plant cells is dead at maturity?
   a. epidermal cell       b. companion cell       c. vessel element       d. collenchyma cell

2. The conducting parenchyma cell of angiosperm phloem is called a
   a. sieve tube member.       c. stoma.       b. tracheid.       d. cuticle.

3. Intercalary meristems are found in some
   a. conifers.       b. gymnosperms.       c. dicots.       d. monocots.

4. In woody stems and roots, the epidermis is replaced by
   a. the vascular cambium.       c. apical meristems.       b. cork cells.       d. sieve plates.

5. Primary growth refers to
   a. the germination of a seedling.       b. an increase in the length of a plant.       c. an increase in the diameter of a stem.       d. growth produced by the lateral meristems.
SHORT ANSWER Answer the questions in the space provided.

1. What type of parenchyma cell is found in the nonwoody parts of plants, and what are the functions of this cell type? ________________________________

2. Describe the appearance, primary function, and location of collenchyma cells. ________________________________

3. In what parts of a plant would you expect to find sclerenchyma cells? ________________________________

4. What kinds of meristems are found in monocots, and where are they located? ________________________________

   What kinds of meristems are found in dicots, and where are they located? ________________________________

5. Critical Thinking Why is it advantageous for plants to have water-transporting cells that are dead? ________________________________

STRUCTURES AND FUNCTIONS The drawings below depict the major components of xylem and phloem. Identify the structures labeled a–d. In the spaces below the drawings labeled e–g, name the type of component each drawing represents.
SECTION 29-2 REVIEW

ROOTS

VOCABULARY REVIEW Define the following terms.

1. adventitious root

2. cortex

3. pericycle

4. macronutrient

5. micronutrient

MULTIPLE CHOICE Write the correct letter in the blank.

1. One example of a plant with a fibrous root system is a
   a. carrot.    b. cottonwood.    c. radish.    d. grass.

2. All of the following adaptations increase the ability of roots to absorb water except
   a. root caps.    b. root hairs.    c. fibrous root systems.    d. mycorrhizal associations.

3. The cortex of a primary root is made of
   a. epidermal cells.    b. parenchyma cells.    c. vascular tissues.    d. pith.

4. Roots perform all of the following functions except
   a. absorbing water and minerals from the soil.
   b. anchoring the plant in the soil.
   c. carrying out the light reactions of photosynthesis.
   d. storing water and organic compounds.

5. One of the micronutrients plants absorb is
   a. manganese.    b. nitrogen.    c. potassium.    d. carbon.
**SHORT ANSWER** Answer the questions in the space provided.

1. What kind of tissue forms the innermost cylinder of a root? 

2. What cells divide to form lateral roots? 

3. Where does a vascular cambium form during secondary growth in roots? 

4. What structures does this vascular cambium produce, and where are they produced? 

5. Name four macronutrients in plants. 

6. **Critical Thinking** Would you expect water absorption to be greater in parts of roots that have undergone secondary growth or in parts that have not? Explain your reasoning. 

**STRUCTURES AND FUNCTIONS** The drawings below show cross sections of a monocot root and a dicot root. Identify the structures labeled a–f. In the spaces below the drawings, name the type of root each drawing represents.
SECTION 29-3 REVIEW

STEMS

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. heartwood, sapwood
   ________________________________

2. springwood, summerwood
   ________________________________

3. source, sink
   ________________________________

4. translocation, transpiration
   ________________________________

5. pith, wood
   ________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

   1. Which of the following are found in both roots and stems?
      a. buds          b. vascular tissues          c. nodes          d. internodes

   2. Lateral stems arise from meristems located
      a. randomly along the main stem.       c. between the bark and the wood.
      b. deep inside the main stem.          d. at nodes on the surface of the main stem.

   3. One difference between monocot stems and dicot stems is that monocot stems usually
      a. have vascular bundles arranged in a ring.
      b. replace primary tissues with secondary tissues.
      c. retain the primary growth pattern their entire lives.
      d. have secondary growth.

   4. In a stem cross section, an annual ring represents an abrupt change between
      a. summerwood and springwood.       c. bark and cork.
      b. heartwood and sapwood.          d. xylem and phloem.

   5. The driving force for transpiration is provided by
      a. water pressure in the roots.       c. the evaporation of water from the leaves.
      b. water tension in the stems.       d. the hydrolysis of ATP.
SHORT ANSWER  Answer the questions in the space provided.

1. What structures on a stem are analogous to the root cap on a root?  ____________________________  
   How do these structures differ from a root cap?  ____________________________  

2. Explain how evaporation, tension, cohesion, and adhesion are involved in the movement of water through a plant.  ____________________________  
   ____________________________  
   ____________________________  

3. **Critical Thinking** Besides serving as a conduit for water, what other function does wood have in trees and other woody plants? How is this function important in stimulating photosynthesis?  
   ____________________________  

STRUCTURES AND FUNCTIONS  The diagram below represents the movement of carbohydrates in a plant as described by the pressure-flow model. Identify the structures labeled a–d and the substances that are transported along the arrows labeled e–i.
SECTION 29-4 REVIEW

LEAVES

VOCABULARY REVIEW  Define the following terms.

1. petiole

2. mesophyll

3. guard cell

MULTIPLE CHOICE  Write the correct letter in the blank.

1. A leaf that is divided into leaflets is called a
   a. simple leaf.         b. compound leaf.       c. veined leaf.       d. parallel leaf.

2. Leaves consist of
   a. dermal tissue only.
   b. dermal tissue and ground tissue only.
   c. ground tissue and vascular tissue only.
   d. dermal tissue, ground tissue, and vascular tissue.

3. One adaptation that reduces water loss from leaves without reducing the rate of photosynthesis is the
   a. closure of stomata during the night.
   b. closure of stomata during a water shortage.
   c. presence of large numbers of stomata.
   d. presence of epidermal hairs.

4. Most photosynthesis occurs in a portion of the leaf called the
   a. vascular bundle.                  c. palisade mesophyll.
   b. spongy mesophyll.                d. upper epidermis.

5. Leaves that develop in full sun
   a. are thicker.
   b. have a larger area per leaf.
   c. have fewer chloroplasts per unit area.
   d. have minimal shading of one chloroplast by another.
SHORT ANSWER Answer the questions in the space provided.

1. Describe three adaptations of leaves for functions besides photosynthesis. __________________________
   __________________________
   __________________________

2. What is the usual function of the epidermal hairs on a leaf? __________________________
   __________________________

3. What are the products of photosynthesis in a leaf used for, and where are they used within the plant?
   __________________________
   __________________________
   __________________________

4. Explain how potassium ions are involved in the opening of stomata. __________________________
   __________________________

5. **Critical Thinking** Why would an agricultural practice that eliminated transpirational water loss
   be disadvantageous for plants? __________________________
   __________________________
   __________________________

**STRUCTURES AND FUNCTIONS** Identify the structures labeled a–f in the drawing of the
internal structure of a leaf shown below.

```
   a  
   b  
   c  
   d  
   e  
   f  
```
SECTION 30-1 REVIEW

PLANT LIFE CYCLES

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. antheridium, archegonium

2. homospory, heterospory

3. integument, micropyle

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Which of the following is the correct order of formation of structures in the life cycle of a moss?
   a. archegonium and antheridium, spores, sporophyte, egg and sperm, zygote
   b. zygote, spores, sporophyte, archegonium and antheridium, egg and sperm
   c. sporophyte, spores, archegonium and antheridium, egg and sperm, zygote
   d. egg and sperm, archegonium and antheridium, zygote, spores, sporophyte

2. The production of a single type of spore is a characteristic of the life cycles of
   a. mosses and most ferns.
   b. mosses and most gymnosperms.
   c. most ferns and gymnosperms.
   d. mosses, most ferns, and most gymnosperms.

3. One structure that is found in ferns but not in mosses or conifers is
   a. an ovule.
   b. a pollen grain.
   c. a sporophyte.
   d. a sorus.

4. The dominant stage in the life cycle of a conifer is the
   a. gametophyte.
   b. sporophyte.
   c. megasporangium.
   d. microsporangium.

5. Sexual reproduction in conifers and other seed plants is independent of seasonal rains because
   a. these plants grow only near streams and rivers.
   b. pollinators carry the sperm to the eggs.
   c. fertilization occurs inside structures within the sporophyte.
   d. fertilization always involves eggs and sperm of the same plant.
SHORT ANSWER Answer the questions in the space provided.

1. Which of the following structures in a moss life cycle are haploid and which are diploid: sporophyte, spore, archegonium, antheridium, gametophyte, zygote? 

Which structure represents the dominant phase of the life cycle?

2. How do the sperm of conifers differ from those of mosses and ferns?

How do the spores of conifers differ from those of mosses and most ferns?

3. What kind of cell division results in the production of spores?

What kind of cell division results in the production of gametes?

4. Critical Thinking Why must mosses and ferns live in environments that are wet during at least part of the year?

STRUCTURES AND FUNCTIONS Identify the structures labeled a–h in the diagram of the life cycle of a fern shown below.
VOCABULARY REVIEW Explain the relationship between the terms in each of the following pairs of terms.

1. anther, filament

2. stigma, style

3. polar nuclei, double fertilization

MULTIPLE CHOICE Write the correct letter in the blank.

1. During ovule formation in a flowering plant, the resulting structure contains
   a. four megaspores.
   b. one megaspore mother cell with four nuclei.
   c. one egg cell and two polar nuclei.
   d. four megaspores and four egg cells.

2. In a flowering plant, the female gametophyte is referred to as
   a. an embryo sac.
   b. a megaspore mother cell.
   c. an ovule.
   d. a carpel.

3. During pollen formation in a flowering plant, the resulting structure contains
   a. two sperm cells.
   b. a generative cell and a tube cell.
   c. one microspore mother cell.
   d. four microspores.

4. Successful wind pollination usually requires
   a. large, colorful flowers.
   b. the release of small amounts of pollen.
   c. wet weather.
   d. the relative proximity of individuals to one another.

5. In a flowering plant, one sperm fertilizes the polar nuclei to form the
   a. micropyle.
   b. endosperm.
   c. pollen tube.
   d. zygote.
SHORT ANSWER  Answer the questions in the space provided.

1. What happens to the four megaspores produced during ovule formation? 

What happens to the four microspores produced during pollen grain formation? 

2. Which of the following structures and events occur in both gymnosperms and angiosperms, and which occur only in angiosperms: wind pollination, animal pollination, pollen grain, pollen tube, fertilization quickly following pollination, double fertilization, embryo sac, endosperm? 

3. What adaptive advantage does a plant gain by producing nectar? 

4. What is the function of endosperm? 

5. Critical Thinking  Are plants that are pollinated by moths and bats more likely to have colorful flowers or fragrant flowers? Explain your reasoning. 

STRUCTURES AND FUNCTIONS  Identify the structures labeled a–i in the diagram of a flower shown below.
SECTION 30-3 REVIEW

DISPERAL AND PROPAGATION

VOCABULARY REVIEW Define the following terms.

1. radicle
2. hypocotyl
3. epicotyl
4. plumule
5. hilum

MULTIPLE CHOICE Write the correct letter in the blank.

1. One structure that is not an adaptation for fruit or seed dispersal is the
   a. “parachute” on a milkweed seed.  
   b. pair of wings on a pine seed. 
   c. air chamber in a coconut.  
   d. cotyledon of a corn grain.

2. Fruits are classified partly on the basis of how
   a. they are dispersed.  
   b. many seeds they contain. 
   c. many pistils or flowers form the fruit.  
   d. large they are.

3. Which of the following plants has mature seeds that contain endosperm?
   a. corn  
   b. lima bean  
   c. pea  
   d. pine

4. The first visible sign of seed germination is the
   a. growth of the shoot.  
   b. emergence of the radicle. 
   c. appearance of the cotyledons above the soil.  
   d. unfolding of the plumule’s embryonic leaves.

5. Vegetative propagation refers to the
   a. sexual reproduction of plants that are consumed as vegetables.  
   b. growth of the leaves and stems of a plant. 
   c. use of vegetative structures to produce new plants.  
   d. crossing of two strains of plants to produce hybrid vegetables.
SHORT ANSWER Answer the questions in the space provided.

1. Name the category of fruit to which each of the following belongs: raspberry, pineapple, pea pod.

2. Identify four environmental factors or conditions that are required for the germination of at least some seeds.

3. What is the main advantage of asexual reproduction?

   What is the main disadvantage of asexual reproduction?

4. Name four plant structures that are adapted for vegetative reproduction.

5. Name three common methods of seed dispersal, and give an example of each method.

6. Critical Thinking Because plants make their own food through photosynthesis, why is it necessary for plant seeds to contain food reserves?

STRUCTURES AND FUNCTIONS Identify the structures labeled a–g in the diagram of a corn grain shown below.
SECTION 31-1 REVIEW

PLANT HORMONES

VOCABULARY REVIEW  Define the following terms.

1. plant hormone _______________________________________________________
   _______________________________________________________

2. apical dominance _____________________________________________________
   _______________________________________________________

3. ethephon ____________________________________________________________
   _______________________________________________________

4. abscission ____________________________________________________________
   _______________________________________________________

5. cytokinin _____________________________________________________________
   _______________________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

____ 1. The major effect of indoleacetic acid is to
   a. inhibit the enlargement of fruit.  c. stimulate dormancy.  
   b. stimulate cell growth.  d. inhibit germination.

____ 2. After a shoot has had its tip removed, apical dominance can be maintained artificially by
   the application of
   a. GA.  b. 2,4-D.  c. ABA.  d. NAA.

____ 3. One of the effects of gibberellins is to stimulate
   a. germination.  b. ripening.  c. dormancy.  d. abscission.

____ 4. Ethylene differs from other plant hormones in that it
   a. has only inhibitory effects on plants.  c. is a gas at room temperature.
   b. is produced only in seeds.  d. affects only the plant that produces it.

____ 5. By varying the ratio of auxins to cytokinins in a tissue-culture medium, botanists can
   selectively stimulate the formation of
   a. roots or shoots.  c. flowers or fruits.
   b. stems or leaves.  d. seeds or lateral buds.
SHORT ANSWER Answer the questions in the space provided.

1. Why does the removal of seeds from a strawberry fruit prevent the fruit from enlarging? __________

2. Identify three agricultural uses of gibberellins. ______________

3. Identify three agricultural uses of ethylene or ethephon. ______________

4. How is it adaptive for a water-stressed plant to produce ABA? ______________

5. Critical Thinking Abscisic acid was originally named “dormin.” Why was that an appropriate name for this hormone? ______________

STRUCTURES AND FUNCTIONS The drawings below show two plants of the same species and the same age. The plant on the right was treated with a hormone. The plant on the left was not. Which of the five major groups of plant hormones was used to treat the plant on the right? Explain your answer.

__________________________

__________________________

__________________________

__________________________

__________________________

__________________________
SECTION 31-2 REVIEW

PLANT MOVEMENTS

VOCABULARY REVIEW Define the following terms, and provide one example of a type of plant or a plant part to which each term applies.

1. thigmotropism

2. thigmonastic movement

3. nyctinastic movement

MULTIPLE CHOICE Write the correct letter in the blank.

1. The positive phototropism shown by shoots is caused by the movement of
   a. auxin to the shaded side of the shoot.
   b. auxin to the lighted side of the shoot.

2. The coiling of a morning glory stem around a fence post is an example of
   a. phototropism.
   b. chemotropism.
   c. thigmotropism.
   d. a thigmonastic movement.

3. The opposite responses of stems and roots to gravity are thought to be due to the
   a. inhibition of cell elongation in the lower side of the stems and the stimulation of cell elongation in the lower side of the roots.
   b. stimulation of cell elongation in the lower side of the stems and the inhibition of cell elongation in the lower side of the roots.
   c. inhibition of cell elongation in the lower side of both the stems and the roots.
   d. stimulation of cell elongation in the lower side of both the stems and the roots.

4. Unlike tropisms, nastic movements are
   a. always positive.
   b. always negative.
   c. restricted to flowers.
   d. independent of the direction of stimuli.

5. The daily change in the orientation of the prayer plant’s leaves is an example of
   a. solar tracking.
   b. a nyctinastic movement.
   c. a thigmonastic movement.
   d. gravitropism.
SHORT ANSWER Answer the questions in the space provided.

1. What is the adaptive advantage of positive phototropism? ____________________________

What is the adaptive advantage of positive gravitropism? ____________________________

2. What type of plant hormone is thought to be involved in all plant tropisms that involve cell elongation? ________________________________

3. What cellular events make nastic movements possible? __________________________

4. What are three adaptive advantages of thigmonastic movements? ____________________

5. Critical Thinking The Venus’ flytrap obtains nitrogen and minerals by closing its leaves around insects and then digesting the insects. Why would a thigmonastic movement be more useful than thigmotropism for this type of plant response? ________________________________

STRUCTURES AND FUNCTIONS Use the diagram of a seedling below to answer the following questions.

1. What tropisms are being exhibited by the various parts of this seedling? ________________

2. What hormones are involved in these responses? ____________________________
SECTION 31-3 REVIEW

SEASONAL RESPONSES

VOCABULARY REVIEW  Define the following terms.

1. photoperiodism

   

2. vernalization

   

3. bolting

   

4. critical night length

   

MULTIPLE CHOICE  Write the correct letter in the blank.

   1. Long-day plants flower
      a. in the fall.
      b. when the day length is longer than 12 hours.
      c. when the night length is shorter than a critical number of hours.
      d. when the night length is longer than a critical number of hours.

   2. Flower growers can induce winter flowering in a long-day plant by
      a. spraying the plant with gibberellin.
      b. exposing the plant to low temperatures.
      c. covering the plant in the late afternoon with an opaque cloth.
      d. exposing the plant to a low level of light in the middle of the night.

   3. Plants monitor changes in day length with the pigment
      a. anthocyanin.
      b. phytochrome.
      c. chlorophyll.
      d. carotenoid.

   4. Crop plants whose flowering is stimulated by vernalization are usually sown in the
      a. fall.
      b. winter.
      c. spring.
      d. summer.

   5. The fall colors displayed by many tree leaves are caused partly by the
      a. stimulation of carotenoid synthesis that occurs only in the fall.
      b. disappearance of chlorophyll, which allows the carotenoids to become visible.
      c. migration of chlorophyll from the stems into the leaves.
      d. replacement of carotenoids by anthocyanins.
**SHORT ANSWER** Answer the questions in the space provided.

1. Identify three processes that are affected by photoperiodism in at least some plant species.

2. Name one short-day plant and identify the time of year when it flowers.

Name one long-day plant and identify the time of year when it flowers.

3. Identify three plant processes in which phytochrome is involved.

4. How can plants whose flowering is stimulated by vernalization be prevented from flowering?

5. **Critical Thinking** Spinach is a long-day plant with a critical night length of 10 hours. Why is spinach not usually grown in the northern United States during the summer?

**STRUCTURES AND FUNCTIONS** Use the diagram below to fill in lines a–f.

The diagrams below represent three different conditions of day and night length. A short-day plant, with a critical night length of 14 hours, and a long-day plant, with a critical night length of 8 hours, are grown under each condition. On the lines, indicate whether each plant will flower under each condition.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Does short-day plant flower?</th>
<th>Does long-day plant flower?</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 hr light</td>
<td>7 hr dark</td>
<td>a</td>
</tr>
<tr>
<td>9 hr light</td>
<td>15 hr dark</td>
<td>c</td>
</tr>
<tr>
<td>9 hr light</td>
<td>7 hr dark</td>
<td>e</td>
</tr>
</tbody>
</table>
SECTION 32–1 REVIEW

THE NATURE OF ANIMALS

VOCABULARY REVIEW Define the following terms.

1. vertebrate ________________________________

2. ingestion ________________________________

3. dorsal nerve cord __________________________

4. cephalization ______________________________

MULTIPLE CHOICE Write the correct letter in the blank.

____ 1. Which of the following statements accurately describes animals?
   a. All animals are multicellular, all are heterotrophic, and all lack cell walls.
   b. All animals are multicellular, some are heterotrophic, and some lack cell walls.
   c. Some animals are multicellular, all are heterotrophic, and all lack cell walls.
   d. Some animals are multicellular, some are heterotrophic, and some lack cell walls.

____ 2. An animal’s ability to move results from the interrelationship between
   a. dermal tissue and vascular tissue.
   b. vascular tissue and nervous tissue.
   c. nervous tissue and muscle tissue.
   d. muscle tissue and ground tissue.

____ 3. Scientists infer that the first invertebrates evolved from
   a. simple vertebrates.
   b. large groups of bacteria.
   c. loosely connected fungi.
   d. colonial protists.

____ 4. Cephalization is associated with
   a. bilaterally symmetrical animals.
   b. radially symmetrical animals.
   c. sponges.
   d. hydras.

____ 5. A body cavity aids in an animal’s movement by
   a. anchoring the animal firmly to objects in its environment.
   b. providing a firm structure against which muscles can contract.
   c. giving rise to muscle tissue during embryonic development.
   d. secreting a fluid that allows the animal to glide over surfaces.
SHORT ANSWER  Answer the questions in the space provided.

1. Explain the relationship between differentiation and specialization.

2. On what basis do taxonomists group animals into phyla?

3. Why is cephalization important to animals?

4. Name three functions of a coelom.

5. Critical Thinking  Why is it important for a taxonomist to look at patterns of development when trying to classify animals?

STRUCTURES AND FUNCTIONS  In the drawing of a prairie dog shown below, label the animal’s anterior and posterior ends and its dorsal and ventral sides in spaces a–d.

What type of symmetry does this animal have?
SECTION 32-2 REVIEW

INVERTEBRATES AND VERTEBRATES

VOCABULARY REVIEW  Explain the relationship between the terms in each of the following pairs of terms.

1. segmentation, vertebrae

2. integument, exoskeleton

MULTIPLE CHOICE  Write the correct letter in the blank.

1. In a closed circulatory system,
   a. cells exchange nutrients directly with the environment.
   b. the bloodlike circulatory fluid never leaves the coelom.
   c. blood circulates through the body in tubular vessels.
   d. the blood carries gases but not nutrients or wastes.

2. A gut is a
   a. structure specialized for gas exchange in water.
   b. simple excretory organ of invertebrates.
   c. digestive chamber with one opening.
   d. digestive tract that runs through the body.

3. A hermaphrodite is an organism that
   a. produces only male gametes.
   b. produces only female gametes.
   c. produces both male and female gametes.
   d. does not produce any gametes.

4. The moist skin of an amphibian functions as
   a. a respiratory organ.
   b. a structure for conserving water.
   c. an insulating material.
   d. a rigid exoskeleton.

5. Development of zygotes outside the body of the female parent is a characteristic of
   a. all fishes and amphibians.
   b. many fishes, amphibians, reptiles, and birds.
   c. all reptiles and birds.
   d. reptiles, birds, and some amphibians.
SHORT ANSWER  Answer the questions in the space provided.

1. Name two animal phyla whose members show segmentation.

2. What waste excretion problem is shared by invertebrates and vertebrates? 

   How do some invertebrates and vertebrates deal with this problem?

3. Explain how the legs of a deer and the integument of a reptile are adaptations for life on land.

4. What is one advantage of the multichambered heart that is found in some vertebrates?

5. Critical Thinking  Name one advantage and one disadvantage of being a hermaphrodite.

STRUCTURES AND FUNCTIONS  The table below summarizes the functions of some vertebrate structures. Complete the table by filling in the missing structures and functions.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>filters wastes from the blood</td>
</tr>
<tr>
<td>Lung or gill</td>
<td>b</td>
</tr>
<tr>
<td>c</td>
<td>provides a barrier against the environment</td>
</tr>
<tr>
<td>Brain</td>
<td>d</td>
</tr>
<tr>
<td>e</td>
<td>provides structural support for the body</td>
</tr>
</tbody>
</table>
SECTION 32-3 REVIEW

FERTILIZATION AND DEVELOPMENT

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. archenteron, blastopore

2. pseudocoelom, coelom

3. protostome, deuterostome

4. schizocoely, enterocoely

MULTIPLE CHOICE  Write the correct letter in the blank.

____ 1. The eggs of different animal species vary greatly in size, depending on
   a. whether the egg and sperm are haploid or diploid.
   b. how long the food supply in the yolk must last.
   c. the number of chromosomes in the egg.
   d. the number of chromosomes in the sperm.

____ 2. The central cavity of a blastula is called a
   a. blastocoel.  
   b. coelom.  
   c. blastopore.  
   d. gastrula.

____ 3. Body parts formed by the mesoderm include the
   a. lungs.  
   b. liver.  
   c. muscles.  
   d. pancreas.

____ 4. Animals in which the anus develops from the blastopore include
   a. mollusks.  
   b. arthropods.  
   c. annelids.  
   d. chordates.

____ 5. Animals that develop from three germ layers without a body cavity are called
   a. coelomates.  
   b. pseudocoelomates.  
   c. acoelomates.  
   d. schizocoelomates.
SHORT ANSWER  Answer the questions in the space provided.

1. Contrast the structure of a blastula with that of a gastrula.  

2. Name the three germ layers in order, from outside to inside.  

3. What features of development indicate that echinoderms and chordates are more closely related to each other than they are to other animals?  

4. Critical Thinking  Why is it important to have a mechanism that prevents more than one sperm from entering an egg?  

STRUCTURES AND FUNCTIONS  The diagrams below show coelom formation during the two distinct patterns of development that most animals can undergo. In spaces a and b, name each pattern of development. In spaces c and d, name each type of coelom formation. In spaces e and f, name the structure that the opening at the bottom becomes.
SECTION 33-1 REVIEW

Porifera

VOCABULARY REVIEW Define the following terms.

1. choanocyte

2. osculum

3. spicule

4. amoebocyte

MULTIPLE CHOICE Write the correct letter in the blank.

1. Invertebrates are animals that lack
   a. true tissues.   b. true organs.   c. a skeleton.   d. a backbone.

2. Adult sponges are sessile, which means that they
   a. have no gastrula stage.   c. use a jellylike substance for body support.
   b. attach to a surface and do not move.   d. produce both eggs and sperm.

3. Choanocytes perform all of the following functions except
   a. pumping water into the interior of the sponge.
   b. engulfing and digesting food that is filtered from the water.
   c. passing nutrients to amebocytes.
   d. distributing nutrients throughout the rest of the body.

4. Sponges eliminate carbon dioxide and cellular wastes by
   a. allowing them to diffuse into the water that passes through the sponge.
   b. excreting them into the surrounding water through pores in the body wall.
   c. transporting them to an excretory organ that empties into the osculum.
   d. converting them into usable carbohydrates.

5. After a sponge egg is fertilized, it develops into a(n)
   a. external bud.   b. gemmule.   c. larva.   d. gastrula.
SHORT ANSWER  Answer the questions in the space provided.

1. On what basis are animals placed into the invertebrate category? ____________________________
   ____________________________________________________________________________________
   ____________________________________________________________________________________

2. What are the two substances that a sponge’s skeleton may be made of? _______________________
   ____________________________________________________________________________________
   How do these substances differ? ____________________________________________________________________________________
   ____________________________________________________________________________________

3. How do choanocytes participate in the sexual reproduction of sponges? ______________________
   ____________________________________________________________________________________
   ____________________________________________________________________________________

4. Why is hermaphroditism beneficial in sponges even though they rarely self-fertilize?
   ____________________________________________________________________________________
   ____________________________________________________________________________________

5. Critical Thinking Would gemmules or larvae be better at distributing a population of sponges
   through an area? Explain your reasoning. ___________________________________________________________________________
   ____________________________________________________________________________________
   ____________________________________________________________________________________

STRUCTURES AND FUNCTIONS  Identify the structures labeled a–e in the diagram of a sponge shown below.

a ____________________________
b ____________________________
c ____________________________
d ____________________________
e ____________________________
SECTION 33-2 REVIEW

CNIDARIA AND CTENOPHORA

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. **polyp, medusa**

2. **epidermis, gastrodermis**

3. **mesoglea, planula**

4. **cnidocyte, nematocyst**

5. **colloblast, apical organ**

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Cnidarians and ctenophores are more complex than sponges because, unlike sponges, they have
   - a. tissues and organs.
   - b. both asexual and sexual reproduction.
   - c. a skeleton.
   - d. a backbone.

2. The structure that coordinates the complex activities of a cnidarian’s body is the
   - a. gastrovascular cavity.
   - b. colloblast.
   - c. nerve net.
   - d. tentacle.

3. An example of a cnidarian in the class Hydrozoa is a
   - a. coral.
   - b. sea anemone.
   - c. jellyfish.
   - d. Portuguese man-of-war.

4. Corals exist in a symbiotic relationship with
   - a. fungi.
   - b. algae.
   - c. hydras.
   - d. mosses.

5. Ctenophores move through the water by
   - a. somersaulting.
   - b. contracting their bell-shaped bodies.
   - c. beating their cilia.
   - d. rotating like a propeller.
SHORT ANSWER Answer the questions in the space provided.

1. How are nematocysts adapted for capturing prey?

2. List three differences between hydras and most other hydrozoans.

3. What is the dominant body form in the life cycle of a scyphozoan?

What is the dominant body form in the life cycle of an anthozoan?

4. Describe two examples of symbiosis found among cnidarians.

5. How do coral polyps produce a coral reef?

6. Critical Thinking Would you expect to find green hydras in a cave pond that receives little or no light? Explain your reasoning.

STRUCTURES AND FUNCTIONS Identify the structures labeled a–f in the diagram of a cnidarian body shown below.

Which body form is represented by this diagram?
VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. proglottid, tegument

2. cerebral ganglia, eyespots

3. primary host, intermediate host

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Flatworms are the simplest animals with  
   a. a backbone.  
   b. a coelom.  
   c. bilateral symmetry.  
   d. radial symmetry.

2. The gastrovascular cavity of a flatworm  
   a. has no opening to the outside.  
   b. has a single opening.  
   c. has two openings.  
   d. is connected to the outside by numerous pores.

3. One difference between free-living flatworms and parasitic flatworms is that  
   a. free-living flatworms have proglottids.  
   b. free-living flatworms do not have a gastrovascular cavity.  
   c. parasitic flatworms have simpler life cycles.  
   d. parasitic flatworms have a tegument.

4. The eggs of the blood fluke Schistosoma  
   a. leave the primary host in feces or urine.  
   b. are produced by hermaphroditic adults.  
   c. must be deposited on dry land to develop.  
   d. are ingested by the intermediate host.

5. The primary hosts of beef tapeworms are  
   a. cows.  
   b. snails.  
   c. pigs.  
   d. humans.
SHORT ANSWER Answer the questions in the space provided.

1. How do planarians eliminate excess water from their bodies? ______________________________________________________
   ______________________________________________________
   ______________________________________________________

2. How do planarians and tapeworms differ in their ability to detect light? ____________________________
   ______________________________________________________
   ______________________________________________________

3. What are the primary host and the intermediate host of a blood fluke? ____________________________
   ______________________________________________________
   How does a blood fluke enter its primary host? ____________________________
   ______________________________________________________

4. What stage of the beef tapeworm life cycle is spent inside a cyst? ____________________________

5. Critical Thinking Some people mistakenly believe that all organisms are perfectly adapted to their environments. What aspect of blood fluke reproduction suggests that these flatworms are not perfectly adapted to the environment inside their human hosts? ____________________________
   ______________________________________________________

STRUCTURES AND FUNCTIONS Identify the structures labeled a–g in the diagram of a tapeworm shown below.

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SECTION 34-2 REVIEW

NEMATODA AND ROTIFERA

VOCABULARY REVIEW  Define the following terms.

1. trichinosis
2. filarial worm
3. mastax

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Pseudocoelomates have a hollow, fluid-filled cavity that is
   a. lined by ectoderm on the outside and mesoderm on the inside.
   b. lined by mesoderm on the outside and endoderm on the inside.
   c. completely surrounded by mesoderm.
   d. completely surrounded by endoderm.

2. The roundworm digestive tract
   a. has no opening.
   b. has a single opening.
   c. has two openings.
   d. is absent in parasitic roundworms.

3. Ascaris eggs enter the body of a human host when the
   a. host ingests contaminated food or water.
   b. eggs attach to the bare sole of a human foot.
   c. eggs are inhaled as spores.
   d. cysts rupture inside uncooked meat.

4. Hookworms normally reach the human intestine after they
   a. are ingested as cysts in contaminated meat.
   b. bore directly from the skin of the abdomen to the intestine.
   c. enter the host’s anus and migrate to the intestine.
   d. travel through the blood to the lungs and throat and are then swallowed.

5. A rotifer’s excretory system includes
   a. flame cells and excretory tubules.
   b. contractile vacuoles.
   c. a single, small kidney.
   d. many excretory pores on the body surface.
**SHORT ANSWER** Answer the questions in the space provided.

1. What advantage does a digestive tract have over a gastrovascular cavity? 

2. Compare the sites where eggs hatch in the life cycles of *Ascaris*, hookworms, and pinworms.

3. What insect carries the roundworm that causes elephantiasis?

4. What structure on a rotifer looks like a pair of rotating wheels? 
   What is the function of this structure?

5. Critical Thinking Most roundworms that parasitize the digestive tract live in the small intestine, which is close to the stomach. What is the adaptive advantage of living in the small intestine for a worm that does not feed directly on its host’s tissues?

**STRUCTURES AND FUNCTIONS** Identify the structures labeled a–g in the diagram of a rotifer shown below.
SECTION 35-1 REVIEW

MOLLUSCA

VOCABULARY REVIEW Explain the relationship between the terms in each of the following pairs of terms.

1. visceral mass, mantle

   ____________________________

   ____________________________

2. hemolymph, hemocoel

   ____________________________

   ____________________________

3. incurrent siphon, excurrent siphon

   ____________________________

   ____________________________

MULTIPLE CHOICE Write the correct letter in the blank.

   1. One advantage of a coelom over a pseudocoelom is that a coelom
      a. contains fluid while a pseudocoelom does not.
      b. is completely surrounded by endoderm.
      c. eliminates the need for a circulatory system.
      d. allows body wall muscles to contract without hindering digestion.

   2. One feature that is shared by many mollusks and annelids is the
      a. radula.
      b. mantle cavity.
      c. trochophore.
      d. pseudopodium.

   3. Mollusks in the class Gastropoda
      a. lack a distinct head.
      b. have an open circulatory system.
      c. do not have a hemocoel.
      d. are usually sessile.

   4. Bivalves have all of the following structures except
      a. a radula.
      b. adductor muscles.
      c. siphons.
      d. gills.

   5. An octopus generally moves by
      a. pumping a jet of water through its incurrent siphon.
      b. crawling along the bottom with its tentacles.
      c. gliding on a layer of mucus with the help of cilia.
      d. repeatedly opening its valves and snapping them shut.
**SHORT ANSWER** Answer the questions in the space provided.

1. Identify the two main regions of a typical mollusk's body. 
   ________________________________
   Which region contains most of the internal organs? 
   ________________________________
   Which region is directly involved with locomotion? 
   ________________________________

2. What is the usual function of the mantle in a snail or clam? 
   ________________________________

3. Contrast the feeding methods of gastropods and bivalves. 
   ________________________________
   ________________________________
   ________________________________

4. Contrast sexual reproduction of marine clams and most freshwater clams. 
   ________________________________
   ________________________________

5. **Critical Thinking** A cephalopod called the paper nautilus makes a type of shell with its foot. This shell, which consists largely of protein, is formed only by the female and is used to protect the eggs. List four reasons why this shell is not a typical molluskan shell. 
   ________________________________
   ________________________________
   ________________________________
   ________________________________

**STRUCTURES AND FUNCTIONS** Identify the structures labeled a–h in the diagram of the basic body plan of a mollusk shown below.

- a ________________________________
- b ________________________________
- c ________________________________
- d ________________________________
- e ________________________________
- f ________________________________
- g ________________________________
- h ________________________________
SECTION 35-2 REVIEW

ANNELIDA

VOCABULARY REVIEW  Define the following terms.

1. seta  

2. parapodium  

3. typhlosole  

4. nephridium  

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Segmentation is an advantage for annelid worms because it
   a. requires the whole body to move as a single unit.  
   b. reduces the number of setae on the parapodia.  
   c. divides the pseudocoelom into multiple compartments.  
   d. is accompanied by the duplication of some internal organs.

2. Contraction of an earthworm’s longitudinal muscles
   a. pushes the anterior end forward.  
   b. pulls the anterior end backward.  
   c. pulls the posterior end forward.  
   d. pushes the posterior end backward.

3. An earthworm uses its setae to
   a. grip the soil surface.  
   b. contract in a circular direction.  
   c. contract in a longitudinal direction.  
   d. form a protective case for its eggs.

4. One difference between leeches and polychaetes is that leeches
   a. do not have segments.  
   b. do not have setae.  
   c. have parapodia.  
   d. are never carnivorous.

5. All annelids in the classes Oligochaeta and Hirudinea have
   a. gills.  
   b. parapodia.  
   c. a segmented coelom.  
   d. an open circulatory system.
SHORT ANSWER Answer the questions in the space provided.

1. How does the function of an earthworm’s crop differ from that of its gizzard?
   ________________________________
   ________________________________
   ________________________________

2. List three benefits of earthworm activity.
   ________________________________
   ________________________________
   ________________________________

3. What is the function of an earthworm’s aortic arches?
   ________________________________
   ________________________________
   ________________________________

4. Describe the locomotion of a leech on land.
   ________________________________
   ________________________________
   ________________________________

5. Critical Thinking Some parasitic leeches are attracted by warmth. What type of host would you expect such leeches to have, and what would be the adaptive advantage of this attraction?
   ________________________________
   ________________________________
   ________________________________

STRUCTURES AND FUNCTIONS Identify the structures labeled a–h in the diagram of an earthworm shown below.

[Diagram of an earthworm with labeled structures a–h]
SECTION 36-1 REVIEW

PHYLUM ARTHROPODA

VOCABULARY REVIEW  Define the following terms.

1. arthropod ____________________________

2. compound eye ____________________________

3. tagma ____________________________

4. chelicera ____________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. An arthropod’s exoskeleton performs all of the following functions except
   a. producing gametes.   c. supporting the animal’s weight.
   b. protecting internal organs.   d. helping prevent desiccation.

_____ 2. One feature that arthropods share with annelids is
   a. a closed circulatory system.   c. a ventral nerve cord.
   b. jointed appendages.   d. a lack of cephalization.

_____ 3. An arthropod sheds its old exoskeleton when
   a. the old exoskeleton wears out.
   b. the new exoskeleton exerts pressure on the epidermis.
   c. the animal is 1–2 years old.
   d. a hormone is produced that induces molting.

_____ 4. Ancestral arthropods probably had
   a. no coelom.
   b. one pair of appendages on every segment.
   c. bodies consisting of a few, highly specialized tagmata.
   d. endoskeletons.

_____ 5. The subphylum Crustacea includes
   a. insects.   b. spiders.   c. ticks.   d. shrimps.
SHORT ANSWER Answer the questions in the space provided.

1. What substance makes an arthropod’s exoskeleton repel water, and where is this substance located?
   
2. What substance makes some arthropods’ exoskeletons hard, and where is this substance located?
   
3. List two examples of arthropod appendages.
   
4. Identify three ways that arthropods show cephalization.
   
5. Critical Thinking The extinct animal *Marella* is thought to have been a distant ancestor of some living arthropods. *Marella* had branched legs and unbranched antennae. Why is it difficult to place *Marella* in any of the subphyla of living arthropods?
   
STRUCTURES AND FUNCTIONS The figure below shows a phylogenetic diagram of living arthropods. In the blank spaces at the top of the diagram, write the names of the animals that belong on each branch of the tree. Some branches will have more than one name. Choose the names from the following list:

- spider
- shrimp
- mite
- insect
- horseshoe crab
- millipede
- sea spider
- scorpion

Choose the names from the following list:"
SECTION 36-2 REVIEW

SUBPHYLUM CRUSTACEA

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. cirrus, cheliped  
   ____________________________

2. cephalothorax, thorax  
   ____________________________

3. antenna, antennule  
   ____________________________

4. telson, swimmeret  
   ____________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

   1. Crustaceans are the only arthropods that have  
      a. three pairs of legs.  
      b. two pairs of feeling appendages on their head.  
      c. chitin in their exoskeleton.  
      d. chelicerae.  

   2. Freshwater crustaceans include  
      a. copepods and barnacles.  
      b. barnacles and water fleas.  
      c. water fleas and crayfish.  
      d. crayfish and sow bugs.  

   3. A crayfish uses its swimmerets to  
      a. defend itself.  
      b. propel itself during tailflips.  
      c. manipulate food.  
      d. create water currents.  

   4. A crayfish has teeth in its  
      a. stomach.  
      b. esophagus.  
      c. uropods.  
      d. green glands.  

   5. The hairs that project from the exoskeleton of a crayfish are used to  
      a. create water currents over the surface of the crayfish.  
      b. sense vibrations and chemicals in the water.  
      c. retain body heat within the crayfish.  
      d. protect the crayfish from predators.
SHORT ANSWER Answer the questions in the space provided.

1. Describe the structural features of a nauplius. ________________________________________

2. Explain how a barnacle feeds. ______________________________________________________

3. List the functions of the mandibles, maxillae, and maxillipeds in a crayfish. ____________

4. Describe the path of hemolymph flow through a crayfish, beginning with the heart. _______

5. Critical Thinking In a stagnant pool of water, a crayfish may spend much of its time lying with
one side of its carapace near the surface of the water. In this position, it will move the walking
legs on that side in a rhythmic back-and-forth motion. Explain the likely function of this behavior.

__________________________

STRUCTURES AND FUNCTIONS Identify the structures labeled a–g in the diagram of the
internal structure of a crayfish shown below.

[Diagram of crayfish with labeled structures a-g]
SUBPHYL A CHELICERATA AND MYRIAPODA

VOCABULARY REVIEW Define the following terms.

1. arachnid ____________________________

2. pedipalp ____________________________

3. spiracle ____________________________

4. Malpighian tubule ____________________

5. spinneret ___________________________

6. book lung __________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. How many pairs of appendages are on the cephalothorax of most arachnids?
   a. two  b. four  c. six  d. eight

2. A spider’s respiratory system may include
   a. tracheae  b. spinnerets  c. pedipalps  d. chelicerae.

3. One difference between scorpions and spiders is that scorpions
   a. are herbivores  c. are not venomous.
   b. have large pincerlike pedipalps  d. do not have an abdomen.

4. A chigger is the larva of a
   a. centipede  b. spider  c. tick  d. mite.

5. Millipedes have
   a. two pairs of legs on most body segments.
   b. long antennae.
   c. a flattened body.
   d. a waxy exoskeleton.
**SHORT ANSWER** Answer the questions in the space provided.

1. Name three ways that spiders use silk.

2. Describe the structure and function of book lungs.

3. Identify the two spiders in the United States whose bites are poisonous to humans, and describe the appearance of these spiders.

4. How are centipedes adapted to a predatory way of life?

5. **Critical Thinking** Some biologists believe that smaller animals can occupy a greater variety of habitats and are more abundant than larger animals. Which group of arthropods is an example of this idea? Explain your reasoning, and list the habitats occupied by that group.

**STRUCTURES AND FUNCTIONS** Identify the structures labeled a–h in the diagram of the internal structure of a spider shown below.
VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. labrum, labium

2. tympanum, ovipositor

3. incomplete metamorphosis, complete metamorphosis

4. nymph, pupa

MULTIPLE CHOICE  Write the correct letter in the blank.

1. One of the most important factors responsible for the success of insects is their
   a. large size.  b. heavy exoskeleton.  c. long life span.  d. ability to fly.

2. The protozoan that causes malaria is transmitted by
   a. fleas.  b. mosquitoes.  c. flies.  d. cockroaches.

3. Which of the following is a structure that insects do not share with spiders?
   a. chelicera.  b. trachea.  c. Malpighian tubule.  d. abdomen.

4. The life cycle of an insect that undergoes complete metamorphosis may include all of the
   following stages except a(n)
   a. adult.  b. pupa.  c. nymph.  d. larva.

5. The bombardier beetle defends itself by
   a. dropping seeds on its enemies.  b. spraying a noxious chemical.  c. resembling the plants on which it feeds.  d. resembling a bumblebee.
SHORT ANSWER Answer the questions in the space provided.

1. List three characteristics that insects share with other members of the subphylum Myriapoda.

   

List two differences between insects and other members of the subphylum Myriapoda.

2. What beneficial function do termites serve in wild habitats?

3. Describe the roles of the salivary glands and the gastric ceca in digestion in a grasshopper.

4. How does a chrysalis differ from a cocoon?

5. Critical Thinking Female mosquitoes feed on blood, while male mosquitoes feed on plant sap or nectar. How is this difference in feeding behavior important for the reproductive success of mosquitoes?

STRUCTURES AND FUNCTIONS Identify the structures labeled a–g in the drawing of a grasshopper shown below.

[Diagram of grasshopper with labels a, b, and c]
SECTION 37-2 REVIEW

INSECT BEHAVIOR

VOCABULARY REVIEW Define the following terms.

1. pheromone

2. innate behavior

3. royal jelly

4. queen factor

5. kin selection

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. Insects that communicate at a distance by producing sounds include
   a. ants.       b. mosquitoes.     c. silkworm moths.     d. fireflies.

_____ 2. Honeybees that develop from unfertilized eggs are called
   a. workers.      b. queens.         c. nurse bees.        d. drones.

_____ 3. A queen honeybee stops producing the queen factor when the
   a. first worker hatches from its egg.     c. hive becomes overcrowded.
   b. first drone hatches from its egg.      d. hive population drops below about 20 bees.

_____ 4. Which body part does a scout bee move from side to side when the bee performs a
   waggle dance?
   a. abdomen       b. labrum       c. thorax         d. antenna

_____ 5. The stinging behavior of worker honeybees is
   a. learned from the queen.     c. not an altruistic behavior.
   b. learned from the drones.    d. an innate behavior.
SHORT ANSWER Answer the questions in the space provided.

1. In which of the following kinds of insects does the male use its antennae to find distant females: cricket, mosquito, moth, firefly? ________________________________

Name the communication signal detected by the antennae in each case. ________________________________

2. What mechanism ensures that female crickets are attracted to males of the same species? ______

3. Which of the three types of bees in a honeybee colony is (are) female? ________________________________

Which of the three types is (are) sterile? ________________________________

4. Under what conditions will worker honeybees kill drones? ________________________________

5. Critical Thinking For an altruistic behavior to be maintained in a population over time, it must be directed at close relatives. Why is that so? ________________________________

______________________________

______________________________

______________________________

______________________________

STRUCTURES AND FUNCTIONS The diagrams below show two types of dances performed by honeybees. In the space below each diagram, identify the dance and briefly describe the information it conveys.

a ________________________________

______________________________

______________________________

b ________________________________

______________________________
SECTION 38-1 REVIEW

ECHINODERMS

VOCABULARY REVIEW Explain the relationship between the terms in each of the following pairs of terms.

1. ossicle, test

2. tube foot, ampulla

3. cardiac stomach, pyloric stomach

4. water-vascular system, radial canal

MULTIPLE CHOICE Write the correct letter in the blank.

1. Both echinoderms and chordates
   a. lack a coelom.                    c. have bilateral symmetry as adults.
   b. have radially symmetrical larvae. d. are deuterostomes.

2. One characteristic that is found only in echinoderms is
   a. a nerve net.
   b. the presence of only two tissue layers during development.
   c. a water-vascular system.
   d. an endoskeleton.

3. Members of the class Echinoidea include
   a. sea urchins.          b. sea cucumbers.  c. sea stars.       d. sea lilies.

4. The surface that is opposite the mouth in a sea star is called the
   a. oral surface.          b. aboral surface.  c. posterior surface. d. dorsal surface.

5. Sexual reproduction among sea stars usually involves
   a. separate sexes and internal fertilization.
   b. separate sexes and external fertilization.
   c. hermaphrodites and internal fertilization.
   d. hermaphrodites and external fertilization.
SHORT ANSWER  Answer the questions in the space provided.

1. What do the larvae of echinoderms indicate about the evolution of echinoderms? 

2. Name the class of each of the following echinoderms: basket star, sea star, feather star, brittle star.

3. Describe the organization of a sea star’s nervous system.

4. How do sea stars reproduce sexually?

5. How do sea stars use their ability to regenerate as a defensive mechanism?

6. Critical Thinking  Why is the lack of cephalization not a disadvantage for a sea star?

STRUCTURES AND FUNCTIONS  Identify the structures labeled a–f in the drawing of part of a sea star shown below.

[Diagram with labeled structures]
SECTION 38-2 REVIEW

INVERTEBRATE CHORDATES

VOCABULARY REVIEW  Define the following terms.

1. notochord ____________________________________________________________

2. lancelet ____________________________________________________________

3. tunicate _____________________________________________________________

4. atrio pore ___________________________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. In most chordates, the function of the notochord is taken over by the
   a. vertebral column.  b. brain.  c. spinal cord.  d. pharynx.

_____ 2. The gill chambers of aquatic chordates evolved from the
   a. dorsal nerve cord.  b. backbone.  c. pharyngeal pouches.  d. postanal tail.

_____ 3. Animals in the subphyla Cephalochordata and Urochordata live
   a. only in fresh water.  b. only in the ocean.  c. only on land.  d. in fresh water, in the ocean, and on land.

_____ 4. A lancelet feeds by
   a. pursuing and capturing small animals with its tentacles.
   b. sucking blood from the skin of a larger animal.
   c. digesting nutrients contained in the bottom sediments it swallows.
   d. filtering food particles from the water that passes through its pharynx.

_____ 5. Unlike adult lancelets, adult tunicates
   a. have segmented muscles in their tail.  c. are usually sessile.
   b. are radially symmetrical.  d. have separate sexes.
SHORT ANSWER Answer the questions in the space provided.

1. List the chordate characteristics that lancelets have as adults.

2. How do lancelets use their tail?

3. How did tunicates receive their name?

4. What behavior do tunicates exhibit when touched?

5. How does the structure of a larval tunicate differ from that of an adult tunicate?

6. Critical Thinking How are most adult tunicates similar to sponges, and how are they different from sponges?

STRUCTURES AND FUNCTIONS Identify the structures labeled a–f in the diagram of a lancelet shown below.
SECTION 39-1 REVIEW

INTRODUCTION TO VERTEBRATES

VOCABULARY REVIEW Define the following terms.

1. vertebra

2. cranium

3. gill arch

MULTIPLE CHOICE Write the correct letter in the blank.

1. All of the following are vertebrate characteristics except
   a. a post-anal tail.
   b. pharyngeal pouches.
   c. a ventral hollow nerve cord.
   d. an endoskeleton.

2. Skates belong to the class
   a. Myxini.
   b. Chondrichthyes.
   c. Reptilia.
   d. Amphibia.

3. Which of the following fishes is jawless?
   a. hagfish
   b. ray
   c. guppy
   d. catfish

4. The earliest vertebrates were
   a. bony fishes.
   b. spiny fishes with skeletons of cartilage.
   c. amphibians with thin, moist skin.
   d. jawless fishes.

5. The evolution of paired fins was important to early fishes because paired fins
   a. led directly to the evolution of gill arches.
   b. led directly to the evolution of paired legs in mammals.
   c. increased the stability and maneuverability of the fishes.
   d. allowed the fishes to seize and manipulate prey.

6. Jaws are thought to have evolved from the
   a. second and third vertebrae.
   b. first pair of gill arches.
   c. first pair of fins.
   d. anterior half of the pharynx.
SHORT ANSWER Answer the questions in the space provided.

1. Compare modern jawless fishes with those that lived 500 million years ago. 

2. Compare and contrast the skin of amphibians with the skin of reptiles. 

3. Name the class to which horses belong, and describe two major characteristics of the animals in that class. 

4. What two important evolutionary events occurred in fishes about 450 million years ago? 

5. Critical Thinking Explain why the class Chondrichthyes contains many more species than the class Cephalaspidomorphi. 

STRUCTURES AND FUNCTIONS The figure below shows a phylogenetic diagram of vertebrates. In the blank space at the end of each branch of the diagram, write the name of the vertebrate class represented by that branch.
SECTION 39-2 REVIEW

JAWLESS AND CARTILAGINOUS FISHES

VOCABULARY REVIEW  Define the following terms.

1. lateral line ________________________________
   ________________________________

2. cartilage ________________________________
   ________________________________

3. placoid scale ________________________________
   ________________________________

4. chemoreception ________________________________
   ________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. Fishes obtain the oxygen they need by absorbing it through their
   a. kidneys.       b. gills.       c. skin.       d. rectal gland.

_____ 2. The body of a freshwater fish usually
   a. tends to gain chloride ions through diffusion.
   b. tends to gain sodium ions through diffusion.
   c. tends to lose water through osmosis.
   d. has a higher concentration of solutes than the surrounding water does.

_____ 3. One characteristic of many lampreys but not of hagfishes is
   a. a parasitic lifestyle.       c. the presence of unpaired fins.
   b. a cartilaginous skeleton.       d. the presence of jaws.

_____ 4. Fishes in the class Chondrichthyes
   a. have skeletons composed of bone.       c. have movable jaws.
   b. are usually herbivores.       d. usually live in fresh water.

_____ 5. Some cartilaginous fishes store lipids in their liver as an adaptation that
   a. increases buoyancy.
   b. increases the overall density of their body.
   c. removes toxic ammonia from their body.
   d. allows the fishes to swim continuously.
SHORT ANSWER  Answer the questions in the space provided.

1. Describe the feeding behavior of a hagfish. ____________________________________________

2. Describe how some sharks’ teeth are adapted to capturing large fish or mammals. ________

3. Describe two methods by which cartilaginous fishes can cause water to flow across their gills.

4. Contrast fertilization in lampreys with that in cartilaginous fishes. ______________________

5. Critical Thinking  Which type of fishes would you expect to produce more gametes each time they reproduce—jawless fishes or cartilaginous fishes? Explain your reasoning. __________

STRUCTURES AND FUNCTIONS  Identify the structures labeled a–i in the drawing of a shark shown below.

a ________________  c ________________  d ________________

b ________________  e ________________  f ________________

h ________________  i ________________

g ________________
BONY FISHES

VOCABULARY REVIEW Define the following terms.

1. swim bladder ________________________________

2. lobe-finned fish ________________________________

3. ray-finned fish ________________________________

4. countercurrent flow ________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. One of the functions of the scales on a bony fish is to
   a. help reduce water resistance.  
   b. conserve body heat.  
   c. absorb salt from the surrounding water.  
   d. sense vibrations in the water.

2. The coelacanth is an example of a
   a. primitive, fishlike amphibian.  
   b. jawless fish.  
   c. lobe-finned fish.  
   d. ray-finned fish.

3. The part of a fish’s digestive tract that secretes bile is the
   a. intestine.  
   b. liver.  
   c. stomach.  
   d. pancreas.

4. In a fish, the blood that leaves the heart goes first to the
   a. kidneys.  
   b. brain.  
   c. muscles.  
   d. gills.

5. Fish gills are efficient organs for gas exchange because they
   a. have a small surface area.  
   b. have no other functions besides gas exchange.  
   c. can transport oxygen out of the body at the same time they transport carbon dioxide into the body.  
   d. operate on the principle of countercurrent flow.
SHORT ANSWER  Answer the questions in the space provided.

1. Explain how the scales of a bony fish can respond to changes in the food supply.

2. What two organs are involved in maintaining water and ion balance in a bony fish?

3. How does a bony fish adjust its buoyancy?

4. Where does fertilization occur in bony fishes?

5. **Critical Thinking** Why would a fish with faulty valves in its conus arteriosus probably suffer from a lack of energy?

STRUCTURES AND FUNCTIONS  Identify the structures labeled a–d in the diagram of a fish’s heart shown below. Draw three arrows on the diagram to show where blood enters and leaves the heart.

![Diagram of a fish's heart](image)
ORIGIN AND EVOLUTION OF AMPHIBIANS

VOCABULARY REVIEW Define the following terms.

1. preadaptation

2. tadpole

MULTIPLE CHOICE Write the correct letter in the blank.

1. One factor that may have favored the evolution of land-dwelling amphibians from aquatic vertebrates was the
   a. decreasing temperature of the world’s oceans.
   b. decreasing competition for food in lakes, rivers, and ponds.
   c. increasing abundance of food sources on land.
   d. increasing presence of predators on land.

2. The teeth of *Ichthyostega* indicate that it ate
   a. fish.
   b. insects.
   c. plants.
   d. plankton.

3. Most amphibian eggs
   a. are fertilized internally.
   b. have a shell around them.
   c. are surrounded by membranes.
   d. are laid in water or in moist places.

4. The feet of most amphibians
   a. are webbed.
   b. have claws.
   c. have eight toes.
   d. are homologous to the fins of fishes.

5. Caecilians detect prey by
   a. using their keen eyesight.
   b. sensing electric fields generated by prey.
   c. using their forelimbs to feel for prey in the mud.
   d. using chemosensory tentacles on their head.
1. Explain why scientists think that amphibians evolved from lobe-finned fishes.

2. What evidence suggests that Ichthyostega spent most of its time in the water?

3. Name three ways that amphibians carry out gas exchange.

4. Compare the skin and body shape of a frog with those of a salamander.

5. Critical Thinking Many frogs are both poisonous and very colorful. What function does their coloration likely serve?

STRUCTURES AND FUNCTIONS The diagram below summarizes the division of the class Amphibia into its three orders. In spaces a–c, write the scientific name of each order. In spaces d–g, fill in the common names of the animals in each order.
SECTION 40-2 REVIEW

CHARACTERISTICS OF AMPHIBIANS

VOCABULARY REVIEW Distinguish between the terms in each of the following pairs of terms.

1. pulmonary circulation, systemic circulation

2. pulmonary respiration, cutaneous respiration

3. duodenum, ileum

4. mesentery, columella

5. nictitating membrane, tympanic membrane

MULTIPLE CHOICE Write the correct letter in the blank.

1. An amphibian’s mucous glands
   a. filter nitrogenous wastes from the blood.
   b. produce enzymes that help break down food.
   c. secrete poisonous substances that repel predators.
   d. supply a lubricant that keeps the skin moist in air.

2. The weight of an amphibian’s body is transferred to the limbs by the
   a. cervical vertebra.
   b. pectoral and pelvic girdles.
   c. radio-ulna.
   d. tibiofibula.

3. The part of a frog’s heart that pumps blood to the lungs and the rest of the body is the
   a. ventricle.
   b. left atrium.
   c. right atrium.
   d. sinus venosus.

4. The direction that air flows when a frog breathes is controlled by the
   a. conus arteriosus.
   b. floor of the mouth.
   c. nostrils.
   d. lungs.

5. In amphibians, bile is produced by the
   a. cloaca.
   b. liver.
   c. pancreas.
   d. duodenum.
SHORT ANSWER  Answer the questions in the space provided.

1. Explain how the vertebrae of a frog’s spine help the frog to live on land. 

2. Why does oxygenated blood reach muscles and organs more rapidly in an amphibian than it does in a fish? 

3. Identify the function of each of the following parts of the amphibian nervous system: cerebrum, cerebellum, optic lobes, medulla oblongata. 

4. Critical Thinking  The ventral muscles of the belly are more developed in amphibians than they are in fishes. Explain why. 

STRUCTURES AND FUNCTIONS  Identify the structures labeled a–f in the diagram of a frog’s skeleton shown below.

a 

b 

c 

d 

e 

f 

girdle
SECTION 40-3 REVIEW

Reproduction in Amphibians

VOCABULARY REVIEW Define the following terms.

1. amplexus ____________________________________________________________

2. thyroxine __________________________________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. In a female frog, immature eggs are contained in a pair of lobed
   a. ovaries.
   b. oviducts.
   c. testes.
   d. kidneys.

2. A frog croaks by
   a. rapidly rubbing its hind legs together.
   b. brushing its forelegs against its vocal sacs.
   c. moving air back and forth between its mouth and lungs.
   d. forcing air out of its nostrils under positive pressure.

3. One factor that increases the chances of successful fertilization in frogs is that
   a. eggs can be fertilized by sperm of any frog species.
   b. the female produces a single egg.
   c. fertilization occurs internally.
   d. fertilization occurs while the male grasps firmly onto the female.

4. A newly hatched tadpole lives off
   a. nutrients in the ovaries of its mother.
   b. yolk stored in its body.
   c. plants that grow underwater.
   d. flying insects that land on the water’s surface.

5. Metamorphosis in amphibians
   a. involves a slow change from adult to larva.
   b. is triggered by the disappearance of the lungs.
   c. is stimulated by a hormone.
   d. occurs in all species that produce eggs.
SHORT ANSWER Answer the questions in the space provided.

1. List two reasons why male frogs call during the breeding season.

2. List three changes that occur in the body of a tadpole during metamorphosis.

3. Describe two varieties of amphibian development that do not involve metamorphosis.

4. Why do some species of frogs sit on their eggs?

5. Critical Thinking The jellylike material that surrounds the eggs of many frogs and toads is often very sticky. Suggest an adaptive advantage that this stickiness may provide.

STRUCTURES AND FUNCTIONS The drawings below represent the stages in the life cycle of a frog. Place the stages in the correct order by writing the numbers 1–6 in the spaces beneath the drawings, beginning with the stage that shows fertilization.
SECTION 41-1 REVIEW

ORIGIN AND EVOLUTION OF REPTILES

VOCABULARY REVIEW Define the following terms.

1. amnion ____________________________________________________________

2. allantois ____________________________________________________________

3. chorion _____________________________________________________________

4. albumen ____________________________________________________________

5. keratin _____________________________________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. One group of extinct reptiles that could fly were the
   a. dinosaurs.   b. pterosaurs.   c. plesiosaurs.   d. ichthyosaurs.

_____ 2. The asteroid-impact hypothesis proposes that
   a. all dinosaur fossils more than 65 million years old were destroyed by an asteroid.
   b. all reptiles were destroyed by an asteroid 65 million years ago.
   c. the ancestors of dinosaurs were brought to Earth on an asteroid.
   d. the sudden extinction of dinosaurs was caused by an asteroid that hit Earth.

_____ 3. Birds are thought to be most closely related to
   a. dinosaurs.   b. lizards.   c. crocodiles.   d. turtles.

_____ 4. The amniotic egg is found only in
   a. reptiles.   b. reptiles and birds.   c. reptiles, mammals, and birds.
   d. amphibians, reptiles, mammals, and birds.

_____ 5. Gas exchange in reptiles takes place in the
   a. gills.   b. lungs.   c. skin.   d. lungs and skin.
**SHORT ANSWER** Answer the questions in the space provided.

1. List two pieces of evidence that support the asteroid-impact hypothesis. 
   
   
   

2. What functions are performed by the shell of a reptilian egg? 
   
   

3. Why is the skin of a reptile better adapted to a terrestrial environment than is the skin of an amphibian? 
   
   

4. **Critical Thinking** At one time, all of Earth’s land masses were joined in a supercontinent called Pangaea. About 180 million years ago, Pangaea began to break up into separate continents, which slowly drifted apart. Fossil evidence indicates that dinosaurs became much more diverse after this time. Explain how the breakup of Pangaea may have contributed to the increase in dinosaur diversity. 
   
   
   
   
   

**STRUCTURES AND FUNCTIONS** The phylogenetic diagram below provides a hypothesis for how modern reptiles are related to each other and to dinosaurs and birds. In the blank spaces, write the names of the animals that belong on each branch of the diagram. Choose the names from the following list:

- birds
- crocodiles
- dinosaurs
- lizards
- snakes
- tuataras
- turtles

---

Early reptiles
SECTION 41-2 REVIEW

CHARACTERISTICS OF REPTILES

VOCABULARY REVIEW Define the following terms.

1. alveoli

2. Jacobson’s organ

3. ectotherm

4. viviparity

5. placenta

MULTIPLE CHOICE Write the correct letter in the blank.

1. Unlike the heart of a lizard, the heart of a crocodile has
   a. no atria.  
   b. no conus arteriosus.  
   c. a single ventricle that is partially divided.  
   d. two separate ventricles.

2. A snake uses its columella to
   a. inject venom.  
   b. detect odors.  
   c. hear.  
   d. detect heat.

3. Ectotherms require less energy than endotherms because
   a. their muscles are very efficient.  
   b. their metabolism is very slow.  
   c. they have very large fat reserves.  
   d. their cellular activities do not require ATP.

4. The body temperature of a lizard is
   a. usually maintained within a narrow range.  
   b. usually equal to the environmental temperature.  
   c. always lower than the environmental temperature.  
   d. always higher than the environmental temperature.

5. A female snake that retains her fertilized eggs within her body exhibits a pattern of reproduction called
   a. oviparity.  
   b. ovoviviparity.  
   c. viviparity.  
   d. vovoparity.
**SHORT ANSWER** Answer the questions in the space provided.

1. List three conditions under which a reptile might redirect blood away from its lungs. 

2. Explain how a snake detects ground vibrations. 

3. Explain how a pit viper detects warm objects. 

4. List three things a lizard might do to regulate its body temperature. 

5. List three ways a female crocodile provides parental care. 

6. **Critical Thinking** Why is internal fertilization necessary in reptiles? 

**STRUCTURES AND FUNCTIONS** Identify the structures labeled a–d in the diagram of a turtle’s heart shown below. In the rectangles labeled e–g, draw an arrow to indicate the direction in which blood normally flows through that part of the heart.
SECTION 41-3 REVIEW

MODERN REPTILES

VOCABULARY REVIEW Define the following terms.

1. carapace _____________________________

2. autotomy _____________________________

3. constrictor _____________________________

4. elapid _____________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. One difference between turtles and other reptiles is that turtles
   a. have their pelvic and pectoral girdles within their ribs.
   b. fertilize their eggs externally.
   c. do not produce amniotic eggs.
   d. respire with gills rather than lungs.

2. The living reptiles most closely related to dinosaurs are
   a. turtles.
   b. lizards.
   c. crocodiles.
   d. tuataras.

3. Crocodilians usually capture prey by
   a. chasing after prey on land.
   b. digging prey out of the mud at the bottom of a lake.
   c. lying in wait until the prey approaches.
   d. using bait to lure prey into a pit.

4. Lizards live on every continent except
   a. Africa.
   b. Asia.
   c. Australia.
   d. Antarctica.

5. An example of a constrictor is a
   a. cobra.
   b. king snake.
   c. rattlesnake.
   d. coral snake.
**SHORT ANSWER** Answer the questions in the space provided.

1. Explain how the shell and limbs of water-dwelling turtles are adapted to an aquatic environment.

2. How can a snake swallow an object that is larger in diameter than the snake’s head?

3. How does a viper immobilize its prey?

4. Why is *tuatara* an appropriate name for reptiles in the order Rhynchocephalia?

5. **Critical Thinking** Explain why snakes have a difficult time moving forward if they are placed on a very smooth surface.

**STRUCTURES AND FUNCTIONS** The table below lists several structures found in reptiles. Complete the table by identifying a reptilian order in which each structure is found and briefly describing the function of each structure.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Order</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fangs in back of mouth</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Valve at back of throat</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>Forked tongue</td>
<td>e</td>
<td>f</td>
</tr>
<tr>
<td>Domed carapace</td>
<td>g</td>
<td>h</td>
</tr>
<tr>
<td>Pads on fingers and toes</td>
<td>i</td>
<td>j</td>
</tr>
<tr>
<td>Elastic ligaments in jaw and skull</td>
<td>k</td>
<td>l</td>
</tr>
</tbody>
</table>
SECTION 42-1 REVIEW

ORIGIN AND EVOLUTION OF BIRDS

VOCABULARY REVIEW Define the following terms.

1. furcula

2. beak

MULTIPLE CHOICE Write the correct letter in the blank.

1. Feathers are composed mainly of
   a. albumen.    b. chitin.    c. keratin.    d. cellulose.

2. Which of the following statements about a bird’s skeleton is untrue?
   a. The skeleton is very flexible because none of the bones are fused.
   b. Many of the bones are thin-walled and hollow.
   c. Air sacs from the respiratory system penetrate some of the bones.
   d. The bones are lighter than those of nonflying animals.

3. Bird reproduction is characterized by
   a. ovoviviparity.
   b. oviparity.
   c. viviparity.
   d. both oviparity and viviparity.

4. Birds are thought to have evolved from
   a. small, tree-dwelling mammals.
   b. small, fast-running dinosaurs.
   c. ancient, flying reptiles.
   d. modern, two-legged reptiles.

5. One characteristic that Archaeopteryx shared with modern birds is the presence of
   a. teeth.    c. a long, bony tail.
   b. claws on its forelimbs.    d. a fused collarbone.

6. One characteristic that Sinornis shared with modern birds is the presence of
   a. wings that could be folded against the body.
   b. ectothermic metabolism.
   c. a long, bony tail.
   d. solid, thick-walled bones.
SHORT ANSWER Answer the questions in the space provided.

1. List two functions for which feathers are important.

2. What makes a bird’s respiratory system more efficient than the respiratory systems of other terrestrial vertebrates?

3. List three similarities between birds and some dinosaurs.

4. Describe two hypotheses for the evolution of flight in birds.

5. Critical Thinking Compared with other vertebrates, birds are poorly represented in the fossil record. Propose a possible explanation for this observation.

STRUCTURES AND FUNCTIONS The phylogenetic diagram at right shows how birds could be related to some other groups of vertebrates. In the blank spaces, write the name of the animals that belong on each branch. Choose the name from the following list:

Birds
Dinosaurs
Mammals
Reptiles
SECTION 42-2 REVIEW

CHARACTERISTICS OF BIRDS

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. shaft, vane 

2. barb, barbule 

3. sternum, pygostyle 

4. proventriculus, gizzard 

5. precocial, altricial 

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Birds use their beaks to rub their feathers with oil secreted by the
   a. follicles.    b. preen gland.    c. crop.    d. vasa deferentia.

2. The humerus, radius, and ulna are part of a bird’s
   a. furcula.    b. leg.    c. wing.    d. pelvic girdle.

3. In a bird, the breakdown of food begins in the
   a. proventriculus.    b. esophagus.    c. small intestine.    d. cloaca.

4. When a bird breathes, air moves from the posterior air sacs to the
   a. anterior air sacs.    b. lungs.    c. trachea.    d. outside of the bird.

5. One bird that bears precocial young is the
   a. hawk.    b. parrot.    c. pigeon.    d. duck.

6. Modifications for flight in the skeleton of a bird include
   a. hollow bones.    b. the pygostyle.    c. a fused pelvic girdle.    d. All of the above
SHORT ANSWER Answer the questions in the space provided.

1. What functions does a bird’s tail perform during flight? ________________________________
   ________________________________
   ________________________________
   ________________________________

2. How do birds eliminate nitrogenous waste? ________________________________
   ________________________________
   ________________________________
   ________________________________

3. Explain the advantage of having eyes located near the front of the head. ________________
   ________________________________
   ________________________________
   ________________________________

4. Name three navigation cues that may be used by migrating birds. ______________________
   ________________________________
   ________________________________
   ________________________________

5. Critical Thinking What might happen to a bird with a defective preen gland? _______________
   ________________________________
   ________________________________
   ________________________________

STRUCTURES AND FUNCTIONS Identify the structures labeled a–g in the diagram of a bird shown below.

a
b
c
d
e
f
g
VOCABULARY REVIEW  Define the following terms.

1. syrinx

2. crop milk

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. The cardinal has a beak that is specialized for
   a. tearing flesh.
   b. feeding on nectar.
   c. sifting through mud.
   d. cracking seeds.

_____ 2. Hummingbirds are found only in
   a. the Western Hemisphere.
   b. South America.
   c. Asia.
   d. Africa.

_____ 3. Toucans and woodpeckers belong to the order
   a. Anseriformes.
   b. Strigiformes.
   c. Piciformes.
   d. Apodiformes.

_____ 4. Due to habitat destruction and excessive collecting for the pet trade, extinction is threatening many species in the order
   a. Struthioniformes.
   b. Psittaciformes.
   c. Falconiformes.
   d. Columbiformes.

_____ 5. The bird order that contains the greatest number of species is
   a. Ciconiiformes.
   b. Galliformes.
   c. Sphenisciformes.
   d. Passeriformes.

_____ 6. Which of the following characteristics can be observed in the order Struthioniformes?
   a. a large wingspread for flying.
   b. long, strong legs for running.
   c. sharp talons for seizing prey.
   d. crop milk for feeding their young.
SHORT ANSWER Answer the questions in the space provided.

1. Contrast the feet of a kestrel with those of a goose.

2. What are raptors, and where are they found?

3. Describe the unusual construction of a passerine’s feet, and explain the usefulness of this feature.

4. Critical Thinking When a homing pigeon is released some distance from its loft with a small magnet tied to its back, it has no difficulty finding its way back to the loft on a sunny day but becomes disoriented and lost on an overcast day. What do these observations suggest about how homing pigeons navigate?

STRUCTURES AND FUNCTIONS In the spaces below, write the name that corresponds to the order of the bird shown. Choose the names from the following list:

- Anseriformes
- Apodiformes
- Ciconiiformes
- Columbiformes
- Galliformes
- Passeriformes
- Piciformes
- Psittaciformes
- Strigiformes
- Struthioniformes

Red-tailed hawk

Great blue heron

Great horned owl

Blue jay

Mallard
SECTION 43-1 REVIEW

ORIGIN AND EVOLUTION OF MAMMALS

VOCABULARY REVIEW  Define the following terms.

1. mammary gland
2. monotreme
3. marsupial

MULTIPLE CHOICE  Write the correct letter in the blank.

1. The heart of a mammal
   a. contains two chambers, like the heart of a bird.
   b. contains four chambers, like the heart of an amphibian.
   c. has two completely separate ventricles.
   d. allows deoxygenated blood to mix with oxygenated blood.

2. The lower jaw of a mammal
   a. is composed of a single bone.
   b. contains teeth that are uniform in size.
   c. contains teeth that are uniform in shape.
   d. does not usually leave a trace in the fossil record.

3. Some therapsids are believed to have had all of the following features except
   a. limbs positioned under the body.  c. endothermy.
   b. moist, wet skin.  d. hair.

4. Two groups of vertebrates that appeared at about the same time during the Triassic period were
   a. synapsids and fishes.  c. mammals and reptiles.
   b. therapsids and amphibians.  d. mammals and dinosaurs.

5. Early mammals are thought to have avoided competition with dinosaurs by feeding on
   a. insects at night.  c. plants during the day.
   b. plants at night.  d. small vertebrates during the day.
SHORT ANSWER  Answer the questions in the space provided.

1. Describe a function of hair.  

2. List three characteristics of Dimetrodon.  

3. Why are modern terrestrial mammals considered more like Lycaenops than Dimetrodon?  

4. What kind of animal constituted most of the large terrestrial carnivores and herbivores during the Cretaceous period, and what kind of animal fills these roles today?  
   What biological event is responsible for this change over time?  

5. Critical Thinking  Although hair is not preserved in fossils, scientists are fairly certain that the first mammals had hair. How can scientists be so certain about this?  

STRUCTURES AND FUNCTIONS  The drawings below show the fossilized skulls of two extinct vertebrates. One of the skulls is from an animal in the group that gave rise to modern reptiles. The other skull is from an animal in the group that gave rise to mammals. Identify the group that each skull belongs to, and give two reasons that support your identification.
SECTION 43-2 REVIEW

CHARACTERISTICS OF MAMMALS

VOCABULARY REVIEW  Define the following terms.

1. diaphragm ____________________________

2. baleen ____________________________

3. echolocation ____________________________

4. rumen ____________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

1. One place where you would expect to find mammals but not reptiles is
   a. a desert.  
   b. the Arctic.  
   c. a rain forest.  
   d. the ocean.

2. One mammalian feature that is an adaptation for endothermy is
   a. a four-chambered heart.  
   b. the presence of specialized teeth.  
   c. a single lower jawbone.  
   d. oviparity.

3. Which of the following is NOT true about the cecum?
   a. It branches from the small intestine.  
   b. It acts as a fermentation chamber.  
   c. It is found in mammals that chew cud.  
   d. It contains microorganisms that complete digestion.

4. The lungs of a mammal
   a. expel air when the diaphragm contracts.  
   b. contain a few large but very efficient alveoli.  
   c. supply blood to placental mammals even before they are born.  
   d. have a much larger surface area than the lungs of a reptile.

5. At hatching, a monotreme is
   a. very small and only partially developed.  
   b. small but fully developed.  
   c. nearly adult-sized but only partially developed.  
   d. nearly adult-sized and fully developed.
SHORT ANSWER Answer the questions in the space provided.

1. Explain how the respiratory system of a mammal helps sustain a rapid metabolism. 

2. How are microorganisms beneficial to herbivorous mammals?

3. Name the largest part of a mammalian brain, and list three of its functions.

4. How does a placenta form?

5. Critical Thinking The ears, feet, and tail of North American mammals are often smaller in northern species than they are in southern species. Explain the adaptive advantage of these size differences.

STRUCTURES AND FUNCTIONS Identify the structures labeled a–e in the diagram of a mammalian heart shown below. In the rectangles labeled f–l, draw an arrow to indicate whether blood is flowing toward the heart or away from the heart.

[Diagram of a mammalian heart with labeled parts a-e and labeled rectangles f-l]
Diversity of Mammals

Vocabulary Review Define the following terms.

1. pinniped

2. ungulate

Multiple Choice Write the correct letter in the blank.

1. The only egg-laying mammals are found in the order

2. The fossil record indicates that marsupials once dominated South America but were gradually displaced by
   a. monotremes.  c. dinosaurs.  b. placental mammals.  d. opossums.

3. The teeth of insectivores are adapted for
   a. chiseling through roots and twigs.  b. grinding plant material.  c. consuming a variety of foods.  d. grasping and piercing prey.

4. Mammals in the order Chiroptera are commonly called
   a. sloths.  b. manatees.  c. bats.  d. whales.

5. Mammals with streamlined bodies adapted for efficient swimming are found in the orders

6. Which of the following mammals is a tapir most closely related to?
   a. horse  b. pig  c. walrus  d. porcupine
**SHORT ANSWER** Answer the questions in the space provided.

1. A large mammal is standing in a meadow chewing its cud. Identify the order to which this mammal belongs. ________________________________

   Is this mammal more likely to have three toes or four? ________________________________

2. Name the mammalian order to which humans belong.

   ________________________________

3. **Critical Thinking** Shrews are the smallest mammals, some weighing as little as 2 g (0.07 oz). They also eat constantly and must hunt for food both day and night. Explain why shrews have such a voracious appetite. ________________________________

**STRUCTURES AND FUNCTIONS** In the space above each drawing below, write the name that corresponds to the order of the mammal shown in that drawing. Choose the names from the following list:

- Artiodactyla
- Chiroptera
- Marsupialia
- Primates
- Sirenia
- Carnivora
- Insectivora
- Monotremata
- Proboscidea
- Xenarthra
- Cetacea
- Lagomorpha
- Perissodactyla
- Rodentia

—

—

—
SECTION 43-4 REVIEW

PRIMATES AND HUMAN ORIGINS

VOCABULARY REVIEW Define the following terms.

1. prehensile appendage __________________________________________________________

2. opposable thumb ______________________________________________________________

3. bipedalism _______________________________________________________________________

4. hominid __________________________________________________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

____ 1. Which of the following is NOT a primate characteristic?
   a. large brain relative to body size        c. teeth specialized for a carnivorous diet
   b. binocular vision                      d. opposable thumbs

____ 2. Primates that exhibit bipedalism include
   a. humans.                               c. the great apes.
   b. New World monkeys.                  d. All of the above

____ 3. The oldest known australopithecine is
   a. Lucy.                                 c. Australopithecus africanus.

____ 4. Similarities between Homo habilis and modern humans include
   a. height.                               c. facial structure.
   b. brain capacity.                      d. ability to use tools.

____ 5. According to the multiregional hypothesis
   a. local populations of H. erectus gave rise to local populations of H. sapiens.
   b. H. sapiens evolved from H. erectus in Africa.
   c. H. sapiens evolved from H. erectus in Asia.
   d. H. sapiens evolved from at least two species of hominids.
SHORT ANSWER  Answer the questions in the space provided.

1. List three characteristics of primates.

2. Describe two anthropoid adaptations.

3. How is the human skeleton adapted to bipedalism?

4. Contrast the multiregional hypothesis with the recent-African-origin hypothesis.

5. Critical Thinking  Why is it considered inaccurate to refer to a “missing link” with respect to human evolution?

STRUCTURES AND FUNCTIONS  The table below compares several physical traits between humans and chimpanzees. Complete the table by filling in the missing information.

<table>
<thead>
<tr>
<th>Physical Traits</th>
<th>Human</th>
<th>Chimpanzee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial capacity</td>
<td>a</td>
<td>500 cm³</td>
</tr>
<tr>
<td>Spine</td>
<td>S-shaped</td>
<td>b</td>
</tr>
<tr>
<td>Pelvis</td>
<td>c</td>
<td>flat</td>
</tr>
<tr>
<td>Toes</td>
<td>aligned</td>
<td>d</td>
</tr>
<tr>
<td>Jaw</td>
<td>e</td>
<td>larger</td>
</tr>
</tbody>
</table>
SECTION 44-1 REVIEW

DEVELOPMENT OF BEHAVIOR

VOCABULARY REVIEW Define the following terms.

1. innate behavior ________________________________

2. fixed action pattern ________________________________

3. habituation ________________________________

4. operant conditioning ________________________________

5. imprinting ________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. A biologist who studies behavior is
   a. called a psychologist.   c. called an ethologist.
   b. called an ethnographer.   d. concerned only with the genetics of behavior.

_____ 2. Removal of infected young from a bee hive is an example of behavior that is
   a. unresponsive to environmental conditions, or fixed.
   b. triggered only by environmental stimuli.
   c. mostly learned.
   d. both genetic and triggered by environmental conditions.

_____ 3. A fixed action pattern
   a. continues from start to finish without modification.
   b. is adaptive.
   c. may be triggered by an environmental stimulus.
   d. All of the above

_____ 4. Learning to associate a reward with a predictive stimulus, such as a hamburger with the
   sight of a neon sign, is an example of
   a. classical conditioning.   c. imprinting.
   b. operant conditioning.   d. reasoning.
5. Which of the following is an example of imprinting?
   a. a salmon’s ability to recognize chemical cues in the water when returning to the stream where it was born to spawn
   b. a chimpanzee stacking boxes to reach a banana
   c. an octopus using its arms to unscrew a jar lid and eat the fish inside the jar
   d. a dog salivating in response to a bell

SHORT ANSWER Answer the questions in the space provided.

1. List four questions that ethologists ask about an animal’s behavior. __________________________
   __________________________
   __________________________
   __________________________

2. Describe an example of how natural selection shapes behavior. __________________________
   __________________________
   __________________________

3. Give two examples of innate behaviors. __________________________
   __________________________

4. How is habituation adaptive? __________________________
   __________________________

5. Critical Thinking What kinds of behaviors might be involved in using a computer?
   __________________________

STRUCTURES AND FUNCTIONS The table below compares several kinds of behavior. Complete the table by filling in the missing information.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Learned or Innate</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed action pattern</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td></td>
<td>Operant conditioning</td>
<td>e</td>
</tr>
<tr>
<td></td>
<td>Classical conditioning</td>
<td>g</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td>j</td>
</tr>
<tr>
<td></td>
<td>k</td>
<td>l</td>
</tr>
</tbody>
</table>

Not hearing planes overhead
An octopus opening a jar for fish
Goslings following their mother
SECTION 44-2 REVIEW

TYPES OF ANIMAL BEHAVIOR

**VOCABULARY REVIEW** Define the following terms.

1. dominance hierarchy ____________________________________________

2. aposematic coloration ____________________________________________

3. pheromone ____________________________________________________

4. circadian rhythm ______________________________________________

**MULTIPLE CHOICE** Write the correct letter in the blank.

_____ 1. The optimality hypothesis helps to explain
   a. courtship behavior.   c. parental behavior.
   b. dominance hierarchies.   d. feeding behavior.

_____ 2. An animal may establish and defend a territory by using
   a. chemical signals.   b. vocal signals.   c. visual signals.   d. All of the above

_____ 3. A mating system in which a male mates with multiple females is called
   a. male polygamy.   b. female polygamy.   c. monogamy.   d. sexual selection.

_____ 4. Social behavior is defined as an interaction that involves
   a. several species.
   b. sacrificing one's own security to help another.
   c. two or more animals of the same species.
   d. None of the above

_____ 5. Hibernation is associated with
   a. circadian rhythms.
   b. annual biological cycles.
   c. migration.
   d. days becoming longer in the springtime.
SHORT ANSWER Answer the questions in the space provided.

1. What is the usual outcome of aggressive behavior? ______________________________________________________________________

2. Describe a situation in which monogamy would be favored. ______________________________________________________________________

3. Contrast the costs and benefits of parental care. ______________________________________________________________________

4. List the criteria that must be met for communication to be considered language. ______________

5. Critical Thinking Crossbills are birds that use their beaks to eat the seeds of pine cones. One day, a flock of crossbills feeds in a single pine tree for several hours. On another day, the same flock moves from tree to tree as it feeds. Explain these behaviors.

________________________________________________________________________

STRUCTURES AND FUNCTIONS The table below lists several examples of behaviors. Complete the table by filling in the missing behavior.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>A ground squirrel giving an alarm call</td>
</tr>
<tr>
<td>b</td>
<td>Owls hunting at night and resting during the day</td>
</tr>
<tr>
<td>c</td>
<td>Monarch butterflies traveling to Mexico for the winter</td>
</tr>
<tr>
<td>d</td>
<td>Male and female mourning doves bowing and cooing to each other</td>
</tr>
<tr>
<td>e</td>
<td>Head-butting in bighorn sheep</td>
</tr>
<tr>
<td>f</td>
<td>A cat urinating on bushes in its neighborhood</td>
</tr>
<tr>
<td>g</td>
<td>Pecking orders in chickens</td>
</tr>
</tbody>
</table>
THE HUMAN BODY PLAN

VOCABULARY REVIEW  Describe the functions of the tissues listed below.

1. nervous tissue ____________________________________________

2. muscular tissue __________________________________________

3. skeletal muscle ___________________________________________

4. epithelial tissue __________________________________________

5. connective tissue _________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Nervous tissue contains specialized cells called
   a. transmitters.  b. messenger cells.  c. neurons.  d. cardiac cells.

2. Tissue that binds, supports, and protects structures is called
   a. connective tissue.  c. skeletal tissue.
   b. muscle tissue.  d. epithelial tissue.

3. Organ systems consist of
   a. tissues.  b. cells.  c. organs.  d. All of the above

4. The body cavity that contains the heart, esophagus, and organs of the respiratory system is the
   a. cranial cavity.  c. abdominal cavity.
   b. spinal cavity.  d. thoracic cavity.

5. Which organ system includes the kidneys, ureters, bladder, urethra, lungs, and skin?
   a. integumentary system  b. digestive system
   c. excretory system  d. endocrine system
SHORT ANSWER Answer the questions in the space provided.

1. List three types of muscle tissue.  
   ________________________________  
   ________________________________  
   ________________________________  

2. Describe how body tissues, organs, and organ systems are related.  
   ________________________________  
   ________________________________  
   ________________________________  

3. Describe the composition of connective tissue.  
   ________________________________  
   ________________________________  
   ________________________________  

4. Describe two functions of nervous tissue.  
   ________________________________  
   ________________________________  
   ________________________________  

5. Critical Thinking Can an organ be part of more than one organ system? Explain your answer.  
   ________________________________  
   ________________________________  
   ________________________________  

STRUCTURES AND FUNCTIONS Use the figure below to answer the following questions.

1. Label each part of the figure in the spaces provided.
   a  
   b  
   c  

2. Which of the labeled body cavities contain the central nervous system?  
   ________________________________  
   ________________________________  
   ________________________________  

3. What is the function of the body cavities?  
   ________________________________  
   ________________________________  
   ________________________________  

246 Section 45-1 Review
VOCABULARY REVIEW  Explain the relationship between the terms in each of the following pairs of terms.

1. axial skeleton, appendicular skeleton

2. periosteum, compact bone

3. bone marrow, spongy bone

4. ossification, epiphyseal plate

5. joint, ligament

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. The process in which bone cells gradually replace cartilage is called
   a. ossification.  
   b. osteoarthritis.  
   c. restoration.  
   d. None of the above

_____ 2. The axial skeleton includes bones of the
   a. arms.  
   b. legs.  
   c. ribs.  
   d. All of the above

_____ 3. Semimovable joints are found
   a. in the knees.  
   b. between vertebrae.  
   c. in the thumbs.  
   d. in the elbows.

_____ 4. Tough bands of connective tissue that hold bones in place are called
   a. ligaments.  
   b. tendons.  
   c. gliding joints.  
   d. muscles.

_____ 5. Osteoarthritis is characterized by
   a. stretching of ligaments.  
   b. autoimmunity.  
   c. fracturing of bones.  
   d. thinning of cartilage.
SHORT ANSWER Answer the questions in the space provided.

1. Describe three functions of bones.

2. List three types of joints, and give an example of each type.

3. Describe the importance of bone marrow.

4. Critical Thinking Why is dietary calcium important to bone growth and maintenance?

STRUCTURES AND FUNCTIONS Use the figure of the human skeleton at right to answer the following questions.

1. Label each part of the figure in the spaces provided.

2. What are the primary functions of the skeleton?

3. How do bones elongate?
SECTION 45-3 REVIEW

MUSCULAR SYSTEM

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. voluntary muscle, involuntary muscle

2. origin, insertion

3. flexor, extensor

4. actin, myosin

5. muscle fatigue, oxygen debt

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Which of the following types of muscle tissues is found in the walls of the stomach, intestines, and blood vessels?
   a. cardiac muscle  b. smooth muscle  c. skeletal muscle  d. voluntary muscle

2. Which of the following types of muscle tissues is responsible for moving most parts of the body?
   a. cardiac muscle  b. smooth muscle  c. skeletal muscle  d. involuntary muscle

3. A sarcomere
   a. is the functional unit of muscle contraction.  c. uses ATP.
   b. consists of myofibrils.  d. All of the above

4. Muscles that cause a joint to bend are called
   a. flexors.  b. origins.  c. extensors.  d. insertions.

5. Which of the following happens when a skeletal muscle contracts?
   a. Sarcomeres shorten.  c. Myosin heads attach to actin filaments.
   b. Myosin heads bend outward.  d. All of the above
SHORT ANSWER  Answer the questions in the space provided.

1. How does a runner acquire an oxygen debt?

2. How does a muscle contract?

3. Distinguish between the three types of muscle tissue.

4. Critical Thinking  Why are flexors and extensors considered antagonistic muscles?

STRUCTURES AND FUNCTIONS  Use the figure of the human arm below to answer the following questions.

1. Label each part of the figure in the spaces provided.

2. Which muscle is a flexor and which muscle is an extensor?

3. Where is the insertion of a located? Where is the origin of a located?
SECTION 45-4 REVIEW

INTEGUMENTARY SYSTEM

VOCABULARY REVIEW  Define the following terms.

1. exocrine gland
2. melanin
3. sebum
4. keratin
5. sweat gland

MULTIPLE CHOICE  Write the correct letter in the blank.

____ 1. The dermis
   a. covers the epidermis.  
   b. produces melanin.       
   c. contains nervous tissue and blood vessels. 
   d. consists mostly of dead cells.

____ 2. Which of the following is secreted by oil glands in the skin?
   a. melanin
   b. sebum
   c. keratin
   d. sweat

____ 3. Which of the following is not a function of the layer of fat cells beneath the dermis?
   a. produces oil
   b. provides an energy reserve
   c. absorbs shock
   d. insulates the body

____ 4. Hair and nails are composed primarily of
   a. sebum.
   b. keratin.
   c. glands.
   d. All of the above

____ 5. Sweat glands
   a. secrete sebum into the bloodstream.
   b. stimulate hair follicles.
   c. help maintain a steady body temperature.
   d. insulate the body.
SHORT ANSWER Answer the questions in the space provided.

1. Describe the functions of the skin.

2. How does exposure to ultraviolet light influence melanin production in the skin?

3. Describe the functions of the epidermis.

4. How are hair and nails similar in structure?

5. Critical Thinking What causes freckles and pigmented moles?

STRUCTURES AND FUNCTIONS Use the figure below to answer the following questions.

1. Label each part of the figure in the spaces provided.

2. Which structures contain keratin?

3. Explain how the dermis enables the body to interact with the external environment.
SECTION 46-1 REVIEW

THE CIRCULATORY SYSTEM

VOCABULARY REVIEW  Distinguish between the terms in each of the following pairs of terms.

1. ventricle, atrium

2. sinoatrial node, atrioventricular node

3. artery, vein

4. pulmonary circulation, systemic circulation

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Which of the following is most important to the heartbeat?
   a. aortic valve  b. sinoatrial node  c. lymph node  d. tricuspid valve

2. During its circulation from the left atrium to the left ventricle, what percentage of the blood enters the pulmonary circulation?
   a. 25%  b. 50%  c. 100%  d. None of the above

3. Exchange of nutrients and waste between blood and body tissues occurs across
   a. arterioles.  b. capillaries.  c. arteries.  d. veins.

4. Which one of the following characteristics is unique to the pulmonary circulation?
   a. capillaries that exchange gases with the surrounding tissue
   b. arteries that carry blood away from the heart
   c. an artery that originates at the right ventricle
   d. an artery that originates at the right atrium

5. The lymphatic system is important for the normal function of the body because it
   a. carries newly formed blood to the cardiovascular system.
   b. returns excess intercellular fluid to the cardiovascular system.
   c. provides an alternate route for blood during strenuous exercise.
   d. carries oxygen to the lymph nodes.
SHORT ANSWER Answer the questions in the space provided.

1. Trace the flow of blood through the heart.

2. Describe the function of the lymphatic system.

3. **Critical Thinking** If the aortic valve could not close completely, would the diastolic pressure or systolic pressure be affected the most? Explain your answer.

STRUCTURES AND FUNCTIONS Use the figure of the human heart below to answer the following questions.

1. Label each part of the figure in the spaces provided.

2. How would a defect of the mitral valve affect circulation?
VOCABULARY REVIEW  Explain the relationship between the terms in each of the following pairs of terms.

1. leukocyte, phagocyte

2. antigen, antibody

3. erythrocyte, hemoglobin

4. platelet, fibrin

MULTIPLE CHOICE  Write the correct letter in the blank.

1. When oxygen is carried by the blood, it is bonded to
   a. platelets.  b. antibodies.  c. plasma.  d. hemoglobin.

2. Phagocytes
   a. carry hemoglobin.  c. engulf microorganisms.
   b. synthesize erythrocytes.  d. produce antibodies.

3. Platelets
   a. are formed in lymph nodes.  c. produce hemoglobin.
   b. are involved with blood clotting.  d. are whole cells.

4. Mature red blood cells
   a. live for several years.  c. promote clotting.
   b. are the largest cells in the blood.  d. do not have a nucleus.

5. If someone is receiving a blood transfusion, which of the following is most important to know?
   a. the number of erythrocytes in the donated blood
   b. if the father of the blood donor is Rh
   c. the donor’s blood type
   d. if the blood recipient has eaten within the last six hours
SHORT ANSWER  Answer the questions in the space provided.

1. How is oxygen transported in the blood? ________________________________

2. List two structural differences and two functional differences between erythrocytes and leukocytes.

   Structural differences:
   - ________________________________
   - ________________________________

   Functional differences:
   - ________________________________
   - ________________________________

3. Explain why a person with type AB blood can donate blood only to a person with the same
   blood type. ________________________________

4. Describe the role of platelets in blood clotting. ________________________________

5. Critical Thinking  How might lack of dietary iron affect the oxygen-carrying capacity of the blood?

______________________________

______________________________

______________________________

______________________________

STRUCTURES AND FUNCTIONS  Use the table below to answer the following questions.

<table>
<thead>
<tr>
<th>Blood types</th>
<th>Antigen on red blood cells</th>
<th>Can give blood to</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>A, AB</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>B, AB</td>
</tr>
<tr>
<td>AB</td>
<td>A and B</td>
<td>AB</td>
</tr>
<tr>
<td>O</td>
<td>none</td>
<td>A, B, AB, O</td>
</tr>
</tbody>
</table>

1. Explain why type O blood can be donated in a blood transfusion regardless of the recipient’s
   blood type. ________________________________

2. Describe the antibody-antigen interactions that would occur if an Rh⁻ person with type B blood
   received blood from an Rh⁺ person with type AB blood. ________________________________

______________________________

______________________________

______________________________

______________________________
SECTION 46-3 REVIEW

THE RESPIRATORY SYSTEM

VOCABULARY REVIEW Explain the relationship between the terms in each of the following pairs of terms.

1. epiglottis, trachea
   a. move the inspired air to the alveoli.
   b. move the expired air to the nasal cavity.
   c. moisten the expired air.
   d. clean the inspired air.

2. expiration, larynx
   a. elevated blood pressure.
   b. mucus carrying dissolved oxygen.
   c. concentration gradients.
   d. bronchioles closing during expiration.

3. bronchi, bronchioles
   a. bound to hemoglobin.
   b. plasma.
   c. as bicarbonate ions.
   d. All of the above

4. alveoli, inspiration
   a. the diaphragm pushes upward.
   b. thoracic volume increases.
   c. blood pressure increases.
   d. thoracic pressure increases.

5. The rate of breathing is controlled by cells within
   a. a specialized node located in the bronchus.
   b. the diaphragm.
   c. the brain.
   d. stretch receptors located between the ribs.

MULTIPLE CHOICE Write the correct letter in the blank.

   1. Cilia that line the walls of air passageways
      a. move the inspired air to the alveoli.
      b. move the expired air to the nasal cavity.
      c. moisten the expired air.
      d. clean the inspired air.

   2. The exchange of gases that occurs at an alveolus depends on
      a. elevated blood pressure.
      b. mucus carrying dissolved oxygen.
      c. concentration gradients.
      d. bronchioles closing during expiration.

   3. Carbon dioxide is transported in the blood
      a. bound to hemoglobin.
      b. plasma.
      c. as bicarbonate ions.
      d. All of the above

   4. Inspiration occurs when
      a. the diaphragm pushes upward.
      b. thoracic volume increases.
      c. blood pressure increases.
      d. thoracic pressure increases.

   5. The rate of breathing is controlled by cells within
      a. a specialized node located in the bronchus.
      b. the diaphragm.
      c. the brain.
      d. stretch receptors located between the ribs.
SHORT ANSWER Answer the questions in the space provided.

1. Is the nasal cavity a part of the respiratory system? Explain your answer.

2. How is most carbon dioxide transported in the blood?

3. Describe how the skeleton is involved with expiration.

4. Critical Thinking Oxygen deficiency is called hypoxia. Suggest two possible causes of inadequate delivery of oxygen to body tissues.

STRUCTURES AND FUNCTIONS Use the figure below to answer the following questions.

1. What drives the diffusion of oxygen into the blood and carbon dioxide from a blood cell to an alveolus?

2. In the lungs, is carbon dioxide more concentrated in the alveoli or in the blood? Explain your answer.

3. Does the exchange of carbon dioxide depend on the concentration of oxygen in the alveoli and the blood? Explain your answer.
SECTION 47-1 REVIEW

NONSPECIFIC DEFENSES

VOCABULARY REVIEW Define the following terms.

1. Koch’s postulates ____________________________

2. interferon ____________________________

3. histamine ____________________________

4. natural killer cell ____________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. Mucus serves as a nonspecific defense to pathogens by
   a. being secreted by the skin.  
   b. capturing pathogens.  
   c. digesting pathogens.  
   d. secreting cytokines.

2. Which of the following statements is false?
   a. Fever stimulates the body’s defense mechanisms.  
   b. Fever suppresses the growth of certain bacteria.  
   c. Fever activates cellular enzymes.  
   d. Fever promotes the action of white blood cells.

3. Macrophages
   a. are white blood cells.  
   b. cross blood-vessel walls.  
   c. engulf and destroy large pathogens.  
   d. All of the above

4. Natural killer cells are
   a. specialized red blood cells.  
   b. infected cells.  
   c. phagocytes.  
   d. None of the above

5. An inflammatory response is initiated by
   a. release of histamines.  
   b. pathogens.  
   c. fever.  
   d. drying of mucous membranes.
**SHORT ANSWER** Answer the questions in the space provided.

1. How are neutrophils involved in the body’s defense against pathogens? 
   __________________________________________
   __________________________________________
   __________________________________________

2. How does interferon inhibit viruses? 
   __________________________________________
   __________________________________________
   __________________________________________

3. How does the first line of defense protect the body against pathogens? 
   __________________________________________
   __________________________________________
   __________________________________________

4. **Critical Thinking** Why might taking aspirin to reduce fever slow rather than hasten your recovery from a bacterial infection? 
   __________________________________________
   __________________________________________
   __________________________________________

**STRUCTURES AND FUNCTIONS** Use the table below to answer the following questions.

1. The table lists the steps that occur in the inflammatory response. Put the steps in the correct order by writing in the numbers 1–5 in the table under the column labeled “Order.”

<table>
<thead>
<tr>
<th>Order</th>
<th>Events of inflammatory response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Damaged cells secrete histamine.</td>
</tr>
<tr>
<td></td>
<td>White blood cells attack and destroy the pathogens.</td>
</tr>
<tr>
<td></td>
<td>Pathogens enter the body by penetrating the skin.</td>
</tr>
<tr>
<td></td>
<td>White blood cells move to the infected area.</td>
</tr>
<tr>
<td></td>
<td>Flow of blood to the infected area increases.</td>
</tr>
</tbody>
</table>

2. Why is an increase in the permeability of capillaries essential to the inflammatory response? 
   __________________________________________
   __________________________________________
   __________________________________________

3. How would applying ice to a wounded area to reduce blood flow to the area affect the inflammatory response? 
   __________________________________________
   __________________________________________
   __________________________________________
SECTION 47-2 REVIEW

SPECIFIC DEFENSES: THE IMMUNE SYSTEM

VOCABULARY REVIEW Define the following terms.

1. plasma cell ____________________________________________

2. antigen ______________________________________________

3. memory cell __________________________________________

4. antibody ______________________________________________

5. allergy _________________________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. Which of the following are not lymphocytes?
   a. memory cells       b. helper T cells       c. macrophages       d. B cells

2. Bone marrow is considered part of the immune system because it
   a. filters pathogens from blood.       c. produces white blood cells.
   b. drains into the lymphatic system.   d. produces plasma cells.

3. B cells
   a. are involved with the humoral immune response.
   b. kill infected cells.
   c. mature within the thymus.
   d. are derived from plasma cells.

4. Interleukins are secreted by
   a. cytotoxic T cells.       b. helper T cells.       c. plasma cells.       d. All of the above

5. Cell-mediated immune responses require
   a. production of antibodies.       c. B cells.
   b. helper T cells.                d. a secondary immune response.
SHORT ANSWER  Answer the questions in the space provided.

1. What signals does a T cell require in order to divide? ________________________________

2. How do vaccinations produce immunity? ________________________________

3. How do antibodies provide defense from viruses? ________________________________

4. Critical Thinking Would you expect defective T cells or defective B cells to be the primary
cause of autoimmune diseases? Explain your answer. ________________________________

STRUCTURES AND FUNCTIONS  Use the figure of the immune response below to answer
the following questions.

1. Label each part of the figure in the spaces provided.

   a

   b

   c

   d

   e

   f

   g

   h

2. What event triggers the chain of events shown in the figure? ________________________________

3. How would an enzyme that destroys cytokines affect both the cell-mediated and humoral
   immune responses? ________________________________
SECTION 47-3 REVIEW

HIV AND AIDS

VOCABULARY REVIEW Explain the relationship between the terms in each of the following pairs of terms.

1. helper T cells, AIDS

2. AIDS, HIV

3. opportunistic infection, AIDS

MULTIPLE CHOICE Write the correct letter in the blank.

1. A diagnosis of AIDS is made when a person has
   a. an HIV infection.       b. few B cells.
   c. few T cells.           d. All of the above

2. Which of the following is a route of HIV transmission?
   a. breathing air in a room with a person with AIDS
   b. touching a person infected with HIV
   c. sharing of hypodermic needles
   d. insect bites

3. The most common means of HIV transmission is
   a. sexual intercourse with a person infected with HIV.
   b. blood transfusion.
   c. shaking hands with a person with AIDS.
   d. performing experiments with HIV.

4. Vaccines against HIV are difficult to design because HIV
   a. is a retrovirus.         b. is difficult to isolate.
   c. changes rapidly.        d. is not detectable.

5. HIV begins to reproduce
   a. when AIDS occurs.       b. shortly after infection.
   c. months after infection.
   d. All of the above
SHORT ANSWER  Answer the questions in the space provided.

1. Is HIV the primary cause of death in people with AIDS? Explain your answer. ____________________________

2. Can a person be infected with HIV but not exhibit AIDS? Explain your answer. ____________________________

3. List two ways that HIV can be transmitted. ____________________________

4. Critical Thinking  Could people become exposed to HIV during an organ transplant or skin graft operation? Explain your answer. ____________________________

STRUCTURES AND FUNCTIONS  Use the graph below to answer the following questions.

The graph shows a decrease in the number of helper T cells in a person with HIV over time.

1. In this person, how many years after infection did the onset of AIDS occur? ____________________________

2. The person tested positive for HIV six months after infection but tested negative for HIV six years later. Explain how this might happen. ____________________________
VOCABULARY REVIEW  Answer the questions in the space provided.

1. What are the six basic nutrients?  

2. What is an unsaturated fat?  

3. What is the function of vitamins?  

4. How does dehydration affect the body?  

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Which of the following is not an organic nutrient?
   a. vitamins  
   b. lipids  
   c. carbohydrates  
   d. minerals

2. Carbohydrates are important sources of
   a. monosaccharides.  
   b. nonessential amino acids.  
   c. legumes.  
   d. glycerol.

3. Essential amino acids are obtained from
   a. animal products.  
   b. plant products.  
   c. legumes.  
   d. All of the above

4. Saturated fats
   a. are found in most plant oils.  
   b. have double bonds.  
   c. are found in animal fats.  
   d. do not have a glycerol molecule.

5. Which of the following statements is true?
   a. Potassium is a component of ascorbic acid.  
   b. Potassium is required for the formation of red blood cells.  
   c. Bananas are good sources of potassium.  
   d. It is not necessary to consume foods containing potassium.
SHORT ANSWER Answer the questions in the space provided.

1. Explain the difference between essential amino acids and nonessential amino acids. 

2. Describe the importance of simple sugars for normal body functioning. 

3. List two reasons that water is an important nutrient. 

4. Critical Thinking What characteristic is common to all of the nutrients? 

STRUCTURES AND FUNCTIONS Use the food pyramid below to answer the following questions.

1. Based on the organization of the pyramid, which food group does the body need and use the most? What is the primary nutrient in this group?

2. Which food group contains all of the essential amino acids? Is this the only group that contains essential amino acids? Explain your answer.
SECTION 48-2 REVIEW

DIGESTIVE SYSTEM

VOCABULARY REVIEW  Explain the relationship between the terms in each of the following pairs of terms.

1. pharynx, epiglottis

2. ulcer, gastric fluid

3. peristalsis, colon

4. pyloric sphincter, chyme

5. villus, gastrointestinal tract

MULTIPLE CHOICE  Write the correct letter in the blank.

_____ 1. The gastrointestinal tract includes the
   a. liver.  
   b. large intestine.  
   c. pancreas.  
   d. All of the above

_____ 2. Bile is
   a. released into the small intestine.  
   b. produced by the liver.  
   c. stored in the gallbladder.  
   d. All of the above

_____ 3. Chemical digestion involves
   a. the molars.  
   b. saliva.  
   c. the hard palate.  
   d. the incisors.

_____ 4. Which of the following is a component of both the respiratory system and the digestive system?
   a. esophagus  
   b. salivary glands  
   c. pharynx  
   d. peristalsis

_____ 5. Ulcers are linked to breakdown of the
   a. pyloric sphincter.  
   b. gallbladder function.  
   c. stomach lining.  
   d. common bile duct.
SHORT ANSWER Answer the questions in the space provided.

1. What is the function of mucus in the stomach? 

2. What is the primary role of pepsin in digestion? 

3. How does the pancreas aid digestion? 

4. Critical Thinking Which part of the gastrointestinal tract should have the highest concentration of blood capillaries? Explain your answer.

STRUCTURES AND FUNCTIONS Use the figure of the gastrointestinal tract below to answer the following questions.

1. Label each part of the figure in the spaces provided.

2. Which organ is not part of the gastrointestinal tract? How does this organ aid digestion?

3. In which organ does absorption take place? What structural features make this organ particularly well-suited for absorption of nutrients into the blood?
SECTION 48-3 REVIEW

URINARY SYSTEM

VOCABULARY REVIEW Define the following terms.

1. nephron ________________________________

2. urethra ________________________________

3. renal medulla ____________________________

4. excretion ________________________________

5. urea ________________________________

MULTIPLE CHOICE Write the correct letter in the blank.

1. Most reabsorption within a nephron occurs in the
   a. Bowman’s capsule. b. duodenum. c. collecting duct. d. proximal convoluted tubule.

2. Which of the following is not part of the nephron?
   a. glomerulus b. loop of Henle c. ureter d. Bowman’s capsule

3. Which of the following substances would not normally be collected in the Bowman’s capsule?
   a. small proteins b. glucose c. erythrocytes d. vitamins

4. The renal pelvis
   a. empties into the renal vein. b. is a part of the nephron. c. is a part of the nephron. d. All of the above

5. During the process of reabsorption, components of the filtrate are
   a. actively transported out of the nephron. b. transferred to the capillaries surrounding the nephron. c. separated from waste products. d. All of the above
SHORT ANSWER  Answer the questions in the space provided.

1. Describe the importance of filtration in urine production. 

2. How do the kidneys contribute to homeostasis? 

3. Why are nephrons considered the structural and functional units of the kidney? 

4. Critical Thinking  How is ammonia related to kidney functioning? 

STRUCTURES AND FUNCTIONS  Use the figure of a nephron and the information below to answer the following questions.

About 99 of every 100 mL of filtrate are reabsorbed into the blood, and about 1,500 mL (1.6 qt) of urine are excreted per day.

1. Label each part of the figure in the spaces provided.

2. In which structure is the filtrate collected? 

3. Based on the amount of urine excreted daily, about how many milliliters of filtrate would be produced daily by a pair of normally functioning kidneys? 

VOCABULARY REVIEW Define the following terms.

1. dendrite

2. axon terminal

3. action potential

4. neurotransmitter

5. synapse

MULTIPLE CHOICE Write the correct letter in the blank.

1. Myelin sheaths surround
   a. dendrites.   b. the spinal cord.   c. axons.   d. synapses.

2. The initiation of an action potential
   a. causes the membrane potential to become more negative.
   b. requires sodium ions move into the neuron.
   c. originates in Schwann cells.
   d. happens at axon terminals.

3. A typical neuron has more than one
   a. nucleus.   b. axon.   c. dendrite.   d. All of the above

4. Action potentials require
   a. sodium ions.   b. gated channels.   c. diffusion.   d. All of the above

5. In a neuron, neurotransmitters are stored in
   a. the cell body.   b. the cytoplasm of the nucleus.   c. vesicles within dendrites.   d. vesicles within axon terminals.
**SHORT ANSWER** Answer the questions in the space provided.

1. Describe how a neurotransmitter can affect the activity of a postsynaptic neuron. ________________

2. Describe the relative concentrations of sodium and potassium ions inside and outside a neuron at resting potential. ________________

3. Explain why action potentials move through axons in only one direction: away from the cell body, toward the axon terminal. ________________

4. **Critical Thinking** In myelinated axons, ions can cross the cell membrane only at the nodes of Ranvier. How does myelination increase the speed of an action potential? ________________

**STRUCTURES AND FUNCTIONS** Use the figures below to answer the following questions.

The figures below represent the cell membrane of an axon at different states of activity.

1. Explain why sodium ions do not cross the cell membrane in figure a. ________________

2. Describe what is happening in figure b. ________________

3. What are two factors that cause the movement of sodium and potassium ions as shown in figure b? ________________
SECTION 49-2 REVIEW

STRUCTURE OF THE NERVOUS SYSTEM

**VOCABULARY REVIEW** Explain the relationship between the terms in each of the following groups of terms.

1. brain stem, medulla oblongata

2. somatic nervous system, autonomic nervous system

3. central nervous system, peripheral nervous system

4. thalamus, hypothalamus

**MULTIPLE CHOICE** Write the correct letter in the blank.

_____ 1. Each cerebral hemisphere is divided into

   a. four lobes.
   b. right and left halves.
   c. the cerebral cortex and the corpus callosum.
   d. All of the above

_____ 2. Which of the following is *not* a component of the brain stem?

   a. midbrain
   b. thalamus
   c. medulla oblongata
   d. pons

_____ 3. A spinal reflex requires

   a. the spinal cord to be separated from the brain.
   b. involvement of the diencephalon.
   c. neurons in the body but not the brain.
   d. only afferent neurons.

_____ 4. The cell bodies of neurons are located within the

   a. ventricles.
   b. nerves.
   c. corpus callosum.
   d. gray matter.

_____ 5. The sympathetic division of the autonomic nervous system

   a. is part of the central nervous system.
   b. inhibits body systems.
   c. stimulates body systems.
   d. All of the above
SHORT ANSWER Answer the questions in the space provided.

1. Describe the function of the limbic system.

2. What kind of information is carried in the ventral roots of spinal nerves?

3. How does the body respond to stress or danger?

4. Which part of the peripheral nervous system is most important for homeostasis? Explain your answer.

5. Critical Thinking Do the central nervous system and the peripheral nervous system function independently of one another? Explain your answer.

STRUCTURES AND FUNCTIONS Use the figure below of a cross section of the spinal cord with a spinal nerve to answer the following questions.

1. Which of the identified structures contains cell bodies of neurons?

2. How would cutting at point B affect the functioning of the central nervous system?

3. How would cutting at point D affect the functioning of the central nervous system?
SECTION 49-3 REVIEW

SENSORY SYSTEMS

VOCABULARY REVIEW  Define the following terms.

1. papillae ____________________________________________

2. rod ______________________________________________

3. retina ___________________________________________

4. cone _____________________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Which of the following statements is false?
   a. Rods and cones are specialized neurons.
   b. Rods and cones lie deep within each retina.
   c. Cones respond to dim light, whereas rods are stimulated by bright light.
   d. Rods and cones are photoreceptors.

2. The perception of taste
   a. depends on sensory receptors in the nasal passages.
   b. is based on chemicals dissolved in food.
   c. does not involve the thalamus.
   d. is a function of the digestive system.

3. The olfactory epithelium
   a. is located in the pharynx.
   b. contains chemoreceptors.
   c. is responsible for taste sensations.
   d. contains papillae.

4. Bones of the middle ear
   a. vibrate the tympanic membrane.
   b. transfer sound vibrations to the inner ear.
   c. contain hair cells.
   d. All of the above

5. Which of the following is associated with the semicircular canals?
   a. balance
   b. taste
   c. hearing
   d. vision
SHORT ANSWER Answer the questions in the space provided.

1. How does the cochlea detect and transmit sound signals? 

2. What is the first event that is required for the detection and perception of sound?

3. Describe the path that visual information takes from the eyes to the brain.

4. Discuss the role of the thalamus in hearing, vision, taste, and smell.

5. Critical Thinking More of the neurons in the cerebral cortex are involved with body parts that have complex, or “important,” functions—such as the fingers, which make fine, detailed movements and interact with the environment—than with body parts that have less-complex functions. What advantage is gained by this variable representation of body parts in the nervous system?

STRUCTURES AND FUNCTIONS In the table below, write the type of sensory receptor—mechanoreceptor, photoreceptor, thermoreceptor, pain receptor, or chemoreceptor—that is associated with each sensory system. There may be more than one answer for each system.

<table>
<thead>
<tr>
<th>Sensory System</th>
<th>Receptor Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vision</td>
<td>1.</td>
</tr>
<tr>
<td>Balance</td>
<td>2.</td>
</tr>
<tr>
<td>Hearing</td>
<td>3.</td>
</tr>
<tr>
<td>Smell</td>
<td>4.</td>
</tr>
<tr>
<td>Touch</td>
<td>5.</td>
</tr>
<tr>
<td>Temperature</td>
<td>6.</td>
</tr>
<tr>
<td>Taste</td>
<td>7.</td>
</tr>
</tbody>
</table>
SECTION 49-4 REVIEW

DRUGS AND THE NERVOUS SYSTEM

VOCABULARY REVIEW  Explain the relationship between the terms in each of the following groups of terms.

1. psychoactive drug, stimulant

2. tolerance, addiction

3. addiction, withdrawal

4. nicotine, emphysema

MULTIPLE CHOICE  Write the correct letter in the blank.

____ 1. Emphysema is
   a. an inflammation of the bronchi and bronchioles.
   b. an infectious lung disease similar to pneumonia.
   c. a degenerative lung disease in which alveoli lose their elasticity.
   d. caused by using smokeless tobacco.

____ 2. Which of the following is an example of a drug?
   a. aspirin       b. iodine       c. penicillin       d. All of the above

____ 3. Blood alcohol concentration, BAC, can be fatal at
   a. 0.50      b. 0.30      c. 0.10      d. 0.08

____ 4. Reuptake receptors
   a. transfer neurotransmitters from one neuron to the next.
   b. reabsorb neurotransmitters for later use.
   c. are more efficient in the presence of drugs such as cocaine.
   d. None of the above

____ 5. Codeine, heroin, and opium are examples of
   a. depressants. b. stimulants. c. narcotics. d. hallucinogens.
SHORT ANSWER  Answer the questions in the space provided.

1. Describe how tolerance to a drug develops.  

2. List the symptoms of drug withdrawal.  

3. Summarize how cocaine functions at the synaptic level.  

4. Critical Thinking  Is the relationship between body weight and blood alcohol concentration direct or inverse? Why do you think body weight would affect blood alcohol concentration?  

STRUCTURES AND FUNCTIONS  Organize the following terms and phrases into two groups: Group A for those associated with smoking tobacco, and Group B for those associated with drinking alcohol. Write your answers in the table below.

<table>
<thead>
<tr>
<th>throat irritation</th>
<th>dehydration</th>
</tr>
</thead>
<tbody>
<tr>
<td>decreased body temperature</td>
<td>emphysema</td>
</tr>
<tr>
<td>tars</td>
<td>addiction</td>
</tr>
<tr>
<td>liver damage</td>
<td>heart attack</td>
</tr>
<tr>
<td>fetal alcohol syndrome</td>
<td>chronic bronchitis</td>
</tr>
</tbody>
</table>

Group A

Group B
HORMONES

VOCABULARY REVIEW Define the following terms.

1. target cell

2. second messenger

3. prostaglandin

4. hormone

MULTIPLE CHOICE Write the correct letter in the blank.

___ 1. Amino acid–based hormones are
   a. protein hormones only.  
   b. derived from cholesterol.  
   c. considered as second messengers.  
   d. None of the above

___ 2. Because steroid hormones are fat-soluble, they can
   a. synthesize new enzymes.  
   b. activate DNA synthesis.  
   c. diffuse through the cell membrane of target cells.  
   d. act as a first messenger or a second messenger.

___ 3. Cyclic AMP
   a. is produced in response to amino acid–based hormones.  
   b. appears in cycles.  
   c. is produced in response to steroid hormones.  
   d. attaches to DNA to control mRNA transcription.

___ 4. Glands do not secrete
   a. hormones.  
   b. mucus.  
   c. prostaglandins.  
   d. saliva.

___ 5. A steroid-hormone-receptor complex
   a. binds to cyclic AMP.  
   b. acts through cell-surface receptors.  
   c. binds to DNA in the nucleus.  
   d. All of the above
SHORT ANSWER  Answer the questions in the space provided.

1. How does a first messenger affect a target cell? 

2. How are hormones transported throughout the body? 

3. Are sweat glands considered to be endocrine glands? Explain your answer. 

4. Critical Thinking  Why might the cells of two different organs respond differently to cyclic AMP activation? 

STRUCTURES AND FUNCTIONS  Use the information given and the figure at right to answer the following questions.

The diagram at right shows an amino acid–based hormone (a protein) that has been divided into four segments—A, B, C, and D—with an enzyme that cuts up proteins. In the experiment, each segment was physically isolated from the others, and a specific antibody was raised against each segment. The antibodies are identified according to the segment to which each of them binds. Cultured target cells of the hormone were then exposed to a mixture of the complete protein hormone and one of the antibodies. The responses of the cells are presented in the data table at right.

1. Which of the antibodies prevented the action of the hormone? 

2. In general, does the binding of an antibody prevent the hormone’s action? Explain your answer. 

3. What do these observations suggest about the hormone’s action on its target cells?
SECTION 50-2 REVIEW

ENDOCRINE GLANDS

VOCABULARY REVIEW  Explain the relationship between the terms in each of the following pairs of terms.

1. hypothalamus, pituitary gland

2. epinephrine, norepinephrine

3. follicle-stimulating hormone, luteinizing hormone

4. insulin, diabetes mellitus

5. estrogen, testosterone

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Which of the following endocrine glands is not controlled by the pituitary gland?
   a. testes  b. thyroid gland  c. adrenal cortex  d. adrenal medulla

2. Thyroxine is important to the control of
   a. cellular metabolic rates.  b. sex-hormone production.  c. diabetes mellitus.  d. calcium uptake.

3. Which of the following is a sex hormone?
   a. norepinephrine  b. cholesterol  c. progesterone  d. cortisol

4. Lethargy and low body temperature are symptoms of a defect in the
   a. adrenal medulla.  b. islets of Langerhans.  c. pancreas.  d. thyroid gland.
SHORT ANSWER Answer the questions in the space provided.

1. List two hormones that regulate the concentration of calcium in the blood and describe their effects. 

2. Name the two posterior-pituitary hormones, and describe their actions and sites of production.

3. Critical Thinking In a person with goiter, would the blood level of TSH be below normal, normal, or above normal? Explain your answer.

STRUCTURES AND FUNCTIONS Use the figure of a feedback mechanism below to answer the following questions. In the figure, the number of hormone molecules represents the relative blood concentrations of hormone A and hormone B.

1. Which cell is defective in Situation 1? What happens to the hormone concentrations as a result of this defect?

2. Which cell is defective in Situation 2? What happens to the hormone concentrations as a result of this defect?
SECTION 51-1 REVIEW

MALE REPRODUCTIVE SYSTEM

VOCABULARY REVIEW Define the following terms.

1. semen __________________________

2. testes __________________________

3. ejaculation ______________________

4. seminiferous tubules ___________________

5. epididymis ________________________

MULTIPLE CHOICE Write the correct letter in the blank.

_____ 1. A human sperm
   a. does not have a nucleus.
   b. has the haploid number of chromosomes located in the midpiece.
   c. has a small amount of cytoplasm.
   d. All of the above

_____ 2. The vas deferens connects the epididymis to the
   a. seminal vesicles.
   b. bulbourethral glands.
   c. urethra.
   d. seminiferous tubules.

_____ 3. The prostate gland is important to the
   a. proper functioning of the scrotum.
   b. completion of meiosis.
   c. ejaculation of normal semen.
   d. maturation of sperm.

_____ 4. After sperm move through the vas deferens, they enter the
   a. seminal vesicles.
   b. urinary bladder.
   c. urethra.
   d. All of the above

_____ 5. A sperm tail consists of
   a. a nuclear envelope.
   b. enzymes used to penetrate an egg.
   c. mitochondria.
   d. a flagellum.
SHORT ANSWER  Answer the questions in the space provided.

1. Describe the path that sperm take in leaving the body.

2. Describe the composition of semen.

3. Describe two differences between seminiferous tubules and the vas deferens.

4. How is the structure of a sperm suited for fertilization?

5. Critical Thinking  Is there an advantage for cells that secrete androgens (particularly testosterone) to be located within the testes instead of in other areas of the body? Explain your answer.

STRUCTURES AND FUNCTIONS  Use the figure below to answer the following questions.

1. Label each part of the figure in the spaces provided.

2. For each labeled structure, indicate whether sperm would be immature or mature.
SECTION 51-2 REVIEW

FEMALE REPRODUCTIVE SYSTEM

VOCABULARY REVIEW  Explain the relationship between the terms in each of the following pairs of terms.

1. ovulation, ovary

2. menopause, menstruation

3. uterus, cervix

4. menstrual cycle, follicular phase

5. corpus luteum, luteal phase

MULTIPLE CHOICE  Write the correct letter in the blank.

1. How many mature eggs does each complete meiotic division yield?
   a. one  b. two  c. three  d. four

2. Fallopian tubes are connected to
   a. the corpus luteum.  b. the urethra.  c. the vagina.  d. the uterus.

3. Which stage of the menstrual cycle is characterized by thickening of the uterine lining?
   a. follicular phase  b. luteal phase  c. menstruation  d. ovulation

4. Which of the following hormones initiates ovulation?
   a. progesterone  b. follicle-stimulating hormone  c. luteinizing hormone  d. oxytocin

5. Which of the following hormones acts directly on the uterine lining during the menstrual cycle?
   a. estrogen  b. luteinizing hormone  c. follicle-stimulating hormone  d. testosterone
SHORT ANSWER  Answer the questions in the space provided.

1. Does the male or female gamete contribute more chromosomes to the fertilized egg? Explain your answer. ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

2. Describe two structural differences between a mature sperm and a mature egg. ________________
   ________________________________________________________________
   ________________________________________________________________

3. Critical Thinking  What does the onset of menopause indicate about the number of immature eggs remaining in the ovaries? ________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

STRUCTURES AND FUNCTIONS  Use the figures of the menstrual cycle below to answer the following question.

Briefly describe what is depicted in each figure. ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
VOCABULARY REVIEW  Define the following terms.

1. human chorionic gonadotropin ________________________________

2. implantation ________________________________

3. chorionic villi ________________________________

4. umbilical cord ________________________________

5. amniotic sac ________________________________

MULTIPLE CHOICE  Write the correct letter in the blank.

1. Fertilization occurs in the
   a. vagina.   b. uterus.   c. fallopian tubes.   d. ovaries.

2. The morula is
   a. the outer cell layer of a rupturing follicle.
   b. an unfertilized egg.
   c. formed after the fusion of sperm and egg nuclei.
   d. attached to the uterine lining after implantation.

3. Which of the following organ systems begins to form during the first trimester?
   a. nervous system
   b. circulatory system
   c. digestive system
   d. All of the above

4. Afterbirth includes
   a. amniotic fluid.
   b. the placenta.
   c. unfertilized eggs.
   d. ruptured ovarian follicles.

5. A zygote is a(n)
   a. implanted fertilized egg.
   b. ovulated egg.
   c. fertilized egg.
   d. blastocyst.
SHORT ANSWER Answer the questions in the space provided.

1. Explain why ovulation does not occur during pregnancy.

2. Describe how the placenta, chorionic villi, and allantois are functionally and structurally related.

3. Explain the importance of estrogen during pregnancy.

4. What events must be completed before implantation is successful?

5. Critical Thinking If you were asked to design a pregnancy test that was based on hormones, which hormone would you select to indicate a pregnancy? Explain your answer.

STRUCTURES AND FUNCTIONS Use the figure of part of the female reproductive system below to answer the following questions.

1. Label each part of the figure in the spaces provided.

   a

   b

   c

   d

2. Use the letters of the labeled structures to indicate where the following would normally be found during pregnancy:

   _____ blastocyst

   _____ corpus luteum

   _____ zygote

   _____ morula
**Section 1-1**

**VOCABULARY REVIEW**
1. Development is the process involving cell division and cell differentiation by which an organism becomes a mature adult.
2. Reproduction is the process by which an organism produces new organisms like itself.
3. An organ is a structure that carries out a specialized job inside an organ system.
4. A tissue is a group of cells in an organ that have similar abilities and that allow the organ to function.

**MULTIPLE CHOICE**
1. c 2. b 3. d 4. b 5. a

**SHORT ANSWER**
1. A cell is the smallest unit that can perform all of life’s processes.
2. Sample answer: An owl maintains its body temperature by burning fuel to produce body heat and by fluffing up its feathers to trap an insulating layer of air next to its body.
3. Sample answer: By studying biology, you can make informed decisions on issues that impact you and society, such as environmental issues, health, and technology.
4. Bacteria reproduce asexually by splitting in two. Frogs reproduce sexually by producing sperm and eggs. One sperm and one egg combine to form a single cell that divides many times to produce a new frog.
5. Rocks are not composed of cells, do not have internal systems for maintaining homeostasis, and do not contain hereditary information in the form of DNA.

**STRUCTURES AND FUNCTIONS**
The buffaloes and grass are all composed of cells (cells). Different types of cells compose the different tissues in the buffaloes (organization). The grass uses energy from the sun to manufacture food, and the buffaloes consume the grass for their food (energy use). The buffaloes have hair to help maintain their internal environment (homeostasis). The calf will eventually grow into a full-grown buffalo (growth). Buffalo increase their herds through reproduction.

**Section 1-2**

**VOCABULARY REVIEW**
1. A domain is one of three major subdivisions of organisms that can be divided into one or more kingdoms.
2. Diversity of life describes the variety of different kinds of living things. Unity of life describes the features that living things have in common.
3. Adaptations are traits that improve an individual’s ability to survive and reproduce. Evolution is the process in which a population changes over time due to increased reproduction of organisms with certain adaptations.
4. An ecosystem is a community of living things and their physical environment. Ecology is the branch of biology that studies how organisms interact with each other and with their environments.

**MULTIPLE CHOICE**
1. d 2. b 3. d 4. c 5. d

**SHORT ANSWER**
1. Animals produce carbon dioxide and water, which is needed by plants. Accept all reasonable answers.
2. If an adaptation is not inherited, future generations of organisms will not have the favorable trait and evolution cannot occur.
3. Natural selection is the process by which organisms that have certain favorable traits are better able to survive and reproduce successfully than organisms that lack these traits.
4. Two organisms that share the same kingdom must also share the same domain because kingdoms are subdivisions of domains.
5. This trait will not spread through the population. Since the frog produces no eggs, it will have no offspring to inherit the trait.

**STRUCTURES AND FUNCTIONS**
The deer eat the grass and get energy and nutrients from the grass. The panther kills and eats the deer, getting energy and nutrients from the deer and the grass.

**Section 1-3**

**VOCABULARY REVIEW**
1. A prediction is what is expected to happen if a hypothesis were true.
2. A control group is a normal standard against which to compare an experimental group.
3. A dependent variable is a factor that is measured in a controlled experiment.
4. An independent variable is a factor that distinguishes the control and experimental groups in a controlled experiment.
5. A theory is a set of related hypotheses that have been confirmed and that explain a great amount of data.

**MULTIPLE CHOICE**
1. c 2. b 3. c 4. a 5. d

**SHORT ANSWER**
1. Quantitative data are data that can be measured in numbers. Examples include the dimensions of an object, the number of objects in a group, and the duration of an event.
2. The validity of the research is checked by experts in the field.
3. A prediction is a statement made in advance that declares the results that will be obtained from testing a hypothesis in an experiment, if the hypothesis is true.
4. They might use statistics to determine relationships between variables, compare the data with those obtained in other studies, and determine possible sources of experimental error.
5. The control group should have consisted of rats that were injected with the same type of salt solution but without the drug. The dependent variable was blood pressure, and the independent variable was the drug.

**STRUCTURES AND FUNCTIONS**
Observations:
The owl is sitting in a tree.
The owl has a mouse in its beak.
The owl has sharp talons.

Inferences:
Owls can fly.
Owls have binocular vision.
Owls hunt at night.
Section 1-4

VOCABULARY REVIEW
1. Light electron does not belong; the other three are types of microscopes.
2. Base unit does not belong; the other three are parts of a light microscope.
3. Mass density does not belong; the other three are characteristics of microscopes.
4. Minute does not belong; the other three are SI base units.
5. Meter does not belong; the other three are SI derived units.

MULTIPLE CHOICE
1. d  2. b  3. c  4. a  5. c

SHORT ANSWER
1. light source, specimen, objective lens, ocular lens
2. LM, about 2,000×; TEM, 200,000×; SEM, 100,000×
3. m, km, cm, mm, µm. 1 km = 1,000 m; 1 cm = 0.01 m; 1 mm = 0.001 m; 1 µm = 0.000001 m
4. They should use a TEM, since it has the magnification necessary to view viruses and, unlike an SEM, can reveal structures that are inside cells.

STRUCTURES AND FUNCTIONS
a, ocular lens (eyepiece); b, nosepiece; c, objective lenses; d, stage; e, light source

Section 2-1

VOCABULARY REVIEW
1. An atom is the simplest particle of an element that retains all of the properties of that element.
2. A neutron is a nuclear particle that has no electrical charge.
3. A compound is a substance that is made up of atoms of two or more elements in fixed proportions.
4. A covalent bond is an attachment between two atoms that share one or more pairs of electrons.
5. An ion is an atom or molecule with an electrical charge.

MULTIPLE CHOICE
1. b  2. a  3. d  4. c  5. a

SHORT ANSWER
1. Mass is the quantity of matter an object has, while weight is a measure of the pull of gravity on mass.
2. BO₂, 1 boron and 2 oxygen atoms; C₆H₁₂O₆, 6 carbon, 12 hydrogen, and 6 oxygen atoms; KCl, 1 potassium and 1 chlorine atom; NH₃, 1 nitrogen and 3 hydrogen atoms
3. The oxygen atoms share two pairs of electrons, and the chlorine atom gains one or more electrons.
4. Argon will not tend to form bonds with other elements. With an atomic number of 18, argon must have 18 electrons: 2 in the first energy level, 8 in the second, and 8 in the third. Since the orbitals of its outermost energy level is filled, argon is chemically stable.

STRUCTURES AND FUNCTIONS
1. A covalent bond is formed between hydrogen and chlorine atoms.
2. A hydrogen atom and a chlorine atom share one electron. This process gives the hydrogen atom a full orbital of 2 electrons. The chlorine atom will have full orbitals corresponding to its three energy levels of 2, 8, and 8 electrons.

Section 2-2

VOCABULARY REVIEW
1. In a chemical reaction, a reactant is the starting substance and a product is the ending substance. Reactants are shown on the left side of an equation and products are shown on the right side.
2. A catalyst reduces the amount of activation energy needed to start a reaction. An enzyme serves as a catalyst in the reactions of living things.
3. In an oxidation reaction, a reactant loses one or more electrons; in a reduction reaction, a reactant gains one or more electrons.

MULTIPLE CHOICE
1. b  2. c  3. d  4. a  5. b

SHORT ANSWER
1. Reactants: C₁₂H₂₂O₁₁, H₂O, Products: C₆H₁₂O₆, C₆H₁₂O₆
2. By reducing the activation energy that is needed for a reaction, a catalyst allows the reaction to proceed spontaneously or with the addition of a small amount of energy.
3. It indicates that the reaction can proceed in either the forward or the reverse direction.
4. Cl is reduced; Na is oxidized.
5. The reaction proceeds slowly because the activation energy is high. An enzyme or other catalyst is needed to lower the activation energy and speed up the reaction.

STRUCTURES AND FUNCTIONS
1. energy needed without a catalyst
2. energy needed with a catalyst
3. There is a net release of energy. Energy of the products is less than energy of the reactants.

Section 2-3

VOCABULARY REVIEW
1. A solvent is a substance in which a solute is dissolved.
2. An aqueous solution is a solution in which water is the solvent.
3. A hydroxide ion is a negatively charged ion consisting of one oxygen atom and one hydrogen atom, OH⁻.
4. A base is a solution that contains more hydroxide ions than hydronium ions.
5. A buffer is a chemical substance that neutralizes small amounts of either an acid or a base added to a solution.

MULTIPLE CHOICE
1. c  2. b  3. a  4. c  5. d

SHORT ANSWER
1. Adhesion allows water to stick to a dry surface.
2. Solutions can be mixtures of liquids, solids, or gases.
3. The solution contains 10 g of sugar, and the solvent is water.
5. The solution with a pH of 9 has 10⁶, or 1,000,000, times more hydroxide ions.
6. By neutralizing small amounts of acid or base that may be added to a solution, buffers keep pH values at normal and safe levels. The control of pH is essential for the function of enzymes.
7. Since a tenfold increase in $H_3O^+$ ion concentration reflects a decrease of one pH unit, a 100-fold increase in concentration reflects a decrease of two pH units. Therefore, the new pH would be 5.5.

**STRUCTURES AND FUNCTIONS**
Drawings should show two water molecules below and one above the central water molecule. The molecules below should have their H atoms facing away from the central molecule, and the molecule above should have one of its H atoms pointing toward the central molecule. Dashed lines should be drawn between each H atom in the central molecule and the O atom in each of the lower water molecules, and between the O atom in the central molecule and the nearer H atom in the upper water molecule.

**Section 3-1**

**VOCABULARY REVIEW**
1. An organic compound is a compound containing carbon atoms covalently bonded to other carbon atoms and to other elements. Examples: any carbon-containing compound, such as benzene, ethanol, glycerol, glucose, fructose, sucrose, ATP, and ADP.
2. A functional group is a cluster of atoms in a compound that influences the properties of that compound. Examples: hydroxyl group, phosphate group.
3. An alcohol is an organic compound with a hydroxyl group attached to one of its carbon atoms. Examples: ethanol, methanol, glycerol.
4. A monomer is a simple molecule that can bond to others of its kind to form more complex molecules. Examples: glucose, fructose.
5. A polymer is a complex molecule that consists of repeated, linked units. Example: DNA, proteins.

**MULTIPLE CHOICE**
1. a 2. c 3. b 4. a 5. d

**SHORT ANSWER**
1. The hydroxyl group on alcohols is polar, and this makes alcohols polar compounds. Alcohols can therefore form hydrogen bonds.
2. carbon atom, monomer, polymer, macromolecule
3. The glucose molecule releases a hydroxide ion, OH\(^-\), and the fructose molecule releases a hydrogen ion, $H^+$. These two ions combine to produce water, $H_2O$.
4. The hydrolysis products are ADP and inorganic phosphate. Energy is released.
5. With seven electrons in its outermost energy level, carbon could not form double or triple bonds with other atoms, so far fewer organic compounds could be formed.

**STRUCTURES AND FUNCTIONS**
1. Forward reaction: reactants, glucose and fructose; products, sucrose and $H_2O$. 2. condensation reaction 3. Reverse reaction: reactants, sucrose and $H_2O$; products, glucose and fructose. 4. hydrolysis

**Section 3-2**

**VOCABULARY REVIEW**
1. A monosaccharide is a simple sugar containing carbon, hydrogen, and oxygen in a ratio of 1:2:1; a polysaccharide is a complex molecule composed of three or more monosaccharides.
2. An amino acid is a compound containing carbon, hydrogen, oxygen, and nitrogen. A protein is a large polymer of amino acids.
3. A nucleotide is a compound containing a phosphate group, a five-carbon sugar, and a ring-shaped nitrogen base; a nucleic acid is a very large polymer of nucleotides.

**MULTIPLE CHOICE**
1. c 2. a 3. d 4. b 5. d

**SHORT ANSWER**
1. The storage form is glycogen, and the quick-energy form is glucose. Glycogen consists of hundreds of glucose molecules linked in a highly branched chain.
2. Starch, 1; proteins, 20.
3. Phospholipid composes most of the cell membrane. The hydrophobic tails of the phospholipids provide a barrier between the inside and outside of the cell.
4. Steroids are lipids made of four fused carbon rings. Examples: testosterone and cholesterol.
5. Wax serves as a waterproof layer, limiting water loss and preventing insects from drying out.

**STRUCTURES AND FUNCTIONS**

**Section 4-1**

**VOCABULARY REVIEW**
1. A cell is the smallest unit that can carry on all of the processes of life.
2. The cell theory states that all living organisms are made of one or more cells, that cells are the basic units of structure and function, and that cells come only from the reproduction of existing cells.

**MULTIPLE CHOICE**
1. c 2. a 3. c 4. b 5. d

**SHORT ANSWER**
1. (1) All living things are composed of one or more cells. (2) Cells are the basic units of structure and function in an organism. (3) Cells come only from the reproduction of existing cells.
2. Information about cells could not be understood and organized into a central theory until microscope technology had improved and accurate observations were made.
3. The cork cells that Hooke observed were the remains of dead plant cells. The material from the inside of the cells had been lost or destroyed.
4. You would know that it was made of cells and the cells reproduce to make more cells.
Section 4-2
VOCABULARY REVIEW
1. An organelle is a cell component that performs specific functions for the cell.
2. The nucleus is an organelle that contains coded information in the form of DNA for regulating functions and reproduction and directs most of the activities of the cell.
3. A eukaryote is an organism whose cells contain a membrane-bound nucleus and other organelles.
4. A prokaryote is an organism that lacks a nucleus and membrane-bound organelles.

MULTIPLE CHOICE
1. a 2. b 3. a 4. d

SHORT ANSWER
1. Its flat platelike shape covers and protects the body's surface.
2. Just as organs carry out the organism's life functions, organelles maintain the life of the cell.
3. Eukaryotic cells have a membrane-bound nucleus and membrane-bound organelles.
4. The surface area increases by a factor of 100. The volume increases by a factor of 1,000.

Section 4-3
VOCABULARY REVIEW
1. The nucleoplasm is the jellylike liquid that fills the nucleus. The nuclear envelope is a double membrane that surrounds the nucleus.
2. The cytoskeleton is the network of tubes and filaments that give a cell its shape and serves as tracks for the movement of organelles in the cell. Microtubules are one of three structural elements that make up the cytoskeleton.
3. Both are hairlike organelles that extend from the surface of a eukaryotic cell, but cilia are shorter and are present in larger numbers on a cell.

MULTIPLE CHOICE
1. d 2. a 3. c 4. b 5. c

SHORT ANSWER
1. Some proteins form channels or pores through which certain substances can pass. Other proteins bind to a substance on one side of the membrane and carry it to the other side.
2. Ribosomes are made of proteins and RNA. They are involved in protein synthesis.
3. The cytoskeleton is a network of long protein strands located in the cytosol. Three major components are microfilaments, microtubules, and intermediate filaments.

Section 4-4
VOCABULARY REVIEW
1. A cell wall is a rigid layer that lies outside the plasma membrane of a plant cell.
2. A plastid is an organelle that is surrounded by a double membrane and contains DNA.
3. Thylakoids are flattened membranous sacs that contain chlorophyll.
4. Chlorophyll is a green pigment that absorbs light and captures energy for a plant cell.
5. A central vacuole is a large, fluid-filled organelle that stores water, enzymes, and wastes in plant cells.

MULTIPLE CHOICE
1. b 2. b 3. a 4. c 5. c

SHORT ANSWER
1. Primary cell walls are assembled on the surface of the plasma membrane while the cell is growing. They can grow as the cell grows. Secondary cell walls are produced after the cell has stopped growing. Secondary cell walls cannot expand.
2. Plant cell walls are made of cellulose embedded in proteins and carbohydrates. Cell walls help support and protect the plant.
3. When water is plentiful, the central vacuole expands. The other organelles are pushed against the plasma membrane in a thin layer.
4. The nucleoid is not surrounded by a membrane and is therefore not a nucleus. Bacteria do not have an internal membrane system or membrane-bound organelles.

Section 5-1
VOCABULARY REVIEW
1. A difference in the concentration of molecules in two areas, called a concentration gradient, can result in diffusion, the movement of molecules from the area of higher concentration to the area of lower concentration.
2. Osmosis is the diffusion of water molecules across a cell membrane. When osmosis results in water molecules entering a plant cell, the molecules exert a pressure against the cell wall, called turgor pressure.
3. A hypertonic solution has a higher solute concentration than the cytosol of a cell. In a hypertonic solution a plant cell will lose water and shrink away from the cell wall, a process called plasmolysis.

MULTIPLE CHOICE
1. d 2. b 3. a 4. c 5. b
SHORT ANSWER
1. At equilibrium, the movement of molecules continues, but because there is no concentration gradient, there is no net movement in any particular direction.
2. Carrier proteins bind to a molecule of the substance on one side of the membrane, change shape, transport the molecule across the membrane, and release the molecule on the other side.
3. The stimuli are stretching of the cell membrane, electrical signals, and chemicals in the cytosol or external environment.
4. Both involve the binding of a specific substance to a particular kind of protein and a change in shape of the protein as the process (transport or chemical reaction) proceeds. After the process is completed, the protein is unchanged.

STRUCTURES AND FUNCTIONS
a, hypotonic; b, hypertonic; c, isotonic; d, hypertonic; e, isotonic; f, hypertonic

Section 5-2
VOCABULARY REVIEW
1. Active transport is the movement of materials across a membrane from an area of lower concentration to an area of higher concentration.
2. Endocytosis is the process by which cells ingest external fluid, macromolecules, and large particles.
3. A vesicle is a membrane-bound organelle that pinches off from the cell membrane during endocytosis or fuses with the cell membrane during exocytosis.
4. Phagocytosis is a type of endocytosis in which cells ingest large particles or whole cells.

MULTIPLE CHOICE
1. b 2. a 3. c 4. b 5. d

SHORT ANSWER
1. The mechanism uses energy to move (pump) Na+ and K+ up their concentration gradients.
2. The phagocyte forms a pouch in its cell membrane and engulfs bacteria in the pouch. It then pinches off the surrounding fluid to form a vesicle. Lysosomes fuse with the vesicle, and lysosomal enzymes destroy the bacteria it contains.
3. Proteins are made on ribosomes and packaged into vesicles by the Golgi apparatus. The vesicles move to the cell membrane and fuse with it, releasing the proteins from the cell through exocytosis.
4. The interior of the lipid bilayer is nonpolar and therefore would repel ions, which are attracted to polar environments.

STRUCTURES AND FUNCTIONS
1. The correct order is d, c, f, b, a, e. 2. Na+ ions are released on the external side of the cell membrane. 3. K+ ions are released on the cytosolic side of the cell membrane.

Section 6-1
VOCABULARY REVIEW
1. Grana are stacks of thylakoids inside a chloroplast; the stroma is the solution that surrounds the thylakoids.
2. Carotenoids are accessory pigments that assist chlorophyll a in capturing light energy during photosynthesis.
3. Chemiosmosis is the process by which ATP is made during photosynthesis. The production of ATP is catalyzed by the enzyme ATP synthase.

MULTIPLE CHOICE
1. a 2. c 3. d 4. b 5. d

SHORT ANSWER
1. Photosynthesis involves many chemical reactions linked such that the product of one reaction is consumed in the next reaction.
2. Chloroplasts have an inner membrane system consisting of thylakoids. The pumping of protons into the thylakoids builds up a proton concentration gradient across the thylakoid membrane.
3. The energy-carrying products are ATP and NADPH.
4. They help chlorophyll a capture light energy by absorbing energy in wavelengths that chlorophyll a cannot absorb. This enables photosynthesis to capture more of the energy in light.
5. Photosystem II most likely evolved first, because it replaces electrons lost from chlorophyll a with electrons from water. Since photosystem I accepts electrons from photosystem II, it probably evolved after photosystem II.

STRUCTURES AND FUNCTIONS
a, electrons; b, NADPH; c, ATP; d, H+  

Section 6-2
VOCABULARY REVIEW
1. The Calvin cycle is a biochemical pathway that produces a three-carbon sugar from carbon dioxide during photosynthesis.
2. Carbon fixation is the incorporation of carbon dioxide into organic compounds.
3. A stoma is a small pore on the surface of a plant through which water, O2, CO2, and other gases enter or leave the plant.
4. The C4 pathway is a carbon fixation pathway in which CO2 is incorporated into four-carbon compounds.
5. The CAM pathway is a carbon fixation pathway in which CO2 is incorporated into organic compounds at night and released to enter the Calvin cycle during the day.

MULTIPLE CHOICE
1. a 2. c 3. d 4. b 5. d

SHORT ANSWER
1. In each turn of the cycle, three molecules of ATP and two molecules of NADPH are used.
2. CO2 + H2O + light energy $\rightarrow$ (CH2O) + O2
3. CAM plants open their stomata at night, whereas C3 and C4 plants open their stomata during the day.
4. Increasing the temperature initially accelerates the various chemical reactions involved in photosynthesis. At higher temperatures, many of the enzymes that catalyze these reactions become ineffective, and the stomata begin to close.
5. The stomata would open. That would allow more CO2 to enter the leaf from the surrounding air, stimulating photosynthesis.

STRUCTURES AND FUNCTIONS
Clockwise from the top: 3 CO2, 6 3-PGA, 6 ATP, 6 ADP, 6 NADPH, 6 NADP+, 6 G3P, 3 ATP, 3 ADP, 3 RuBP
**Section 7-1**

**VOCABULARY REVIEW**

1. Cellular respiration is the process in which cells make ATP by breaking down organic compounds.
2. Glycolysis is a biochemical pathway in which one molecule of glucose is oxidized to two molecules of pyruvic acid.
3. Lactic acid fermentation is an anaerobic pathway in which pyruvic acid is converted into lactic acid.
4. Alcoholic fermentation is an anaerobic pathway in which pyruvic acid is converted into ethyl alcohol and CO₂.

**MULTIPLE CHOICE**

1. a 2. c 3. d 4. b 5. c

**SHORT ANSWER**

1. The fermentation pathways can operate in the absence of oxygen.
2. The energy-containing products are NADH, ATP, and pyruvic acid.
3. These pathways regenerate NAD⁺, which the cells can use to keep glycolysis going to make more ATP in the absence of oxygen.
4. Without niacin or the ability to make it, the person would be deficient in NAD⁺. Since NAD⁺ is used in Step 3 of glycolysis, glycolysis would be inhibited.

**STRUCTURES AND FUNCTIONS**

a. glucose; b. glycolysis; c. pyruvic acid; d. lactic acid fermentation; e. alcoholic fermentation; f. lactic acid; g. ethyl alcohol

**Section 7-2**

**VOCABULARY REVIEW**

1. Aerobic respiration is the set of pathways in cellular respiration that require oxygen to break down pyruvic acid.
2. The mitochondrial matrix is the space inside the inner membrane of a mitochondrion.
3. The Krebs cycle is a biochemical pathway that breaks down acetyl coenzyme A, producing CO₂, hydrogen atoms, and ATP.
4. FAD, or flavine adenine dinucleotide, is a molecule that accepts electrons during redox reactions.

**MULTIPLE CHOICE**

1. b 2. c 3. a 4. d 5. c

**SHORT ANSWER**

1. Most of the energy is acquired by NADH; three molecules are produced during each turn of the cycle.
2. The reactions of the electron transport chain occur in the inner mitochondrial membrane.
3. C₆H₁₂O₆ → CO₂ + H₂O + energy
4. The mitochondrial membranes segregate the enzymes and reactants of the Krebs cycle, facilitating the reactions they participate in. The folding of the inner mitochondrial membrane provides a large surface area for the molecules of the electron transport chain. The area between the inner and outer mitochondrial membranes provides a confined space in which protons can accumulate, driving chemiosmosis.

**STRUCTURES AND FUNCTIONS**

a. protons; b. protons; c. protons; d. NAD⁺; e. FADH₂; f. O₂; g. ADP + phosphate

**Section 8-1**

**VOCABULARY REVIEW**

1. Histones help maintain the shape of a chromosome and aid in the tight packing of DNA; nonhistone proteins control the activity of specific regions of DNA.
2. A chromatid is one-half of a chromosome; a centromere is the area of a chromatid that holds the two chromatids in a chromosome together.
3. A sex chromosome is a chromosome that determines the sex of an organism; an autosome is any other chromosome.
4. A diploid cell has both chromosomes in each homologous pair; a haploid cell has only one chromosome in each homologous pair.

**MULTIPLE CHOICE**

1. d 2. b 3. a 4. c 5. a

**SHORT ANSWER**

1. Histones help coil and package the DNA into a very small volume.
2. Homologous chromosomes are the same size and shape and carry genes for the same traits.
3. The picture is called a karyotype. If it shows two X chromosomes, the person is a female; if it shows one X and one Y chromosome, the person is a male.
4. Relatively simple organisms with more chromosomes might have smaller chromosomes containing less DNA. Also, some of the DNA in an organism’s chromosomes may not carry information that is actually used by the organism.

**STRUCTURES AND FUNCTIONS**

a. chromosome; b. centromere; c. chromatids; d. homologous chromosomes, or homologues

**Section 8-2**

**VOCABULARY REVIEW**

1. Telophase does not belong; it is a phase of mitosis, and the other three are phases of interphase.
2. Interphase does not belong; it is a phase of the cell cycle, and the other three are phases of mitosis.
3. Binary fission does not belong; it pertains to prokaryotes, and the other three pertain to eukaryotes.
4. Spindle fiber does not belong; it pertains to nuclear division, and the other three pertain to cytoplasmic division.
5. Vesicles does not belong; vesicles are organelles, some of which participate in cytoplasmic division, and the other three are involved in nuclear division.

**MULTIPLE CHOICE**

1. c 2. b 3. d 4. a 5. c

**SHORT ANSWER**

2. Prophase: the chromatin coils and forms chromosomes, the nucleolus and nuclear envelope disappear, and the mitotic spindle forms. Metaphase: kinetochore fibers move the chromosomes to the cell equator. Anaphase: the chromatids in each chromosome separate and move toward opposite poles of the cell. Telophase: the mitotic spindle disappears, the chromatids unwind to form chromatin, the nuclear envelope reforms, and a nucleolus appears.
3. Vesicles formed by the Golgi apparatus fuse at the midline of the cell to form the cell plate, a cell wall that elongates to separate the cell into two cells.
4. Without a G1 growth phase, the cells would not grow to their mature size after cytokinesis. Therefore, the offspring cells would become smaller with each cell cycle.

STRUCTURES AND FUNCTIONS
a, telophase; b, metaphase; c, prophase; d, anaphase

Section 8-3
VOCABULARY REVIEW
1. Oogenesis is the production of mature egg cells, or ova.
2. A tetrad is a pair of homologous chromosomes lined up next to each other during prophase I of meiosis.
3. Independent assortment is the random separation of homologous chromosomes during anaphase I.
4. Polar bodies are haploid offspring cells produced by meiosis during oogenesis.

MULTIPLE CHOICE
1. d 2. c 3. a 4. b 5. c

SHORT ANSWER
1. Genetic recombination occurs during crossing-over and independent assortment.
2. Prophase I: DNA coils into chromosomes, the nucleolus and nuclear envelope disappear, the mitotic spindle forms, and synapsis and crossing-over occur. Metaphase I: the tetrads line up randomly along the midline of the cell, and spindle fibers attach to the centromere of each homologue. Anaphase I: the homologues move toward opposite poles of the cell. Telophase I: the chromosomes reach the opposite ends of the cell, and cytokinesis begins.
3. In meiosis I, the offspring cells are haploid but each cell contains two copies of the chromosome because the original cell copied its DNA before meiosis I. The offspring cells of meiosis II are also haploid, but each cell contains only one copy of the chromosome because, unlike meiosis I, the cells do not copy their DNA before meiosis II.
4. The advantage of asexual reproduction is that offspring are genetically identical to their parent, so if the parent is well adapted to its environment, the offspring will also be well adapted. The disadvantage of asexual reproduction is that without genetic recombination, the offspring lack the variability that would allow some to survive if the environment became less favorable to their survival.

STRUCTURES AND FUNCTIONS
a, anaphase II; b, metaphase I; c, anaphase I; d, metaphase II

Section 9-1
VOCABULARY REVIEW
1. The F1 generation consists of the offspring of a cross between two parents; the F2 generation consists of the offspring of a cross between two individuals in the same F1 generation.
2. A dominant factor is one that masks the effect of another factor for the same characteristic; a recessive factor is one whose effect is masked by another factor for the same characteristic.

3. Self-pollination occurs between flowers on the same plant. Cross-pollination occurs between flowers on different plants.

MULTIPLE CHOICE
1. c 2. a 3. d 4. b

SHORT ANSWER
1. An allele is each of two alternative forms of a gene.
2. In meiosis, the two alleles of each gene are segregated when the two chromosomes in each pair of homologues are separated into different gametes. Alleles of genes located on different chromosomes or far apart on the same chromosome assort independently when homologues are randomly separated during meiosis.
3. Orange flower color is dominant. All of the F1 plants will have orange flowers.
4. Mendel would have observed that the traits controlled by dominant factors for these characteristics almost always appeared together. Thus, he might not have concluded that the factors for different characteristics are assorted independently.

STRUCTURES AND FUNCTIONS
Possible combinations are RB, Rb, rB, and rb.

Section 9-2
VOCABULARY REVIEW
1. In complete dominance, heterozygous and dominant homozygous individuals have the same phenotype. For example, in pea plants, the P allele is completely dominant over the p allele, so both PP and Pp plants have purple flowers.
2. In incomplete dominance, neither allele is completely dominant over the other and both influence the phenotype. For example, in four o’clocks, neither the R nor r allele is completely dominant, so Rr plants have pink flowers.
3. In codominance, neither allele is dominant or recessive; both are expressed in heterozygotes. For example, in MN blood blood types, both M and N molecules are produced by an L\(^{M,N}\) individual.

MULTIPLE CHOICE
1. b 2. a 3. c 4. d 5. c

SHORT ANSWER
1. In a homozygous individual, both alleles of a pair are the same; in a heterozygous individual, the two alleles of a pair are different.
2. 0.25 × 80 individuals = 20 individuals
3. AA and Aa will result. 100% will have the dominant phenotype.
4. In a testcross, the dominant phenotype would appear in all of the offspring if the cow were homozygous dominant but in only about 50% of the offspring if the cow were heterozygous. With only one individual per F1 generation, distinguishing between these two possibilities would take a long time, until a calf with the recessive phenotype was born.

STRUCTURES AND FUNCTIONS
Arrangements of the offspring alleles will vary according to the order of the parental alleles in the Punnett square. 1. 9/16 2. 1/4 3. 1/16 4. 1/16
Section 10-1

VOCABULARY REVIEW
1. A virulent strain of a bacterium is one that causes disease.
2. Transformation is the transfer of genetic material from one cell to another cell or from one organism to another organism.
3. A bacteriophage is a virus that infects bacteria.

MULTIPLE CHOICE
1. a 2. c 3. d 4. a 5. b

SHORT ANSWER
1. to show that live R cells are not virulent
2. to show that live S cells are virulent and can kill a mouse
3. to show that heat-killed S cells do not cause disease
4. to show that something in the heat-killed S culture was acting on the live R cells to kill the mouse; experiment 3 showed that it was not the killed S cells themselves that killed the mouse.
5. The slippery capsule prevents the cells of the defense system from capturing and destroying the bacterial cells.

STRUCTURES AND FUNCTIONS
1. Experiment 2
2. Experiment 1

Section 10-2

VOCABULARY REVIEW
1. A purine is a nitrogenous base with two rings of carbon and nitrogen atoms. Examples may include adenine or guanine.
2. A pyrimidine is a nitrogenous base with one ring of carbon and nitrogen atoms. Examples may include cytosine or thymine.
3. A complementary base pair is a pair of nitrogenous bases connected to each other by hydrogen bonds. Examples may include adenine-thymine and cytosine-guanine.
4. A nitrogenous base is a base in DNA containing nitrogen and carbon.

MULTIPLE CHOICE
1. c 2. d 3. a 4. b 5. b

SHORT ANSWER
1. The three parts are a deoxyribose sugar, a phosphate group, and a nitrogenous base. The phosphate group and the base are connected to different parts of the sugar.
2. Since guanine and cytosine are complementary, another 15% of the nucleotides must contain cytosine. The remaining 70% of the nucleotides (100%−30%) must contain adenine and thymine in equal proportions (35% each), since they are complementary to each other.
3. Complementary base pairing is important because the hydrogen bonds between the bases hold the two strands of DNA together and because it serves as a way for DNA to replicate.
4. The X-ray diffraction photographs showed that the shape of the DNA molecule was a double helix.

STRUCTURES AND FUNCTIONS
a. deoxyribose; b. guanine; c. adenine; d. phosphate group

Section 10-3

VOCABULARY REVIEW
1. A replication fork is a Y-shaped region that results when the two strands of DNA separate during replication.
2. A helicase is an enzyme that separates the strands of DNA during replication.
3. Semi-conservative replication produces a new DNA molecule with one original strand and one new strand.

MULTIPLE CHOICE
1. b 2. a 3. b 4. d 5. c

SHORT ANSWER
1. Replication occurs simultaneously at many origins along the DNA.
2. Producing exact copies ensures that when a cell divides, the offsprings cells will receive the same genetic information as the parent cell.
3. Cancer can result when errors occur in the replication of DNA in genes that control how a cell divides. A mass of cancerous cells called a tumor can result.
4. The hydrogen bonds break easily, making it easier for the two strands in the molecule to separate during replication. The strong covalent bonds ensure that the sequence of nucleotides remains fixed in each strand.

STRUCTURES AND FUNCTIONS
Part a: helicase enzymes separate DNA strands;
Part b: DNA polymerase enzymes add complementary nucleotides to each original strand of DNA and covalent bonds form between adjacent nucleotides;
Part c: DNA polymerases finish replicating DNA and fall off, two DNA molecules identical to original DNA molecule have formed.

Section 10-4

VOCABULARY REVIEW
1. A codon is a sequence of three mRNA nucleotides that codes for a specific amino acid or a start or stop signal.
2. Translation is the process of assembling polypeptides from information encoded in mRNA.
3. An anticodon is a sequence of three tRNA nucleotides that pairs with a specific codon.

MULTIPLE CHOICE
1. a 2. d 3. b 4. b 5. b

SHORT ANSWER
1. The anticodons are UAC, GUA, CGU, and UCA. (The last three nucleotides in the mRNA sequence are a stop codon, which has no anticodon.) The polypeptide will initially contain four amino acids.
2. The tRNA that pairs with the start codon on mRNA carries methionine.
3. RNA contains ribose; DNA contains deoxyribose. RNA usually contains uracil in place of thymine. RNA is single stranded; DNA is double stranded.
4. All of the codons from the deletion point to the end of the transcript would be shifted by one nucleotide, so the sequence of amino acids specified from that point on would be different. Translation would terminate prematurely if the shift resulted in a new stop codon before the end of the transcript.
A proto-oncogene is a gene that regulates cell growth, cell division, and the ability of cells to adhere to one another. An oncogene, formed when a proto-oncogene mutates, causes uncontrolled cell division.

Section 11-1

**VOCABULARY REVIEW**

1. A regulator gene is a prokaryotic gene that codes for the production of a repressor protein, which inhibits the transcription of one or more structural genes.
2. An operator is a DNA segment that controls the access of RNA polymerase to the promoter. An operon is the DNA segment that contains an operator, promoter, and structural genes.
3. An intron is a section of a structural gene that is transcribed but not translated. An exon is a section of a structural gene that is transcribed and translated.
4. A transcription factor is a protein that facilitates gene transcription by binding to RNA polymerase and to an enhancer.

**MULTIPLE CHOICE**

1. c
2. d
3. a
4. b
5. d

**SHORT ANSWER**

1. An operon is a series of genes that code for specific products and the regulatory elements that control those genes. Operons have been found mostly in prokaryotes.
2. Lactose binds to the repressor protein, which causes the repressor protein to be released from the operator site. This permits the RNA polymerase to transcribe the structural genes.
3. In the absence of lactose, the repressor protein binds to the operator site; this inhibits the RNA polymerase from transcribing the structural genes.
4. Without a nuclear envelope, there is no structure to segregate newly synthesized RNA from ribosomes. Therefore, ribosomes can begin to translate the RNA as soon as it is formed, before it has had a chance to be modified.

**STRUCTURES AND FUNCTIONS**

1. a, regulator gene; b, lactose, or inducer; c, repressor protein; d, promoter; e, operator.
2. If the regulator gene were deleted then the repressor protein could no longer be produced. Without a repressor protein at the operator site, RNA polymerase would transcribe structural genes continuously.
3. Transcription is activated because the lactose molecule has bound to the repressor protein. This causes the repressor protein to release from the operator site, which then permits RNA polymerase to transcribe the structural genes.

Section 11-2

**VOCABULARY REVIEW**

1. A homeotic gene is a regulatory gene that determines where anatomical structures will form. A homeobox is a specific nucleotide sequence within a homeotic gene that regulates patterns of development.
2. A proto-oncogene is a gene that regulates cell growth, cell division, and the ability of cells to adhere to one another. An oncogene, formed when a proto-oncogene mutates, causes uncontrolled cell division.
3. A sarcoma is a cancer of bone or muscle tissue; a lymphoma is a cancer of the tissues that form blood cells.
4. An oncogene causes uncontrolled cell proliferation; a tumor-suppressor gene prevents it.

**MULTIPLE CHOICE**

1. a
2. d
3. a
4. b
5. d

**SHORT ANSWER**

1. Homeotic genes code for regulatory proteins that are thought to control the rate of cell division in various body areas by switching genes on or off. These variations in cell division produce specific patterns of structural development.
2. Factors include the person’s age, number of exposures to carcinogens, amount of carcinogen in each exposure, and possibly a genetic predisposition to certain types of cancer.
3. Viruses can introduce oncogenes into a host cell, activate the host cell’s own oncogenes, or cause mutations in the host cell’s proto-oncogenes or tumor-suppressor genes.
4. Two key characteristics of cancer cells include uncontrolled growth and metastasis.
5. Cancer is a disease in which cells grow and undergo mitosis at an abnormally high rate. If the genes that control the cell cycle and the mechanism of that control were better understood, the causes of cancer would also be better understood. Perhaps cancer could be slowed or cured if the cell cycle of cancerous cells could be modified.

**STRUCTURES AND FUNCTIONS**

left box, regulate cell growth; middle box, cancer; right box, prevention of uncontrolled cell division

Section 12-1

**VOCABULARY REVIEW**

1. A sex chromosome contains genes that determine an individual’s sex. An autosome is a chromosome that is not directly involved in determining sex.
2. A germ-cell mutation occurs in one of an organism’s gametes; a somatic-cell mutation occurs in one of the other cells in an organism’s body.
3. Translocation occurs when a chromosome piece breaks off and attaches to a nonhomologous chromosome; nondisjunction occurs when homologues fail to separate during meiosis, so that one gamete receives both homologues.
4. A deletion is a loss of a piece of chromosome due to breakage. An inversion occurs when a broken piece of chromosome is reattached backwards.
5. In a substitution, one nucleotide in a codon is replaced with a different one; in a frameshift mutation, the loss or addition of a nucleotide causes the remaining codons to be incorrectly grouped.

**MULTIPLE CHOICE**

1. b
2. a
3. c
4. d
5. a

**SHORT ANSWER**

1. The male parent determines the offspring’s sex. Offspring that receive an X chromosome from the male parent will be female; those that receive a Y chromosome will be male.
2. Morgan crossed a white-eyed male with a female homozygous for red eyes, and then crossed members of the F₁ generation resulting from the first cross. He found that all of the white-eyed flies in the F₂ generation were male.
3. Crossing-over during meiosis causes homologous chromosomes to exchange alleles, resulting in new combinations of alleles in the offspring.
4. A frameshift mutation would have a more serious effect if it occurred near the beginning of a gene, since it would change nearly all of the codons in the gene. The resulting protein likely would be nonfunctional.

**STRUCTURES AND FUNCTIONS**
white eyes (map unit number 1), vermillion eyes (31), miniature wings (34)

**Section 12-2**

**VOCABULARY REVIEW**
1. skin color, eye color, height, or hair color
2. ABO blood groups
3. Huntington's disease
4. pattern baldness
5. wavy hair

**MULTIPLE CHOICE**
1. d 2. c 3. d 4. a 5. b

**SHORT ANSWER**
1. Pattern baldness is controlled by the allele B. Testosterone interacts with the heterozygous genotype (BB′) to produce baldness. Since males have higher levels of testosterone, BB′ males are more likely to lose their hair than BB females.
2. A small sample is removed from the amniotic fluid surrounding the fetus or from the chorionic villi between the uterus and the placenta. Fetal cells in the sample are used to construct a karyotype, which may reveal chromosomal abnormalities.
3. A sex-influenced trait is influenced by the presence of sex hormones and its genes are not located on sex chromosomes, while a sex-linked trait is linked to a sex chromosome.
4. Children: type A, I⁺i; type B, I⁺i; type AB, I⁺I⁺i; type O, ii. One parent is type A, I⁺i; the other parent is type B, I⁺i.

**STRUCTURES AND FUNCTIONS**
X-linked recessive trait: one filled square, one open square, one half-filled circle, and one open circle.
Autosomal recessive trait: one half-filled square, one open square, one half-filled circle, and one open circle.

**Section 13-1**

**VOCABULARY REVIEW**
1. A DNA fingerprint is a pattern of bands on a photographic film, where the bands represent specific fragments from an individual's DNA.
2. Gel electrophoresis is a technique in which nucleic acids or proteins are separated according to size and charge as they migrate through a gel.
3. A probe is a radioactive segment of single-stranded DNA that is complementary to DNA fragments that have been selected for comparison.
4. A primer is a single-stranded sequence of DNA required for the initiation of replication in PCR.

**MULTIPLE CHOICE**
1. d 2. c 3. b 4. c 5. b

**SHORT ANSWER**
1. Radioactive probes bind to specific fragments in a DNA sample such as a donor gene. A probe can identify which bacteria contain recombinant DNA.
2. When only a very small amount of DNA is available, PCR can be used to produce enough copies of the DNA to make a DNA fingerprint.
3. Since each restriction enzyme recognizes a specific DNA sequence, only those DNA pieces that have been produced by the same restriction enzyme will have complementary sticky ends.
4. Answers could include: identifying human remains, determining a person's paternity, tracing human origins, provide evidence in criminal cases, improve food crops, determine susceptibility to genetic diseases, and provide treatments or cures for genetic disorders.

**STRUCTURES AND FUNCTIONS**
a, human gene; b, restriction enzyme; c, sticky ends; d, plasmid; e, recombinant DNA; f, recombinant bacterium

**Section 13-2**

**VOCABULARY REVIEW**
1. Proteomics is the study of all of an organism's proteins, including their identities, structures, interactions, and abundances.
2. Bioinformatics is the use of computers to investigate biological questions.
3. The 8 million SNPs in the human genome are unique spots where individuals differ by a single nucleotide.
4. The Human Genome Project is a research effort to sequence the entire human genome and locate all of the functionally important sequences.

**MULTIPLE CHOICE**
1. d 2. a 3. d 4. d 5. b

**SHORT ANSWER**
1. They wanted to learn the location of all the important genes in the genome in order to learn how the genome is organized, how gene expression and cell growth are controlled, and about human evolution.
2. Answers should include three of the following: Only about 2 percent of the human genome encodes proteins. Exons are not distributed equally on chromosomes. The human genome contains only about 30,000 to 40,000 genes. Exons are spliced to allow a gene to encode different proteins. Half the human genome arises from the shuffling of transposons. There are about 8 million SNPs.
3. It is the proteins, not the DNA, that carry out the work of cells. Scientists must understand proteins and how they work if they are to understand how genes work.

**STRUCTURES AND FUNCTIONS**
1. The more complex organisms generally have larger genomes than less complex organisms, but there are many exceptions.
2. If the genome is larger than expected for the number of genes, there might be large amounts of non-coding DNA present. If the genome is smaller than
expected for the number of genes, the size of the organism's proteins may be small, requiring fewer nucleotides.

**Section 13-3**

**VOCABULARY REVIEW**

1. A DNA vaccine is a vaccine that is made from the DNA of a pathogen but does not have disease-causing capability.
2. A telomere is a repeated DNA sequence at the end of a chromosome that shortens with each cell division.
3. Bioethics is the study of ethical issues related to DNA technology.
4. In gene therapy, a genetic disorder is treated by introducing a normally functioning gene into a patient’s cells.

**MULTIPLE CHOICE**

1. c 2. a 3. d 4. b 5. a 6. a

**SHORT ANSWER**

1. A DNA vaccine contains DNA from a pathogen but cannot cause disease. When the vaccine is injected into a patient, the DNA directs the synthesis of a protein. Antibodies are produced by the body against the protein. If the patient contracts the disease in the future, the antibodies in his or her body will be able to provide protection.
2. Dolly suffered from premature aging and disease, possibly because the nucleus that produced her had chromosomes with shortened telomeres.
3. Although a normal gene is introduced into a patient’s surface cells in the lung, these cells are not the ones that need to produce the highest levels of the missing transport protein. The virus carrying the normal gene cannot reach the deep lung cells where the normal gene is most needed.
4. Sample answer: Engineered traits such as herbicide resistance could transfer to weeds and create “superweeds.”
5. Acceptable answers could include making plants that carry out photosynthesis at a higher rate, produce greater yields with less water or in warmer or colder climates, and produce crops that have a greater nutritional value, taste better, or look more appealing.

**STRUCTURES AND FUNCTIONS**

a and b: acceptable answers include medicines and organs that do not trigger rejection when transplanted into humans. Answers c, d, and e may include pest-resistant crops, herbicide-resistant crops, disease-resistant crops, and rice with higher nutritional value.

**Section 14-1**

**VOCABULARY REVIEW**

1. Biogenesis is the principle that all living things come from other living things.
2. Spontaneous generation is the supposed origin of living things from nonliving things.
3. Vital force was the force that according to supporters of spontaneous generation, caused life to appear spontaneously.

**MULTIPLE CHOICE**

1. b 2. c 3. a 4. b 5. c

**SHORT ANSWER**

1. Observations with the microscope revealed the existence of microorganisms that are simple in structure, numerous, and widespread. Investigators of that time concluded that microorganisms arise spontaneously from a “vital force” in the air.
2. Spallanzani reasoned that boiling the broth would kill all of the microorganisms in the broth, on the inside of the glass, and in the air inside the flask.
3. Instead of sealing the flask in the experimental group after boiling, Pasteur used a flask with a curved neck, which allowed air inside and outside the flask to mix but prevented microorganisms from entering the body of the flask.
4. Pasteur’s experiment permitted air from the outside to mix with air from the inside, which would have allowed any “vital force” to enter and cause the broth to become cloudy if there were such a “vital force.”
5. Believers in spontaneous generation could have argued that the meat Redi used was somehow unable to develop into maggots, regardless of whether flies were present or absent. The control group showed that this was not the case.

**STRUCTURES AND FUNCTIONS**

Control group: c, e, a. Experimental group, c, b, d.

**Section 14-2**

**VOCABULARY REVIEW**

1. A radioactive isotope is an isotope whose nucleus tends to release particles, radiant energy, or both; radioactive dating is a technique for determining the age of a material by measuring the amount of a particular radioactive isotope the material contains.
2. The release of particles, radiant energy, or both by a radioactive isotope is called radioactive decay; half-life is the time it takes for one-half of any size sample of a particular isotope to decay.
3. A microsphere is a spherical collection of many protein molecules organized as a membrane; a coacervate is a collection of droplets that are composed of different types of molecules, including amino acids and sugars. Both structures are cellular-like and form spontaneously in the laboratory from simple organic molecules.

**MULTIPLE CHOICE**

1. d 2. c 3. b 4. a 5. a

**SHORT ANSWER**

1. Isotopes with short half-lives are most useful for dating relatively young rocks, while those with long half-lives are most useful for dating older rocks.
2. Some scientists think that the atmosphere of early Earth contained large amounts of CO₂, a gas that interferes with the production of organic compounds in laboratory simulations of proposed early-Earth conditions.
3. Their discovery showed that some aspects of cellular life can arise without direction from genes.
4. No, this method estimates the age of the oldest unmelted surface rocks on Earth. Since the surface of Earth probably melted many times as the planet was formed, the Earth should be older than these rocks.

**STRUCTURES AND FUNCTIONS**

An isotope content of 1/16 will occur after four half-lives; 4 × 75,000 years = 300,000 years.
**Section 14-3**

**VOCABULARY REVIEW**

1. A ribozyme is an RNA molecule that can act as an enzyme.
2. Chemosynthesis is the synthesis of organic compounds using energy contained in inorganic molecules.
3. Cyanobacteria are a group of photosynthetic unicellular prokaryotes.
4. Endosymbiosis is the mutually beneficial relationship that is hypothesized to have existed between large prokaryotes and the smaller prokaryotes that invaded them and eventually gave rise to mitochondria and chloroplasts.

**MULTIPLE CHOICE**

1. a  2. d  3. c  4. b  5. d

**SHORT ANSWER**

1. Each RNA molecule might have competed with slightly different RNA molecules for nucleotides. An RNA molecule that was more successful in getting nucleotides would have an advantage, and it would pass that advantage on to the new RNA molecules it created by replicating.
2. Ultraviolet radiation from the sun damages DNA, but the development of the ozone layer in the upper atmosphere prevented much of this radiation from reaching the surface of Earth, allowing life to exist on land.
3. Both organelles replicate independently of the cell, have circular DNA like that in prokaryotes, and contain genes that are different from those of the rest of the cell.
4. The pre-eukaryotic cells would have received protection from the damaging effects of oxygen, obtained the energy-containing products of aerobic respiration, and been able to harness the energy in sunlight. The small prokaryotes may have experienced a more stable environment inside the larger cell.

**STRUCTURES AND FUNCTIONS**

a, photosynthetic eukaryotes; b, aerobic eukaryotes; c, photosynthetic prokaryotes; d, chemosynthetic prokaryotes; e, heterotrophic prokaryotes

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**Section 15-1**

**VOCABULARY REVIEW**

1. Evolution is the development of new types of organisms from preexisting types of organisms over time.
2. Natural selection is a process in which organisms best suited to their environment reproduce more successfully than other organisms.

**MULTIPLE CHOICE**

1. d  2. c  3. a  4. d  5. c

**SHORT ANSWER**

1. Since acquired traits are not genetically determined, they cannot be passed on to offspring. Therefore, they cannot cause a population to change over generations.
2. Darwin extended Malthus’ ideas to populations of all organisms and reasoned that the environment limits the populations of all organisms by causing deaths or limiting births.

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**Section 15-2**

**VOCABULARY REVIEW**

1. A homologous structure is an anatomical structure that occurs in different species and originated by heredity from a structure in a common ancestor; analogous structures have closely related functions but are not derived from the same ancestral structure.
2. A fossil is the evidence or remains of a preexisting organism; the principle of superposition states that if a sequence of sedimentary rock strata have been undisturbed, the oldest strata will be at the bottom of the sequence and younger strata will be on top. The relative age of the strata is usually determined by comparing the fossils contained in the strata.
3. The relative age of a fossil or rock is simply an indication of whether the fossil or rock is younger or older than another fossil or rock; the absolute age of a rock is the rock’s age in years.

**MULTIPLE CHOICE**

1. b  2. c  3. b  4. a  5. a

**SHORT ANSWER**

1. A biologist would concentrate on homologous features, since they originated in a shared ancestor.
2. The animal evolved from an ancestor in which that structure was functional.
3. In biogeography studies, similar animals that seem to be closely related are adapted to different environments in nearby areas. Also, in areas that are widely separated animals that seem to be unrelated are observed to have similar adaptations to similar environments in the separate areas.
4. Fossils show that a group of organisms, such as marine mammals, have changed over time to adapt to different environments.
5. The environment will not select for or against organisms that have a particular structure unless that structure affects the organisms’ fitness.

**STRUCTURES AND FUNCTIONS**

a, youngest fossil; b, mammal fossils; c, first dinosaurs; d, first land plants; e, trilobites; f, oldest fossil

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**Section 15-3**

**VOCABULARY REVIEW**

1. the evolution of Caribbean anole lizards
2. Examples may include different breeds of dogs, cats, cattle, or food crops.
3. some flowers and insects; animals and microbes
4. the evolution of Caribbean anole lizards with similar adaptations on separate islands
5. Two examples are the evolution of the Galápagos finches and the evolution of domestic dogs.
6. evolution of resistance to pesticides by insect populations, of plants to herbicides, and evolution of resistance to antibiotics by disease-causing bacteria

**MULTIPLE CHOICE**
1. b 2. c 3. a 4. d 5. a

**SHORT ANSWER**
1. Adaptive radiation occurs when a new population in a new environment, such as an island, undergoes divergent evolution until the descendant populations fill many parts of the environment.
2. Answer will vary, but could include the lizards moving to an area where the trees are still healthy, or they could adapt to live in another part of the environment, such as living in small shrubs or on the ground. The lizards could also go extinct if they could not move to another area or adapt to the new environment.
3. Answers will vary, but could include domestic dogs, domestic cats, cattle, sheep, and pigs for animals and corn, wheat, fruit trees, such as apples or oranges, and flowers, such as roses or orchids.
4. The long-lived species would be more likely to become extinct after a sudden environmental change. The short-lived species, with large numbers of offspring, would be more likely to adapt to the changing environment. The short-lived species can adapt more easily because of the larger pool of genetic variations available in the larger population.

**STRUCTURES AND FUNCTIONS**
divergent evolution; approximately 16 million years ago; the galago

### Section 16-1

**VOCABULARY REVIEW**
1. Population genetics is the study of evolution from a genetic point of view.
2. A gene pool is the total genetic information available in a population.
3. Allele frequency is the frequency of a certain allele among all alleles of the same gene in a population.
4. Phenotype frequency is the frequency of individuals with a particular phenotype in a population.
5. Hardy-Weinberg genetic equilibrium is a condition in which the allele frequencies in a population remain the same from generation to generation.

**MULTIPLE CHOICE**
1. b 2. c 3. b 4. d 5. a

**SHORT ANSWER**
1. Individuals represented by the two ends are those with extreme variations of a specific trait.
2. Variations arise through mutation, recombination during meiosis, and the random pairing of gametes during fertilization.

3. (1) No net mutations occur; (2) individuals neither enter nor leave the population; (3) the population is large; (4) individuals mate randomly; and (5) selection does not occur.
4. no, because those genes are not available for the next generation

**STRUCTURES AND FUNCTIONS**
Phenotype frequencies: red = 0.625 × 0.625 = 0.391; white = 0.375 × 0.375 = 0.141; pink = 1 – 0.391 – 0.141 = 0.468. Allele frequencies: \( R = 0.391 + (0.468 \div 2) = 0.625 \); \( r = 0.141 + (0.468 \div 2) = 0.375 \).

### Section 16-2

**VOCABULARY REVIEW**
1. Immigration is the movement of individuals into a population. Emigration is the movement of individuals out of a population.
2. Gene flow is the movement of genes from one population to another. Genetic drift is a change in allele frequencies in a population due to random events.
3. Random mating is mating that occurs without regard to genetic makeup. Assortative mating is mating based on similarity of characteristics.
4. In stabilizing selection, individuals with the average form of a trait have the highest fitness. In directional selection, individuals with one extreme form of a trait have the highest fitness.

**MULTIPLE CHOICE**
1. c 2. d 3. a 4. c 5. b

**SHORT ANSWER**
1. mutations, gene flow, genetic drift, nonrandom mating, and natural selection
2. By producing totally new alleles for a trait, mutations can change allele frequencies.
3. Matings with some degree of kinship may occur, increasing the chance of offspring with disorders caused by recessive genes.
4. The bright coloration may increase a male's chances of being selected for mating by a female.
5. Genetic homozygosity leaves no variation for natural selection to act on. Therefore, a new disease could wipe out the entire population.

6. directional selection; the cow would not eliminate all white flowers because the allele for white flowers is also carried by plants with pink flowers, which are not eaten. Crosses between plants with pink flowers would continue to produce some plants with white flowers.

**STRUCTURES AND FUNCTIONS**
a, disruptive; b, directional; c, stabilizing

### Section 16-3

**VOCABULARY REVIEW**
1. Morphology is the internal and external structure and appearance of an organism.
2. Geographic isolation is the physical separation of members of a population.
3. Punctuated equilibrium is a pattern of species formation in which periods of sudden speciation are preceded and followed by long periods with little speciation.

**MULTIPLE CHOICE**
1. d 2. a 3. b 4. c 5. b
SHORT ANSWER
1. A satisfactory definition is not provided for species of extinct organisms or for organisms that do not reproduce sexually.
2. Individuals do not waste gametes by producing offspring that cannot reproduce.
3. Some species of moths on the Hawaiian Islands appear to have evolved during the past thousand years, whereas speciation in other organisms may take millions of years. The fossil record shows that periods of a few thousand years during which many species appeared were separated by much longer periods during which there was little speciation.
4. If the peninsulas become islands, the species that live there could become geographically isolated and eventually evolve into different species.

STRUCTURES AND FUNCTIONS
They may have other barriers to mating, such as geographic isolation, postzygotic isolation, and prezygotic isolation (they may not recognize one another’s mating call).

Section 17-1
VOCABULARY REVIEW
1. Taxonomy is the science of describing, naming, and classifying organisms. A taxon is any particular group within a taxonomic system.
2. A kingdom is the largest category in Linnaeus’s system of classifying life. A species is the smallest category in the system, containing only a single organism type.
3. A phylum is the largest subset within the animal kingdom of Linnaeus. A division is the largest subset within the plant kingdom.
4. A species name is the two-part scientific name of an organism. The species identifier is the second part of an organism’s scientific name.
5. A species is the smallest taxonomic group, containing only a single kind of organism. Subspecies are animals that belong to the same species but live in different areas.

MULTIPLE CHOICE
1. c 2. b 3. a 4. d 5. c

SHORT ANSWER
1. Sample answers: Both systems divided all living things into two main groups, animals and plants, but Aristotle’s system had three sublevels each for animals and plants, whereas Linnaeus’s system had six sublevels. Aristotle also divided animals on the basis of habitat and plants on the basis of stem differences, whereas Linnaeus divided all organisms mainly on the basis of morphology. Aristotle used common names for organisms, whereas Linnaeus used binomial nomenclature.
2. Scientists use binomial nomenclature, a system in which each organism is identified with two names, the genus and the species identifier.
3. Modern taxonomists consider the evolutionary history of an organism when classifying the organism; Linnaeus considered mainly the organism’s morphology.
4. Answers will vary. Aristotle’s division of the animal kingdom into land, water, and air dwellers does not describe accurate morphological or evolutionary relationships among animals.

For example, bats and birds are air dwellers, and whales and fish are water dwellers, but bats are more closely related to whales than to birds, and whales are more closely related to bats than to fish.

STRUCTURES AND FUNCTIONS
a. species; b. genus; c. family; d. order; e. class; f. phylum or division; g. domain

Section 17-2
VOCABULARY REVIEW
1. Systematics is the branch of biology that organizes living things in the context of their natural relationships.
2. A phylogenetic diagram is a diagram that uses a branching pattern to indicate how closely related a subset of taxa are thought to be.
3. Cladistics is a system of phylogenetic analysis in which shared and derived characters of organisms are used to group taxa.

MULTIPLE CHOICE
1. d 2. b 3. c 4. a 5. b

SHORT ANSWER
1. Types of evidence include the morphology of fossil and living species, patterns of embryological development, and comparisons of chromosomes and macromolecules, such as DNA and RNA.
2. An out-group in cladistic analysis is a group of organisms that is only distantly related to the other organisms being analyzed. The out-group provides a starting point for the comparisons with the other organisms.
3. A derived character is found only among members of a particular group. Therefore, cladistic taxonomists assume that the character evolved within that group and that all of the organisms in the group have a common ancestor.
4. Sample answer: The fossil organism thought to be the common ancestor could have been on another branch of the phylogenetic diagram, sharing an earlier ancestor with both modern species. The changes in the protein’s amino acid sequence may have been nonrandom, affected by natural selection, or produced at a greater-than-normal rate.

STRUCTURES AND FUNCTIONS
1. 3 and 4; 2. D; 3. G

Section 17-3
VOCABULARY REVIEW
1. prokaryotic, unicellular, both
2. prokaryotic, unicellular, both
3. eukaryotic, both, both
4. eukaryotic, both, heterotrophy
5. eukaryotic, multicellular, autotrophy (rarely heterotrophy)
6. eukaryotic, multicellular, heterotrophy

MULTIPLE CHOICE
1. b 2. c 3. a 4. c 5. d 6. b

SHORT ANSWER
1. Archaeabacteria can flourish in harsh environments, such as sulfurous hot springs and very salty lakes, where eubacteria cannot. Also their cell membranes and biochemical and genetic properties are different from those of eubacteria.
2. Fungi include some unicellular forms, but plants do not; most plants are autotrophic, but all fungi are heterotrophic. Fungi have cell walls made of chitin, while plant cell walls are made of cellulose.

3. Multicellular heterotrophic organisms are included in kingdoms Protista, Fungi, Plantae, and Animalia.

4. Differences in rRNA sequences suggest that all organisms can be divided into three broad groups.

5. Other characteristics, such as the presence or absence of a nucleus and the type of nutrition, are more useful for understanding phylogenetic relationships. This system would place some organisms in the same group even though they are very different with regard to these characteristics.

**STRUCTURES AND FUNCTIONS**

**Section 18-1**

**VOCABULARY REVIEW**

1. Ecology is the study of the interactions between organisms and the living and nonliving components of their environment.

2. Interdependence in an ecosystem occurs because all organisms interact with other organisms and the abiotic portions of the environment, and their survival depends on these interactions.

3. The biosphere is the thin volume of Earth and its atmosphere that supports life.

4. An ecosystem is a component of the biosphere that includes all of the organisms and the nonliving environment found in a particular place.

5. A community includes all interacting organisms living in an area.

6. A population is a group within a community that includes all the members of a species that live in one place at one time.

**MULTIPLE CHOICE**

- 1. b 2. c 3. d 4. a

**SHORT ANSWER**

1. When more acorns are produced by oak trees the populations of mice and deer that eat acorns increase. This causes an increase in the population of ticks that feed on these animals. The ticks carry the bacterium that causes Lyme disease, therefore human cases of the disease may also increase.

2. The applications of ecological models are limited because the models are normally very simple and do not accurately reflect the complex nature of real ecosystems.

3. A population consists of all members of a single species that live in an area, whereas a community consists of all organisms of any species that live in an area.

4. Since plants consume CO2 during photosynthesis, extensive deforestation could result in a rise in atmospheric CO2 levels, contributing to a change in the environment.

**STRUCTURES AND FUNCTIONS**

- from left to right top row: 3, community; 5, organism; 1, biosphere; bottom row: 4, population; and 2, ecosystem

**Section 18-2**

**VOCABULARY REVIEW**

1. A habitat is the place where an organism lives. A resource is one of the materials or the energy an organism needs to survive.

2. A biotic factor is a living component of the environment that influences an organism. An abiotic factor is a nonliving physical or chemical characteristic of the environment that influences an organism.

3. A conformer is an organism whose internal conditions change as the environment changes. A regulator is an organism that uses energy to keep its internal conditions within an optimal range as the environment changes.

4. Dormancy is a long-term strategy to escape unfavorable environmental conditions by an organism that involves a period of reduced activity. Migration is also a strategy for escaping unfavorable conditions, but it involves organisms moving to a more favorable habitat.

5. A generalist is a species with a broad niche. A specialist is a species with a narrow niche.

**MULTIPLE CHOICE**

- 1. d 2. a 3. c 4. b 5. a

**SHORT ANSWER**

1. Abiotic factors include temperature, humidity, pH, salinity, O2 concentration, amount of sunlight, availability of nitrogen, and precipitation. Temperature may influence humidity and precipitation. Precipitation may influence pH, nitrogen availability, and salinity.

2. Dormancy during the period of unfavorable conditions and migration to a more favorable habitat

3. The opossum feeds on almost anything, while the koala feeds only on the leaves of a few species of eucalyptus trees.

4. The habitat is where an organism lives, but its niche is how that organism interacts in its habitat and with other organisms within the habitat.

5. Pesticides could be developed that make those limits narrower, environmental conditions could be altered (e.g., through refrigeration or desiccation) so that they lie outside those limits, or human activities could be modified to occur when or where conditions lie outside those limits.

**STRUCTURES AND FUNCTIONS**

- a, regulator (any mammal or bird); b, conformer (any other organism)

**Section 18-3**

**VOCABULARY REVIEW**

1. A producer is an autotroph; a consumer is a heterotroph.

2. Gross primary productivity is the rate at which producers in an ecosystem capture energy. Net primary productivity is the rate at which this energy is used to produce organic material.

3. A food chain is a single pathway of feeding relationships among organisms in an ecosystem that results in energy transfer. A food web is a feeding relationship consisting of interlinked food chains.

**MULTIPLE CHOICE**

- 1. c 2. b 3. a 4. d 5. b
Section 18-4

VOCABULARY REVIEW
1. All three are biogeochemical cycles that involve the movement of water, carbon, and nitrogen, respectively, between the living and nonliving parts of an ecosystem.
2. All three are parts of the nitrogen cycle; nitrogen fixation converts nitrogen gas into ammonia, nitrification converts ammonia into nitrites and nitrates, and denitrification converts nitrates back into nitrogen gas.

MULTIPLE CHOICE
1. b 2. a 3. d 4. c 5. b

SHORT ANSWER
1. Precipitation removes water from the atmosphere, and transpiration and evaporation return water to the atmosphere.
2. Autotrophs take CO₂ from the environment and incorporate it into organic compounds during photosynthesis; both autotrophs and heterotrophs release CO₂ from organic compounds during cellular respiration; and decomposers also release CO₂.
3. Nitrogen-fixing bacteria are found in the soil and in the roots of some kinds of plants. These bacteria convert nitrogen gas into a form which plants can absorb and use to make proteins.
4. The crop plants absorb much of the nitrogen from the soil and incorporate it into organic compounds. When the plants are harvested and removed from the field, the nitrogen leaves with them. Some of the nitrogen returns to the atmosphere through denitrification.

STRUCTURES AND FUNCTIONS
a. precipitation; b. transpiration; c. photosynthesis; d. cellular respiration; e. nitrogen fixation; f. denitrification

Section 19-2

VOCABULARY REVIEW
1. Growth rate is the amount by which a population’s size changes in a given time; it is equal to the birth rate minus the death rate.
2. Exponential growth is a phenomenon in which a population grows more rapidly as it becomes larger; a limiting factor in the environment ultimately restrains population growth.

MULTIPLE CHOICE
1. b 2. a 3. c 4. d 5. a

SHORT ANSWER
1. Birth rate = 4 million/265 million = 0.015; death rate = 2.4 million/265 million = 0.009; growth rate = 0.015 – 0.009 = 0.006.
2. Elton found that both hare and lynx populations underwent regular cycles, with peaks in the lynx population usually following those in the hare population by a year or two. Other evidence showed that hare populations underwent the same cycles on islands without lynxes.
3. Inbreeding can reduce the number of offspring produced, increase susceptibility to disease, decrease genetic variability, and reduce a population’s ability to adapt to changing environmental conditions.
4. Population after 1 year = 01.02 × 100,000,000 = 102,000,000; after 2 years = 01.02 × 102,000,000 = 104,040,000; after 3 years = 01.02 × 104,040,000 = 106,120,800; after 4 years = 01.02 × 106,120,800 = 108,243,216; after 5 years = 01.02 × 108,243,216 = 110,408,080.
Section 19-3
VOCABULARY REVIEW
1. The hunter-gatherer lifestyle is one in which humans obtain food by hunting animals and gathering roots, berries, nuts, shellfish, and fruits.
2. The agricultural revolution occurred about 10,000 to 12,000 years ago, when humans first domesticated animals and cultivated plants for food.
3. A developed country is a modern, industrialized country.
4. A developing country is one with a relatively low level of industrial activity and financial wealth.

MULTIPLE CHOICE
1. c  2. d  3. c  4. a  5. c

SHORT ANSWER
1. Agriculture greatly stabilized and increased the available food supply.
2. The death rate declined due to better sanitation and hygiene, control of disease, increased availability of food, and improved economic conditions.
3. Most developing countries are poor and have high population growth rates.
4. Improvements in health and hygiene in the world’s poorer countries caused mortality rates to drop. This caused the world population growth rate to increase.
5. This might happen in a country that is experiencing a high rate of immigration or emigration.

Section 20-1
VOCABULARY REVIEW
1. A predator is an organism that captures, kills, and consumes another individual, the prey.
2. A herbivore is an animal that eats plants. Some plants defend against herbivores by producing secondary compounds that are poisonous, irritating, or bad-tasting.
3. A parasite is an organism that feeds on another organism, known as the host.

MULTIPLE CHOICE
1. a  2. a  3. d  4. b  5. a

SHORT ANSWER
1. They protect plants from herbivores by making the plants poisonous, irritating, or bad-tasting.
2. The fundamental niche is the range of conditions that the species can potentially use. The realized niche is the part of the niche that the species actually used.
3. Ectoparasites live on their host but not inside the host; endoparasites live inside the host’s body.
4. When two species of finches are found living on the same island, they have different-sized beaks, allowing them to reduce competition by eating different food resources.

Section 20-2
VOCABULARY REVIEW
1. Species richness is the number of species in a community.
2. Primary succession is the development of a community in an area that has not supported life previously.
3. The species-area effect is a relationship in which larger areas usually contain more species than smaller areas do.

MULTIPLE CHOICE
1. a  2. b  3. a  4. b  5. b

SHORT ANSWER
1. Primary succession often proceeds very slowly because the area has not supported life previously and thus the minerals necessary for plant growth are unavailable.
2. In general, the closer a community is to the equator, the greater its species richness will be.
3. Because agricultural fields usually contain one species of crop plant, they have low community stability, and they are therefore more vulnerable to outbreaks of insect pests or disease.
4. Soil is needed for succession to take place. Winds and precipitation will remove most of the soil that forms on the slopes and carry it to the valley.

Section 21-1
VOCABULARY REVIEW
1. A biome is a very large terrestrial ecosystem that contains a number of smaller but related ecosystems within it.
2. The tundra is a cold and largely treeless biome that forms a continuous belt across northern North America, Europe, and Asia.
3. The taiga is a biome dominated by cone-bearing evergreen trees that stretches across northern Europe, Asia, and North America.
4. A savanna is a tropical or temperate grassland with scattered trees and shrubs found in Africa, South America, and Australia.
5. A canopy is a continuous layer formed by treetops in a tropical rain forest.

MULTIPLE CHOICE
1. d  2. a  3. b  4. c  5. b

SHORT ANSWER
1. The winters are long and bitterly cold; permafrost prevents tree roots from penetrating far into the soil; there is very little precipitation; the growing season is very short.
2. The actively growing part of the plant is at or below the ground, not at the tip of the stem.
3. Some trees of the savanna conserve water during the dry season by shedding their leaves; the above-ground parts of grasses often die during the dry season and regenerate after a period of rain.

4. Plants may open their stomata only at night, have sharp protective spines, and have a waxy coating on their leaves to reduce evaporation.

5. The taiga has a shorter growing season, less precipitation, and poorer soil than do temperate deciduous forests. These characteristics make the taiga less suitable for growing many crops.

6. As they grow, vines cling to other objects. This adaptation enables vines to reach higher levels in the rain forest, where there is more light.

STRUCTURES AND FUNCTIONS
a. tropical forest; b. tundra; c. temperate grassland; d. desert

de. The taiga less suitable for growing many crops.

Section 21-2

VOCABULARY REVIEW
1. The photic zone is the part of the ocean that receives sunlight. The aphotic zone is the deeper part of the ocean where sunlight cannot penetrate.

2. The neritic zone extends from the end of the intertidal zone over the continental shelf. The oceanic zone is the part of the ocean that extends beyond the continental shelf.

3. The pelagic zone is the open ocean. The benthic zone is the ocean bottom.


MULTIPLE CHOICE
1. c  2. a  3. b  4. c  5. d

SHORT ANSWER
1. Crabs burrow into the sand or mud; clams, mussels, and oysters retreat into their shells; sea anemones and sea stars cling to surfaces with a muscular disk or tube feet, respectively.

2. Plankton is consumed by many larger organisms, forming the base of many marine food chains.

3. The oceanic zone covers a vast area; thus, even though productivity per square meter is low, total productivity is high.

4. Producers near deep-sea vents obtain energy from hydrogen sulfide through chemosynthesis.

5. The nutrients would stimulate the growth of photosynthetic organisms, which would increase the concentration of organic matter in the lake, making the lake’s water murky. If the situation persisted, the organic matter would accumulate and the lake would eventually fill in and disappear.

STRUCTURES AND FUNCTIONS
a. oceanic zone; b. pelagic zone; c. benthic zone; d. photic zone; e. aphotic zone; f. neritic zone; g. intertidal zone

Section 22-1

VOCABULARY REVIEW
1. the variety of organisms in a given area
2. Species evenness is a measure of biodiversity that considers how many individuals belong to each species in a community.

3. Genetic diversity is the amount of genetic variation among the individuals in a population.

MULTIPLE CHOICE
1. b  2. d  3. a  4. c  5. b

SHORT ANSWER
1. The geosphere is Earth’s rocky interior from the solid crustal surface to the center of the planet. The hydrosphere is the portion of Earth that is water, and the atmosphere is the gaseous envelope that surrounds Earth. The biosphere is the part of Earth where life exists.

2. A population with a low genetic diversity could be more likely to be wiped out by a disease because the population has less genetic variation and therefore less chance of surviving the natural selection caused by the disease.

3. The greenhouse effect is a phenomenon in which atmospheric gases such as CO₂ trap reradiated heat from the Earth, much as the glass panes of a greenhouse retain heat within the greenhouse.

4. This type of storage preserves seeds so that the plants can be grown and tested in the future for their potential value, even if the natural habitats of the plants are destroyed.

STRUCTURES AND FUNCTIONS

Section 22-2

VOCABULARY REVIEW
1. Smog is air pollution which consists of water vapor mixed with chemicals.

2. Extinction is the death of all members of a species.

3. Keystone species are species that are critical to the functioning of an ecosystem.

4. A CFC is a chemical once widely used as a coolant and aerosol propellant that catalyzes the breakdown of ozone in the upper atmosphere.

MULTIPLE CHOICE
1. b  2. b  3. d  4. b  5. c

SHORT ANSWER
1. Acid precipitation is the result of air pollutants that combine with water vapor in the atmosphere to form acids, causing precipitation that is more acidic than normal.

2. Increased CO₂ in the atmosphere and global warming; increased use of resources to produce homes, schools, roads, and hospitals; decrease of fresh water availability; and an increase in wastes.

3. Sustainability is the ability to meet human needs in a way that will allow a human population to survive indefinitely.

4. A controlled experiment in which all other variables are held constant would be needed. A reduction in global CO₂ levels followed by a decrease in global temperatures would support the idea of cause-and-effect relationship.

STRUCTURES AND FUNCTIONS
a. use of chlorofluorocarbons; b. increased amounts of ultraviolet radiation reach the Earth’s surface; c. increased incidence of skin cancer in humans; d. increased levels of atmospheric CO₂; e. and f. changes in rainfall patterns, changes in soil moisture, changes in sea level, shifting of agricultural regions, disruption of natural ecosystems.
Section 22-3
VOCABULARY REVIEW
1. Conservation biology is a discipline that seeks to identify and maintain natural areas that retain a high biodiversity.
2. Restoration biology is a discipline that seeks to reverse major environmental damage and replace missing ecosystem components.

MULTIPLE CHOICE
1. b 2. c 3. a 4. b 5. c

SHORT ANSWER
1. A biodiversity hotspot is an area that contains an especially high density of unique but threatened or endangered species.
2. The winter and summer destinations of most migratory birds are not in the same country.
3. Ecotourism is tourism involving people who want to see intact ecosystems and their unique organisms. Income generated from ecotourism increases the value of natural ecosystems, thus providing an incentive for preserving biodiversity.
4. Actions include the drainage of land and the planting of melaleuca trees.
5. Answer will vary, but could include that restoring the Everglades will protect endangered species, such as the Florida panther, and restore the water flow needed by many organisms. The restoration will also protect groundwater resources needed by people, reduce invasive plant species, and restore the breeding grounds and the nurseries of many species.

STRUCTURES AND FUNCTIONS
a. wildlife refuges; b. migratory birds; c. the whooping crane; d. answers may vary and include careful study of the species to be reintroduced, regulation of hunting, and establishment of refuges; e. the Everglades; f. answers may vary and include eliminating some drainage canals, restoring the Kissimmee River to its original channel, cutting back stands of melaleuca trees, and purchasing lands for park protection.

Section 23-1
VOCABULARY REVIEW
1. A halophile lives in very high salt concentrations, and a thermoacidophile lives in extremely acidic, hot environments.
2. A bacillus is rod-shaped, a coccus is spherical, and a spirillum is spiral.
3. A streptococcus is a coccus that occurs in chains; a staphylococcus is a coccus that occurs in grape-like clusters.
4. A Gram-positive bacterium retains the Gram stain and appears purple; a Gram-negative bacterium does not retain the Gram stain and takes up a second pink stain.

MULTIPLE CHOICE
1. c 2. b 3. d 4. c 5. d

SHORT ANSWER
1. Bacteria with large amounts of peptidoglycan in the cell wall are able to retain the Gram stain, while those with less peptidoglycan do not.
2. They convert atmospheric nitrogen to ammonia, which plants can use.
3. Cyanobacteria produce much of Earth’s oxygen; some species fix atmospheric nitrogen.
4. Some bacteria cause disease; others make vitamin K and help in digestion.
5. Aerobic organisms require the presence of oxygen, which was first generated by cyanobacteria as a waste product of photosynthesis.
6. These explorations revealed the existence of archaea. Because some archaeal genes resemble bacterial genes while other archaeal genes resemble eukaryotic genes, some biologists think that archaea may resemble ancestral eukaryotes.

Section 23-2
VOCABULARY REVIEW
1. A capsule is an outer covering of polysaccharides made by many bacteria; an endospore is a dormant structure consisting of a thick outer covering that surrounds a bacterial cell’s DNA.
2. A pilus is a short, hairlike protein structure that extends from the cell surface of some bacteria; conjugation is a process during which DNA is transferred from one cell to another through a pilus.
3. An obligate anaerobe cannot survive in the presence of oxygen; a facultative anaerobe can live with or without oxygen.
4. Transformation is a process by which bacteria obtain DNA from its external environment; transduction is the transfer of DNA from one bacterium to another by a virus.

MULTIPLE CHOICE
1. c 2. b 3. a 4. c 5. a

SHORT ANSWER
1. Photosynthesis takes place in internal foldings of the cell membrane called thylakoids.
2. A glycocalyx is a fuzzy coating of sticky sugars that makes up the capsule of some bacteria. It enables bacteria to attach to the surface of host cells and tissues.
3. oxygen, temperature, pH
4. Transduction involves DNA transfer by viruses.
5. New cells are not produced, and the number of cells does not increase.

STRUCTURES AND FUNCTIONS
1. assists the cell in attaching to other surfaces and in genetic recombination
2. protects the cell and assists it in attaching to other surfaces
3. protects the cell and gives it shape
4. regulates the movement of materials into and out of the cell and contains important enzymes
5. carries genetic information
6. carries genes obtained through genetic recombination
7. moves the cell

Section 23-3
VOCABULARY REVIEW
1. Pathology is the scientific study of disease.
2. An exotoxin is a poison that is secreted into the environment by Gram-positive bacteria.
Section 24-1
VOCABULARY REVIEW
1. A virus is a nonliving particle composed of a nucleic acid and a protein or lipoprotein coat.
2. A capsid is the protein coat that surrounds the nucleic acid in a virus.
3. A retrovirus is a virus that contains RNA and the enzyme reverse transcriptase.
4. In the lytic cycle, a virus invades a host cell, produces new viruses, and kills the host cell, which releases the new viruses.
5. In the lysogenic cycle, a virus remains within a host cell for an extended period of time.

MULTIPLE CHOICE
1. d  2. c  3. b  4. c  5. d

SHORT ANSWER
1. sneezes, coughs, direct contact, and sexual contact
2. Diseases affecting nerves include botulism and tetanus; diseases affecting the intestine include salmonella food poisoning and cholera; and diseases affecting the skin include anthrax, Lyme disease, and staph infections.
3. inhibition of cell-wall synthesis and protein synthesis
4. Foods include buttermilk, sour cream, yogurt, ricotta and cheddar cheese, sauerkraut, and pickles.
5. Since broad-spectrum antibiotics affect a wide variety of organisms, they are likely to be more effective than specific antibiotics when the identity of the pathogen is unknown. If overused, however, they may cause several types of bacteria to develop resistance.

STRUCTURES AND FUNCTIONS
A. The bacteria are insensitive to A because bacterial growth around disk A is uninhibited.
B. The bacteria are moderately sensitive to B because some growth inhibition is occurring around disk B.
C. The bacteria are insensitive to C because bacterial growth around disk C is uninhibited.
D. The bacteria are very sensitive to D because of the relatively larger area of growth inhibition around disk D.

Section 25-1
VOCABULARY REVIEW
1. A protist is a single-celled or simple multicellular eukaryotic organism.
2. Binary fission is a method of asexual reproduction in which a single cell divides into two identical cells.
3. Multiple fission is a form of cell division that produces more than two offspring.
4. Conjugation is a method of sexual reproduction in which two individuals join and exchange genetic material.

MULTIPLE CHOICE
1. d  2. b  3. c  4. c  5. c
SHORT ANSWER
1. Protists obtain energy by photosynthesis (autotrophy) or by eating other organisms (heterotrophy). In autotrophy, protists make their own food molecules by absorbing the energy from sunlight with the help of specialized pigments. In heterotrophy, protists get energy by engulfing and eating small organisms or by secreting enzymes into the environment and then absorbing the small molecules that are formed.
2. Protists are classified by reproduction, method of obtaining energy, or type of movement.
3. In endosymbiosis, an organism lives inside a larger organism. Over time, the smaller organism becomes an organelle.
4. Since protists are eukaryotes, their chromosomes are contained inside a nucleus, which must break down and then reform for conjugation to occur. Bacteria lack a nucleus, so division and exchange of genetic material is simpler.

STRUCTURES AND FUNCTIONS
a. sexual reproduction
b. asexual reproduction

Section 25-2
VOCABULARY REVIEW
1. Cilia are short hairlike cytoplasmic projections that beat in waves. Flagella are long, whiplike structures made of microtubules.
2. Both are openings on the surface of a paramecium. Food enters the gullet through the mouth pore, and undigested food molecules are expelled through the anal pore.
3. Both contain DNA. The macronucleus is large, contains multiple copies of DNA, and is responsible for metabolic functions, and the micronucleus is small and participates in the exchange of genetic material during conjugation.

MULTIPLE CHOICE
1. b 2. c 3. c 4. c 5. c

SHORT ANSWER
1. The hard tests that cover the bodies of these organisms sink to the bottom of the ocean, where they accumulate as layers of sediment.
2. Cilia lining the oral groove sweep food down the groove to the mouth pore, which opens into the gullet. Food passes from the gullet into food vacuoles, where digestion occurs. Undigested molecules are expelled via the anal pore.
3. A pseudopodium extends forward as cytoplasm streams into it, and the organism moves forward. A food particle is surrounded by pseudopodia and engulfed.
4. The protozoans use the circulatory system of their human and mosquito hosts to transport them through their hosts’ bodies, and they depend on the mosquitoes to transport them from one human host to another.

STRUCTURES AND FUNCTIONS
a. anal pore; b. gullet; c. cilia; d. oral groove; e. food vacuole; f. pellicle; g. contractile vacuole

Section 25-3
VOCABULARY REVIEW
1. A fruiting body is a stationary, reproductive, spore-bearing structure of funguslike protists.
2. A gametangium is a single-celled chamber in which the gametes of algae are produced.
3. A euglenoid is a flagellated, unicellular alga that has both plantlike and animal-like features.
4. An accessory pigment is a pigment that captures light energy and transfers it to chlorophyll a.

MULTIPLE CHOICE
1. b 2. d 3. c 4. d 5. c

SHORT ANSWER
1. Algae lack tissue differentiation and have no true roots, stems, and leaves. The gametangia of algae are single-celled; the gametangia of plants are multicelled.
2. Photoplankton form the base of nearly all marine and freshwater food chains.
3. Algae can exist as unicellular, colonial, filamentous, and multicellular organisms.
4. Dinoflagellates have two flagella of unequal length that are oriented perpendicular to each other.
5. Plantlike: presence of chlorophyll, ability to photosynthesize; animal-like: lack cell walls, are highly motile
6. Brown and red algae are multicellular, like plants. They contain structures that resemble the structures of plants, although the structures lack tissue differentiation.

STRUCTURES AND FUNCTIONS
a. Myxomycota
b. Chytridiomycota
c. Dictyostelida
d. Oomycota

Section 25-4
VOCABULARY REVIEW
1. A sporozoite is the Plasmodium stage that enters the human bloodstream and infects the liver. A merozoite is the stage that emerges from the liver and infects red blood cells.
2. Giardiasis is the intestinal illness caused by Giardia. Trichomoniasis is the sexually transmitted illness caused by Trichomonas.
3. Alginate is a commercially important polysaccharide that comes from red algae.

MULTIPLE CHOICE
1. c 2. d 3. a 4. a 5. c

SHORT ANSWER
1. Protoplasts live in a close relationship with corals, giving the corals their color and supplying much of their carbon. Lichens are symbiotic relationships between algae and fungi. Lichens create new soil from rock. Protoplasts live in termite guts and digest cellulose.
2. Carrageenan is added to control the texture of food products.
3. Chemotaxis in slime molds is the ability to crawl toward AMP. Human leukocytes also exhibit chemotaxis. By studying slime molds, scientists hope to better understand how leukocytes protect against disease.

4. The toxins from dinoflagellates concentrate as they move up the food chain. Clams and oysters eat the algae, and humans eat the shellfish.

STRUCTURES AND FUNCTIONS
- a. sporozoites; b. sporozoites; c. liver; d. merozoites; e. red blood cells; f. gametocytes

Section 26-1

VOCABULARY REVIEW
1. A hypha is a fungal filament.
2. A mycelium is a mat of hyphae visible to the unaided eye.
3. A coenocyte is a species that has hyphae lacking septa.
4. A sporangiophore is a specialized hypha that looks like an upright stalk and bears a spore-forming sac.
5. A conidium is a fungal spore that is formed without the protection of an enclosing sac.
6. Budding is an asexual process in which part of a yeast cell pinches itself off to produce a small offspring cell.

MULTIPLE CHOICE
1. c  2. b  3. a  4. d  5. a

SHORT ANSWER
1. The cell walls of fungi contain chitin, while the cell walls of plants contain cellulose.
2. The fungus Histoplasma capsulatum normally grows as a mycelium in soil, but when it invades a human, it grows unicellularly as a yeast.
3. A septate hypha dries and shatters, releasing individual cells that act as spores.
4. Plus and minus refer to different mating types of hyphae that may fuse with each other during sexual reproduction.
5. Like animals, fungi store energy in the form of glycogen.
6. Because most fungi are saprophytic, they use the resources from dead organisms and make them available to other organisms in an ecosystem.
7. Most fungi consist of cells that are relatively unspecialized. Like unicellular protists, the cells of a fungus resemble each other and obtain their own nutrients directly from the environment.

STRUCTURES AND FUNCTIONS
- a. septum; b. nucleus; c. cell wall; d. septate hyphae; e. coenocytic hyphae

Section 26-2

VOCABULARY REVIEW
1. A rhizoid is a zygomycete hypha that penetrates the surface on which the fungus is growing; a stolon is a zygomycete hypha that grows across the surface of the area where the zygomycete is growing.
2. A basidium is a reproductive structure produced by a basidiomycete; a basidiocarp is the above-ground spore-bearing portion of a basidiomycete.
3. An ascogonium is a female gametangium; an antheridium is a male gametangium.
4. An ascocarp is a cuplike reproductive structure produced by an ascomycete; an ascus is a spore-bearing sac that develops in an ascocarp.
5. A lichen is a symbiotic relationship between a fungus and a photosynthetic organism; a mycorrhiza is a symbiotic structure formed by a fungus and plant roots.

MULTIPLE CHOICE
1. a  2. d  3. c  4. b  5. c

SHORT ANSWER
1. In basidiomycetes, those structures consist of a stalk and a flattened cap with rows of gills on the underside; in ascomycetes, they usually resemble a cup.
2. Fungi imperfecti lack a sexual stage.
3. A mycorrhiza is a symbiotic association between a fungus and plant roots; a lichen is a symbiotic association between a fungus and usually a cyanobacterium or a green alga.
4. Lichens produce acids that decompose rocks, contributing to the production of soil.
5. Mushrooms are produced by basidiomycetes and are formed as a result of sexual reproduction. Deuteromycetes do not have a sexual stage; therefore, mushrooms cannot be deuteromycetes.
6. A growing plant would benefit more from a mycorrhiza. Although a lichen contributes to the production of soil, it may take years to produce enough soil for a plant to begin to develop; a mycorrhizal fungus, on the other hand, can begin to contribute to a plant’s well-being immediately.
7. The sexual reproductive structures are more specialized and distinctive than the nonreproductive or asexual reproductive structures.

STRUCTURES AND FUNCTIONS
- a. sporangium; b. sporangiospores; c. rhizoid; d. gametangia; e. zygosporangium; f. meiosis

Section 26-3

VOCABULARY REVIEW
1. Aflatoxins are poisons produced by some fungi.
2. Aflatoxins cause liver cancer.
3. They may be found in peanuts, tree nuts, cottonseed, and grains, such as corn.
4. A wheat rust is a basidiomycete that attacks wheat grains.

MULTIPLE CHOICE
1. d  2. b  3. a  4. d  5. c  6. b  7. c

SHORT ANSWER
1. pregnancy, illness, and the use of some antibiotics
2. penicillin, cephalosporin, cortisone, and the hepatitis B vaccine
3. cheese, beer, wine, miso, soy sauce, tempeh, tofu, yeast, bread, and mushrooms
4. Plasmids are used to insert foreign genes into Saccharomyces. The yeast then uses those genes to produce foreign proteins.
5. Such substances might encourage animals to consume the reproductive structures. In doing so, the animals would help disperse the fungal spores to new locations.

STRUCTURES AND FUNCTIONS
- a–c may vary and include bread, cheese, soy products, beer, and wine; d–f may vary and include antibiotics, cortisone, vaccines, and ethanol; g–i, infection, poisoning, and allergies
Section 27-1
VOCABULARY REVIEW
1. Botany is the study of plants; agriculture is the practice of growing plants or raising animals for human use.
2. A cereal is a grass that contains grains; a root crop is a plant whose roots or underground stems are rich in carbohydrates and used by humans for food.
3. A legume is a member of the pea family that bears protein-rich seeds in pods; a nut is a dry, hard fruit that does not split open.
4. A fruit is a part of a flowering plant that usually contains seeds; a vegetable is a food derived from the leaves, stems, seeds, or roots of nonwoody plants.

MULTIPLE CHOICE
1. b 2. a 3. d 4. c 5. b

SHORT ANSWER
1. A cultivar is a cultivated variety of a plant that can be distinguished from other members of its species. Examples include Thompson Seedless grapes, McIntosh apples, Valencia oranges.
2. Such diets are usually low in some amino acids.
3. People can also eat legumes or animal protein.
4. Many cereals thrive in temperate climates but do not grow well in the tropics. Rice is an exception. Many people in dry tropical areas therefore rely more on root crops.

STRUCTURES AND FUNCTIONS
- cantaloupe, fruit; rice, cereal; celery, vegetable; nutmeg, spice; pecan, nut; potato, root crop; lima bean, legume; oregano, herb

Section 27-2
VOCABULARY REVIEW
1. Plant ecology is the study of the interactions between plants and the environment.
2. A weed is an undesirable plant that may crowd out crop plants or native plant species.
3. Hay fever is an allergic reaction that may be caused by pollen and results in sneezing, a runny nose, and watery eyes.

MULTIPLE CHOICE
1. c 2. a 3. b 4. d 5. a 6. d

SHORT ANSWER
1. Through photosynthesis, plants convert carbon dioxide and water into organic compounds and oxygen. Organisms that perform aerobic respiration (including plants) convert these compounds and oxygen back into carbon dioxide and water.
2. Plant roots bind soil particles together; leaves reduce erosion due to wind and rain; and dead plant parts add organic matter to the soil.
3. chestnut blight, an introduced fungal disease
4. small, drab flowers that are wind-pollinated
5. Herbivores or pathogenic microbes that keep native plants in check may not attack introduced plants. Without such natural controls, introduced plants can outcompete native plants for resources.

Section 28-1
VOCABULARY REVIEW
1. The sporophyte is the first phase of a plant's life cycle and is a diploid plant that produces spores; the second phase is a haploid gametophyte plant that produces eggs and sperm.
2. A spore contains a haploid reproductive cell surrounded by a hard outer wall; a seed is a plant embryo surrounded by a protective coat.
3. Both are types of plant vascular tissue; xylem carries water and inorganic nutrients from the roots to the stems and leaves, while phloem carries organic and some inorganic compounds in any direction.
4. A vascular plant has vascular tissue and true roots, stems, and leaves; a nonvascular plant has none of these.
5. An angiosperm’s seeds are enclosed in fruits, while a gymnosperm’s seeds are not.

MULTIPLE CHOICE
1. d 2. b 3. a 4. c 5. b

SHORT ANSWER
1. The cuticle prevents water loss from the plant; spores and/or seeds help disperse species and prevent reproductive cells from drying out; vascular tissue transports water and dissolved substances within the plant.
2. Both have chlorophylls a and b, both store energy as starch, and both have cell walls made of cellulose.
3. Spores, gametophytes, and gametes are haploid.
4. The spores of algae are motile while those of land plants are not. The spores of land plants have a protective covering while those of algae do not.

STRUCTURES AND FUNCTIONS
- a, flowers, fruits; b, seeds; c, hardened vascular tissue; d, reproduction by spores

Section 28-2
VOCABULARY REVIEW
1. A bryophyte is any member of the three phyla of nonvascular plants.
2. unusual-looking plants that grow in moist, shady areas and are from the phylum Hepatophyta
3. Plants from the phylum Anthocerophyta which grow in moist, shaded areas and have long, thin, hornlike sporophytes

MULTIPLE CHOICE
1. b 2. a 3. c 4. d 5. b

SHORT ANSWER
1. The gametophyte phase is dominant.
2. The sperm must swim through water to reach an egg during sexual reproduction.
3. It is used as fuel; added to potting and gardening soils to increase their ability to retain water; and used to pack bulbs and flowers for shipping.
4. Each of their cells contains a single large chloroplast rather than numerous small ones.
5. Mosses are often one of the first species in a disturbed area, and they benefit other plants by accumulating organic and inorganic matter that begins to form a soil layer in which other plants can grow. They also prevent soil erosion.

6. One would expect to find thalloid liverworts in dryer environments since the thalloid form allows the entire body of the liverwort to be in contact with water on the surface that the plant grows on.

**STRUCTURES AND FUNCTIONS**
a, sporophyte; b, gametophyte; c, rhizoid

**Section 28-3**

**VOCABULARY REVIEW**

1. Both are fern leaves; a fiddlehead is a tightly coiled new leaf, and a frond is an uncoiled mature leaf.
2. Both are flowering plants; a monocot usually has one cotyledon, and a dicot usually has two. Monocots also have parallel venation in their leaves, their stems have scattered vascular bundles, and their flowers usually occur in threes. Dicots also have net venation in their leaves, their stems have radially arranged vascular bundles, and their flower parts usually occur in fours or fives.
3. Both are patterns of veins in leaves; the veins run roughly parallel to each other in parallel venation and form an interconnected network in net venation.

**MULTIPLE CHOICE**

1. c 2. d 3. a 4. b 5. d

**SHORT ANSWER**

1. Vascular plants have conducting tissues that transport water and dissolved substances within the plant; nonvascular plants do not. The strong stems of vascular plants allow the plants to grow taller than nonvascular plants, enabling them to receive more sunlight than shorter plants do.
2. Cycadophyta: have thick trunks with fernlike leaves, are male or female, and have large cones. Ginkgophyta: have tall trunks, deciduous fan-shaped leaves, and large seeds. Coniferophyta: have tall trunks, needle or scalelike leaves, and cones.
3. Angiosperms have flowers, which produce pollen, eggs, or both; seeds are enclosed in an ovary that ripens into a fruit. Gymnosperms have cones that produce either pollen or eggs; egg-producing cones hold the seeds without enclosing them.
4. Ferns were able to develop adaptations to a wider range of environments than were the other groups of nonvascular plants.

**STRUCTURES AND FUNCTIONS**
a, Ginkgophyta; b, Psilophyta; c, Cycadophyta; d, Coniferophyta

**Section 29-1**

**VOCABULARY REVIEW**

1. Parenchyma cells are loosely packed, cube-shaped, or elongated cells with a large central vacuole and thin cell walls; collenchyma cells are thicker and have irregularly shaped, thick cell walls; sclerenchyma cells have thick, even, rigid cell walls.
2. The dermal tissue system forms the outside covering of plants; the ground tissue system lies inside the dermal tissue and functions in storage and support; the vascular tissue system lies inside the ground tissue and functions in transport and support.
3. Apical meristems are located at the tips of stems and roots, intercalary meristems are located above the bases of leaves and stems, and lateral meristems are located near the outside of stems and roots.

**MULTIPLE CHOICE**

1. c 2. a 3. d 4. b 5. b

**SHORT ANSWER**

1. Epidermal cells are found in the nonwoody parts; their functions include gas exchange, water absorption, and water-loss prevention.
2. They are thick and have irregularly shaped cell walls; provide support; they are found in regions of the plant that are still lengthening.
3. Where growth is no longer occurring; in vascular tissue, hard seed coats, and cactus spines.
4. Monocots have apical meristems at the tips of stems and roots, and some have intercalary meristems above the bases of leaves and stems. Dicots have apical meristems at the tips of stems and roots, and most have lateral meristems near the outside of stems and roots.
5. The absence of cellular contents inside the walls of the water-transporting cells allows large amounts of water to move rapidly through the xylem.

**STRUCTURES AND FUNCTIONS**
a, companion cell; b, pit; c, sieve pore; d, sieve plate; e, tracheid; f, sieve tube member; g, vessel element

**Section 29-2**

**VOCABULARY REVIEW**

1. An adventitious root is a specialized root that grows from a stem or leaf.
2. The cortex is the portion of a primary root that lies between the epidermis and the vascular tissues.
3. The pericycle is the outermost layer or layers of the central vascular tissues in a root.
4. A macronutrient is an element that is required in relatively large amounts by a plant.
5. A micronutrient is an element that is required in relatively small amounts by a plant.

**MULTIPLE CHOICE**

1. d 2. a 3. b 4. c 5. a

**SHORT ANSWER**

1. vascular tissue
2. Pericycle cells divide to form lateral roots.
3. between primary xylem and primary phloem
4. The vascular cambium produces secondary xylem toward the inside of the root and secondary phloem toward the outside.
5. Macronutrients include nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur.
6. Water absorption should be greater in parts of roots that have not undergone secondary growth. Roots with secondary growth are surrounded by cork cells, which do not absorb much water.
Section 29-3

VOCABULARY REVIEW
1. Heartwood is the darker, older wood in the center of a tree that no longer transports water; sapwood is the functional, often lighter-colored wood nearer the outside of the trunk.
2. Springwood is xylem tissue composed of wide, thinned-walled cells formed when water is plentiful; summerwood is xylem tissue composed of small, thick-walled cells formed when water is more limited.
3. A source is a place in a plant where carbohydrates are made or have been stored; a sink is a place in a plant where carbohydrates are stored or used.
4. Translocation is the movement of carbohydrates through a plant; transpiration is the evaporation of water from a plant.
5. The pith is formed during primary growth; wood is secondary xylem.

MULTIPLE CHOICE
1. b 
2. d 
3. c 
4. a 
5. c

SHORT ANSWER
1. The bud scales are analogous to the root cap. The bud scales are present only when the stem is not growing, whereas the root cap is always on the root.
2. The evaporation of water from a leaf puts the column of water in the xylem under tension. The column does not break because of cohesion. The column does not pull away from the xylem walls because of adhesion. Thus, water is pulled toward the leaf.
3. Wood provides structural support allowing plants to grow tall and enabling them to capture more light.

Section 29-4

VOCABULARY REVIEW
1. A petiole is a stalklike structure that attaches a leaf to a stem.
2. Mesophyll is a ground tissue composed of chloroplast-rich parenchyma cells, which is where photosynthesis takes place.
3. A guard cell is a modified cell found on the leaf epidermis that regulates gas and water exchange.

MULTIPLE CHOICE
1. b 
2. d 
3. a 
4. c 
5. a

SHORT ANSWER
1. Tendrils enable vines to climb, food traps collect small animals as a source of nutrients, and spines protect the plant from being eaten.
2. Epidermal hairs usually protect the leaf from insects and intense light.
3. The products of photosynthesis may be used as an energy source or as building blocks, either in the leaf or in other parts of the plant.
4. Epidermal cells pump potassium ions into guard cells, and water moves into the guard cells by osmosis. The influx of water makes the guard cells swell, causing them to bow apart and open the stomata.
5. It would block the transport of mineral nutrients from the roots to the rest of the plant.

Section 30-1

VOCABULARY REVIEW
1. An antheridium produces many sperm, and an archegonium produces a single egg.
2. Homospory is the production of one type of spore. Heterospory is the production of different types of spores.
3. The integument is a thick layer of cells that surrounds a megasporangium. A micropyle is a small opening in the integument.

MULTIPLE CHOICE
1. c 
2. a 
3. d 
4. b 
5. c

SHORT ANSWER
2. The sperm of conifers are not flagellated, whereas the sperm of mosses and ferns are. The spores of conifers are of two types, whereas the spores of mosses and most ferns are of one type; also, the spores of conifers never leave the parent plant, whereas the spores of mosses and ferns do.
4. They have flagellated sperm, which must swim through water to reach and fertilize the eggs.

Section 30-2

VOCABULARY REVIEW
1. An anther is a male reproductive structure that contains microsporangia. A filament is a stalklike structure that supports an anther.
2. A stigma is a female reproductive structure that traps pollen grains in a flowering plant. A style is a stalklike structure that ends in a stigma.
3. Polar nuclei are produced during the formation of an embryo sac in a flowering plant. In double fertilization, the polar nuclei fuse with one sperm nucleus while the egg fuses with another sperm.

MULTIPLE CHOICE
1. c 
2. a 
3. b 
4. d 
5. b

SHORT ANSWER
1. Three of the megaspores degenerate, and the fourth forms the structures of the embryo sac. Each of the microspores forms a pollen grain.
3. Nectar increases a plant's chances of sexual reproduction since it attracts pollinators.
4. Endosperm provides nourishment for the embryo.
5. Such plants are more likely to have fragrant flowers. Most moths and bats are nocturnal, and at night it would be easier to find flowers by smell than by sight.

STRUCTURES AND FUNCTIONS
a, filament; b, anther; c, stigma; d, style; e, ovary; f, receptacle; g, ovule; h, sepal; i, petal

Section 30-3

VOCABULARY REVIEW
1. A radicle is an embryonic root in a seed.
2. A hypocotyl is the portion of the embryonic stem between the attachment point of the cotyledons and the radicle.
3. An epicotyl is the portion of the embryonic stem above the attachment point of the cotyledons.
4. A plumule is the shoot tip and any embryonic leaves attached to its tip.
5. A hilum is a scar on a seed that marks where the seed was attached to the ovary wall.

MULTIPLE CHOICE
1. c 2. a 3. c 4. d 5. c

SHORT ANSWER
1. raspberry, aggregate fruit; pineapple, multiple fruit; pea pod, simple fruit
2. Factors and conditions include water, oxygen, a particular range of temperatures, light, and passage through an animal's digestive tract.
3. Advantage: many new individuals can be produced in a short time, enabling clones to fill the available space. Disadvantage: since all of the offspring are genetically identical, they have the same tolerance to the environment and are attacked by the same diseases and pests.
4. The structures are runners (or stolons), rhizomes, bulbs, and tubers.
5. wind dispersal: orchid seeds, milkweed seeds; animal dispersal: fruit; water dispersal: coconuts
6. Plant embryos must grow to the soil surface before they can capture enough light to carry out photosynthesis. This growth requires energy, which is provided by the food reserves in the seed.

STRUCTURES AND FUNCTIONS
a, endosperm; b, seed coat; c, cotyledon; d, plumule; e, hypocotyl; f, radicle

Section 31-1

VOCABULARY REVIEW
1. A plant hormone is a chemical messenger that affects a plant's ability to respond to its environment.
2. Apical dominance is the inhibition of lateral buds by the presence of a shoot tip.
3. Ethephon is a synthetic chemical that breaks down to release ethylene gas.
4. Abscission is the detachment of leaves, flowers, or fruits from a plant.
5. A cytokinin is a hormone that promotes cell division.

MULTIPLE CHOICE
1. b 2. d 3. a 4. c 5. a

SHORT ANSWER
1. The seeds produce IAA, which stimulates the development of the fruit; removing the seeds removes the IAA.
2. Gibberellins make plants grow taller, increase the size of seedless fruit, promote uniform germination, and increase the alcohol content of beer.
3. Uses of ethylene or ethephon include ripening fruits, changing the color of citrus fruits, and promoting the abscission of fruits at harvest time.
4. ABA stimulates the transport of potassium ions out of guard cells, causing stomata to close. This reduces the amount of water that evaporates through the stomata.
5. Abscistic acid induces dormancy in buds, maintains dormancy in seeds, and makes leaves effectively dormant by closing their stomata.

STRUCTURES AND FUNCTIONS
The plant on the right was treated with a gibberellin. It is much taller than the one on the left. Gibberellins cause plants to grow to a taller-than-normal height.

Section 31-2

VOCABULARY REVIEW
1. Thigmotropism is a plant's growth response to touching a solid object, for example, tendrils and stems of vines coil when they touch an object.
2. A thigmonastic movement is a type of nastic movement that occurs in response to touching a plant, for example, a Venus' flytrap closes its leaves when touched.
3. A nyctinastic movement is one that occurs in response to the daily cycle of light and dark, for example, the prayer plant's leaves are vertical at night and horizontal during the day.

MULTIPLE CHOICE
1. a 2. c 3. b 4. d 5. b

SHORT ANSWER
1. Positive phototropism maximizes the amount of light that can be absorbed by a plant. Positive gravitropism causes roots to grow into the soil, where they can absorb water and nutrients.
2. auxins
3. Nastic movements are caused by the movement of water into or out of cells, which changes the pressure inside the cells.
4. Thigmonastic movements allow plants to capture prey, discourage insect feeding, and reduce water loss.
5. Insect capture requires the leaves to close rapidly. A thigmonastic movement is fast enough to accomplish this, but not thigmotropic movement.

STRUCTURES AND FUNCTIONS
1. The shoot is exhibiting positive phototropism and negative gravitropism; the root is exhibiting positive gravitropism.
2. Auxins are involved in these responses.
Section 31-3
VOCABULARY REVIEW
1. Photoperiodism is an organism’s response to changes in the length of days and nights.
2. Vernalization is the stimulation of flowering by low temperatures.
3. Bolting is the rapid elongation of a flowering stem.
4. Critical night length is the requirement many plants have for a specific amount of darkness or night length.

MULTIPLE CHOICE
1. c 2. d 3. b 4. a 5. b

SHORT ANSWER
1. flowering, formation of storage organs, and bud dormancy
2. SDPs: ragweed, poinsettias, chrysanthemums, goldenrods, and soybeans; they flower in the spring or fall. LDPs: wheat, radishes, asters, irises, and beets; they flower in the summer.
3. Answers include photoperiodism, flowering, bud dormancy, and seed germination.
4. Protect them from exposure to low temperatures.
5. Spinach will flower in the northern United States during the summer, when the nights are shorter than 10 h. Flowering is undesirable in spinach, because it is grown for its leaves, not its flowers.

STRUCTURES AND FUNCTIONS
a, no; b, yes; c, yes; d, no; e, no; f, yes

Section 32-1
VOCABULARY REVIEW
1. A vertebrate is an animal with a backbone.
2. Ingestion is the process in which an animal takes in organic material, usually in the form of other living things.
3. A dorsal nerve cord is a hollow tube lying just above the notochord.
4. Cephalization is the concentration of sensory and brain structures in the anterior end.

MULTIPLE CHOICE
1. a 2. c 3. d 4. a 5. b

SHORT ANSWER
1. During differentiation, the cells of a multicellular organism become different from each other; these differences enable the cells to specialize in performing different functions.
2. They group animals based on the animal’s evolutionary history, which is inferred from morphology, fossils, RNA, and other factors.
3. As a cephalized animal moves through its environment, sensory structures concentrated on the head can sense the environment.
4. A coelom provides a structure against which muscles can contract, allows the exterior of the body to move more freely with respect to the internal organs, and acts as a reservoir and medium of transport for nutrients and wastes.
5. Some similarities that indicate evolutionary relatedness may be present during development but not in adulthood. Ignoring development might then lead to errors in classification.

STRUCTURES AND FUNCTIONS
a, dorsal; b, anterior; c, posterior; d, ventral
This animal has bilateral symmetry.

Section 32-2
VOCABULARY REVIEW
1. Segmentation refers to a body composed of repeating similar units; in vertebrates, segmentation is evident in the vertebrae.
2. An integument is an outer covering of an animal; an endoskeleton functions as an integument for animals such as arthropods and some mollusks.

MULTIPLE CHOICE
1. c 2. d 3. c 4. a 5. b

SHORT ANSWER
1. Annelida, Arthropoda, and Chordata
2. Both must eliminate ammonia, which is very toxic. Some animals convert ammonia to less toxic substances.
3. The legs of a deer are positioned directly beneath its body, giving the deer greater mobility and speed on land; the integument of a reptile is largely water-tight, minimizing loss of water to the environment.
4. It separates oxygenated and deoxygenated blood, thus improving the efficiency of the circulatory system.
5. Advantage: any two hermaphrodites can mate with each other, and some hermaphrodites can fertilize their own eggs. Disadvantage: with self-fertilization, no genetic variability is introduced by the mating because both gametes come from the same individual.

STRUCTURES AND FUNCTIONS
a, kidney; b, allows gas exchange between the blood and the environment; c, integument; d, processes sensory information, coordinates behavior, makes decisions; e, endoskeleton

Section 32-3
VOCABULARY REVIEW
1. The archenteron is a deep cavity in the gastrula and becomes the gut. The blastopore is the opening to the archenteron.
2. In a pseudocoelom, mesoderm lines the interior of the coelom but does not surround the gut. Both the interior of the coelom and the gut are lined by mesoderm.
3. In a protostome, the blastopore develops into a mouth; in a deuterostome, the blastopore develops into an anus.
4. In schizocoely, the mesoderm forms from cells that split away from the junction of the endoderm and ectoderm; in enterocoely, the mesoderm forms when cells lining the dorsal part of the coelom begin dividing rapidly.

MULTIPLE CHOICE
1. b 2. a 3. c 4. d 5. c

SHORT ANSWER
1. A blastula is a hollow ball of cells; a gastrula is a cup-shaped structure consisting of an outer layer of ectoderm surrounding an inner layer of endoderm, which in turn surrounds a deep cavity.
2. ectoderm, mesoderm, and endoderm
3. Both echinoderms and chordates are deuterostomes. Most deuterostomes undergo radial cleavage, indeterminate cleavage, and exhibit enterocoely.
4. If more than one sperm entered the egg, the egg nucleus would contain more than two sets of chromosomes. Normal mitosis could not occur, and the zygote would fail to develop normally.

STRUCTURES AND FUNCTIONS
a, protostome; b, deuterostome; c, schizocoely; d, enterocoely; e, mouth; f, anus

Section 33-1
VOCABULARY REVIEW
1. A choanocyte is a type of flagellated cell that lines the interior of a sponge and draws water into the sponge.
2. The osculum is the opening at the top of a sponge where water exits the sponge.
3. A spicule is a tiny, hard particle of calcium carbonate or silicon dioxide that makes up the skeleton of some sponges.
4. An amoebocyte is a type of cell that crawls about within the body wall of a sponge and aids in feeding and reproduction.

MULTIPLE CHOICE
1. d  2. b  3. d  4. a  5. c

SHORT ANSWER
1. Invertebrates are defined solely on the basis of what they lack—a backbone—rather than on the basis of characteristics they share.
2. A sponge’s skeleton may be made of spongin or spicules (or both). Spongin is a network of protein fibers, while spicules are tiny, hard particles made of calcium carbonate or silicon dioxide.
3. Choanocytes engulf sperm and transfer them to amoebocytes, which carry the sperm to an egg.
4. Since all hermaphrodites produce eggs, the chances of successful fertilization are greater than they would be if only half the population produced eggs.
5. Larvae would be better, since their flagella enable them to swim away from the parent sponge and produce another sponge in a new location.

STRUCTURES AND FUNCTIONS
a, osculum; b, amoebocyte; c, choanocyte; d, ostium; e, spicules

Section 33-2
VOCABULARY REVIEW
1. A polyp is the vase-shaped form of a cnidarian; a medusa is the bell-shaped form of a cnidarian.
2. The epidermis is the outer cell layer of a cnidarian; the gastrodermis is the inner cell layer.
3. Mesoglea is a jellylike material between the epidermis and gastrodermis in a cnidarian; a planula is the ciliated larva of some cnidarians.
4. A cnidocyte is a specialized cnidarian cell used for defense and capturing prey; a nematocyst is an organelle inside a cnidocyte that contains a long, coiled filament.
5. A colloblast is a cell found in ctenophores that secretes a sticky substance to bind prey; an apical organ is a sensory structure at one end of a ctenophore’s body.

MULTIPLE CHOICE
1. a  2. c  3. d  4. b  5. c

SHORT ANSWER
1. Some nematocysts have filaments with sharp tips and spines that can puncture prey and inject poison; others have filaments that can wrap around prey.
2. Hydras exist only as polyps, are not colonial, and live in fresh water.
3. The medusa is the dominant body form in the life cycle of a scyphozoan. The polyp is the dominant body form in the life cycle of an anthozoan.
4. The clownfish live among sea anemones. The anemones’ stinging tentacles protect the clownfish from predators, and the clownfish drives away other fish that try to feed on the anemone. Algae live inside corals. The corals supply algae with nutrients, and the algae supply the corals with oxygen.
5. Each polyp cements its skeleton to the skeletons of adjoining polyps in the colony. When the polyps die, their skeletons remain, and build up into a reef.
6. No; the hydras are green because they contain algae, which require light to carry out photosynthesis.

STRUCTURES AND FUNCTIONS
a, epidermis; b, mesoglea; c, gastrovascular cavity; d, gastrodermis; e, tentacle; f, mouth; the medusa

Section 34-1
VOCABULARY REVIEW
1. A proglottid is a body section of a tapeworm and contains male and female reproductive structures; a tegument is a continuous sheet of fused cells that covers the external surface of a fluke.
2. Cerebral ganglia are clusters of nerve cells that serve as a brain; eyespots are cup-shaped structures that sense light.
3. A primary host is a host from which an adult parasite derives its nourishment and in which sexual reproduction occurs; an intermediate host is a host from which the larvae of a parasite derive their nourishment.

MULTIPLE CHOICE
1. c  2. b  3. d  4. a  5. d

SHORT ANSWER
1. Flame cells collect excess water, which is then transported through excretory tubules and excreted from numerous pores scattered over the body surface.
2. Planarians detect the intensity and direction of light with two eyespots; tapeworms cannot detect light.
3. The primary host is a human; the intermediate host is a snail. The fluke enters its primary host as a tailed larva that penetrates the host’s skin.
4. The larval stage
5. The eggs sometimes block blood vessels, causing a disease that may kill the host. A parasite that kills its host may not be perfectly adapted to its environment.

STRUCTURES AND FUNCTIONS
a, scolex; b, sucker; c, neck; d, proglottid; e, ovary; f, uterus; g, testes
Section 34-2

VOCABULARY REVIEW
1. Trichinosis is a human disease caused by eating undercooked meat (pork) containing cysts of the *Trichinella* worm.
2. A filarial worm is a parasitic roundworm that causes diseases such as elephantiasis in humans and heartworm disease in dogs.
3. A mastax is a muscular organ that breaks up food in a rotifer.

MULTIPLE CHOICE
1. b 2. c 3. a 4. d 5. a

SHORT ANSWER
1. Food moves through a digestive tract in only one direction, which allows different parts of the tract to carry out different functions.
2. *Ascaris* eggs and pinworm eggs hatch in the intestine; hookworm eggs hatch in warm, damp soil.
3. The mosquito
4. The crown of cilia looks like a pair of rotating wheels. It sweeps food into the digestive tract.
5. The small intestine often contains undigested and partially digested food on which the worm can feed.

STRUCTURES AND FUNCTIONS
a, cilia; b, excretory tubule; c, stomach; d, anus; e, mastax; f, ovary; g, cloaca

Section 35-1

VOCABULARY REVIEW
1. The visceral mass of a mollusk contains the heart and organs of digestion, excretion, and reproduction. The visceral mass is covered by a layer of epidermis called the mantle.
2. Hemolymph is the fluid in an open circulatory system; a hemocoel is a set of hemolymph-filled spaces in the tissues of an animal with an open circulatory system.
3. The incumbent siphon of a bivalve takes in water that contains oxygen and nutrients. Water exiting through the excurrent siphon carries wastes from the body.

MULTIPLE CHOICE
1. d 2. c 3. b 4. a 5. b

SHORT ANSWER
1. The two main regions are the head-foot and the visceral mass. The visceral mass contains most of the internal organs. The head-foot is directly involved with locomotion.
2. The mantle secretes the protective shell.
3. Gastropods use their radula to cut through leaves, scrape up algae, drill holes through the shells of other mollusks, and harpoon prey; bivalves filter small organisms from the water that passes through their gills.
4. Marine clams shed sperm and eggs into the water, and fertilization occurs externally. In most freshwater clams, eggs are fertilized internally by sperm that enter through the incumbent siphon.
5. A typical molluscan shell is secreted by the mantle, consists of calcium carbonate, is formed by both males and females, and protects the entire animal.

STRUCTURES AND FUNCTIONS
a, shell; b, gill; c, mantle cavity; d, anus; e, heart; f, mantle; g, stomach; h, ganglia

Section 35-2

VOCABULARY REVIEW
1. A seta is an external bristle on an annelid.
2. A parapodium is a fleshy protrusion on an annelid.
3. A typhlosole is an infolding of the intestinal wall in an earthworm.
4. A nephridium is an excretory tubule in an earthworm.

MULTIPLE CHOICE
1. d 2. c 3. a 4. b 5. c

SHORT ANSWER
1. The crop is a temporary storage area for ingested soil; the gizzard grinds the soil, releasing and breaking up organic matter.
2. Earthworms help release nutrients from dead matter into the soil, allow air to penetrate into the soil to reach plant roots and soil microorganisms, and loosen the soil, which makes it easier for roots to penetrate and water to seep in.
3. They contract and force blood through the circulatory system.
4. A leech attaches its anterior sucker and then pulls the rest of its body forward.
5. The host would probably be an animal with a high body temperature, such as a mammal or a bird. Moving toward warmth would increase the leech’s chances of finding a suitable host.

STRUCTURES AND FUNCTIONS
a, crop; b, gizzard; c, aortic arches; d, pharynx; e, cerebral ganglion; f, nephridia; g, longitudinal muscle; h, circular muscle

Section 36-1

VOCABULARY REVIEW
1. An arthropod is a segmented animal with jointed appendages and an exoskeleton.
2. A compound eye is an eye with many individual light detectors, each with its own lens.
3. A tagma is a body structure that is produced by the fusion of a number of smaller segments.
4. A chelicera is a pincerlike mouthpart found on some arthropods, such as spiders and scorpions.

MULTIPLE CHOICE
1. a 2. c 3. d 4. b 5. d

SHORT ANSWER
1. Wax makes the exoskeleton repel water; it is in the outer layer of the exoskeleton.
2. Calcium carbonate and chitin make the exoskeleton hard; they are in the middle layer of the exoskeleton.
3. Legs, antennae, mandibles, and chelicerae
4. The anterior end of the body has food-handling appendages, antennae, compound eyes, structures that sense light intensity, and a brain.
5. Members of the subphylum Crustacea have branched antennae; members of the subphylum Chelicerata have no antennae; and members of the subphylum Myriapoda have unbranched appendages, including legs. Therefore, it would be difficult to assign *Marella* to one of these subphyla.
Section 36-2

VOCABULARY REVIEW
1. A cirrus is one of 12 modified legs on a barnacle and is used for filter feeding; a cheliped is one of two modified legs on a crayfish and is used for defense and capturing food.
2. The cephalothorax is the body section consisting of two fused tagmata, the head and thorax; the thorax consists of eight segments and lies behind the head.
3. Crustaceans have two types of feelers. Antennae are longer feelers that respond to touch and taste; antennules are shorter feelers that are sensitive to touch, taste, and balance.
4. Swimmerets are appendages attached to the anterior abdominal segments of a crayfish and function in reproduction; the telson is part of the paddlelike tail on the posterior end of a crayfish.

MULTIPLE CHOICE
1. b  2. c  3. d  4. a  5. b

SHORT ANSWER
1. A nauplius has three pairs of appendages and a single eye in the middle of its head.
2. A barnacle extends its cirri through openings in its shell, sweeping small organisms and food particles from the water into its mouth.
3. The mandibles chew food; the maxillae manipulate food and draw water currents over the gills; and the maxillipeds touch, taste, and manipulate food.
4. Hemolymph flows from the heart through several large vessels to different regions of the body, where it leaves the vessels and enters spaces within the body. The hemolymph then passes through the gills and returns to the heart.
5. By lying on its side near the surface, the crayfish exposes the gills on that side to the oxygenated water at the surface. By moving the walking legs on that side, the crayfish circulates this water over its gills.

STRUCTURES AND FUNCTIONS
a, green gland; b, brain; c, stomach; d, heart; e, ovary; f, digestive gland; g, intestine

Section 36-3

VOCABULARY REVIEW
1. An arachnid is a member of the class Arachnida, which includes spiders, scorpions, mites, and ticks.
2. A pedipalp is an appendage on the cephalothorax of an arachnid; it is used to hold food and chew.
3. A spiracle is an opening in the exoskeleton of a terrestrial arthropod through which the tracheae open to the environment.
4. A Malpighian tubule is the main excretory organ of a terrestrial arthropod.
5. In spiders, a spinneret is an organ that connects to silk glands in the abdomen and is used to secrete silk for spinning webs, building nests, and protecting eggs.
6. Book lungs are paired sacs in the abdomen with many parallel folds that resemble the pages of a book and function in gas exchange.

MULTIPLE CHOICE
1. c  2. a  3. b  4. d  5. a

SHORT ANSWER
1. to snare prey, to wrap prey, to build nests, to protect eggs, and to pull themselves through the air
2. Book lungs are paired sacs with many parallel folds that resemble the pages of a book; their function is to exchange gases with the environment.
3. The black widow has a bright red or orange hour-glass-shaped mark on the ventral surface of its abdomen. The brown recluse has a violin-shaped mark on the dorsal surface of its cephalothorax.
4. Centipedes have long legs, which enable them to move quickly, and poison claws, which enable them to kill prey.
5. Mites and ticks support this idea. They are the smallest and most abundant arachnids. Mites can live in fresh water, in the sea, and on land; some are free living, while others are parasites of plants or animals.

STRUCTURES AND FUNCTIONS
a, stomach; b, poison gland; c, chelicera (fang); d, pedipalp; e, Malpighian tubule; f, silk gland; g, gut; h, book lung

Section 37-1

VOCABULARY REVIEW
1. Both are insect mouthparts; the labrum functions like an upper lip, and the labium functions like a lower lip.
2. The tympanum is a large oval membrane for sensing sound; the ovipositor is the last segment on a female’s abdomen and is used to lay eggs.
3. In incomplete metamorphosis, a nymph hatches from an egg and undergoes a gradual change in body form to become an adult; in complete metamorphosis, an insect undergoes two major stages of development between egg and adult.
4. A nymph is an immature form of an insect that looks somewhat like the adult, but it is smaller, and its wings and reproductive organs are undeveloped; a pupa is a stage of development in which an insect changes from a larva to an adult.

MULTIPLE CHOICE
1. d  2. b  3. a  4. c  5. b

SHORT ANSWER
1. Shared characteristics include mandibles, one pair of antennae, and unbranched appendages. Differences (in most insects) include the presence of wings; only three pairs of legs; a body divided into head, thorax, and abdomen; and a life cycle that includes metamorphosis.
2. Termites feed on decaying wood, thereby recycling nutrients needed to maintain a healthy forest.
3. The salivary glands secrete saliva, which moistens food. The gastric ceca secrete enzymes into the midgut, where food is digested.
4. A chrysalis encloses a butterfly pupa; a cocoon encloses a moth pupa.
5. To produce eggs, female mosquitoes must have a source of protein, which is present in large amounts in blood but not in sap or nectar. Male mosquitoes do not have this requirement.

STRUCTURES AND FUNCTIONS
a, simple eye; b, compound eye; c, thorax; d, tymanum; e, spiracles; f, ovipositor; g, abdomen

Section 37-2
VOCABULARY REVIEW
1. A pheromone is a chemical that is released by an animal and that affects the behavior or development of other members of the same species.
2. Innate behavior is behavior that is genetically determined.
3. Royal jelly is a high-protein substance that worker honeybees secrete and feed to the queen and the youngest larvae.
4. The queen factor is a pheromone secreted by a queen honeybee that prevents other female larvae from developing into queens.
5. Kin selection is a mechanism of increasing the propagation of one’s own genes by helping a closely related individual reproduce.

MULTIPLE CHOICE
1. b 2. d 3. c 4. a 5. d

SHORT ANSWER
1. Male mosquitoes and moths use their antennae to find distant females. Mosquitoes detect buzzing sounds; male moths detect pheromones.
2. Male crickets produce several calls that differ from those of other cricket species.
3. Workers and the queen are female; the workers are sterile.
4. When the honey supply begins to run low.
5. Close relatives share many genes with the individual who performs the altruistic behavior, including the genes that code for that behavior. Those genes will remain in the population if the relatives reproduce successfully.

STRUCTURES AND FUNCTIONS
a, round dance, which indicates that a food source is near the hive; b, waggle dance, which indicates the direction and distance to a food source

Section 38-1
VOCABULARY REVIEW
1. An ossicle is a calcium carbonate plate that makes up the endoskeleton of an echinoderm; a test is the compact, rigid endoskeleton of a sea urchin or sand dollar.
2. A tube foot is a small, movable extension of an echinoderm’s water-vascular system that aids in movement; an ampulla is a bulblike sac at the upper end of each tube foot.
3. Both are parts of a sea star’s digestive tract; the cardiac stomach can be turned inside out to partially digest outside the sea star, and the pyloric stomach completes food digestion inside the sea star.
4. The water-vascular system is a network of water-filled canals that aid movement. The radial canal is part of the water-vascular system and carries water to the tube feet in the arms.

MULTIPLE CHOICE
1. d 2. c 3. a 4. b 5. b

SHORT ANSWER
1. Echinoderm larvae are bilaterally symmetrical, which indicates that echinoderms probably evolved from bilaterally symmetrical ancestors.
2. Basket star, Ophiuroidae; sea star, Asteroidea; feather star, Crinoidea; brittle star, Ophiuroidae.
3. A nerve ring circles the mouth, a radial nerve runs from the nerve ring along the length of each arm, and a nerve net extends near the body surface. The sea star also has an eyespot near the end of each arm and several tentacles that respond to touch.
4. Eggs are fertilized externally and develop into free-swimming larvae. The larvae settle down and develop into adults.
5. A sea star may shed an arm at its base if the arm is captured by a predator.
6. Since sea stars are radially symmetrical, no particular part of a sea star always leads when the animal moves through its environment. Therefore, there is no advantage to having sensory structures and a neural center concentrated at one end.

STRUCTURES AND FUNCTIONS
a, skin gill; b, spine; c, pedicellaria; d, tube feet; e, sensory tentacles; f, eyespot

Section 38-2
VOCABULARY REVIEW
1. A notochord is a stiff, flexible rod of cells that runs the length of the body near the dorsal surface of a chordate.
2. A lancelet is a blade-shaped chordate belonging to the subphylum Cephalochordata.
3. A tunicate is a sessile, barrel-shaped chordate belonging to the subphylum Urochordata.
4. An atriopore is an opening through which water leaves the body of a lancelet.

MULTIPLE CHOICE
1. a 2. c 3. b 4. d 5. c

SHORT ANSWER
1. A notochord, a dorsal nerve cord, pharyngeal pouches, and a postanal tail.
2. Lancelets use their tail to swim weakly and to wriggle backward into the sand.
3. Tunicates are protected by a tough covering called a tunic.
4. They squirt out a stream of water when touched.
5. A larval tunicate has all four chordate characteristics, but an adult tunicate has only one: a pouch-like pharynx with slits.
6. Like sponges, most adult tunicates are sessile animals that feed by filtering food from the water; they are also hermaphrodites, as are most sponges. Unlike sponges, tunicates have true tissues and organs; water enters an adult tunicate through a single opening, while it enters a sponge through numerous pores.

STRUCTURES AND FUNCTIONS
a, notochord; b, dorsal nerve cord; c, pharynx; d, atriopore; e, segmented muscles; f, postanal tail.
Section 39-1

VOCABULARY REVIEW
1. A vertebra is bone or cartilage that surrounds and forms the dorsal nerve cord in the spine.
2. A cranium is a skull, which protects the brain.
3. A gill arch is a skeletal element that supports the pharynx.

MULTIPLE CHOICE
1. c 2. b 3. a 4. d 5. c 6. b

SHORT ANSWER
1. Both groups lack or lacked jaws and paired fins, and both have or had cartilaginous skeletons.
2. The skin of amphibians is thin and permeable to gases and water; the skin of reptiles is dry and scaly.
3. Horses belong to the class Mammalia; animals in that class have hair and nurse their young.
5. Fishes in the class Chondrichthyes have jaws and paired fins. Paired fins increase stability and maneuverability, and jaws make it possible to seize and manipulate prey. These adaptive advantages allowed fishes in the class Chondrichthyes to diversify into numerous species and to be more successful predators than those in the class Cephalaspidomorphi.

STRUCTURES AND FUNCTIONS
a. Myxini; b. Cephalaspidomorphi; c. Chondrichthyes; d. Actinopterygii; e. Sarcopterygii; f. Amphibia; g. Reptilia; h. Aves; i. Mammalia

Section 39-2

VOCABULARY REVIEW
1. The lateral line is a system of canals in the skin that are lined with sensory structures that detect vibrations in the water.
2. Cartilage is a flexible, lightweight material made of cells surrounded by tough fibers of protein.
3. A placoid scale is one of many small, toothlike spines that cover the skin of a cartilaginous fish.
4. Chemoreception is the ability to detect chemicals in the environment.

MULTIPLE CHOICE
1. b 2. d 3. a 4. c 5. a

SHORT ANSWER
1. A hagfish burrows into the body of a dead or dying fish or invertebrate and pinches off chunks of tissue with two movable plates and a rough tonguelike structure in its mouth.
2. Sharks that feed on large fish or mammals have large triangular teeth with sawlike edges that hook and tear flesh.
3. Cartilaginous fishes can move water over their gills by swimming with their mouth open and by expanding and contracting their mouth cavity and pharynx.
4. Fertilization in lampreys occurs outside the body of either parent, but fertilization in cartilaginous fishes occurs inside the body of the female.
5. Jawless fishes should produce more gametes since fertilization occurs externally. With external fertilization, there is a lower chance that sperm and eggs will meet. Producing more gametes increases the chances of fertilization.

STRUCTURES AND FUNCTIONS
a. caudal fin; b. dorsal fin; c. spiracle; d. nostril; e. pelvic fin; f. clasper; g. anal fin; h. gill slit; i. pectoral fin

Section 39-3

VOCABULARY REVIEW
1. A swim bladder is a gas-filled sac that many bony fishes use to control buoyancy.
2. A lobe-finned fish has fleshy fins that are supported by a series of bones with a central bony axis.
3. A ray-finned fish has fins that are supported by long, segmented, flexible, bony elements.
4. In countercurrent flow, water flows across the gill filaments in a direction opposite to blood flow.

MULTIPLE CHOICE
1. a 2. c 3. b 4. d 5. d

SHORT ANSWER
1. The scales grow quickly when food is abundant and grow slowly when food is scarce.
2. The kidneys and the gills are involved in maintaining water-and-ion balance.
3. A bony fish adjusts its buoyancy by varying the amount of gas in its swim bladder.
4. Fertilization occurs externally in most species.
5. Faulty valves would allow blood to flow back into the ventricle, making delivery of blood to the gills less efficient. Body cells would therefore receive less oxygen and make less ATP.

STRUCTURES AND FUNCTIONS
a. conus arteriosus; b. atrium; c. sinus venosus; d. ventricle

Section 40-1

VOCABULARY REVIEW
1. A preadaptation is an adaptation in an ancestral group that allows a shift to new functions, which are later favored by natural selection.
2. A tadpole is a swimming, tailed larva of an anuran.

MULTIPLE CHOICE
1. c 2. a 3. d 4. a 5. d

SHORT ANSWER
1. The two groups of animals have similar skulls and vertebral columns, and the bones in the fin of a lobe-finned fish are similar to the bones in the limb of an amphibian.
2. Ichthyostega had a large tail fin, lateral-line canals on its head, and large, sharp teeth adapted to preying on fish.
3. Amphibians can use gills, lungs, and skin for gas exchange.
4. A frog usually has smooth, moist skin and a compact body with a short, rigid spine; a salamander also has moist skin but has an elongated body.
5. It is likely to make them clearly visible and recognizable to predators, reducing the chance that a predator will mistake them for a nonpoisonous species and attack them.
Section 40-3

VOCABULARY REVIEW
1. Amplexus is a mating behavior in which a male frog climbs onto the back of a female and grasps her firmly in an embrace.
2. Thyroxine is a hormone produced by the thyroid gland and that stimulates metamorphosis in amphibians.

MULTIPLE CHOICE
1. a 2. c 3. d 4. b 5. c

SHORT ANSWER
1. Male frogs call to attract females of their own species and to warn off other males.
2. The legs grow; the tail disappears; the gills disappear; the mouth broadens; the teeth develop; the jaws develop; the lungs become functional.

Section 41-1

VOCABULARY REVIEW
1. The amnion is a thin membrane that encloses the fluid surrounding the embryo of a reptile, mammal, or bird.
2. The allantois is a membrane in the amniotic egg that stores nitrogenous wastes produced by the embryo.
3. The chorion is a membrane that surrounds all of the other membranes in an amniotic egg and helps protect the embryo.
4. Albumen is a mixture of protein and water contained in an amniotic egg.
5. Keratin is protein in fingernails, hair, and skin.

MULTIPLE CHOICE
1. b 2. d 3. a 4. c 5. b

SHORT ANSWER
1. Sediments from the end of the Cretaceous period contain high concentrations of iridium, which is relatively abundant in asteroids. Sediments from this time also contain quartz crystals that were deformed by a powerful force. A large impact crater dating from this time exists on the Yucatán Peninsula.
2. The shell provides protection from physical damage, limits evaporation of water from the egg, and allows exchange of oxygen and carbon dioxide.
3. Whereas an amphibian’s skin is thin and moist, a reptile’s skin is thick and dry; this prevents water loss and protects against the wear and tear of terrestrial environments.
4. As the continents drifted to new locations on Earth’s surface, their climates and vegetation changed, causing species to evolve in different directions on different continents.

Section 41-2

VOCABULARY REVIEW
1. Alveoli are numerous small sacs in the lungs.
2. Jacobson’s organ is located in the roof of the mouth of reptiles and is sensitive to odors.
3. An ectotherm is an animal that warms its body by absorbing heat from its surroundings.
4. Viviparity is a reproductive pattern in which a shell does not form around the egg and the young are retained within the female’s body until they are mature enough to be born.
5. A placenta is a structure through which nutrients and oxygen are transferred from the mother to the embryo.
MULTIPLE CHOICE
1. d  2. c  3. b  4. a  5. b

SHORT ANSWER
1. when it is inactive, when it is underwater, or when it needs to raise its body temperature quickly
2. A snake detects ground vibrations by transmitting the vibrations through the bones of its jaw and its columella to its inner ear.
3. A pit viper detects warm objects with the heat-sensitive pits below its eyes.
4. basking in the sun, staying in the shade, using different body positions, and panting
5. A female crocodile builds a nest, guards against predators while the eggs incubate, opens the nest when the eggs hatch, carries the hatchlings to the water in her mouth, and may protect the young for a year or more.
6. In most reptiles, the egg is enclosed in a shell inside the mother, so it must be fertilized internally before the shell is formed. In viviparous reptiles, the embryo is without a shell but develops inside the mother, so fertilization must also be internal in these reptiles.

STRUCTURES AND FUNCTIONS
a, right atrium; b, septum; c, left atrium; d, ventricle.
In e, the arrow should point toward the end of the left pulmonary artery; in f, the arrow should point toward the right half of the ventricle; in g, the arrow should point toward the left half of the ventricle.

Section 41-3
VOCABULARY REVIEW
1. A carapace is the dorsal part of the shell of a turtle or tortoise.
2. Autotomy is the ability of an animal to detach its tail or other body part.
3. A constrictor is a snake that suffocates its prey by wrapping its body around the prey and squeezing each time the prey exhales.
4. An elapid is a snake that injects poison through two small, fixed fangs in the front of its mouth.

MULTIPLE CHOICE
1. a  2. c  3. c  4. d  5. b

SHORT ANSWER
1. The shell is streamlined and disk-shaped, permitting rapid turning in water; the limbs have webbed feet or have evolved into flippers for swimming and maneuvering.
2. A snake has jaws that are loosely hinged, can move independently, and can open to an angle of 130 degrees; the jaw, palate, and parts of the skull are joined by a flexible, elastic ligament.
3. A viper injects venom through large, mobile fangs in the front of its mouth that swing forward when the viper strikes.
4. Tuatara means “spiny crest”; tuataras, which are the only members of the order Rhynchocephalia, have a spiny crest that runs down their back.
5. Snakes move by extending and contracting the overlapping scales on their body. If a surface is very smooth, it will have no projections for the scales to push against, making it difficult for snakes to move forward.

Section 42-1
VOCABULARY REVIEW
1. A furcula is a bone formed from the fused collarbones in a bird and is commonly called the wishbone.
2. A beak is a tough, horny sheath that covers a bird’s jaws.

MULTIPLE CHOICE
1. c  2. a  3. b  4. b  5. d  6. a

SHORT ANSWER
1. Feathers are important for flight and for insulating a bird’s body against heat loss.
2. The lungs are connected to several sets of air sacs; this arrangement ensures that oxygen-rich air is always in the lungs.
3. Similarities include a flexible, S-shaped neck, a unique ankle joint, and hollow bones.
4. One hypothesis states that the ancestors of birds were tree dwellers that evolved wings that enabled them to glide from tree to tree. Another hypothesis states that the ancestors of birds were ground dwellers; initially, their wings might have stabilized them as they leapt after prey, or they might have been used to trap or knock down prey.
5. Birds’ thin-walled, hollow bones break down easily, so they are not often preserved as fossils. Also, feathers rarely leave fossil imprints.

STRUCTURES AND FUNCTIONS
The order of animals from left to right is mammals, reptiles, dinosaurs, birds.

Section 42-2
VOCABULARY REVIEW
1. The shaft of a feather emerges from the follicle and supports the structures of the feather; the vanes develop on opposite sides of the shaft and contain the branches of the feather.
2. A barb is one of many branches that arise from the shaft of a feather; a barbule is one of many projections with microscopic hooks that arise from each barb.
3. The sternum, or breastbone, is an attachment point for flight muscles; the pygostyle is the terminal fused vertebrae of the spine in a bird, and it supports the tail feathers.
4. The proventriculus is the first chamber of a bird’s stomach; the gizzard is the second, muscular portion of a bird’s stomach.
5. Precocial young can move about and feed themselves as soon as they hatch; altricial young hatch blind, naked, and helpless.

MULTIPLE CHOICE
1. b  2. c  3. a  4. b  5. d  6. d
SHORT ANSWER
1. It provides lift and aids in steering and braking.
   2. A bird filters uric acid from its blood in the kidneys and transports the uric acid in ureters to the cloaca, where the acid mixes with undigested matter from the intestines before it is eliminated.
3. It permits better binocular vision, meaning that depth can be perceived in the area where the visual fields of the two eyes overlap.
4. position of the stars or the sun, topographical landmarks, Earth’s magnetic field, changes in air pressure due to altitude, and low-frequency sounds.
5. Because the preen gland contains oil that is needed to keep the feathers smooth and water-resistant, the feathers would dry out and lose their smooth contour. This, in turn, would affect the bird’s ability to fly and reduce its protection against wet or damp conditions.

STRUCTURES AND FUNCTIONS
a, proventriculus; b, gizzard; c, kidney; d, large intestine; e, cloaca; f, crop; g, heart

Section 42-3
VOCABULARY REVIEW
1. A syrinx is a structure located at the base of a bird’s trachea that produces songs.
2. Crop milk is a nutritious milklike fluid secreted by the crop of birds in the order Columbiformes.

MULTIPLE CHOICE
1. d  2. a  3. c  4. b  5. d  6. b

SHORT ANSWER
1. A kestrel has talons that enable it to grip and kill prey; a goose has webbed feet that it uses for paddling and swimming.
2. Raptors are members of the order Ciconiiformes and include ospreys, hawks, falcons, vultures, and eagles; raptors are found throughout the world.
3. Passerines have a rear toe that is enlarged and particularly flexible; this allows the feet to provide a better grip on branches.
4. They suggest that homing pigeons rely on the position of the sun and Earth’s magnetic field to navigate. When the sun is visible, the birds can navigate. When the sun is not visible, presence of the magnet interferes with their ability to use Earth’s magnetic field.

STRUCTURES AND FUNCTIONS
hawk, Ciconiiformes; blue jay, Passeriformes; great blue heron, Ciconiiformes; owl, Strigiformes; mallard, Anseriformes

Section 43-1
VOCABULARY REVIEW
1. A mammary gland is a milk-producing, modified sweat gland located on the thorax or abdomen of a mammal.
2. A monotreme is a member of the group of oviparous mammals.
3. A marsupial is a viviparous mammal in which the young develop within a pouch on the mother’s body for some time after birth.

MULTIPLE CHOICE
1. c  2. a  3. b  4. d  5. a

SHORT ANSWER
1. Hair insulates the body against heat loss.
2. a single opening in the outer layer of its skull behind the eye socket, a saillike structure on its back, and a mouth with long bladelike teeth in the front and smaller teeth toward the back.
3. Like modern terrestrial mammals but unlike Dimetrodon, Lycaenops had limbs positioned directly beneath its body. Lycaenops also had endothermic metabolism and hair.
4. Cretaceous period: dinosaurs; today: mammals; The extinction of the dinosaurs is responsible for this change.
5. Fossil evidence shows that early mammals were small; they had large eye sockets, suggesting that they were active at night. Small animals tend to lose body heat quickly because of their large surface-area-to-volume ratio. Body hair would have helped early mammals retain body heat.

STRUCTURES AND FUNCTIONS
The skull on the left is from the group that gave rise to mammals; it has a single opening in the skull just behind the eye socket and teeth in different parts of the jaw that are modified for different functions. The skull on the right is from the group that gave rise to modern reptiles; its teeth are uniform in size and shape.

Section 43-2
VOCABULARY REVIEW
1. The diaphragm is a sheet of muscle below the rib cage of a mammal. It functions to draw air into the lungs.
2. Baleen is a set of thin plates of keratin material that hang from the upper jaw of some whales.
3. Echolocation is a process by which some mammals locate objects by emitting high-frequency sound waves and analyzing the returning echoes.
4. A rumen is a chamber in the stomach of some herbivorous mammals; it contains microorganisms that digest cellulose.

MULTIPLE CHOICE
1. b  2. a  3. c  4. d  5. a

SHORT ANSWER
1. Mammalian lungs have a large internal surface area for gas exchange; this enables the lungs to supply oxygen rapidly to sustain a rapid metabolism.
2. Microorganisms that live in the rumen or cecum break down the cellulose contained in plants, producing small molecules that can be absorbed into the mammal’s bloodstream.
3. the cerebrum; it evaluates input from the sense organs, controls movement, initiates and regulates behavior, and is involved in memory and learning.
4. When a fertilized egg attaches to the lining of the uterus, extensions from the chorion grow into the lining and are surrounded by blood vessels from the uterus.
5. Animals in the north generally encounter colder weather; their small extremities have small surface-area-to-volume ratios and thus are adapted to conserving body heat. Animals in the south generally encounter hotter weather; their large extremities have large surface-area-to-volume ratios and thus are adapted to dissipating body heat.

**STRUCTURES AND FUNCTIONS**

a. right atrium; b. right ventricle; c. left atrium; d. left ventricle; e. septum; f. away from heart; g. toward a, right atrium; b, right ventricle; c, left atrium; d, left ventricle; e, septum; f, away from heart; g, toward heart; h, away from heart; i, away from heart; j, toward heart; k, away from heart; l, toward heart

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**Section 43-3**

**VOCABULARY REVIEW**

1. A pinniped is an aquatic carnivore, such as a seal.
2. An ungulate is a mammal with hooves.

**MULTIPLE CHOICE**

1. a  2. b  3. d  4. c  5. b  6. a

**SHORT ANSWER**

1. The order is Artiodactyla. The animal is more likely to have four toes than three.
2. order Primates; most primates are omnivores, have teeth suited for a varied diet, have large brains, have forward-facing eyes, and have grasping hands and feet.
3. The small size of shrews causes them to lose body heat quickly. To maintain a constant, high body temperature, they must have a high metabolic rate. Therefore, they must eat frequently.

**STRUCTURES AND FUNCTIONS**

dolphin, Cetacea; bat, Chiroptera; opossum, Marsupialia; platypus, Monotremata; bear, Carnivora; elephant, Proboscidea

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**Section 43-4**

**VOCABULARY REVIEW**

1. A prehensile appendage is an appendage, such as hands, feet, or tails, that can grasp.
2. An opposable thumb can touch the other fingers.
3. Bipedalism is the tendency to walk upright on two legs.
4. A hominid is a human or extinct humanlike anthropoid species.

**MULTIPLE CHOICE**

1. c  2. a  3. b  4. d  5. a

**SHORT ANSWER**

1. What causes the behavior? What is the role of genes in the behavior? How is the behavior's evolutionary history? How does the behavior affect survival and reproduction?
2. Adult male lions will kill cubs that are not their own in order to mate with females of the pride and produce more offspring males who do not kill cubs. Thus, natural selection favors the alleles that cause male lions to kill cubs.
3. web-building in orb spiders, response of a hognose snake to a predator, egg retrieval in Greylag geese
4. Habituation saves energy and preserves defenses in the event of a genuine emergency.
5. Using a computer is a learned behavior that frequently involves operant conditioning, or trial-and-error learning. It may involve habituation to certain sounds the computer makes. It may involve problem-solving learned by watching others use the computer.

**STRUCTURES AND FUNCTIONS**

a. innate; b. egg retrieval in Greylag geese; c. habituation; d. learned; e. learned; f. pressing a lever to get food; g. learned; h. salivating in response to a bell tone; i. reasoning; j. learned; k. imprinting; l. learned
Section 44-2
VOCABULARY REVIEW
1. A dominance hierarchy is the ranking of individuals in a group to minimize conflict.
2. Monogamy would be favored when it is advantageous for both parents to participate in raising the young.
3. The cost of parental care is the large energy investment by the parent, which results in fewer young being provided with care. The benefit is that it increases the likelihood that young will survive to adulthood.
4. The behaviors can be explained by the optimality hypothesis. The availability of pine seeds affected the food-gathering behavior of the crossbills: when pine seeds were abundant, the birds remained in one tree; when pine seeds were scarce, the birds moved from tree to tree.

SHORT ANSWER
1. A dominance hierarchy is the ranking of individuals in a group to minimize conflict.
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Section 45-1
VOCABULARY REVIEW
1. It senses changes in the internal and external environment, interprets sensory information, causes the body to move in response to sensory information, and coordinates voluntary and involuntary activities and regulation of some body processes.
2. It provides structure and support, moves trunks and limbs, and moves substances through the body.
3. It moves the bones in the trunk, limbs, and face.
4. It lines or covers all internal and external body surfaces, providing a protective barrier.
5. It binds, supports, and protects structures in the body.

MULTIPLE CHOICE
1. c 2. a 3. d 4. d 5. c

SHORT ANSWER
1. skeletal, smooth, and cardiac
2. Tissues compose organs, and organs compose organ systems.
3. Connective tissue is characterized by cells that are embedded in matrix.

Section 45-2
VOCABULARY REVIEW
1. The axial skeleton consists of the skull, ribs, spine, and sternum. The appendicular skeleton consists of bones of the arms, legs, scapula, clavicle, and pelvis.
2. Periosteum covers the bone's surface. Compact bone is the hard material under the periosteum. Both tissues enable bones to withstand stress.
3. Both are contained within the core of a bone.
4. Bones elongate as ossification of cartilage cells occurs at the epiphyseal plates.
5. Ligaments hold the bones of a joint in place.

MULTIPLE CHOICE
1. a 2. c 3. b 4. a 5. d

SHORT ANSWER
1. Bones provide structure and support, give shape and structure to the body, protect internal organs, and provide a framework for muscles.
2. ball and socket, shoulder; hinge joint, elbow; saddle joint, thumbs; pivot joint, top two vertebrae of the human spine; gliding joint, small bones of foot
3. Red bone marrow produces red and white blood cells, and yellow bone marrow serves as an energy reserve.
4. Bone growth is dependent on the availability of calcium. The bones store calcium. If calcium is needed elsewhere in the body, it is taken from the bones. Therefore, calcium intake is necessary to maintain bone health.

Section 45-3
VOCABULARY REVIEW
1. Voluntary muscles can usually be controlled consciously, but involuntary muscles cannot be controlled consciously.

4. Nervous tissue receives and transmits messages in the form of electrical impulses.
5. Yes; for example, the skin has several functions. As part of the integumentary system, it protects against pathogens and helps regulate body temperature. As part of the excretory system, it excretes waste products.

STRACTURES AND FUNCTIONS
1. a, cranial cavity; b, spinal cavity; c, thoracic cavity; d, abdominal cavity; e, pelvic cavity
2. the spinal cavity and cranial cavity
3. They protect delicate internal organs and permit some organs, such as the lungs, to expand and contract while remaining securely supported.
2. The origin is where the muscle attaches to the stationary bone. The insertion is where the muscle attaches to the moving bone.

3. A flexor is a muscle that bends a joint. An extensor is a muscle that straightens a joint.

4. Myosin is a protein that makes up the thick filaments in myofibrils, whereas actin is a protein that makes up the thin filaments of myofibrils.

5. Muscle fatigue is the physiological inability of a muscle to contract. Oxygen debt is a temporary lack of oxygen availability due to sustained strenuous exercise.

MULTIPLE CHOICE
1. b  2. c  3. d  4. a  5. a

SHORT ANSWER
1. through sustained exertion; this occurs if the respiratory and circulatory systems are not able to supply the body with sufficient oxygen to maintain ATP synthesis

2. Myosin and actin filaments interact to shorten the length of a sarcomere. A nerve impulse causes the heads of the myosin filaments to attach to points between the heads of the actin filaments, bending the heads inward and pulling the actin filaments with them. Synchronized shortening of sarcomeres in a muscle causes the muscle to contract.

3. Skeletal muscle tissue is made of elongated cells called muscle fibers. Each fiber has many nuclei. The fibers are crossed by light and dark stripes, which give the tissue its striped appearance. Smooth muscle tissue is made of spindle-shaped cells with a single nucleus that form sheets of muscle tissue. Smooth muscle is surrounded by connective tissue and is not controlled voluntarily. Cardiac muscle, which makes up the walls of the heart, is striated like skeletal tissue and is involuntary. Each cell has a single nucleus.

4. Antagonistic muscles are muscles that work against one another. Therefore, the contractions of flexors and extensors have opposite effects; extensors open a joint, and flexors close a joint.

STRUCTURES AND FUNCTIONS
1. a, biceps; b, insertion; c, radius; d, ulna; e, origin; f, humerus; g, scapula; h, triceps
2. flexor: bicep; extensor: triceps
3. Insertion of a is the radius. Origin of a is the scapula.

Section 45-4

VOCA VULARY REVIEW
1. Exocrine glands release secretions through ducts.
2. Melanin is a pigment produced by cells in the lower layers of the epidermis.
3. Sebum is a fatty substance secreted by oil glands that helps soften and waterproof skin.
4. Keratin is a protein in skin, hair, and nails.
5. Sweat glands function as excretory organs through the release of excess water, salts, and urea. They regulate body temperature by releasing sweat, which cools the body when it evaporates.

SHORT ANSWER
1. It is a barrier that protects the body, retains body fluid, protects against disease, eliminates waste products, and regulates body temperature.
2. It causes skin damage, which causes an increase in melanin production.
3. The epidermis is the outer barrier of the skin and is the first defense against disease, water loss, and ultraviolet radiation damage.
4. Both have clusters of root or base cells, contain dead cells, and have cells that are filled with keratin.
5. Concentrated melanin production in certain areas of the skin causes moles and freckles.

STRUCTURES AND FUNCTIONS
1. a, epidermis; b, dermis; c, muscle fibers; d, blood vessel; e, oil gland; f, pore; g, hair; h, hair follicle; i, sweat gland
2. The epidermis and hair contain keratin.
3. The dermis contains various kinds of sensory neurons that respond to signals, such as heat and pressure.

Section 46-1

VOCA VULARY REVIEW
1. Each side of the heart is divided into an upper chamber (an atrium) and a lower chamber (a ventricle).
2. The sinoatrial node sends electrical impulses to the atrioventricular node, which then relays electrical impulses to the muscles of the ventricles and causes them to contract.
3. Arteries are large, muscular vessels that carry blood away from the heart. Veins carry blood to the heart.
4. In pulmonary circulation, blood travels between the heart and lungs. In systemic circulation, blood travels between the heart and other body tissues.

MULTIPLE CHOICE
1. b  2. d  3. b  4. c  5. b

SHORT ANSWER
1. Deoxygenated blood moves from the right atrium to the right ventricle and then to the lungs. Oxygenated blood returns from the lungs to the left atrium and then moves into the left ventricle. Oxygenated blood is pumped from the left ventricle and circulates throughout the body. Deoxygenated blood returns to the right atrium.
2. It returns fluids that have collected in the tissues to the bloodstream. It also traps foreign particles, microorganisms, and other tissue debris.
3. Diastolic; if blood flowed back into the left ventricle after contraction, less blood would remain in the arteries, reducing the blood pressure when the heart is relaxed.

STRUCTURES AND FUNCTIONS
1. a, aorta; b, superior vena cava; c, right atrium; d, tricuspid valve; e, right ventricle; f, inferior vena cava; g, pulmonary artery; h, left atrium; i, pulmonary veins; j, mitral valve; k, left ventricle
2. Blood would leak from the left ventricle back into the left atrium, causing reduced systemic blood flow and possible oxygen deficiency.
Section 46-2

VOCABULARY REVIEW
1. Leukocytes help defend the body from disease. Phagocytes are a type of leukocyte that engulf invading microorganisms.
2. An antigen is a protein or carbohydrate that causes the body to produce antibodies, which are defensive proteins.
3. Erythrocytes synthesize large amounts of hemoglobin, which carries oxygen.
4. Platelets are cell fragments involved with blood clotting. Fibrin is a protein that traps red blood cells during clotting.

MULTIPLE CHOICE
1. d  2. c  3. b  4. d  5. c

SHORT ANSWER
1. In the blood, oxygen is bonded to molecules of hemoglobin in red blood cells for transport.
2. Structural differences include: no nucleus in the RBC, but a nucleus in the WBC; one type of RBC, but several types of WBC; and a higher number of RBC in circulation, but a lower number of WBC in circulation. Functional differences include: RBCs transport gases, while WBCs fight diseases; a short life span for RBCs, and a long life span for WBCs.
3. All other blood types contain anti-A or anti-B antibodies. A person with type AB blood will have RBCs with A and B antigens, and mixing anti-A or anti-B antibodies with type AB blood would be harmful.
4. Platelets congregate at a damaged site, sticking together and forming a small plug. Platelets release clotting factors, which begin a series of reactions to produce fibrin. Fibrin produces a net that traps other cells and forms a clot.
5. Because hemoglobin requires a molecule of iron to complete its formation, lack of dietary iron might impair the synthesis of hemoglobin. Hemoglobin carries oxygen; therefore, lack of hemoglobin could impair the oxygen carrying capacity of blood.

STRUCTURES AND FUNCTIONS
1. Type O blood does not contain antigens that would react with any antibodies that the recipient might have.
2. Antibodies to antigens A and Rh will cause agglutination, resulting in blocked vessels in the recipient’s body.

Section 46-3

VOCABULARY REVIEW
1. When food is swallowed, the epiglottis covers the trachea. During inspiration, the epiglottis allows air to pass into the trachea.
2. Vocal sounds are produced when air is expired past the vocal chords in the larynx.
3. The trachea branches into two bronchi, each of which leads to a lung. Bronchi branch into smaller tubes called bronchioles.
4. Alveoli are filled with air during inspiration.

MULTIPLE CHOICE
1. d  2. c  3. d  4. b  5. c

SHORT ANSWER
1. Yes; it conducts air between the external environment and the lungs.
2. Most CO₂ is transported as bicarbonate ions. When CO₂ diffuses into plasma, it interacts with an enzyme that converts CO₂ to carbonic acid. The carbonic acid spontaneously breaks down to bicarbonate ions and a proton. Bicarbonate ions are very soluble in the plasma. About a quarter of CO₂ is bound to hemoglobin.
3. The ribs are important for expiration. The muscles between the ribs relax during expiration permitting the ribs to fall. As a result, the thoracic cavity decreases in volume.
4. One possible cause is poor oxygen delivery to cells because of red blood cell deficiency. Other possibilities include impaired blood circulation, defective hemoglobin (sickle cell anemia), damaged lungs, heart, or diaphragm (emphysema), fluid in the alveoli (pneumonia), and living at a very high altitude.

Section 47-1

VOCABULARY REVIEW
1. Koch’s postulates are rules for determining the cause of a given disease.
2. Interferon is a protein produced by virally infected cells. It inhibits the reproduction of viruses by stimulating neighboring cells to produce protein that helps them resist viral infection.
3. Histamine is a chemical messenger that increases blood flow to an injured area and increases the permeability of the surrounding capillaries.
4. Natural killer cells are large white blood cells that attack cells that have been infected by pathogens.

MULTIPLE CHOICE
1. b  2. c  3. d  4. d  5. b

SHORT ANSWER
1. Neutrophils infiltrate damaged areas and engulf invading pathogens.
2. Interferon inhibits the reproduction of viruses by stimulating neighboring cells to produce protein that helps them resist viral infection.
3. The first line of defense includes the skin and mucous membranes. Mucous membranes protect interior surfaces of the body by secreting mucus, a sticky fluid that traps pathogens. Skin serves as a physical barrier to pathogens.
4. Moderate fever stimulates the body’s defense mechanisms by suppressing growth of some bacteria and promoting the action of some white blood cells. Thus, taking aspirin to reduce fever could slow the recovery.

STRUCTURES AND FUNCTIONS
1. from top to bottom, 2, 5, 1, 4, 3
2. It permits neutrophils to squeeze through the capillary walls to reach the site of an infection.
3. The cold ice would cause constriction of blood vessels and therefore inhibit blood flow to a wounded area. Thus, the flow of white blood cells to the area would be reduced, and the inflammatory response would be suppressed.

Section 47-2

VOCABULARY REVIEW
1. A plasma cell is a specialized cell that arises from a B cell and produces antibodies.
2. An antigen is any substance that the immune system does not recognize as part of the body and that provokes an immune response.
3. Memory cells are T cells and B cells that don’t respond the first time they are exposed to a pathogen but will recognize and attack it during later infections.
4. Antibodies are defensive proteins that attach to specific antigens and inactivate them or trigger their destruction by nonspecific defenses.
5. Allergy is an immune response to a harmless antigen that results in harm to the allergic individual.

MULTIPLE CHOICE
1. c 2. c 3. a 4. b 5. b

SHORT ANSWER
1. When a macrophage that displays a pathogen’s antigen on its surface binds to a helper T cell with a receptor matching the antigen, interleukin is released and T cells divide.
2. Vaccines contain the antigens of dead or weakened pathogens. The vaccine causes an immune response and the production of memory cells, which protect the individual from the disease.
3. Antibodies attach to viral surface proteins and prevent the virus from entering host cells and reproducing. Antibodies also cause viruses to clump together, which helps macrophages to engulf the pathogens.
4. T cells would be the cause because if helper T cells are not activated to secrete interleukins, the cytotoxic T cells and B cells will not become activated.

STRUCTURES AND FUNCTIONS
1. a, macrophage; b, helper T cell; c, B cell; d, antigen; e, infected cell; f, cytotoxic T cell; g, antibody; h, plasma cell
2. exposure to a pathogen and production of interleukin-1 and interleukin-2
3. An enzyme that destroys cytokines could destroy interleukin-1 and interleukin-2. Such an enzyme would inhibit the immune response.

Section 47-3

VOCABULARY REVIEW
1. Helper T cells are infected by HIV. The onset of AIDS occurs when the number of helper T cells falls below 200/mL of blood.
2. HIV is the cause of AIDS.
3. Opportunistic infection are infections that are usually stopped by a healthy immune system but succeed when the immune system is impaired, as in the case of AIDS.

MULTIPLE CHOICE
1. c 2. c 3. a 4. c 5. b

SHORT ANSWER
1. No; most AIDS patients die from opportunistic infections.
2. Yes; the immune system is able to combat HIV initially. This period of infection without symptoms may last up to 10 years following infection.
3. Transfer of body fluids through sexual contact, sharing hypodermic syringes, and transfer of fluids between mother and fetus or infant
4. Yes; HIV particles or infected cells may be found within the transplanted organs or skin grafts. This risk is known, and donor organs and grafts are tested for HIV.

STRUCTURES AND FUNCTIONS
1. AIDS began six years after infection.
2. The number of helper T cells has decreased so much that plasma cells can no longer be stimulated to produce HIV antibody.

Section 48-1

VOCABULARY REVIEW
1. The six basic nutrients are carbohydrates, proteins, lipids, vitamins, minerals, and water.
2. An unsaturated fat is a fatty acid that has at least one double bond between carbon atoms.
3. Vitamins function as coenzymes; that is, they activate enzymes and help them function.
4. Dehydration causes the fluid volume of the body to decrease. Water moves from intercellular spaces to blood by osmosis. Eventually water is drawn from the cells. As water is drawn, the cytoplasm becomes more concentrated until the cell can no longer function. Dehydration also impairs the body’s ability to regulate its temperature.

MULTIPLE CHOICE
1. d 2. a 3. d 4. c 5. c

SHORT ANSWER
1. Essential amino acids are those amino acids that must be obtained from food. Nonessential amino acids can be produced by the body.
2. Simple sugars are important because they represent the final carbohydrate that must be formed before it can be used for energy production.
3. Water is important because it is a medium for chemical reactions, it constitutes 90% of blood volume, it is used in waste removal, and it helps regulate body temperature.
4. Nutrients are required for proper function and growth.

STRUCTURES AND FUNCTIONS
1. group a, the carbohydrates
2. group c, animal products. No, essential amino acids are also obtained from plant products and legumes.

Section 48-2

VOCABULARY REVIEW
1. The pharynx serves as a passageway for air to the trachea and food to the esophagus. The epiglottis is a flap that prevents food from entering the trachea during swallowing.
2. An ulcer can develop when the mucous coating of the stomach breaks down, allowing the enzymes contained in gastric fluid to eat through the stomach lining.
3. Peristalsis moves digested material into the colon.
4. The pyloric sphincter, a circular muscle between the stomach and small intestine, regulates the flow of chyme, digested material formed by the stomach, from the stomach to the small intestine.
5. The gastrointestinal tract includes the small intestine, which is lined with numerous villi where absorption of nutrients occurs.

MULTIPLE CHOICE
1. b  2. d  3. b  4. c  5. c

SHORT ANSWER
1. Mucus protects the stomach’s inner lining from digestive secretions.
2. Pepsin, an enzyme, catalyzes the breakdown of proteins to peptides.
3. The pancreas secretes pancreatic fluid into the small intestine. Pancreatic fluid neutralizes stomach acid and has enzymes that hydrolyze disaccharides into monosaccharides, fats into fatty acids and glycerol, and proteins into amino acids.
4. The richest supply of blood capillaries should be in the walls of the small intestine, specifically the ileum and jejunum. These are the areas where the absorption of the digested nutrients occurs.

STRUCTURES AND FUNCTIONS
1. a. esophagus; b. liver; c. colon; d. rectum; e. mouth; f. stomach; g. small intestine
2. The liver stores glycogen, breaks down toxic substances, and secretes bile, which digests fats.
3. Absorption takes place in the small intestine, where villi and microvilli greatly increase the surface area.

Section 48-3
VOCABULARY REVIEW
1. The nephron is the functional unit of the kidney where urine is produced.
2. The urethra is the tube through which urine passes from the urinary bladder out of the body.
3. The renal medulla is the inner two-thirds of the kidney.
4. Excretion is the process of removing metabolic wastes from the body. Students may also include that during excretion, the metabolic wastes pass through a membrane to leave the body.
5. Urea is a nitrogenous waste that is produced from ammonia by the liver and then is removed by the kidneys.

MULTIPLE CHOICE
1. d  2. c  3. c  4. b  5. d

SHORT ANSWER
1. Filtration is the initial step in urine formation. This is when small compounds, including nitrogenous waste products, are separated from the blood and transferred to the nephron.
2. Kidneys assist in the maintenance of fluid volume, blood pH, and the chemical composition of fluids.
3. The entire renal cortex and medulla are composed of nephrons. Nephrons are considered the functional units of the kidney because they perform all of the processes required for urine production.
4. Ammonia is the first step in the production of urea, which is excreted by kidneys.

Section 49-1
VOCABULARY REVIEW
1. Dendrites are extensions of neurons that receive signals from other neurons.
2. Axon terminals are the ends of axons and may communicate with muscle cells, gland cells, or other neurons.
3. An action potential is the transmission of an electrical impulse along the axon of a neuron.
4. A neurotransmitter is a chemical that is released from axon terminals at synapses and that transmits an electrical signal between neurons.
5. A synapse is the junction where a neuron communicates with another neuron or other type of cell.

MULTIPLE CHOICE
1. c  2. b  3. c  4. d  5. d

SHORT ANSWER
1. A neurotransmitter can either increase or decrease the activity of a postsynaptic neuron, depending on the ion channels that are activated by the neurotransmitter.
2. At resting potential, potassium ions are more concentrated inside the cell, whereas sodium ions are more concentrated outside the cell.
3. Action potentials conduct down an axon away from the cell body and toward the axon terminal because of the refractory period, the period of time during which sodium channels cannot open after an action potential.
4. Because ions cannot pass through the myelin sheath, myelin increases the speed of the action potential because the electrical impulse must “jump” from node to node as it moves down the axon.

STRUCTURES AND FUNCTIONS
1. At the resting potential, voltage-gated sodium channels are not open. Thus, sodium ions cannot diffuse into the neuron.
2. Figure b shows the conduction of an action potential down the axon. Sodium ions are flowing into the cell, reversing the polarity of the cell. Potassium ions are rushing out of the cell because their voltage-gated channels are open.
3. Electrical and concentration gradients cause the movement of sodium and potassium ions.
Section 49-2

VOCABULARY REVIEW
1. The brain stem lies below the diencephalon and includes the midbrain, pons, and medulla oblongata. The medulla oblongata serves as a relay center that controls heart rate, respiration rate, and other homeostatic activities.
2. The somatic nervous system and the autonomic nervous system are the two independent components of the motor division of the peripheral nervous system.
3. The central and peripheral nervous systems are the two main divisions of the nervous system and work together to collect and process information and control the body’s response to the information.
4. The thalamus and hypothalamus are both part of the diencephalon of the brain. The thalamus relays sensory signals, and the hypothalamus helps maintain homeostasis and controls hormone production.

MULTIPLE CHOICE
1. a  2. b  3. c  4. d  5. c

SHORT ANSWER
1. The limbic system functions in emotion, memory, motivation, and other social behaviors.
2. The ventral roots contain the axons of motor neurons, which carry information away from the central nervous system.
3. In a state of physical or emotional stress, the sympathetic division of the autonomic nervous system redirects blood flow from the digestive system toward the heart and skeletal muscles.
4. The autonomic nervous system is most important for homeostasis because it acts constantly to modulate the body’s internal conditions.
5. No; the central and peripheral nervous systems constantly interact. The spinal cord constantly relays information to the brain from the body and from the brain to the body.

STRUCTURES AND FUNCTIONS
1. structure A, the gray matter
2. It would eliminate sensory input to the spinal cord from that spinal nerve.
3. It would eliminate sensory input and motor output to and from the spinal cord from that spinal nerve.

Section 49-3

VOCABULARY REVIEW
1. Papillae are bumps on the tongue between which taste buds are embedded.
2. Rods are photoreceptors in the retina that respond to dim light.
3. The retina is the light-sensitive layer that lines the back of the inside of the eye.
4. Cones are photoreceptors in the retina that respond to bright light of different colors.

MULTIPLE CHOICE
1. c  2. b  3. b  4. b  5. a

Section 49-4

VOCABULARY REVIEW
1. A stimulant is a psychoactive drug that alters the nervous system by increasing its activity.
2. Tolerance is a characteristic of drug addiction in which larger doses are required to achieve the desired effect.
3. Addiction produces a dependence on a drug that alters normal functioning of the nervous system to the point that withdrawal is experienced if the drug is removed.
4. Nicotine is the addictive drug in tobacco, the use of which can lead to emphysema, a degenerative lung disease.

MULTIPLE CHOICE
1. c  2. d  3. a  4. b  5. c

SHORT ANSWER
1. Repeated exposure to a drug causes a person to need more and more of the drug to achieve the desired effect. Thus, tolerance increases with repeated use.
2. Symptoms of drug withdrawal include vomiting, headache, insomnia, breathing difficulties, depression, mental instability, and seizures.
3. Cocaine blocks reuptake receptors, inhibiting the reuptake of dopamine from the synaptic cleft. The excess dopamine overstimulates postsynaptic neurons, providing the sensation cocaine users seek.
4. There is an inverse relationship between body weight and BAC. As body weight increases, BAC decreases per number of drinks consumed. People with higher body weights have larger blood volumes. So if two people drink the same amount of alcohol, the alcohol will be less concentrated in the person with the larger volume of blood.
STRUCTURES AND FUNCTIONS

Section 50-1

VOCABULARY REVIEW

1. Target cells are specific cells to which a hormone travels to produce a specific effect.
2. A second messenger is a molecule that initiates changes inside a cell in response to the binding of a specific substance to a receptor on the outside of a cell.
3. A prostaglandin is a modified fatty acid that is secreted by most cells and accumulates in areas where tissues are disturbed or injured.
4. A hormone is a substance that is secreted by cells and acts to regulate the activity of other cells in the body.

MULTIPLE CHOICE

1. d  2. c  3. a  4. c  5. c

SHORT ANSWER

1. A first messenger binds to cell surface receptors and stimulates production of a second messenger that is located within the target cell.
2. Hormones are transported in the bloodstream.
3. No; they have ducts and secrete sweat, not hormones.
4. It depends on the enzymes and other proteins that cAMP activates to change the function of the cell.

STRUCTURES AND FUNCTIONS

1. Anti-C antibody prevents the hormone’s action.
2. No; the fact that three of the antibodies do not alter the hormone’s action is evidence that it is not simply the binding of an antibody that disrupts the action of the hormone.
3. Segment C is probably the receptor binding portion of the hormone.

Section 50-2

VOCABULARY REVIEW

1. The hypothalamus produces hormones that are stored in the pituitary gland or that regulate the pituitary gland’s activities. Both structures are located in the brain.
2. Epinephrine and norepinephrine are secreted by the adrenal medulla and regulate the nervous system’s response to stress.
3. Follicle-stimulating hormone and luteinizing hormone are secreted by the anterior pituitary and stimulate secretion of sex hormones from the gonads.
4. Insulin is a hormone secreted by the pancreas and regulates blood sugar levels. Diabetes mellitus is a condition in which cells are unable to obtain glucose due to an insulin deficiency.
5. Estrogen and testosterone are steroid sex hormones secreted by the gonads.

MULTIPLE CHOICE

1. d  2. a  3. c  4. d

SHORT ANSWER

1. The thyroid glands secrete calcitonin, which lowers blood levels of calcium, and the parathyroid glands secrete parathyroid hormone, which raises blood levels of calcium.
2. Oxytocin and antidiuretic hormone (ADH), are produced in the hypothalamus by neurosecretory cells. Oxytocin stimulates uterine contractions during childbirth, and ADH stimulates water reabsorption in the kidneys.
3. The TSH level should be above normal because the negative feedback mechanism would attempt to normalize the thyroid hormone levels by increasing stimulation.

STRUCTURES AND FUNCTIONS

1. In Situation 1, the receptors of Cell M are defective. There is no Cell M secretion, indicating that hormone secreted by Cell D is required to stimulate Cell M. Cell D secretion increases due to its attempt to increase the level of Cell M secretion to normal. Both of these responses indicate that Cell D secretes the regulating hormone.
2. In Situation 2, the receptors of Cell D are defective. Cell D secretion is increased because it is unable to detect hormone secreted by Cell M. In response to the increased levels of Cell D hormones, Cell M secretions increase.

Section 51-1

VOCABULARY REVIEW

1. Semen contains sperm and the secretions of three exocrine glands—the seminal vesicles, the bulbourethral glands, and the prostate gland.
2. The testes are the gamete-producing organs of the male reproductive system.
3. Ejaculation is the forceful expulsion of semen from the penis.
4. Seminiferous tubules are the tightly coiled tubules of the testes in which sperm are produced.
5. The epididymis is a long, coiled tubule attached to the testis in which sperm develop.

MULTIPLE CHOICE

1. c  2. c  3. c  4. c  5. d

SHORT ANSWER

1. Sperm move from the seminiferous tubules to the epididymis, through the vas deferens and urethra, and out of the penis.
2. Semen is composed of sperm and secretions from three exocrine glands—the seminal vesicles, bulbourethral glands, and the prostate gland.
3. Seminiferous tubules are located in the testes—the vas deferens is not; there is more than one seminiferous tubule—there is only one vas deferens pessertis; seminiferous tubules have meiotic cells in their walls—the vas deferens does not.
4. The sperm’s flagellum enables it to swim to an egg, and its head contains digestive enzymes that help it penetrate the egg’s outer layers.
5. Yes; androgens, including testosterone, are required for the successful completion of spermatogenesis. Therefore, it is advantageous that the source of androgens be within the testes to ensure the success of spermatogenesis.
STRUCTURES AND FUNCTIONS
1. a, vas deferens; b, seminiferous tubule; c, epididymis
2. a, mature; b, immature; c, immature

Section 51-2

VOCABULARY REVIEW
1. Ovulation occurs when an ovum, or mature egg, is released from an ovary into the fallopian tube.
2. A woman stops menstruating when her follicles have either ruptured or degenerated. This is called menopause.
3. The uterus is a hollow, muscular organ in which a fertilized egg develops. The lower entrance to the uterus is the cervix, which leads to the vagina and out the body.
4. The follicular phase is a stage of the menstrual cycle in which an immature egg completes its first meiotic division.
5. The luteal phase is the stage of the menstrual cycle during which the corpus luteum begins to secrete large amounts of progesterone and estrogen.

MULTIPLE CHOICE
1. a 2. d 3. b 4. c 5. a

SHORT ANSWER
1. Male and female gametes contribute equal numbers of chromosomes to the fertilized egg. Without the diploid number of chromosomes, the fertilized egg usually will not survive.
2. An egg is a round cell, a sperm is an elongated cell; a sperm has a flagellum, an egg does not have a flagellum; a sperm has a midpiece encircled by mitochondria, an egg does not have a midpiece; an egg has a large amount of cytoplasm, a sperm has almost no cytoplasm; an egg is larger than sperm; and a sperm has a condensed elongated nucleus, an egg has a round nucleus.
3. At menopause, most of the follicles have either ruptured or degenerated. Students should be able to deduce that without follicles, there are no eggs.

STRUCTURES AND FUNCTIONS
In figure a, FSH stimulates follicular cells within the ovary during the follicular phase of the menstrual cycle. In figure b, a corpus luteum within the ovary secretes progesterone during the luteal phase. In figure c, the uterine lining sloughs off during menstruation. In figure d, an egg is released from an ovarian follicle during ovulation. In figure e, estrogen stimulates the reestablishment of the uterine lining during the follicular phase.

Section 51-3

VOCABULARY REVIEW
1. Human chorionic gonadotropin is a hormone secreted by the placenta that stimulates further hormone production in the corpus luteum.
2. Implantation is the beginning of pregnancy when the blastocyst embeds into the uterine lining.
3. Chorionic villi are the part of the placenta that extend into the uterine lining.
4. The umbilical cord consists of fetal arteries and veins that transport nutrients from the mother to the fetus and waste products from the fetus to the mother via the placenta.
5. The fluid-filled amniotic sac surrounds the embryo and cushions it from injury.

MULTIPLE CHOICE
1. c 2. c 3. d 4. b 5. c

SHORT ANSWER
1. Estrogen and progesterone inhibit the secretion of LH and FSH. Without FSH, new follicles do not develop and eggs are not prepared for ovulation.
2. All three structures are involved in the transfer of nutrients and waste products between the fetus and mother. Blood vessels originating from the allantois (one of the four embryonic membranes) extend into the chorionic villi. The combination of the chorionic villi and the portions of the uterine lining into which they extend is called the placenta.
3. Estrogen maintains the uterine lining throughout development, ensuring the protection and nourishment of the fetus.
4. An egg must be fertilized, then the zygote must undergo a series of mitotic divisions (called cleavage) that produce a morula and finally a blastocyst. Buildup of the uterine lining must occur prior to implantation.
5. Human chorionic gonadotropin (HCG); HCG is only produced by the placenta. Consequently, HCG is a pregnancy-specific hormone.

STRUCTURES AND FUNCTIONS
1. a, fallopian tube; b, ovary; c, vagina; d, uterus
2. blastocyst—d; zygote—a; corpus luteum—b; morula—a