

Study Guide for

THOMPSON

Understanding ANATOMY & PHYSIOLOGY

Fourth Edition

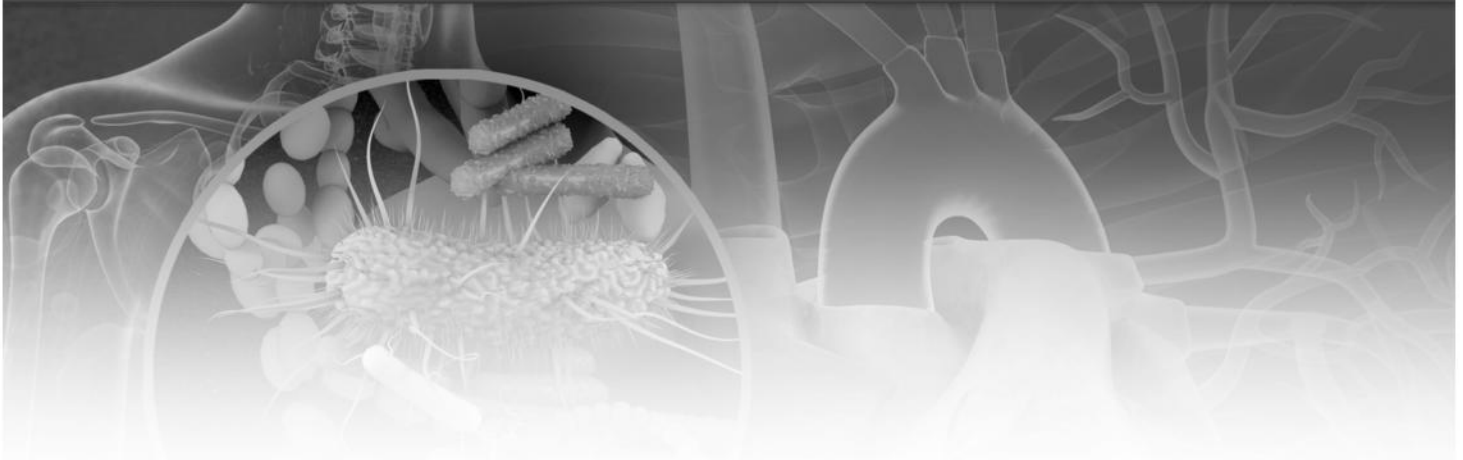
A Visual, Auditory, Interactive Approach



Study Guide for
Understanding
**ANATOMY &
PHYSIOLOGY**

Fourth Edition

A Visual, Auditory, Interactive Approach



Gale Sloan Thompson, RN

 **FA. DAVIS**
Philadelphia

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Introduction

Some students claim to have a preferred method for learning. For example, many say they learn best when they can see a visual image; others prefer to hear a verbal presentation; still others like to incorporate a hands-on activity when learning something new. While that may be true, research shows that everyone benefits when material is presented in a variety of ways. Specifically, incorporating visual images, verbal presentations, *and* hands-on activities into a study regimen will enhance the learning process for all students.

That's where this greatly expanded edition of *Understanding Anatomy & Physiology* study guide can help. Unlike other study guides, the *Understanding Anatomy & Physiology* study guide is packed with unique activities involving drawing, coloring, and highlighting in addition to more traditional activities such as fill-in-the-blank and crossword puzzles. The drawing, coloring, highlighting, and writing activities help students actively engage in the learning process. Using different muscles helps break up the monotony of studying and, by stimulating different parts of the brain, improves the learning experience. What's more, the colorful results of the drawing, coloring, and highlighting activities provide quick, visual cues regarding important topics when it's time to review.

To make the most of this study guide, you'll need at least 10 different colored pencils. Colored pencils will allow you to color various shades of each color, making them a better choice than colored pens. You'll also need an assortment of colorful highlighters, such as yellow, green, blue, and pink.

The following list summarizes the activities you'll find in this study guide:

- **Conceptualize in Color:** This activity involves coloring anatomical structures different colors. All learners will benefit from the movement associated with coloring while focusing on the various features of the human body. Saying the names of various structures out loud while coloring will further enhance learning. Also, coloring forces you to slow down and focus on one structure at a time, which helps solidify learning.
- **Drawing Conclusions:** Combining drawing or coloring with some other activity, such as fill-in-the-blank sentences, "Drawing Conclusions" will hone your reasoning skills while allowing you to link written words to something visual. The physical activity of drawing improves learning that much more.
- **Just the Highlights:** In this activity, you'll place sentences describing various structures, physiological processes, or disorders into separate groups by highlighting sentences in distinct colors. For example, in [Chapter 6, Integumentary System](#), a "Just the Highlights" activity contains sentences describing features of first-, second-, and third-degree burns. You'll be asked to highlight sentences pertaining to first-degree burns in yellow, second-degree burns in orange, and third-degree burns in pink. Once complete, each group will be visually apparent, making reviewing easy.
- **Illuminate the Truth:** A variation of fill-in-the blank, you'll use a highlighter to identify the correct word or phrase that completes each sentence.
- **Fill in the Gaps:** In this fill-in-the-blank activity, you will write the correct word or phrase to complete

each sentence. A Word Bank is provided.

- **Sequence of Events:** This activity will challenge you to place statements about a physiological process—such as the formation of cerebrospinal fluid—in proper sequence by inserting numbers in the blank line before each sentence.
- **Make a Connection:** This two-part activity involves first listing the names of certain structures or processes. Once identified, you'll draw a line from the word to a statement or description, linking the two together. For example, in [Chapter 11](#), *Nervous System*, you'll first list the names of nervous system cells. You'll then draw lines to link the name of a cell to sentences describing characteristics of that type of cell.
- **List for Learning:** This activity will test your recall by asking you to make a list of certain things, such as the five functions of skin.
- **Puzzle It Out:** This traditional crossword puzzle is a fun way to test your knowledge of key terms related to anatomy and physiology.
- **Describe the Process:** Using figures as visual cues, you'll test your recall of physiological processes by describing the steps in a particular process, such as that of endochondral ossification. Successfully completing this activity will assure you that you have committed the process to memory.

Each activity in this book focuses on a specific topic. As previously mentioned, this edition has been greatly expanded so that, no matter the structure or physiological process you'd like to review, you should be able to find an activity to help. So, if you are struggling in a particular area, look for activities relating to that topic. Answers to workbook activities will be available through your instructor.

Mastering the topic of anatomy and physiology requires study and repetition. There is no other way to construct the foundation of knowledge upon which you'll build your future career in health care. The unique activities in the *Understanding Anatomy & Physiology* study guide will aid you toward that goal; they will break up the monotony of studying as you use color and movement to help you commit key facts to memory.

chapter 1

ORIENTATION TO THE HUMAN BODY

As you begin to study anatomy and physiology, you first need to understand how the body is organized. What's more, you need to learn the terms used to describe the various regions of the body. Doing the activities in this chapter will help.

List for Learning Organization of the Body

The various elements of the human body are organized in a hierarchy ranging from the very simple to the very complex. Using the spaces below to list the major structures in this hierarchy, beginning with the atom and ending with the human organism.

1. Atoms
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. A human organism

Make a Connection Types of Tissue

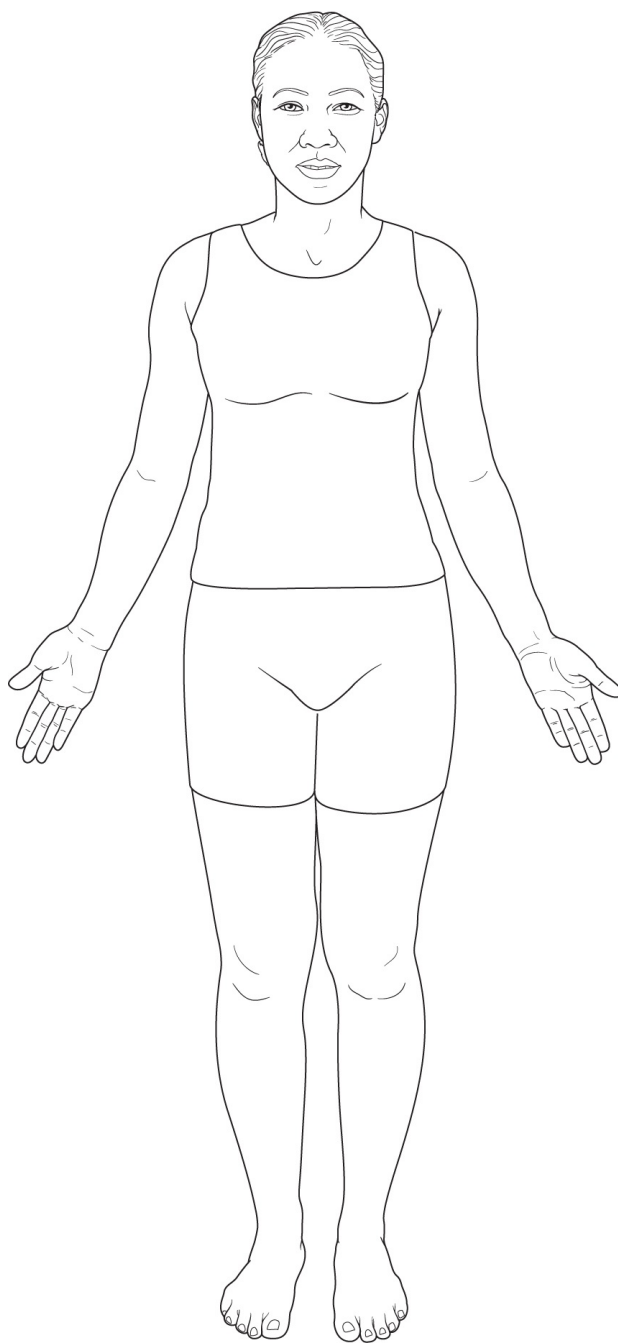
In the spaces below, list the four types of tissue found in the human body. The first letter of each term is provided to get you started. Then draw a line to link each type of tissue with its particular characteristics.

1. E _____
2. C _____
3. M _____

4. N _____

- a. Contracts to produce movement
- b. Examples include the brain and nerves
- c. Covers or lines body surfaces
- d. Generates and transmits impulses to regulate body function
- e. Connects and supports parts of the body; may also transport and store materials
- f. Examples include the outer layer of the skin, the walls of capillaries, and kidney tubules
- g. Examples include bone, cartilage, and adipose tissue
- h. Examples include skeletal muscles and the heart

Drawing Conclusions Directional Terms



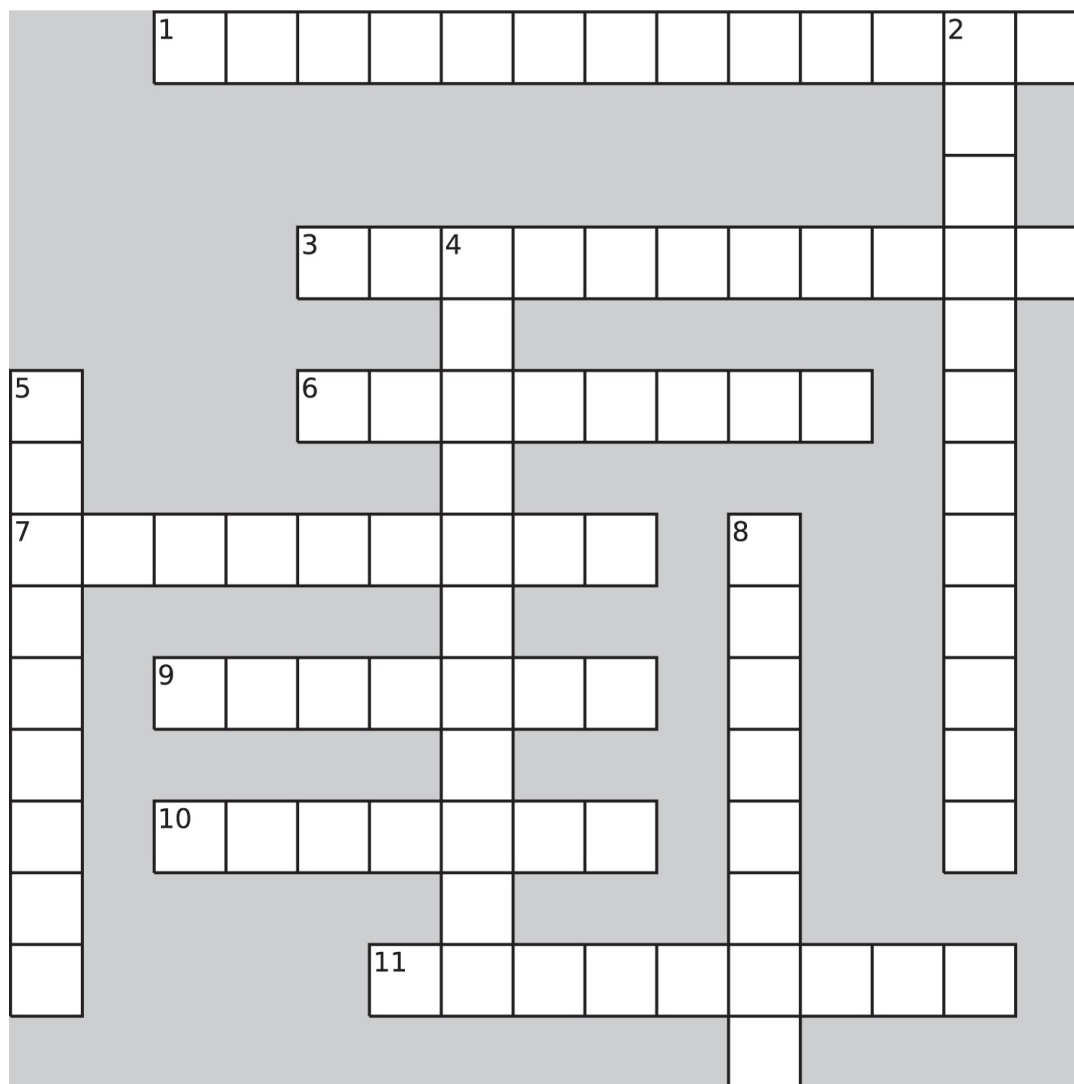
Test your knowledge of directional terms by drawing on the figure as described below.

- A.** Draw a midline incision on the patient's abdomen, superior to the navel.
- B.** Draw a deep wound on the lateral portion of the right knee.
- C.** Draw a superficial wound on the medial right ankle.
- D.** Place a bandage on the proximal right arm.
- E.** Place an adhesive bandage on the left leg, distal to the knee.
- F.** Place a small bandage on the patient's abdomen, inferior to the navel.

Puzzle It Out Organ Systems

Complete the following crossword puzzle to test your knowledge about the 11 organ systems that

contribute to a particular function in the human body.



ACROSS

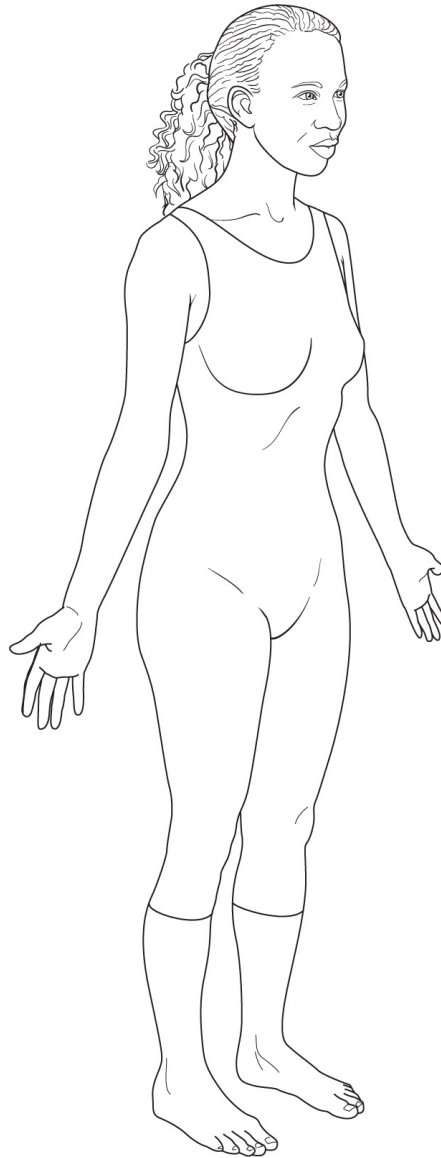
1. System consisting of skin, hair, and nails
3. System consisting of the heart, arteries, veins, and capillaries
6. System that participates in heat production
7. System involved in the breakdown and absorption of nutrients
9. System that helps regulate blood volume and pressure
10. System charged with the control, regulation, and coordination of other systems as well as sensation and memory
11. System that produces immune cells

DOWN

2. System consisting of the testes, vas deferens, prostate, seminal vesicles, and penis in males and the ovaries, fallopian tubes, uterus, vagina, and breasts in females
4. System consisting of the nose, pharynx, larynx, trachea, bronchi, and lungs
5. System involved in hormone production
8. System that plays a key role in blood formation

Drawing Conclusions Body Planes

Test your knowledge of body planes by drawing the planes as described on the figure below. Then, fill in the blanks of each sentence.

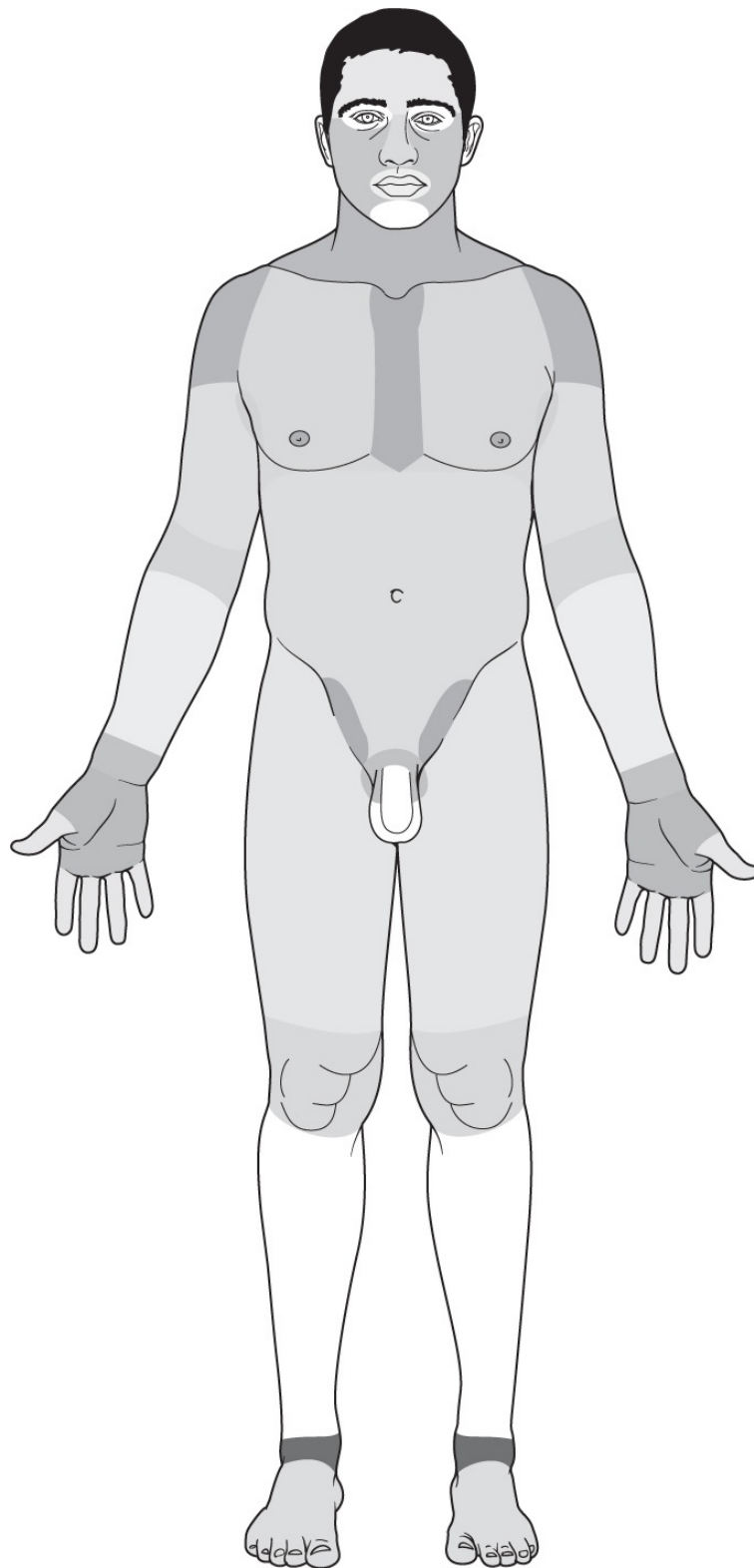


1. Draw a green square through the figure to illustrate a sagittal plane. Also called a _____ plane, this plane divides the body into _____ and _____ sides.
2. Draw an orange square to divide the body into two halves using a transverse plane. Also called a _____ plane, this plane divides the body into _____ and _____ portions.
3. Draw a purple square through the body to illustrate a frontal plane. Also called a _____ plane, this plane divides the body _____ into _____ and portions.

Conceptualize in Color Body Regions

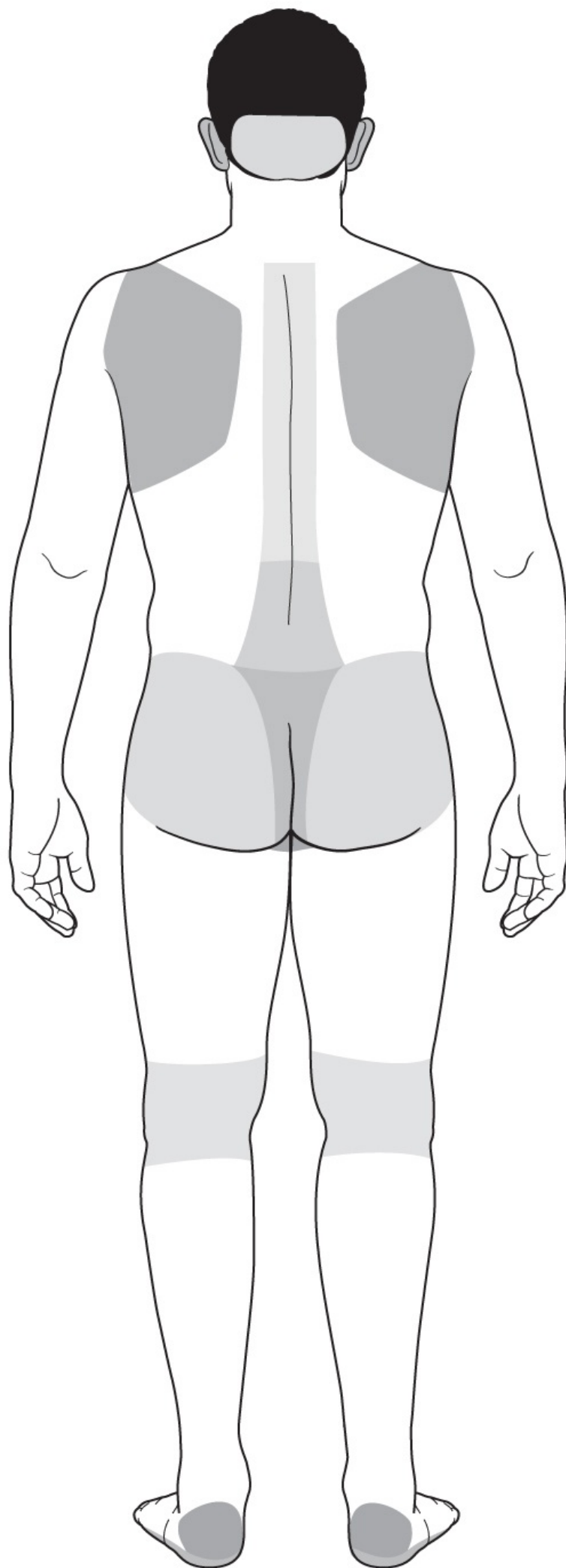
Various terms are used to describe different regions in the body. These terms are used extensively

when performing clinical examinations and medical procedures. Identify the locations of these regions by coloring the figures below. Use the suggested colors or choose your own.



- Patellar area: Green
- Femoral area: Pink
- Pedal area: Yellow
- Gluteal area: Orange
- Palmar area: Orange

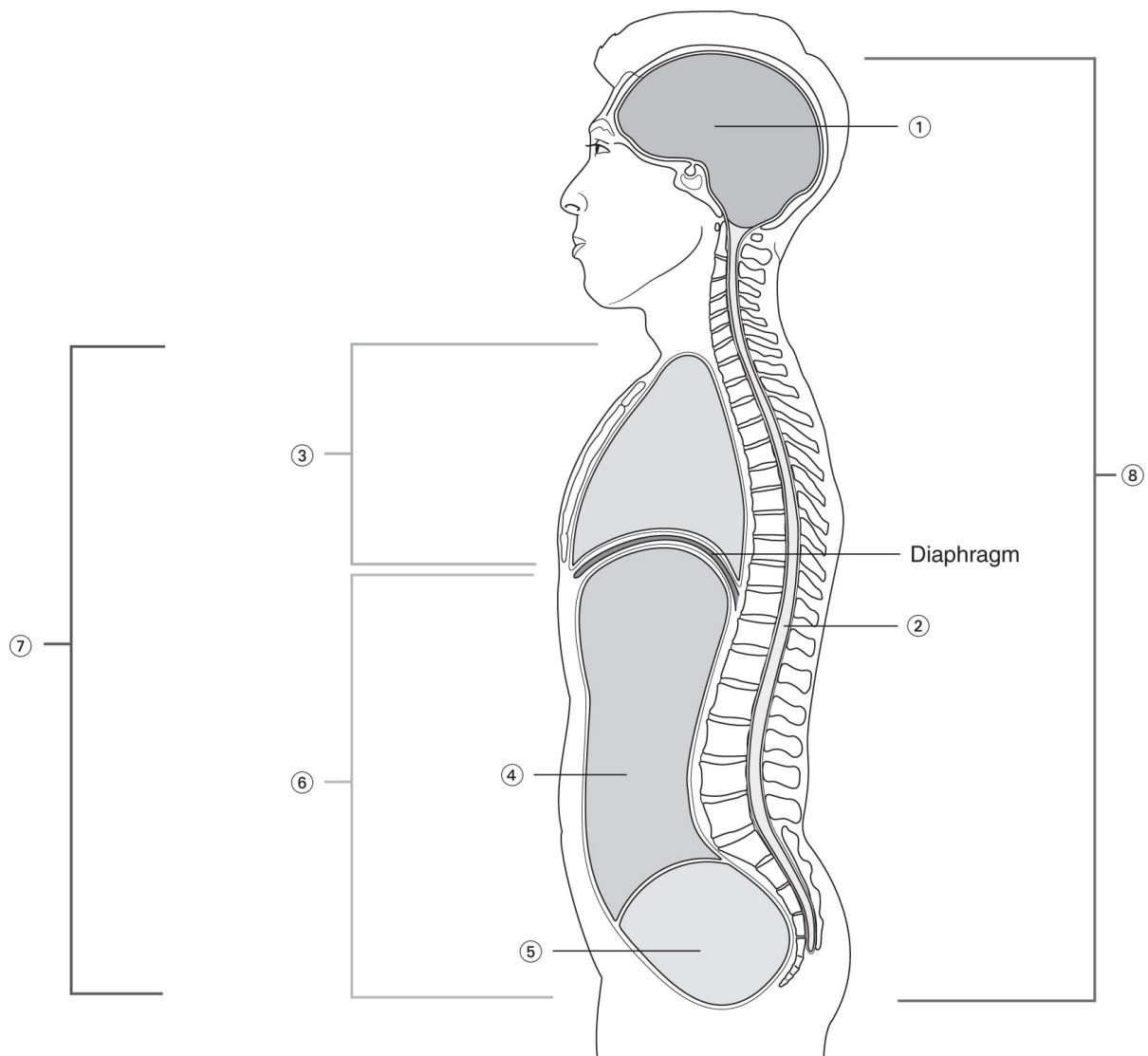
- Digital area: Green
- Scapular area: Pink
- Inguinal area: Green
- Axillary area: Blue
- Sacral area: Red
- Brachial area: Pink



- Deltoid area: Green
- Popliteal area: Green
- Sternal area: Red
- Pelvic area: Blue
- Pubic area: Yellow
- Antecubital area: Blue
- Buccal area: Yellow
- Occipital area: Red
- Lumbar area: Yellow
- Otic area: Blue
- Carpal area: Purple

Drawing Conclusions Body Cavities

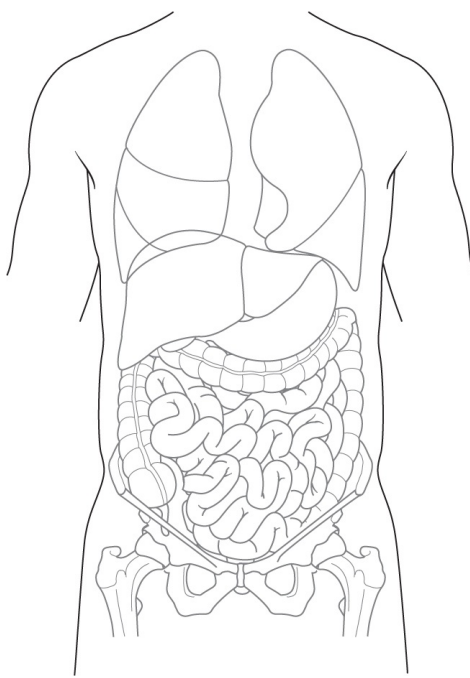
Test your knowledge of cavities that contain the body's internal organs by coloring the cavities in the figure below. Then, in the spaces provided, write the name of each cavity.



1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Drawing Conclusions Abdominal Regions

Because the abdominopelvic cavity is so large and because it contains numerous organs, it is divided into regions. Test your knowledge of the abdominopelvic cavity's regions by drawing lines to divide this cavity into nine regions in the figure below. Then, color each region to identify the names of these regions.



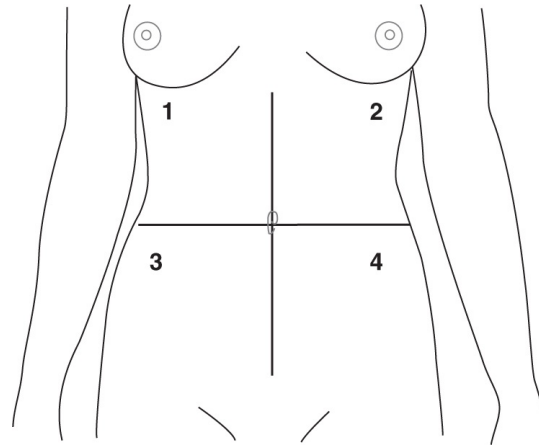
- Right hypochondriac region: Orange
- Left iliac region: Green
- Umbilical region: Yellow
- Right iliac region: Blue
- Left lumbar region: Brown
- Left hypochondriac region: Pink
- Right lumbar region: Purple
- Hypogastric region: Red
- Epigastric region: Gray

Finally, identify the organs in each region by placing the correct letter in the proper region on the figure above. For example, if the small intestines, descending colon, and sigmoid colon are found in the right hypochondriac region, you would insert the letter A in that region on the figure.

- A.** Small intestines, descending colon, sigmoid colon
- B.** Small intestines, appendix, cecum, ascending colon
- C.** Pancreas, small intestines, transverse colon
- D.** Liver, gallbladder, right kidney
- E.** Stomach, liver (tip), left kidney, spleen
- F.** Stomach, liver, pancreas, right and left kidneys
- G.** Small intestines, descending colon, left kidney
- H.** Liver (tip), small intestines, ascending colon, right kidney
- I.** Small intestines, sigmoid colon, bladder

Drawing Conclusions Abdominal Quadrants

Test your knowledge of the abdominal quadrants by coloring each quadrant a different color in the figure below. Then, fill in the names of the quadrants in the spaces provided. Finally, insert the corresponding initials representing that quadrant within the quadrant itself.



1. _____
2. _____
3. _____
4. _____

Illuminate the Truth The Basics

Highlight the word or phrase that completes each sentence correctly.

1. The study of the structure of the body is called (physiology)(anatomy).
2. The smallest living units that make up the body's structure are called (organelles)(cells).
3. Structures of two or more tissue types that work together are called (organs)(organ systems).
4. Anatomical position is when the body is standing erect, arms at the sides, with palms facing (backward)(forward).
5. A disruption in one organ system usually has (no effect on)(consequences in) other systems.

Fill in the Gaps Homeostasis

To maintain a stable environment, the body must constantly monitor conditions and make adjustments as conditions change. This process is called homeostatic regulation. Fill in the blanks with the appropriate word or words to complete each sentence correctly, describing this crucial process. Choose from the words listed in the Word Bank below. Not all words may be used.

AMPLIFIES
CONTROL CENTER
DISEASE DEVELOPMENT
EFFECTOR
EXERCISE ENDURANCE
EQUILIBRIUM
NEGATIVE
OPPOSES
POSITIVE
RECEPTOR
REINFORCES
REVERSES
SUPPRESSES

1. Homeostasis is the state of dynamic _____ of the internal environment of the body.
2. To maintain homeostasis, a _____ system must have three components: a _____, which detects external changes that could influence the environment; a _____, which receives and processes the information from the first component; and a _____, which responds to signals from the second component by either opposing or enhancing the stimulus.
3. Negative feedback is when the effector _____ the stimulus and _____ the direction of change.
4. Positive feedback is when the _____ effector the stimulus and _____ the direction of change.
5. Most systems supporting homeostasis operate by _____ feedback.
6. Uncorrected homeostatic imbalance may promote _____.

chapter 2

CHEMISTRY OF LIFE

The human body is made of chemicals. What's more, life depends upon a precise balance between all those chemicals. So before you can understand how the body functions, you must have a firm grasp on how the chemicals in the body interact. The exercises in this chapter should help you do just that.

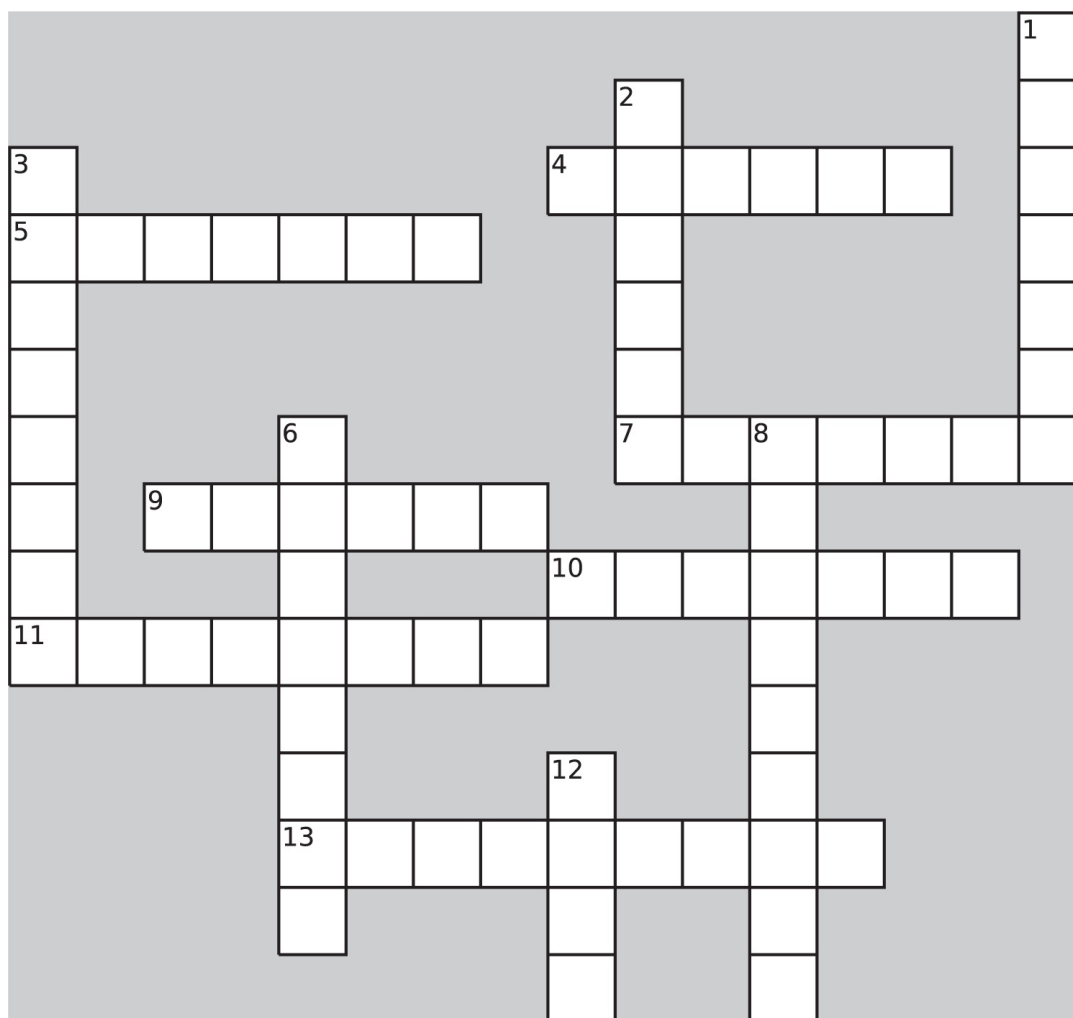
Illuminate the Truth Basic Structures

Highlight the word or phrase that completes each sentence correctly.

1. An element's atomic number is determined by the (number of protons)(number of neutrons) in the nucleus.
2. An element's atomic weight is determined by adding the number of (protons, neutrons, and electrons) (protons and neutrons).
3. The number of electrons equals the number of (protons)(protons and neutrons added together).
4. Atoms are electrically (neutral)(positive).
5. The number of electron rings, or shells, (varies)(is the same) between atoms.
6. (All)(Some) isotopes of an element are unstable and emit radiation as they decay.
7. An element's unique chemical properties result from (the various combinations of protons, neutrons, and electrons)(the various types of protons, neutrons, and electrons making up the atoms of the element).

Puzzle It Out Chemistry Terms

Complete the following crossword puzzle to test your knowledge of general chemistry terms.



ACROSS

4. Anything that has mass and occupies space
5. An atom of an element that contains a different number of neutrons
7. Center of an atom
9. Element represented by the letter *O*
10. A pure substance that can't be broken down or decomposed into two or more substances
11. Particles in the center of an atom that are electrically neutral
13. Tiny particles with a negative charge that whirl around the center of an atom

DOWN

1. Particles in the center of an atom that carry a positive charge
2. Element represented by the letter *C*
3. One of the four elements that comprise the body: carbon, hydrogen, oxygen, and _____
6. Element represented by the letter *H*
8. Chemical combinations of two or more elements
12. Smallest part of an element

Drawing Conclusions Chemical Bonds

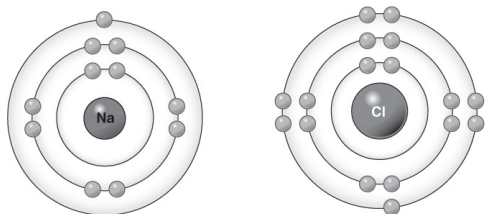
Test your knowledge of the key characteristics of ionic, covalent, and hydrogen bonds by filling in

the blanks of each sentence. Then, in the spaces provided, draw an example of each type of bond.

1. Ionic Bonds

Ionic bonds are formed when one atom _____ an electron from its outer shell to another atom. The electrical charge of the atom then changes from to either _____ or _____.

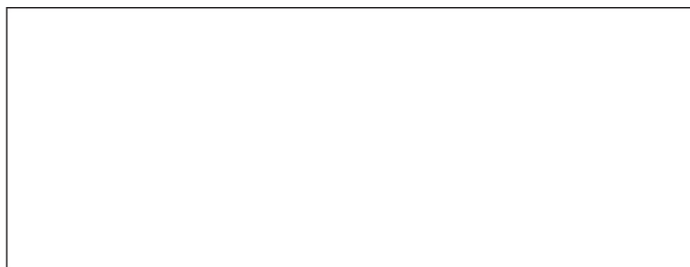
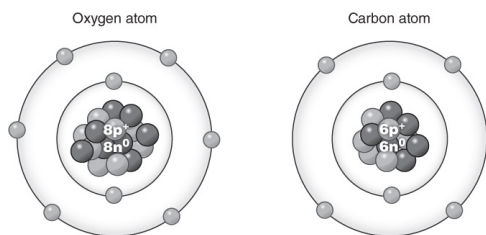
Draw an example of an ionic bond between sodium and chlorine atoms in the space provided. An illustration of a sodium and chlorine atom has been provided to get you started.



2. Covalent Bonds

In covalent bonds, two atoms _____ one or more pairs of electrons. Covalent bonds are _____ than ionic bonds.

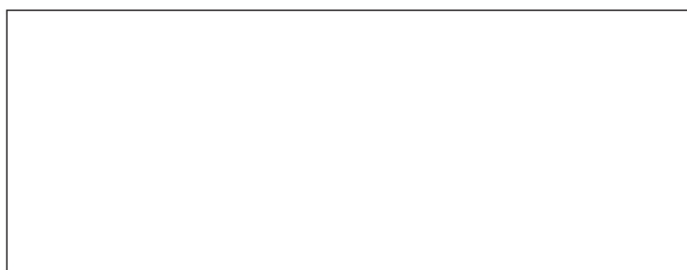
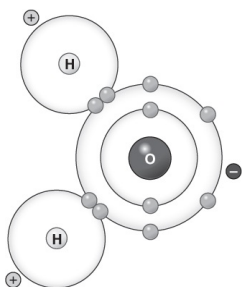
Draw an example of a double covalent bond between carbon and oxygen atoms to form CO₂. An illustration of a carbon and oxygen atom has been provided to get you started.



3. Hydrogen Bonds

A hydrogen bond is a weak _____ between a slightly positive _____ atom in one molecule and a slightly negative _____ or _____ atom in another.

Using the illustration of a water molecule (shown here), draw an example of a hydrogen bond between two water molecules.



Make a Connection Chemical Reactions

In the spaces below, list the three types of chemical reactions. The first letter of each term is provided to get you started. Then draw a line to link each type with its particular characteristics.

1. S_____

2. D_____

3. E_____

- a. Involves the breakdown of a complex substance into two or more simpler substances
- b. Requires energy input
- c. Represented by the equation $AB + CD \rightarrow AC + BD$
- d. Occurs when two molecules exchange atoms or groups of atoms, forming two new compounds
- e. Involves the combination of two or more substances to form a different, more complex substance
- f. Represented by the equation $AB \rightarrow A + B$
- g. Releases energy
- h. Represented by the equation $A + B \rightarrow AB$

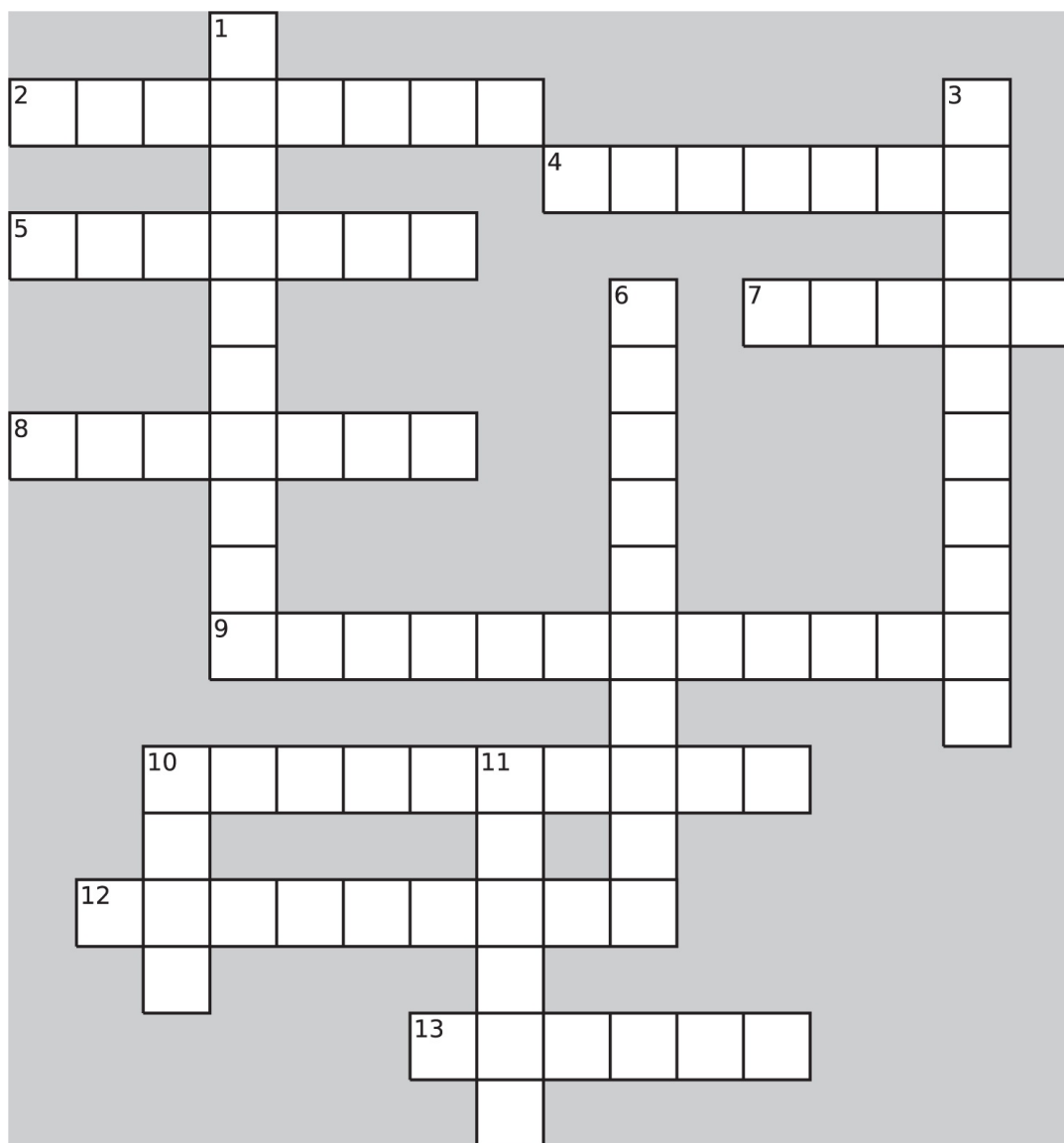
Illuminate the Truth Chemical Reaction Rates

Highlight the word or phrase that completes each sentence correctly.

- 1. A (higher)(lower) temperature speeds up molecular movement, which increases the frequency and force of collisions between molecules.
- 2. Decreasing the concentration of a solution will (accelerate)(slow) the reaction rate.
- 3. Chemical substances called catalysts (speed up)(slow) reaction rates.

Puzzle It Out Chemistry Concepts

Complete the following crossword puzzle to test your knowledge of chemistry concepts.



ACROSS

2. Particle composed of two or more atoms united by a chemical bond
4. The electrons in an atom's outer shell
5. Energy in motion
7. Type of molecule with an uneven distribution of electrons
8. Atoms having a positive charge
9. Compounds that ionize in water to create a solution capable of conducting electricity
10. Process whereby ionic bonds dissociate in water to create a solution of positively and negatively charged particles
12. Involves building larger and more complex chemical molecules, which requires energy input
13. The capacity to do work

DOWN

1. Reactions that can go in either direction under different circumstances
3. All the chemical reactions in the body
6. Involves breaking down complex compounds into simpler ones, releasing energy in the process
10. Electrically charged atoms
11. Atoms having a negative charge

Just the Highlights Characteristics of Water

Unlike any other fluid, water has a number of characteristics that make it essential for life. Link the characteristics of water with its performance in the body by highlighting each of the following sentences as suggested.

- Sentences describing water's action as a solvent: Pink
 - Sentences describing water's action as a lubricant: Yellow
 - Sentences describing water's ability to absorb and release heat: Blue
1. Cells receive the chemicals they need to function.
 2. The heart beats freely without encountering friction.
 3. Joints operate smoothly, allowing the body to move.
 4. The body can maintain a stable temperature despite changes in activity level or environmental temperature.
 5. Large chemical compounds are broken down into components cells can use.
 6. The lungs expand and contract freely for effortless breathing.
 7. Sweat cools the body.

Make a Connection Body Fluids

In the spaces below, list two types of fluid. The first letter of each term is provided to get you started. Then draw a line to link each fluid type to its characteristics as well as to examples of each.

1. C_____
 2. M_____
- a. Results when two or more mixtures blend together, with each retaining its own chemical properties
 - b. Results when two or more elements combine to make a new substance that has its own chemical properties
 - c. Substances involved can be separated
 - d. Example: Table salt
 - e. Example: Water
 - f. Example: Salt in scrambled eggs
 - g. Example: Lemonade

Just the Highlights Types of Mixtures

Mixtures of substances in water can be solutions, colloids, or suspensions. Link the characteristics of each by highlighting each of the following sentences as suggested.

- Sentences describing solutions: Yellow
- Sentences describing colloids: Orange
- Sentences describing suspensions: Blue

1. Usually consist of a mixture of protein and water
2. Contain large particles, causing them to be cloudy or opaque
3. May be gas, solid, or liquid
4. Can change from a liquid to a gel
5. Are clear, with no visible particles; particles don't separate when the mixture is allowed to stand
6. Have particles that separate if the solution is allowed to stand
7. Contain particles small enough to stay permanently mixed but large enough to make the mixture cloudy
8. Example in the body: Glucose in the blood
9. Example in the body: Blood cells in plasma
10. Example in the body: Albumin in blood plasma

Fill in the Gaps Acids, Bases, and pH

Fill in the blanks with the appropriate word to complete each sentence correctly. Choose from the words listed in the Word Bank below.

ACCEPTORS

ACID

ACIDIC

ALKALINE

BASE

BASIC

DONORS

HYDROGEN (H^+)

HYDROXIDE (OH^-)

NEUTRAL

1. Solutions with a pH less than 7 are _____.
2. Solutions with a pH greater than 7 are _____ or _____.
3. When acidic solutions are dissolved in water, they release _____ ions.
4. Alkaline solutions release _____ ions when dissolved in water.
5. Acidic solutions are called proton _____.
6. Alkaline solutions are called proton _____.
7. The greater the concentration of hydrogen (H^+) ions, the stronger the _____.
8. The greater the concentration of hydroxide (OH^-) ions, the stronger the _____.
9. A solution containing equal numbers of H^+ and OH^- ions is known as a _____ solution.

Illuminate the Truth Organic Compounds

Highlight the word or phrase that completes each sentence correctly.

1. The term *organic* is used to describe compounds (containing carbon)(without carbon).
2. (Proteins)(Carbohydrates) are the body's main energy source.
3. Monosaccharides, disaccharides, and polysaccharides are all types of (carbohydrates)(fats).
4. The primary form of sugar found in the body is (glycogen)(glucose).
5. The stored form of glucose is (galactose)(glycogen).
6. Triglycerides, the most abundant lipid in the body, (serve no known purpose and are a major contributor to heart disease)(function as a concentrated source of energy).

7. Saturated fatty acids (form a solid mass)(are liquid) at room temperature.
8. Cholesterol is the body's chief (steroid)(triglyceride).
9. (Proteins)(Fats) are the most abundant, and most important, organic compound in the body.
10. Nonessential amino acids are so named because they (are not necessary for normal body function)(can be manufactured by the body).
11. Proteins consist of (electrolytes)(amino acids) linked together by peptide bonds.
12. Unsaturated fatty acids are derived mostly from (animal)(plant) sources.
13. A protein's function is determined by (the number of amino acids it contains)(its shape).

List for Learning Lipids

Using the spaces below, list five major roles that lipids fulfill in the body.

1. _____
2. _____
3. _____
4. _____
5. _____

Make a Connection Proteins

In the spaces below, list the names of some of the body's proteins. The first letter of each word is provided to get you started. Then draw a line to link each of the proteins to its function.

1. K_____
2. A_____
3. I_____
4. H_____
5. C_____
6. E_____

- a. Defend the body against bacteria
- b. Carries oxygen in the blood
- c. Strengthens nails, hair, and skin

- d. Gives structure to bones, cartilage, and teeth
- e. Serves as a chemical messenger to cells throughout the body
- f. Act as catalysts for crucial chemical reactions

List for Learning Cholesterol

Using the spaces below, list four key roles cholesterol fulfills in the body.

- 1. _____
- 2. _____
- 3. _____
- 4. _____

Fill in the Gaps Glucose and Glycogen

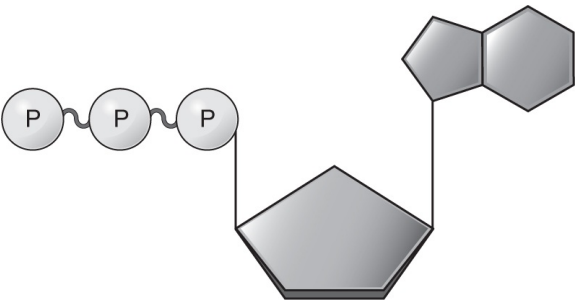
Clarify how the body uses it's prime energy source by filling in the blanks with the appropriate word to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once.

GLUCOSE
GLYCOGEN
LIVER
MUSCLES

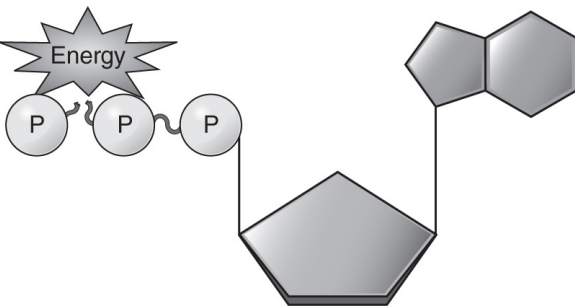
- 1. When _____ blood levels are high (such as after eating), the _____ converts excess into _____, which it then stores.
- 2. When blood _____ levels drop (such as between meals), the _____ converts _____ back into _____ and releases it into the blood.
- 3. This keeps blood _____ levels within normal limits and provides cells with a constant supply of energy.
- 4. The _____ also store _____ to meet its energy needs during physical exercise.

Describe the Process ATP

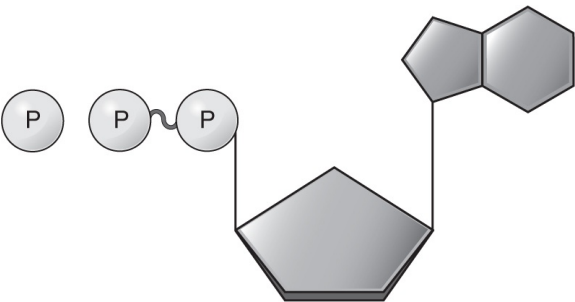
Cells use energy in the form of ATP. Using the spaces below, describe how the body's cells obtain and then restore their supply of energy. Use the illustrations as a guide. The first part of each sentence has been provided to get you started.



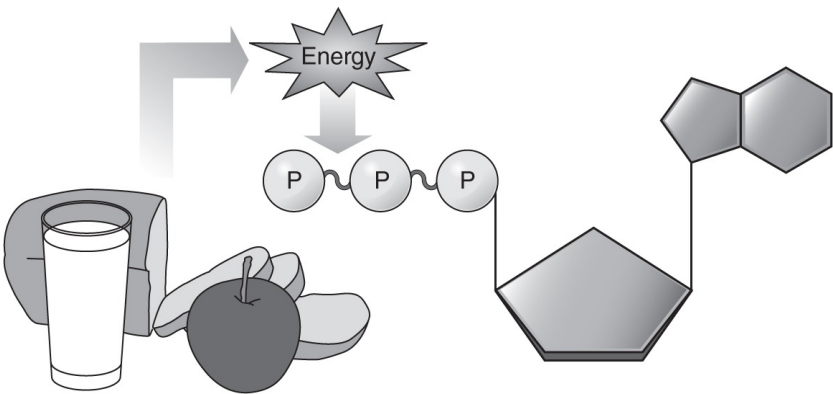
1. ATP consists of_____.



2. When one of the bonds is broken through a chemical reaction, _____.



3. After the bond is broken, _____.



4. Meanwhile, the cell uses _____.

chapter 3

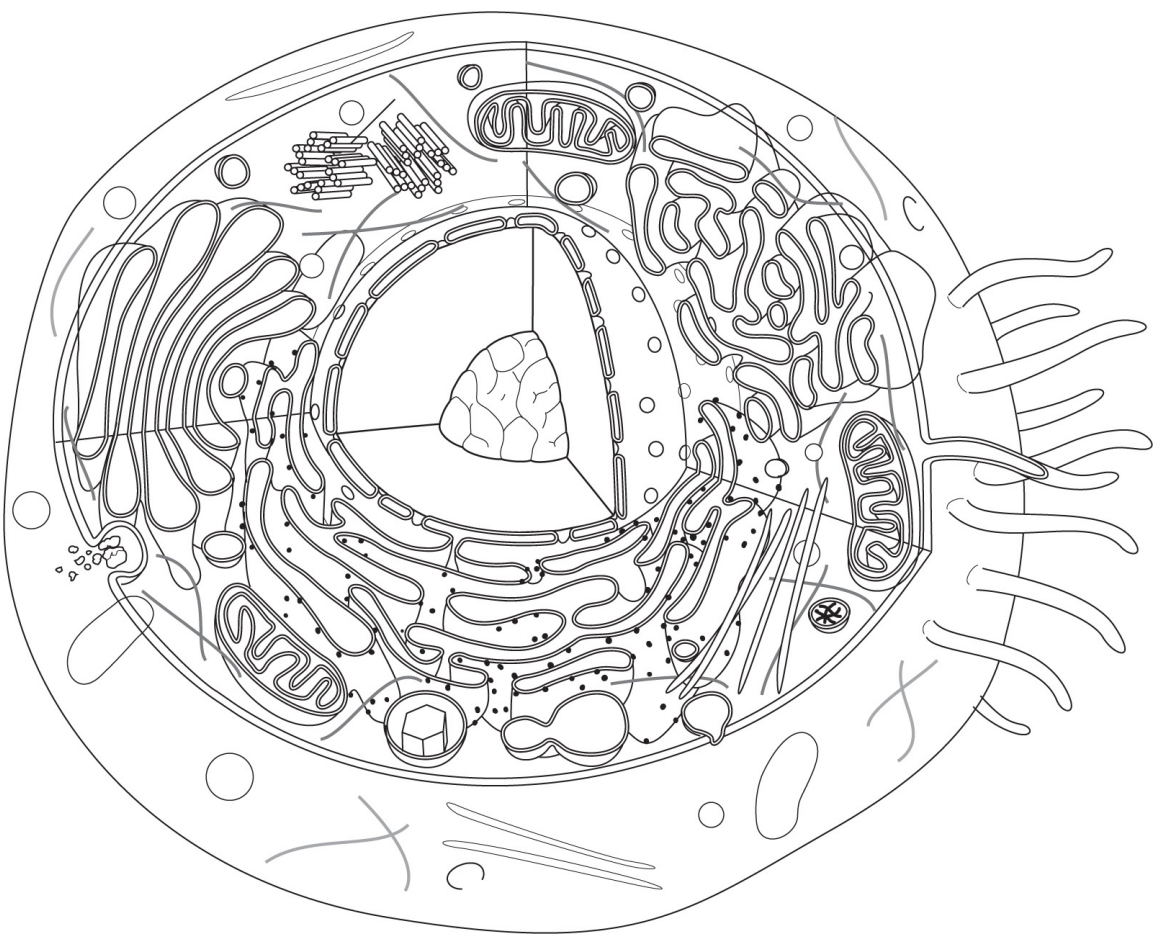
CELLS

Cells may be microscopic, but they are far from simple. In fact, each cell is packed with specialized structures that allow it to perform various tasks crucial to human life. Use this chapter to enhance your understanding of cellular structure and function. Doing so is the key to understanding the inner workings of the body, in both health and disease.

Conceptualize in Color The Cell

Identify the various structures in a human cell by coloring the figure below. Use the suggested colors or choose colors of your own.

- Plasma membrane: Blue
- Nucleus and nuclear envelope: Purple
- Nucleolus: Dark blue
- Centriole: Green
- Mitochondria: Pink
- Golgi apparatus: Orange
- Smooth endoplasmic reticulum: Brown
- Rough endoplasmic reticulum: Tan
- Lysosomes: Red
- Ribosomes: Black
- Cytoplasm: Yellow



Fill in the Gaps Plasma Membrane

Fill in the blanks with the appropriate word or words to complete each sentence correctly about the plasma membrane. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

AWAY FROM
CHOLESTEROL
FEARING
GLUCOSE
LOVING
PASSAGE
PHOSPHOLIPIDS
POROUS
PROTEIN(S)
SELECTIVELY PERMEABLE
SUBSTANCES
TOWARD

1. Besides defining the boundaries of the cell, the plasma membrane regulates the _____ of _____ into and out of the cell.
2. The plasma membrane consists of _____, _____, and _____.
3. The heads of the phospholipids are water _____, causing them to face the fluid in the cell's interior and exterior.
4. The tails of the phospholipids are water _____, causing them to face _____ the fluid in the cell's interior and exterior.
5. _____ molecules stiffen and strengthen the plasma membrane.
6. _____ are embedded in various spots in the membrane and fulfill a number of roles.
7. Because some substances can easily pass through the membrane, while others cannot, the plasma membrane is called _____.

List for Learning Proteins and the Plasma Membrane

Using the spaces provided, describe the three roles fulfilled by proteins in the plasma membrane.

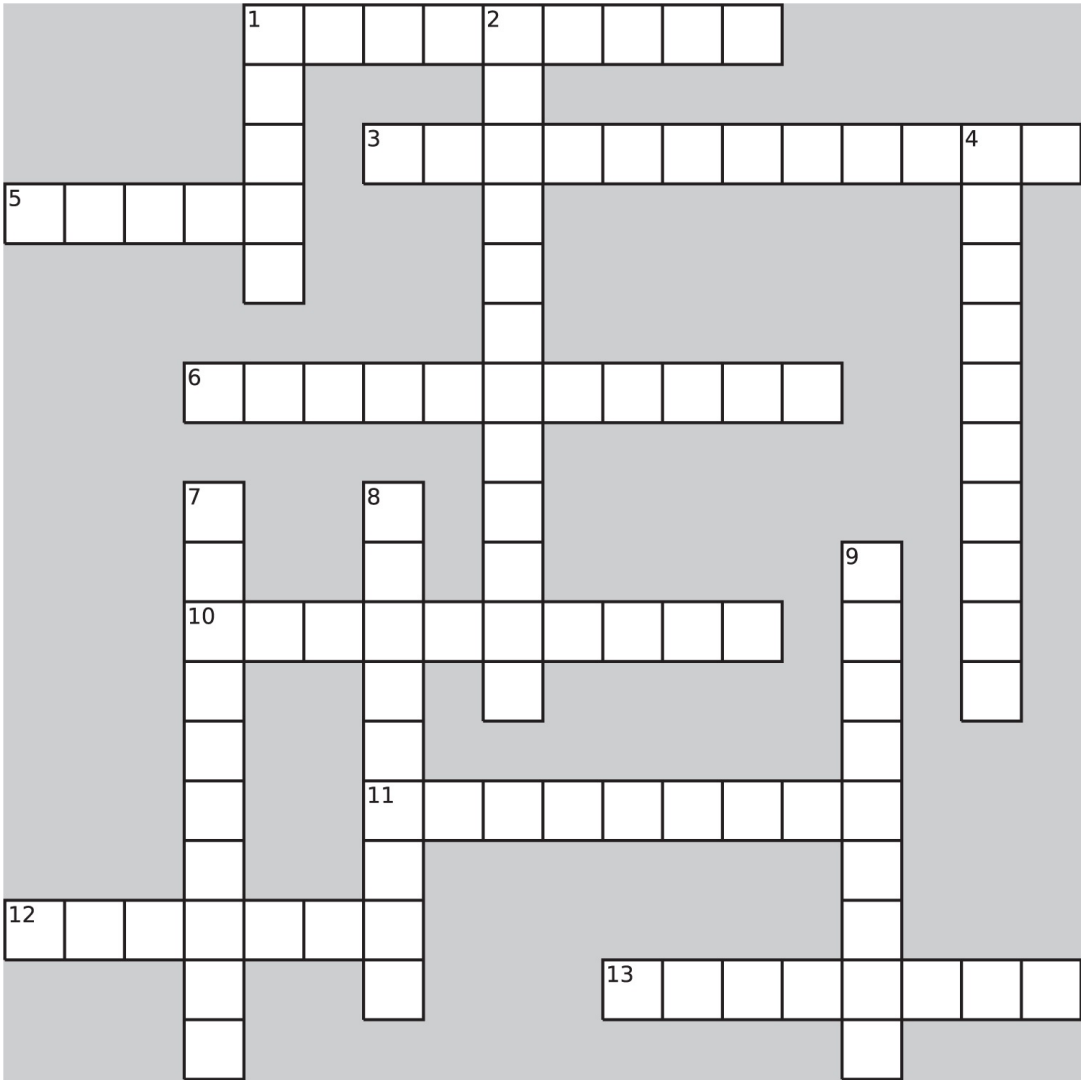
1. _____

2. _____

3. _____

Puzzle It Out Cellular Structures

Complete the following crossword puzzle to test your knowledge of cellular structures and their functions.



ACROSS

- 1. Thread-like structures composed of DNA and protein extending throughout the nucleus
- 3. Supporting framework of the cell
- 5. Apparatus that prepares and packages proteins for export to other parts of the body
- 6. Rod-like structures consisting of tightly coiled DNA
- 10. Bundles of microtubules that participate in cell division
- 11. Cellular garbage disposals
- 12. The cell's control center
- 13. Whip-like projection that helps move a cell

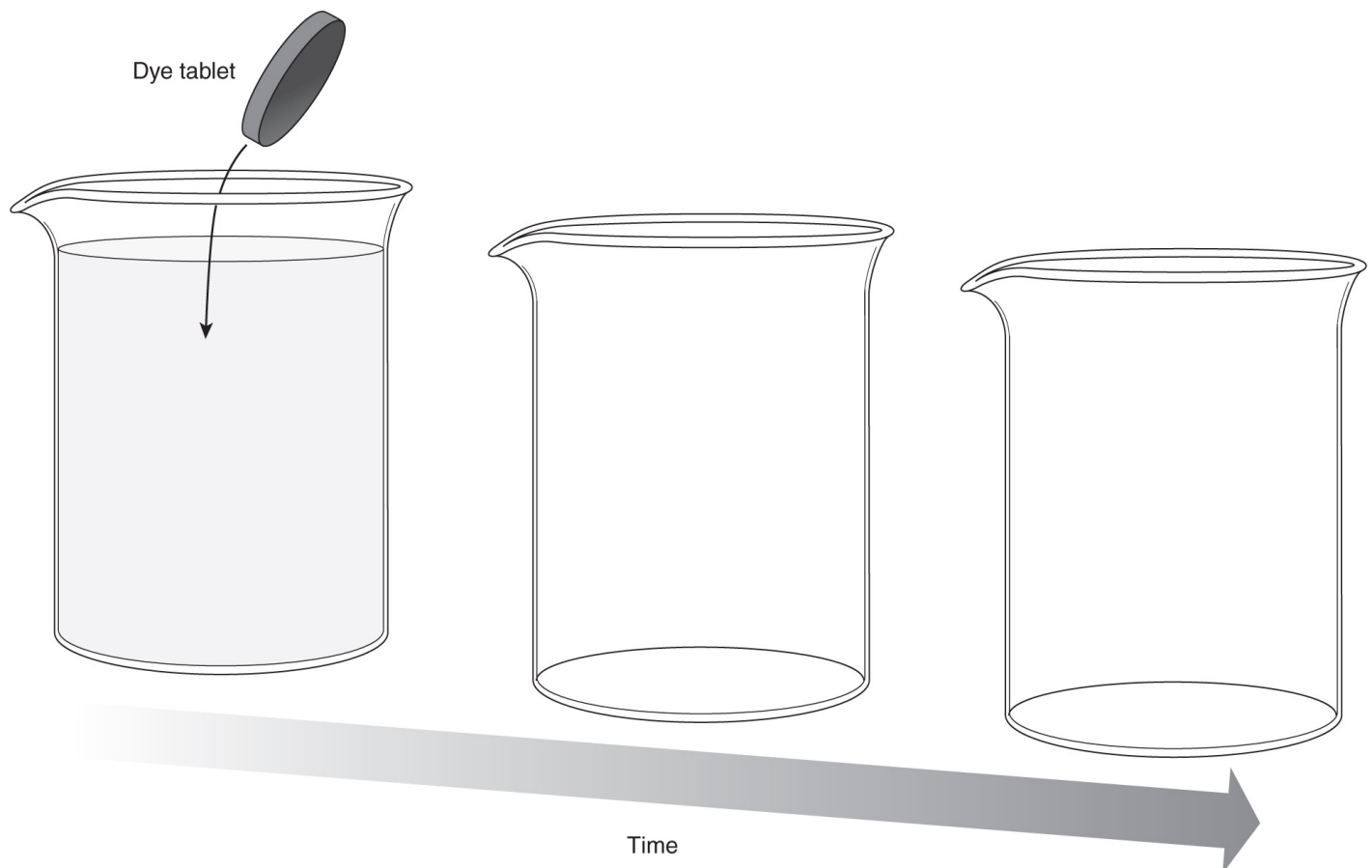
DOWN

1. Hair-like processes that propel substances along a cell's surface
2. The cell's powerhouses
4. Structures filling the cytoplasm that perform specific tasks in cellular metabolism
7. Folds of the cell membrane that greatly increase a cell's surface area
8. Gel-like substance that fills the space between the plasma membrane and nucleus
9. Cell's protein-producing structures

Drawing Conclusions Diffusion

Test your knowledge of diffusion by filling in the blanks of each sentence. Then, draw the process in the figure below.

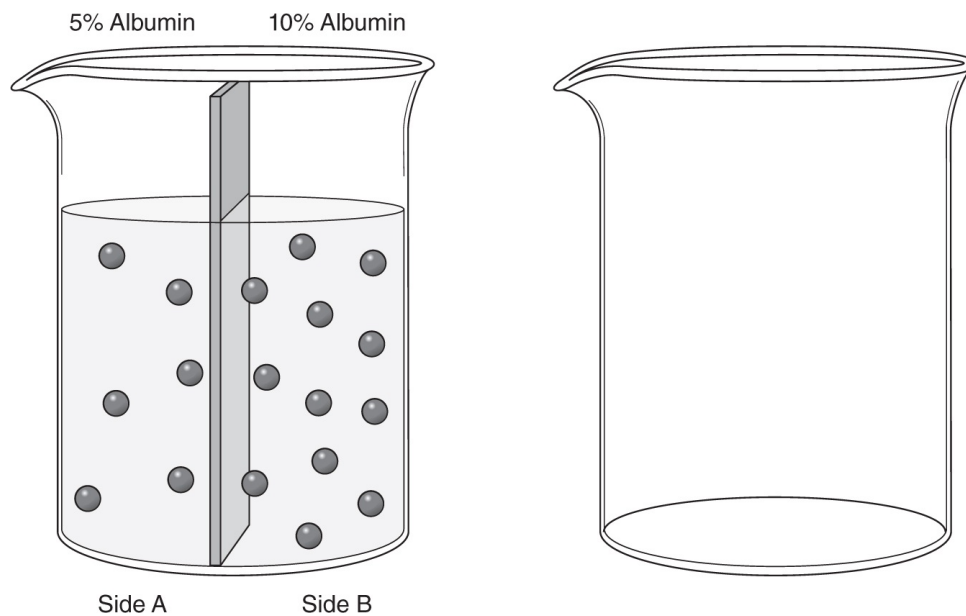
1. Diffusion is a _____ transport mechanism, meaning that it doesn't require energy.
2. Diffusion involves the movement of particles from an area of _____ concentration to an area of _____ concentration.
3. The point at which no further diffusion occurs is called _____.
4. A difference in concentration of a substance from one point to another is called a _____.



Drawing Conclusions Osmosis

Test your knowledge of osmosis by filling in the blanks of each sentence. Then, draw the process in the empty container in the figure below.

1. Osmosis involves the diffusion of _____ across a selectively permeable membrane from an area of _____ to _____ concentration.
2. In the body, osmosis occurs when a particular substance _____ cross the cell membrane.
3. This process helps make the concentration of solutes _____ on both sides of the plasma membrane.
4. As water diffuses by osmosis into a solution, the _____ of that solution increases.
5. Water pressure that develops in a solution as a result of osmosis is called _____.



Illuminate the Truth Tonicity

Highlight the word or phrase that completes each sentence correctly.

1. Tonicity is the ability of a solution to affect the (fluid volume)(solute concentration) and pressure in a cell through osmosis.
2. An isotonic solution contains a concentration of solutes that is (greater than)(the same as) the concentration of solutes inside the cell.
3. A hypertonic solution contains a (higher)(lower) concentration of solutes compared with the fluid in the cell.
4. A hypotonic solution contains a (higher)(lower) concentration of solutes compared with the fluid in the cell.
5. When a blood cell is placed in an isotonic solution, fluid moves into the cell (faster than)(at the same rate as) it moves out of the cell.

6. When a red blood cell is placed in a hypertonic solution, it (swells)(shrivels).
7. When a red blood cell is placed in a hypotonic solution, it (swells)(shrivels).
8. If infused into the human body, distilled water acts as a (hypotonic)(hypertonic) solution.
9. If infused into the human body, a concentrated salt solution would act as a (hypotonic)(hypertonic) solution.
10. Normal saline is considered (a hypotonic)(an isotonic) intravenous solution.

Fill in the Gaps Filtration and Facilitated Diffusion

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Not all words may be used.

CAPILLARIES
CHANNEL PROTEIN
CONCENTRATION
MITOCHONDRION
PRESSURE
VEINS

1. In filtration, water and dissolved particles move from an area of higher to lower _____.
2. Filtration is the method used by _____ to deliver water and nutrients to the body's tissues.
3. In facilitated diffusion, molecules move from an area of higher to lower _____.
4. In facilitated diffusion, a solute enters a _____ to pass through the plasma membrane.

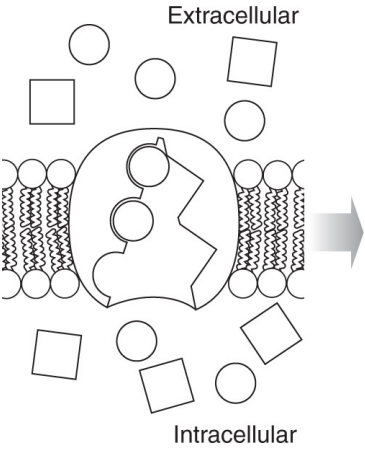
Drawing Conclusions Sodium–Potassium Pump

Test your knowledge of the sodium-potassium pump by describing each step in the process in the spaces provided. Then, color the structures in the figures below as described. Use the suggested colors or choose your own.

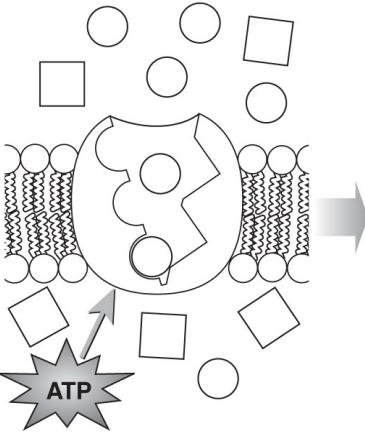
- Channel proteins: Purple
- Sodium molecules: Orange
- Potassium molecules: Green

- Extracellular area: Blue

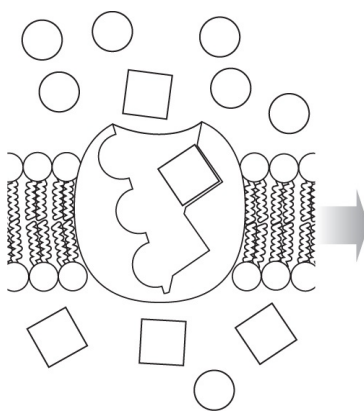
Finally, insert arrows to indicate the direction of flow.



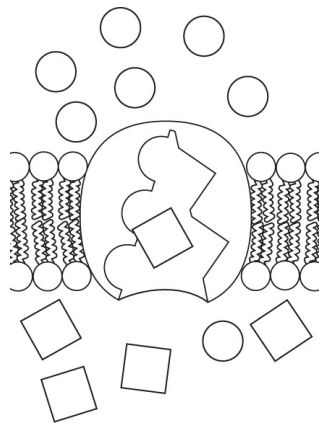
1. _____



2. _____



3. _____



4. _____

Make a Connection Vesicular Transport

In the spaces below, list the terms associated with transport by vesicles. The first two letters of each term are provided to get you started. Then, draw a line to link each term to its characteristics.

1. En_____
2. Ph_____

3. Pi_____

4. Ex_____

- a. Occurs when vesicles release substances outside the cell
- b. Occurs when the cell engulfs a solid particle and brings it into the cell
- c. General type of vesicular transport that brings substances into the cell
- d. Occurs when vacuoles bring droplets of extracellular fluid containing dissolved substances into the cell
- e. An example is when mammary glands secrete breast milk
- f. Method used by white blood cells

Make a Connection Active Transport Mechanisms

In the spaces below, list four active transport mechanisms. The first letter or two of each term has been provided to get you started. Then, draw a line to link each term to its actions.

1. A_____

2. Ph_____

3. Pi_____

4. E_____

- a. Fluid and dissolved particles are trapped in a portion of the plasma membrane and brought into the cell.
- b. Particles are pumped from an area of low to high concentration by an energy-consuming structure in the plasma membrane.
- c. Proteins or other cell products move out of a cell when a secretory vesicle containing those products fuses with the plasma membrane.
- d. Large particles are trapped in a portion of the plasma membrane and brought into the cell.

Make a Connection Passive Transport Mechanisms

In the spaces below, list four passive transport mechanisms. The first letter or two of each term has been provided to get you started. Then, draw a line to link each term to its actions.

1. D_____

2. O_____

3. Fi_____

4. Fa _____

D _____

- a. Water and solutes move through a selectively permeable membrane because of hydrostatic pressure.
- b. Water diffuses across a selectively permeable membrane from an area of low to high concentration of solute.
- c. Particles move across a selectively permeable membrane from an area of high to low concentration.
- d. Particles move from an area of high to low concentration with the help of a channel protein.

List for Learning DNA

Using the spaces below, list the four nitrogenous bases found in DNA. Then, draw circles around the names of two bases that pair together and a square around the names of the other two bases that pair together.

1. _____

2. _____

3. _____

4. _____

Illuminate the Truth DNA

Highlight the word or phrase that completes each sentence correctly.

1. DNA molecules (store all of a cell's genetic information)(contribute to energy production in the cell).
2. DNA forms a dense coil that resembles an X (at all times)(when the cell is preparing to divide).
3. The sugar in DNA is (ribonucleic acid)(deoxyribose).
4. The sequence of bases in DNA is (predetermined)(varied); it's this sequence of bases that (provides the genetic code)(allows DNA to replicate).
5. One of DNA's main functions is to provide information for building (lipids)(proteins).

List for Learning RNA

Using the spaces below, list three ways RNA differs from DNA.

1. _____

2. _____

3. _____

Sequence of Events Transcription

Insert the numbers 1 through 6 in the spaces provided to identify the sequence of events that occur in the transcription process.

- _____A. The mRNA begins the process of translation.
- _____B. The nucleus receives a chemical message to make a new protein.
- _____C. The mRNA separates from the DNA molecule and moves through a nuclear pore and into the cytoplasm.
- _____D. An RNA enzyme assembles RNA nucleotides that would be complementary to the exposed bases.
- _____E. The segment of DNA with the relevant gene unwinds.
- _____F. RNA nucleotides attach to the exposed DNA and then bind to each other to form messenger RNA (mRNA).

Illuminate the Truth Translation

Highlight the word or phrase that completes each sentence correctly.

1. After the mRNA enters the cytoplasm, it attaches to (the Golgi apparatus)(a ribosome), which begins the process of translating the protein.
2. The mRNA carries the code for each amino acid in a series of three bases, called a (codon) (chromosome).
3. Each tRNA consists of (one base)(three bases).
4. The tRNA deposits (three amino acids)(a single amino acid) at the complementary site.
5. The (ribosome)(mRNA) uses enzymes to attach the chain of amino acids together with (cholesterol) (peptide) bonds.

Make a Connection Cell Cycle

In the spaces below, list the four phases of the cell cycle in order. Then, draw a line to link each phase to its particular characteristics.

- 1. _____
- 2. _____
- 3. _____
- 4. _____

- a. The cell is busy performing the tasks it was created to do.
- b. Cell division occurs.
- c. The cell synthesizes enzymes necessary for division.
- d. The cell accumulates materials necessary for DNA replication.
- e. The cell makes an extra set of DNA.

Describe the Process Mitosis

Following are illustrations of four cells in various stages of mitosis. Using the spaces below, write the name of each phase and describe what is occurring.

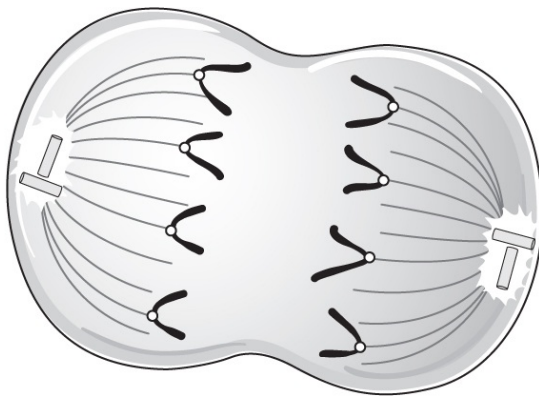
A.



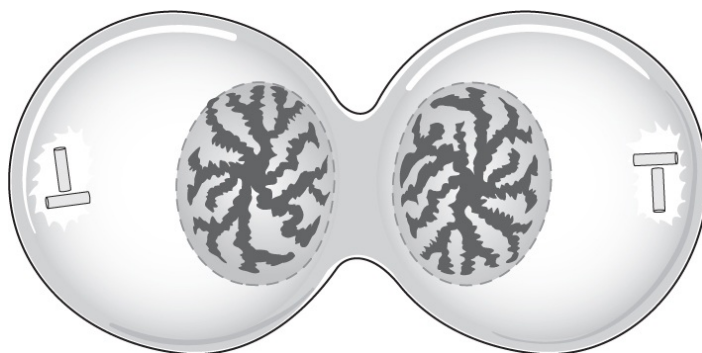
B.



C.



D.



chapter 4

HUMAN MICROBIOME

Use the activities in this chapter to build upon your knowledge of the microbes that exist on, and in, the human body.

Illuminate the Truth Facts about the Human Microbiome

Highlight the word or phrase that completes each sentence correctly.

1. The human microbiome (is complete at birth)(builds over time).
2. Scientists have learned that the inhabitants of specific bacterial communities—such as those in the mouth or intestines—(tend to be consistent)(often vary widely) between individuals.
3. (Bacteria)(Viruses) make up the bulk of the human microbiome.
4. Children acquire the bulk of their microbiomes (through their diet)(from their mothers).
5. The most complex and densely populated microbial community is in the (oral cavity)(intestinal tract).
6. (Prebiotics)(Probiotics) are foods containing indigestible fibers that nourish and feed healthy bacteria in the gut.
7. Low-diversity microbiomes (are associated with strong immune systems)(have been linked to multiple disorders).
8. The first step in colonizing an infant's gastrointestinal tract occurs (at the first feeding)(before birth).
9. A child has an individually distinct microbiome by age (five)(two).
10. With advanced age, the number of microbial species in the intestinal microbiota (decreases)(increases).
11. Breast feeding makes (a significant)(little) difference in a child's health over the long term.

Describe the Process Microbiome

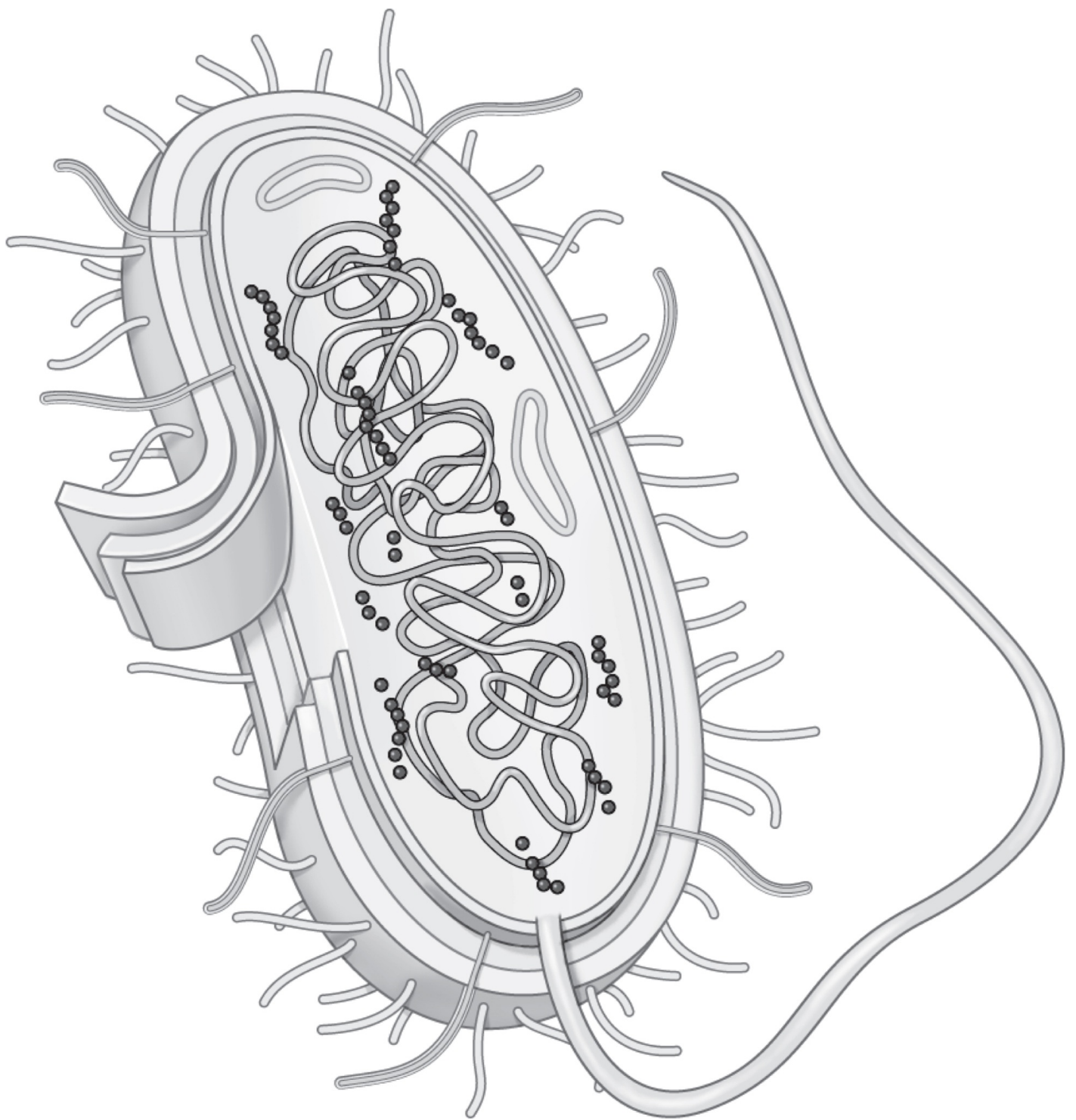
Using the spaces below, describe two ways the microbiome influences health and body function. The first part of each sentence has been provided to get you started.

1. Microbes residing in the intestinal tract release _____.
2. In turn, microbes in the intestinal tract respond to _____.
3. Furthermore, genetic material found in the microbiome _____.

Conceptualize in Color Bacterial Structures

Identify the structures of bacteria by coloring the structures in the figure below. Use the suggested colors or choose your own.

- Capsule: Green
- Cell wall: Orange
- Cytoplasmic membrane: Blue
- DNA: Pink
- Ribosomes: Red
- Plasmids: Brown
- Pilli: Purple
- Flagellum: Dark blue



Fill in the Gaps **Bacteria**

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

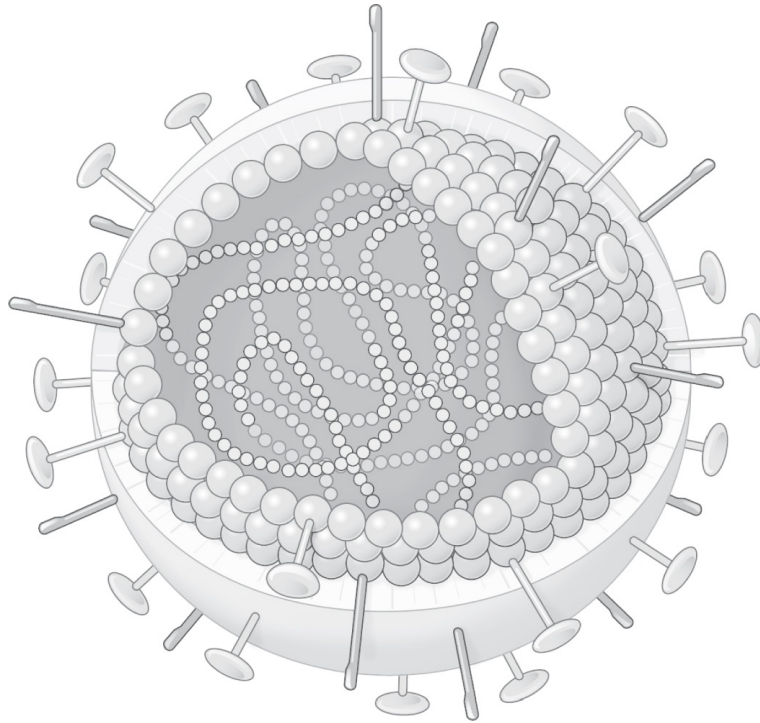
CAPSULE
CELL WALL
CYTOPLASMIC MEMBRANE
FLAGELLA
GROUPED IN THE CELL'S CENTRAL REGION
PILI
PLASMIDS
RESIST
RESPOND TO
THICK
THIN
WITHIN THE CELL'S NUCLEUS

1. Some species of bacteria contain a gelatinous covering called a _____ that keeps the bacterium from drying out.
2. A rigid _____ encloses the bacterium and gives the cell its shape.
3. The regulates _____ the flow of materials into and out of the cell.
4. Because the composition of the _____ varies between species, it is an important distinguishing factor between bacterial types.
5. Many species of bacteria have small, hair-like projections called _____ that allow bacteria to attach to other cells and surfaces.
6. Small loops of bacterial DNA are called _____.
7. Some bacteria have _____, which aid in motility.
8. Bacterial DNA is found _____.
9. Bacterial structures that allow bacteria to trade genes are called _____.
10. Bacteria containing a _____ are more likely to cause disease.
11. Gram-positive bacteria have a layer of peptidoglycan and tend to _____ antibiotic treatment.

Conceptualize in Color Viruses

Identify the structures of viruses by coloring the figure below. Use the suggested colors or choose your own.

- Capsid: Blue
- Envelope: Orange
- Nucleic acid: Yellow
- Spikes: Brown



Illuminate the Truth Viruses

Highlight the word or phrase that completes each sentence correctly.

1. Viruses (are)(are not) cells.
2. Viruses can replicate only (before entering a cell)(after entering a cell).
3. Viruses consist of a bundle of genetic material surrounded by a protein shell called a (capsid) (capsule).
4. Some viruses have an additional spikey layer called (a capsomere)(envelope).
5. This spikey layer helps viruses (kill the host cell)(bind to and enter the host cell).
6. Viruses mutate (slowly)(rapidly).
7. A virus becomes a new variant when it develops (new biologic capabilities)(one or more new mutations).

Make a Connection Viral Shapes

In the spaces below, list the three basic viral shapes. The first letter of each term is provided to get

you started. Then, draw a line to link each shape to its particular characteristics.

1. H_____
2. P_____
3. C_____
- a. Adenovirus has this shape
- b. Rabies virus has this shape
- c. Is a protein cylinder
- d. A bacteriophage has this shape
- e. Consists of many triangular faces

Just the Highlights Boosting the Microbiome

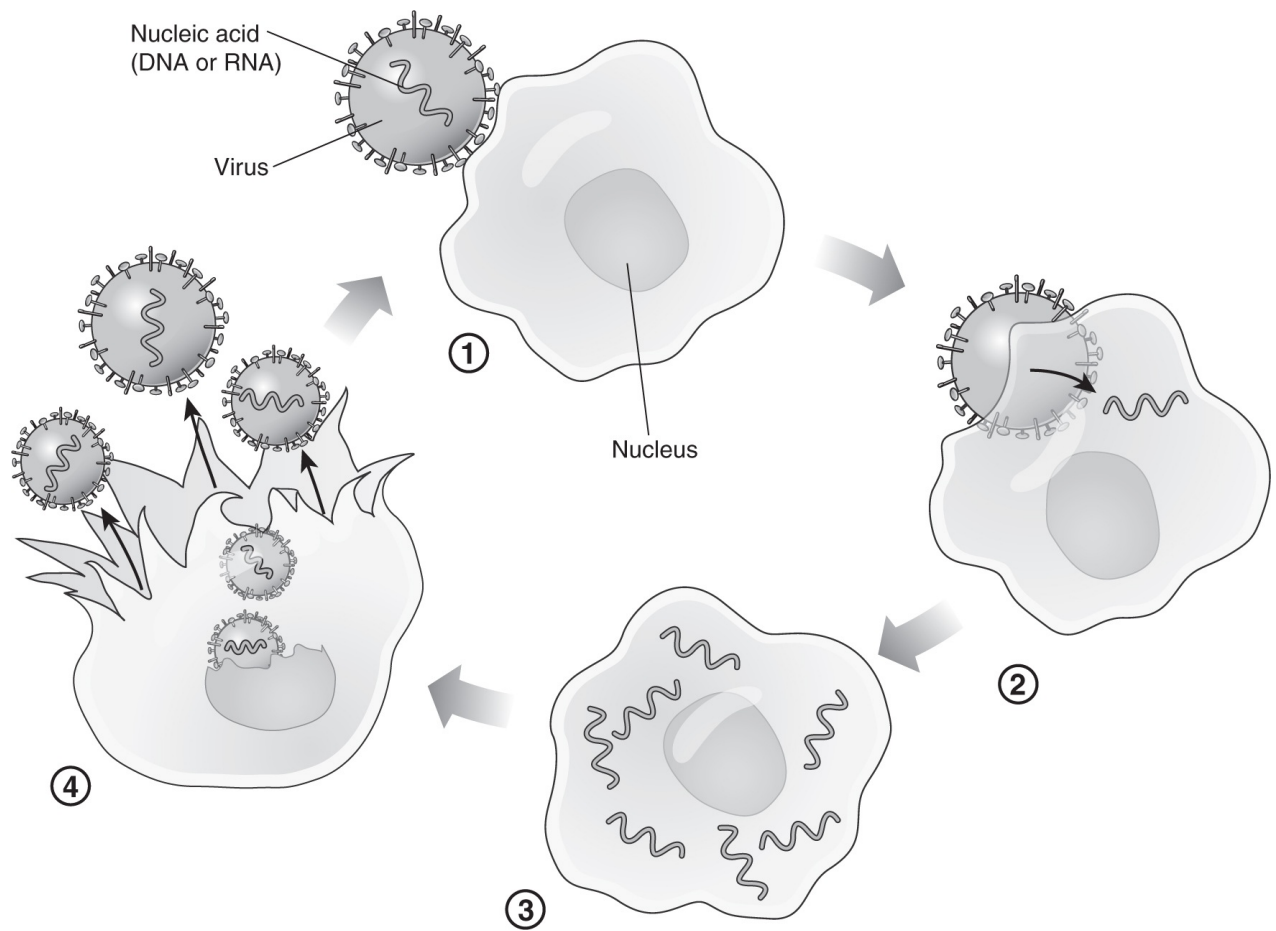
Because of its crucial role in maintaining health, adults should implement measures to nourish and protect the microbiome. In the following list, highlight the factors that can help boost the microbiome in green and the threats to the microbiome in orange.

1. Fermented foods
2. Exercise
3. Pollution
4. Exposure to soil and plants
5. Sanitizing products
6. Prebiotics
7. Foods containing polyphenols
8. High-fat, high-sugar diet
9. Smoking
10. Probiotics
11. High-fiber diet
12. Stress

Describe the Process Viral Replication

Viral replication occurs rapidly: a single cell may produce from 10,000 to 50,000 new viruses in as little as 48 hours. Test your knowledge of how this occurs by describing the process in the spaces

below. Use the figure as a guide. Further test your knowledge by coloring the figures using colors of your own choosing.



- 1.**

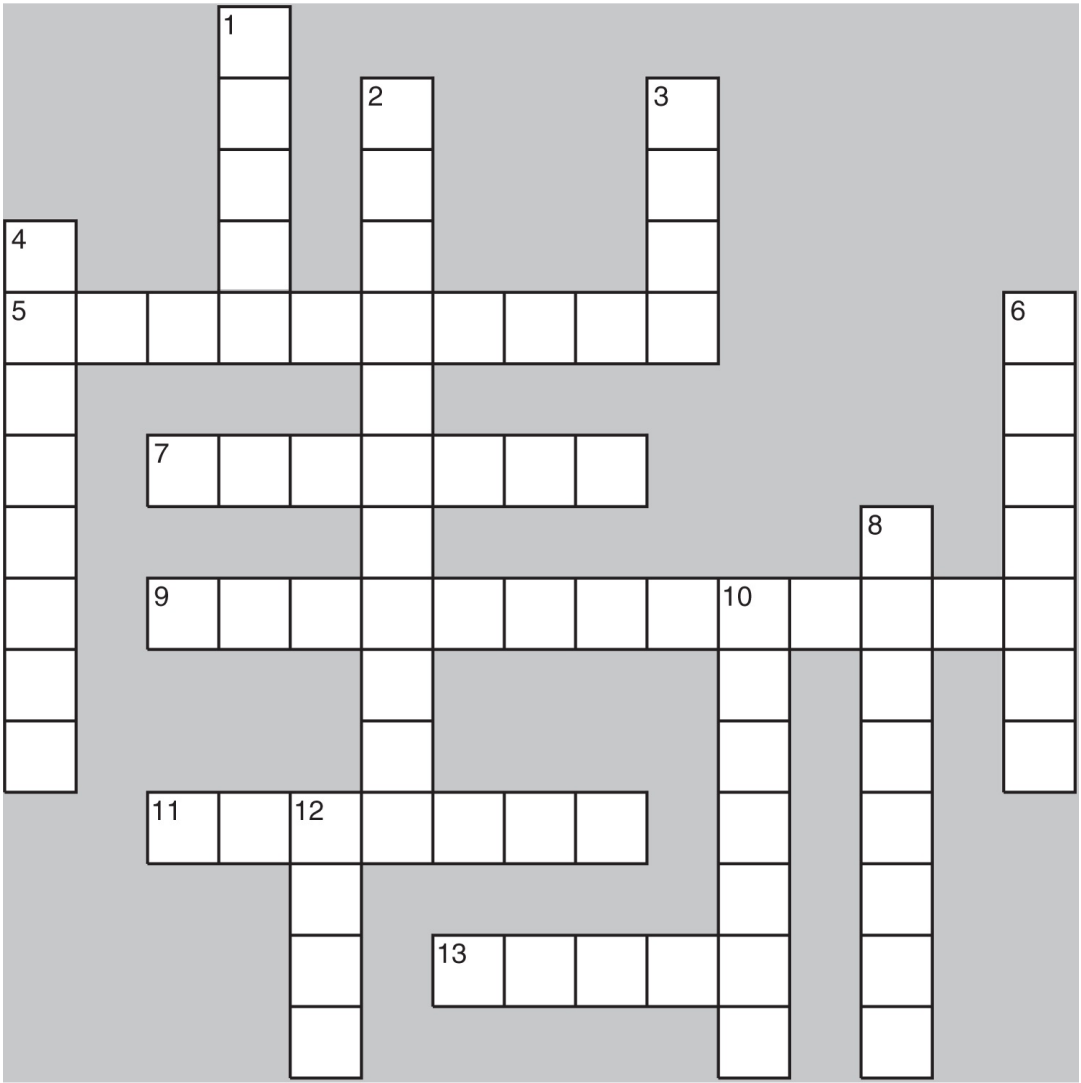
- 2.**

- 3.**

4.

Puzzle It Out Microbiome Facts

Complete the following crossword puzzle to test your knowledge about the human microbiome.



ACROSS

- 5. Interferes with a bacterium’s ability to manufacture peptidoglycan
- 7. Bacteria having a rod shape

9. Complex virus that attaches to the surface of a cell before injecting its nucleic acid into the target cell
11. Structure that allows bacteria to ward off white blood cells
13. Molds and yeasts

DOWN

1. Round bacteria
2. Frequent culprit in microbiome disruption
3. Place on the body where fungal infections often begin
4. Spiral-shaped bacteria
6. Bacteria lack this
8. Microorganism known to cause disease
10. Bacterial structure that allows bacteria to be extremely adaptable
12. Gram-negative bacteria stain this color

Illuminate the Truth Archaea and Fungi

Highlight the word or phrase that completes each sentence correctly.

1. The presence of fungi in the intestinal microbiota is (indicative of disease)(a normal finding) in most instances.
2. Archaea are microscopic, single-celled organisms that are biochemically (distinct from)(similar to) bacteria.
3. When found in the microbiome, archaea are considered to be (pathogenic invaders)(normal contributing occupants).
4. Archaea look (distinct from)(similar to) bacteria.
5. Archaea have a cell membrane that is (similar to the one in bacteria)(distinct from) that of any other organism.
6. The appearance of archaea is (distinct from)(similar to) that of bacteria.
7. The cell wall of archaea (contains)(lacks) peptidoglycans.

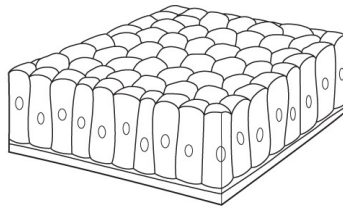
TISSUES

All the trillions of cells of the body can be categorized as belonging to one of four distinct groups of tissue. Remember: Tissues are simply groups of similar cells that perform a common function. Complete the exercises in this chapter to strengthen your knowledge of the four categories of tissue: epithelial, connective, nervous, and muscular.

Drawing Conclusions Epithelial Tissue (Single Layer)

Test your knowledge of the different types of epithelial tissues that have one layer by filling in the blanks of each sentence. (Hint: Some blanks require more than one word.) Next, color and label each of the sample epithelial drawings.

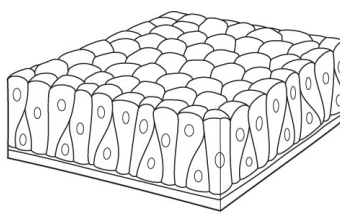
1. Epithelial tissue having only one layer is called _____.
2. _____ epithelium consists of a single layer of flat, scale-like cells.
3. _____ epithelium consists of a single layer of cube-like cells.
4. _____ epithelium consists of a single layer of irregularly shaped columnar cells; the different cell heights make the tissue appear to be stratified.
5. _____ epithelium consists of a single layer of columnar cells.



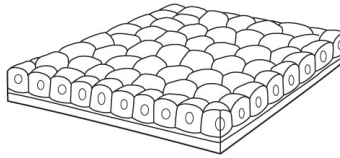
A. _____



B. _____



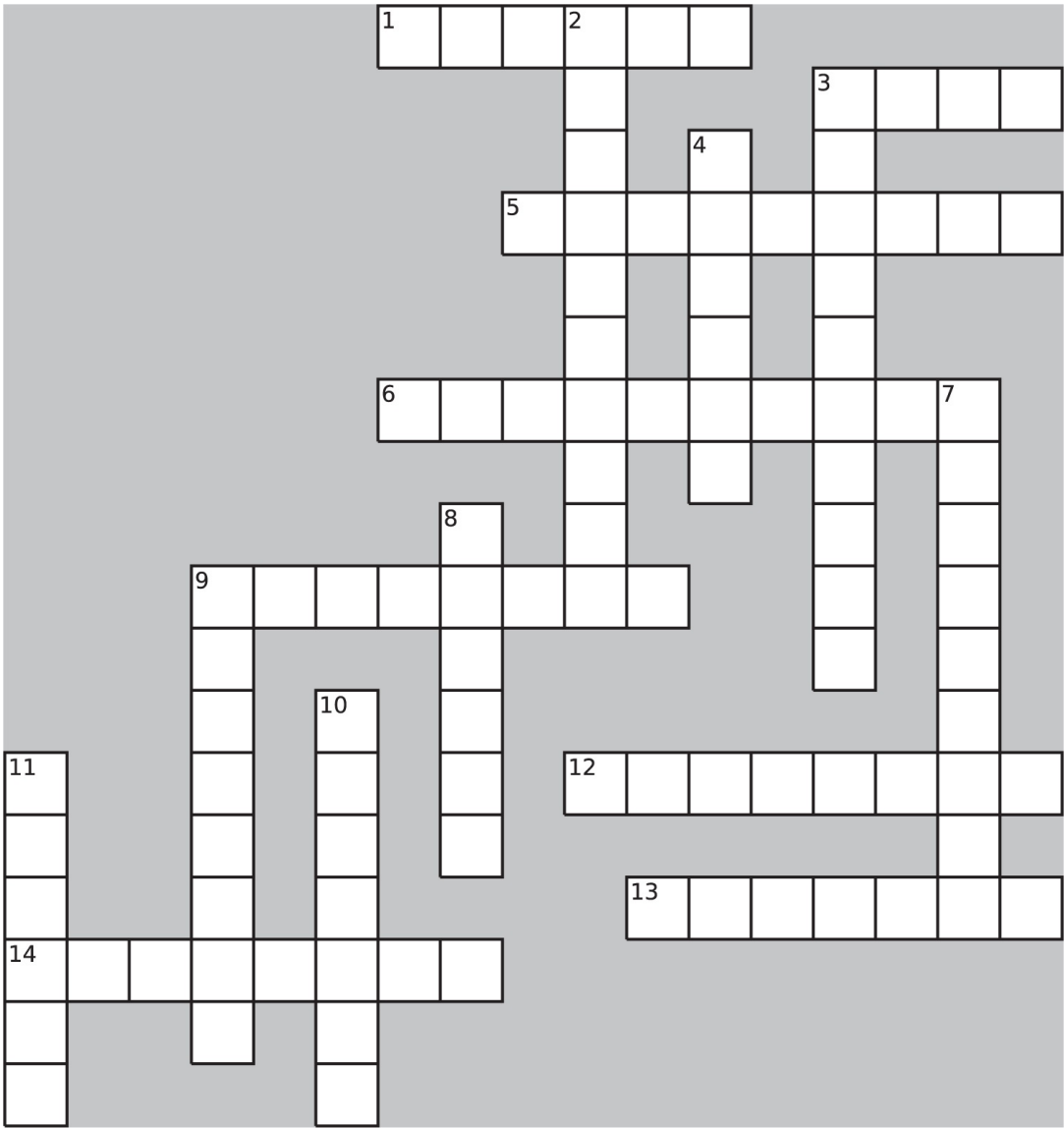
C. _____



D. _____

Puzzle It Out Tissues

Complete the following crossword puzzle to test your knowledge of tissues.



ACROSS

1. Dense connective tissue band or sheet that binds organs and muscles together
3. Type of cell that can differentiate into a number of different cells
5. Gland that secretes its product directly into the bloodstream
6. Tissue that lacks blood vessels and depends on underlying connective tissue for oxygen and nutrients
9. The body's most abundant protein
12. Gland that secretes its product into ducts
13. Tissue dominated by fat cells
14. Cell shape that is flat and plate-like

DOWN

2. The most widespread and most varied of all the tissues
3. Tissue that has multiple layers in which some cells don't touch the basement membrane
4. Modified cells containing secretory vesicles that produce large quantities of mucus
7. Cord-like tissues that attach bones to bones
8. Key component of connective tissue
9. Cell shape that is tall and cylindrical
10. Dense, cord-like tissues that attach muscles to bones
11. Groups of cells that perform a common function

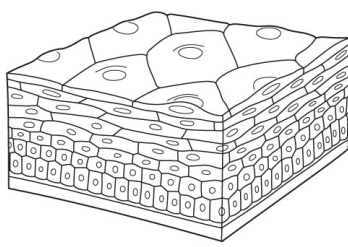
Just the Highlights Epithelial Function

In the following lists, link each type of epithelial tissue to its location in the body by highlighting each with the same color. For example, highlight "simple squamous epithelium" in blue; then highlight the body location where simple squamous epithelium is found in blue. Choose a different color for each type of epithelial tissue.

1. Simple squamous epithelium
2. Simple cuboidal epithelium
3. Simple columnar epithelium
4. Pseudostratified columnar epithelium
 - a. Lines the intestines
 - b. Lines the trachea, large bronchi, and nasal mucosa
 - c. Lines the alveoli
 - d. Lines the ducts and tubules of many organs, including the kidneys

Drawing Conclusions Epithelial Tissue (Several Layers)

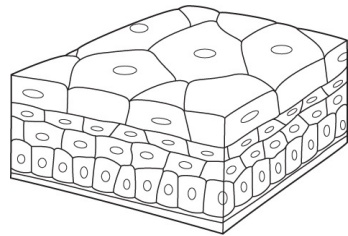
Test your knowledge of each of the following tissue samples by identifying the tissue type and listing at least one location where the tissue can be found.



1.

Tissue Type _____

Location in the Body _____



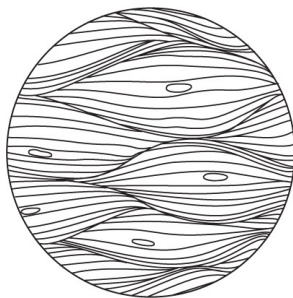
2.

Tissue Type _____

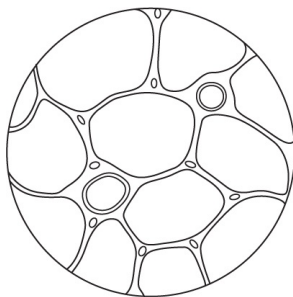
Location in the Body _____

Drawing Conclusions **Connective Tissue**

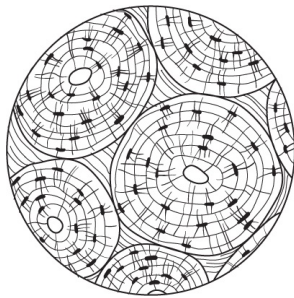
*Test your knowledge of the connective tissue by coloring and labeling the tissue samples below.
(Hint: Use your textbook if necessary to help you choose colors.)*



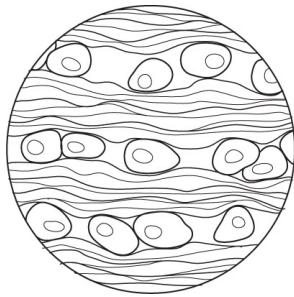
A. _____



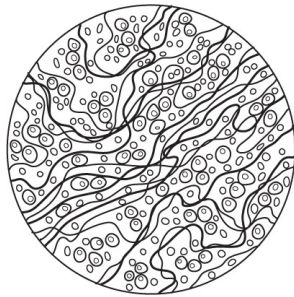
B. _____



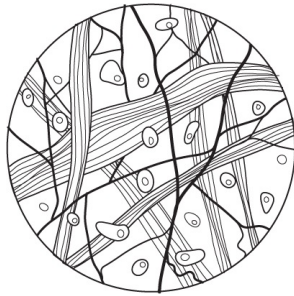
C. _____



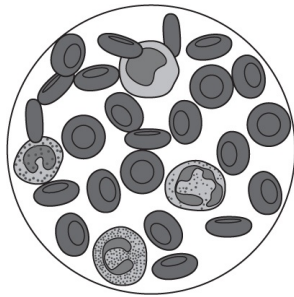
D. _____



E. _____



G. _____



G. _____

Just the Highlights Tissue Traits

Link the traits of various tissues by highlighting each of the following sentences as suggested.

- Sentences relating to epithelial tissues: Pink
 - Sentences relating to connective tissue: Blue
 - Sentences relating to muscle tissue: Orange
 - Sentences relating to nervous tissue: Yellow
1. Glands are made of this tissue.
 2. This tissue consists of elongated cells that contract in response to stimulation.
 3. The cells of this tissue are embedded in an extracellular matrix.
 4. This tissue contains no blood vessels and depends upon underlying connective tissue to supply its needs for oxygen and nutrients.
 5. Types of this tissue include blood, bone, cartilage, and fat.
 6. This tissue is found in the brain, spinal cord, and nerves.
 7. This tissue forms the epidermis of the skin.
 8. This tissue contains various types of fibers.
 9. Tendons and ligaments consist of this type of tissue.
 10. This type of tissue has a high degree of excitability and conductivity.
 11. The key functions of this tissue involve protection, absorption, filtration, and secretion.
 12. Three types of this tissue include skeletal, cardiac, and smooth.
 13. This tissue serves to connect the body together and to support, bind, or protect organs.

List for Learning Fibers in Connective Tissue

Using the spaces below, list the three types of fibers found in connective tissue.

1. _____
2. _____
3. _____

Fill in the Gaps All About Connective Tissue

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words in the Word Bank below. Words may be used more than once.

ADIPOSE
AREOLAR
BLOOD
BONE
CARTILAGE
COLLAGENOUS
DENSE
ELASTIC
EXTRACELLULAR MATRIX
FIBROUS
FLUID
LOOSE
PROTEIN FIBERS
RETICULAR

1. The key component of connective tissue is the _____; it consists of varying kinds and amounts of _____ and _____.
2. _____ fibers are the most abundant fibers in connective tissue.
3. _____ fibers occur in networks and support small structures such as capillaries.
4. _____ fibers can stretch and recoil like a rubber band.
5. _____ The basic classifications of connective tissue are connective tissue, _____, _____, and _____.
6. _____ Fibrous connective tissue can be either _____ or _____.
7. _____ connective tissue is the most widely distributed of all tissues.
8. _____ Loose connective tissue is further divided as being either _____ tissue, _____ tissue, or _____ tissue.
9. _____ tissue lies underneath almost all epithelia and surrounds blood vessels and nerves.
10. _____ tissue is dominated by fat cells and helps insulate the body.
11. _____ tissue forms the framework of the spleen, lymph nodes, and bone marrow.

12. _____ connective tissue forms tendons and ligaments.

Illuminate the Truth Connective Tissue

Highlight the word or phrase that completes each sentence correctly.

1. (Collagenous)(Reticular) fibers occur in networks and support small structures, such as capillaries and nerves.
2. (Collagenous)(Elastic) fibers are the most abundant fibers in connective tissue.
3. Connective tissue is classified according to its (cell layers)(structural characteristics).
4. (Areolar)(Adipose) is a type of loose connective tissue found underneath almost all epithelia.
5. (Adipose)(Reticular) tissue forms the framework of the spleen, lymph nodes, and bone marrow.
6. (Cartilage)(Bone) is a type of dense connective tissue that has no blood supply, making healing slow or absent following an injury.
7. (Elastic cartilage)(Fibrocartilage) resists compression and absorbs shock, making it ideal to form the discs between the vertebrae.
8. The matrix of (bone)(cartilage) serves as a storage site for calcium.
9. Unlike other connective tissues, (bone)(blood) doesn't contain any fibers.
10. Most connective tissue has a (rich)(limited) blood supply.
11. Blood has (no matrix)(a liquid matrix).
12. Blood contains (no fibers)(liquid fibers).

Illuminate the Truth Cartilage

Highlight the word or phrase that completes each sentence correctly.

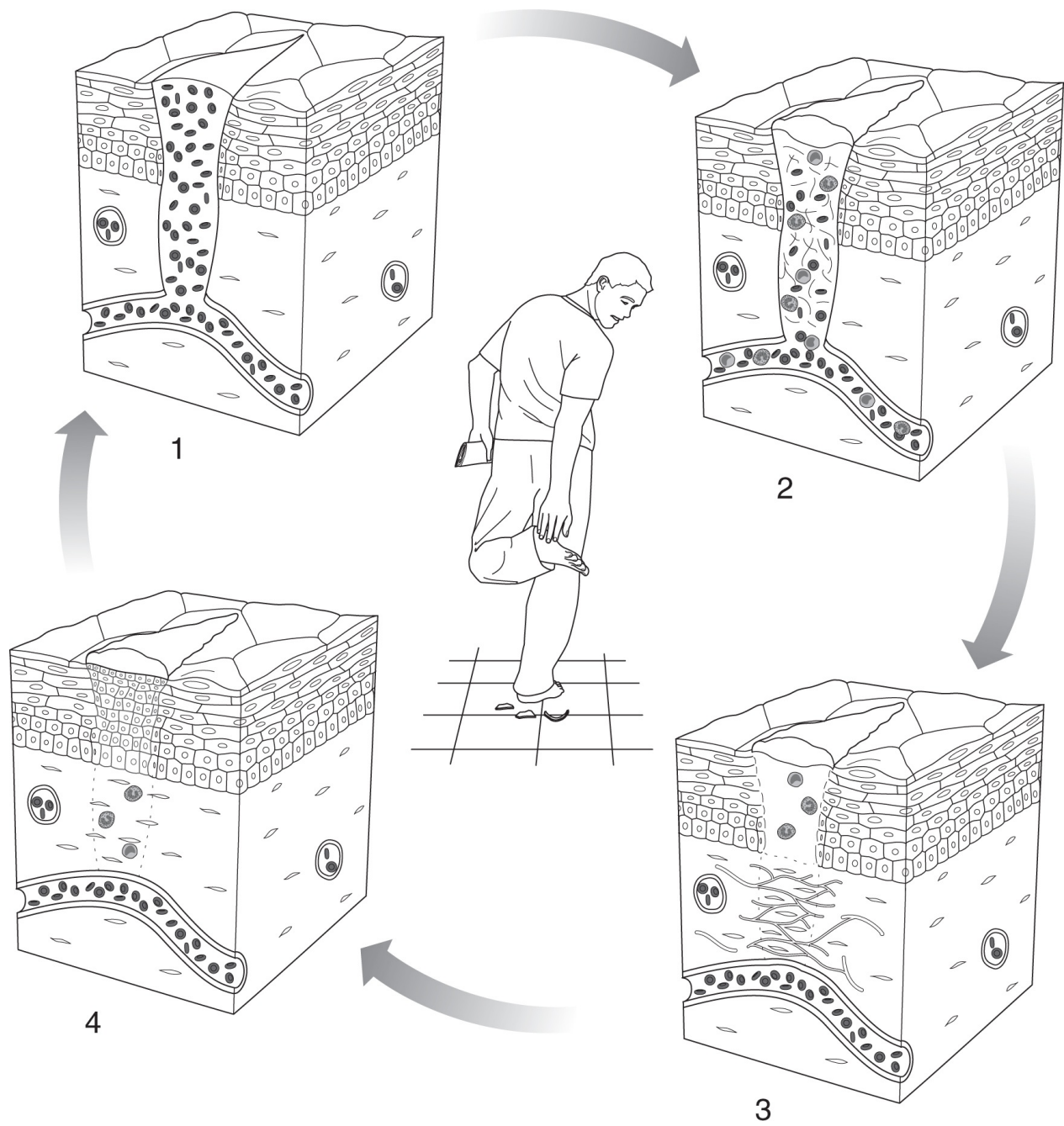
1. Cartilage is composed of cells called (chondrocytes)(osteocytes).
2. The most common type of cartilage is (elastic)(hyaline) cartilage.
3. (Elastic)(Hyaline) cartilage provides flexible support to the external ear and epiglottis.
4. (Hyaline)(Fibrocartilage) is the strongest cartilage.
5. (Fibrocartilage)(Articular cartilage) forms the discs between vertebrae.
6. (Fibrocartilage)(Hyaline cartilage) forms much of the fetal skeleton.
7. Articular cartilage is actually (hyaline)(elastic) cartilage that occurs at the ends of movable joints.

8. Cartilage receives nutrients and oxygen by (active transport from the blood)(diffusion from surrounding connective tissue).

Drawing Conclusions Tissue Repair

Test your knowledge of tissue repair by coloring the figure on the next page (which depicts the various stages in tissue repair) according to the following instructions. Use the suggested colors or choose your own.

- Wound: Dark red
- Scab: Brown
- Granulation tissue: Pink
- White blood cells: Purple
- New cells: Tan
- Scar tissue: White
- Fibroblasts: Orange



Then, describe what's occurring in each step in the spaces provided.

1. _____

2. _____

3. _____

4. _____

In the spaces below, identify the three types of epithelial membranes. The first letter of each term is provided to get you started. Then, draw lines to link each membrane with its characteristics.

1. M_____

2. C_____

3. S_____

- a. Composed of simple squamous epithelium resting on a thin layer of areolar connective tissue
- b. Lines body surfaces that open directly to the body's exterior
- c. Lines some of the closed body cavities and covers many of the organs in those cavities
- d. The body's largest membrane
- e. Secretes a fluid to help prevent friction as the organs move
- f. Consists of different types of epithelium, depending on the location and function of the membrane
- g. Consists of a layer of epithelium resting on a layer of connective tissue
- h. Secretes mucus
- i. Consists of three types: pleural, pericardial, and peritoneal

Illuminate the Truth Facts about Tissues

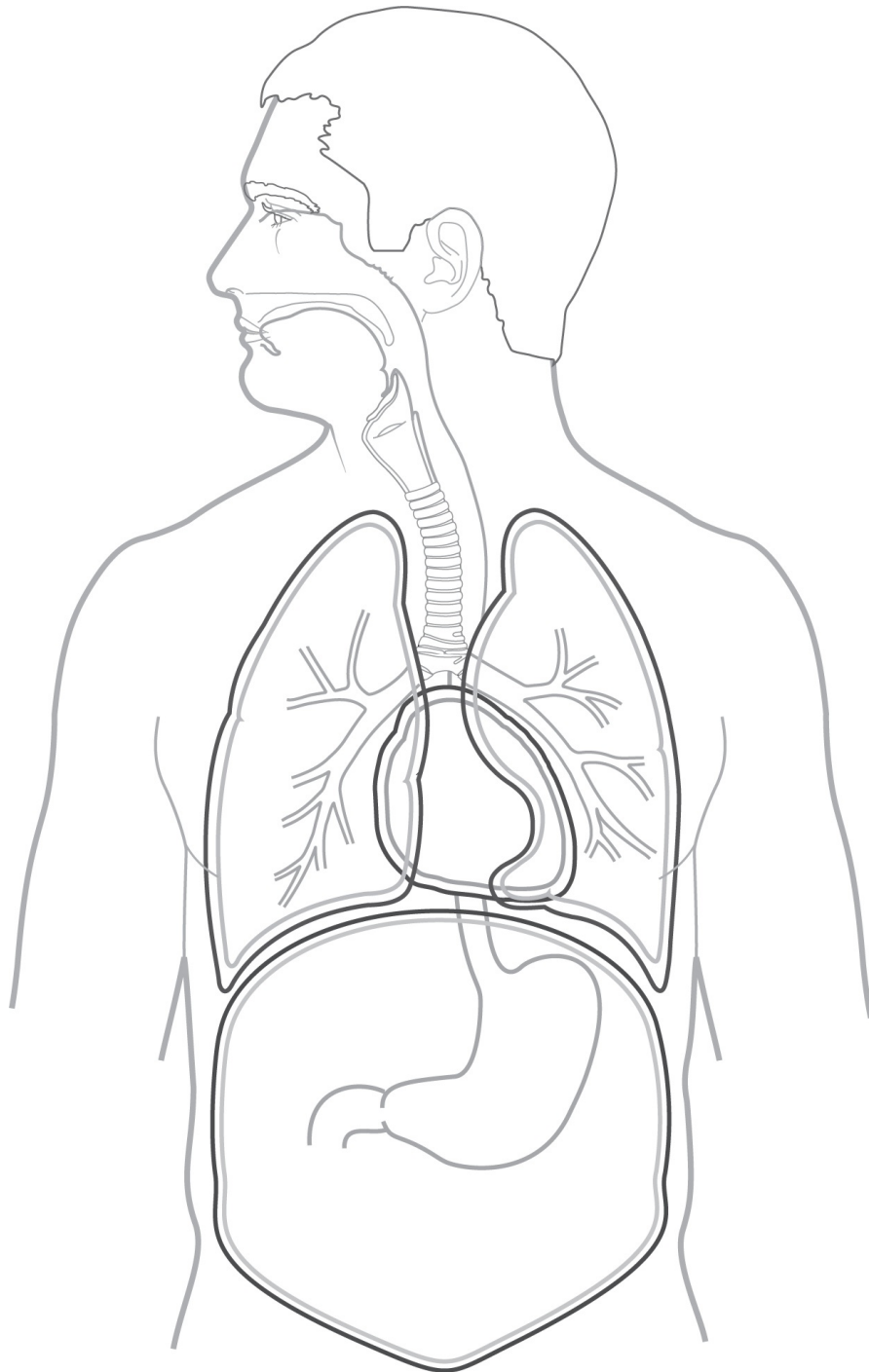
Highlight the word or phrase that completes each sentence correctly.

- 1. With age, connective tissue becomes (more)(less) elastic.
- 2. Stem cells are unique from other body cells because stem cells (remain stable over time)(can differentiate into many types of cells).
- 3. Scientists are working to reprogram adult stem cells because adult stem cells (have a limited capacity to divide)(tend to divide unchecked leading to tumor growth).
- 4. An increased amount of body fat in the (hips and thighs)(abdomen) carries increased health risks.
- 5. The cluster of health conditions associated with increased body fat is called (metabolic syndrome) (fibrocartilage disorder).
- 6. A leading contributor to disability in older adults is (sarcopenia)(anemia).
- 7. Irreversible cell injury and death is (necrosis)(gangrene).
- 8. (Necrosis)(Gangrene) refers to death of tissue as a result of inadequate blood supply.
- 9. (Dry)(Wet) gangrene involves a bacterial infection and can be life threatening.

Conceptualize in Color Epithelial Membranes

Identify the epithelial membranes by coloring the figure below. Use the suggested colors or choose your own.

- Outline the mucous membranes in pink.
- Outline the cutaneous membrane in yellow.
- Outline the visceral pleura in blue.
- Outline the parietal pleura in purple.
- Outline the peritoneal membrane in green.
- Outline the pericardial membrane in red.

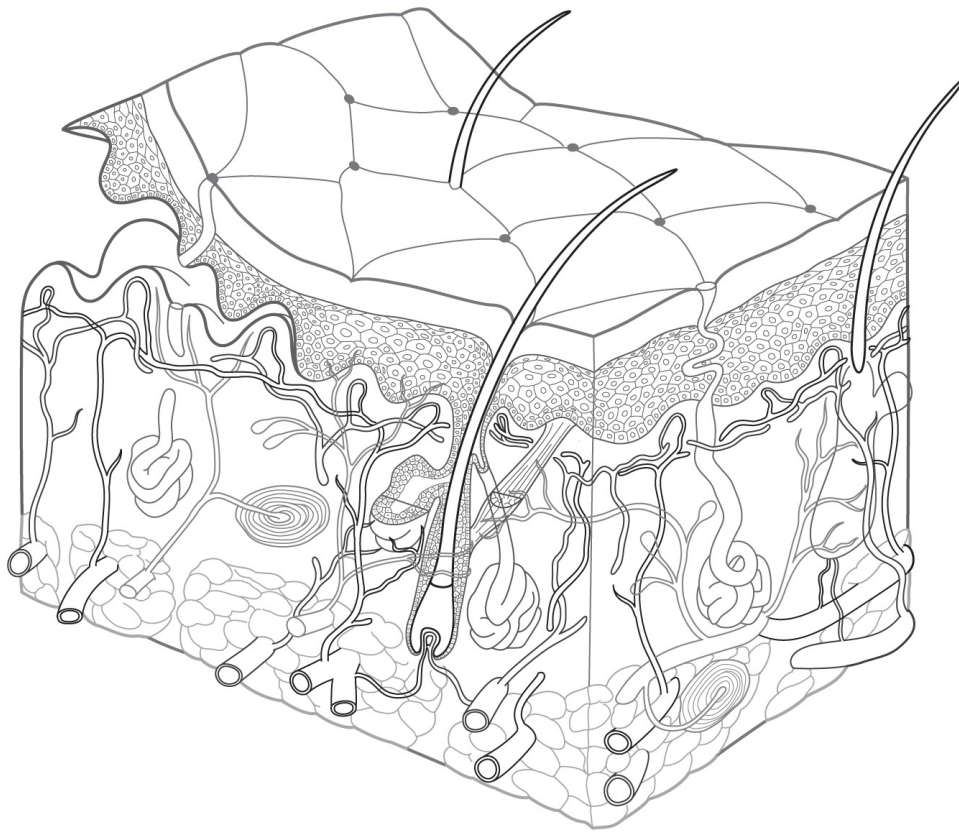


chapter 6

INTEGUMENTARY SYSTEM

The skin—which, together with the hair and nails, forms the integumentary system—is one of the largest organs in the body. Despite its thinness, it consists of multiple layers and many cell types. It also performs many functions crucial for homeostasis and even survival. Use the activities in this chapter to test yourself about this vital body system.

Conceptualize in Color Skin Structures



Identify the skin structures by coloring the figure above. Use the colors suggested or choose your own.

- Epidermis: Brown
- Dermis: Pink
- Hypodermis: Yellow
- Eccrine sweat gland: Orange

- Apocrine sweat gland: Purple
- Sebaceous gland: Green
- Hair follicle: Light beige
- Hair bulb: Blue
- Hair shaft: Black
- Dermal papilla: Dark pink
- Arrector pili muscle: Red

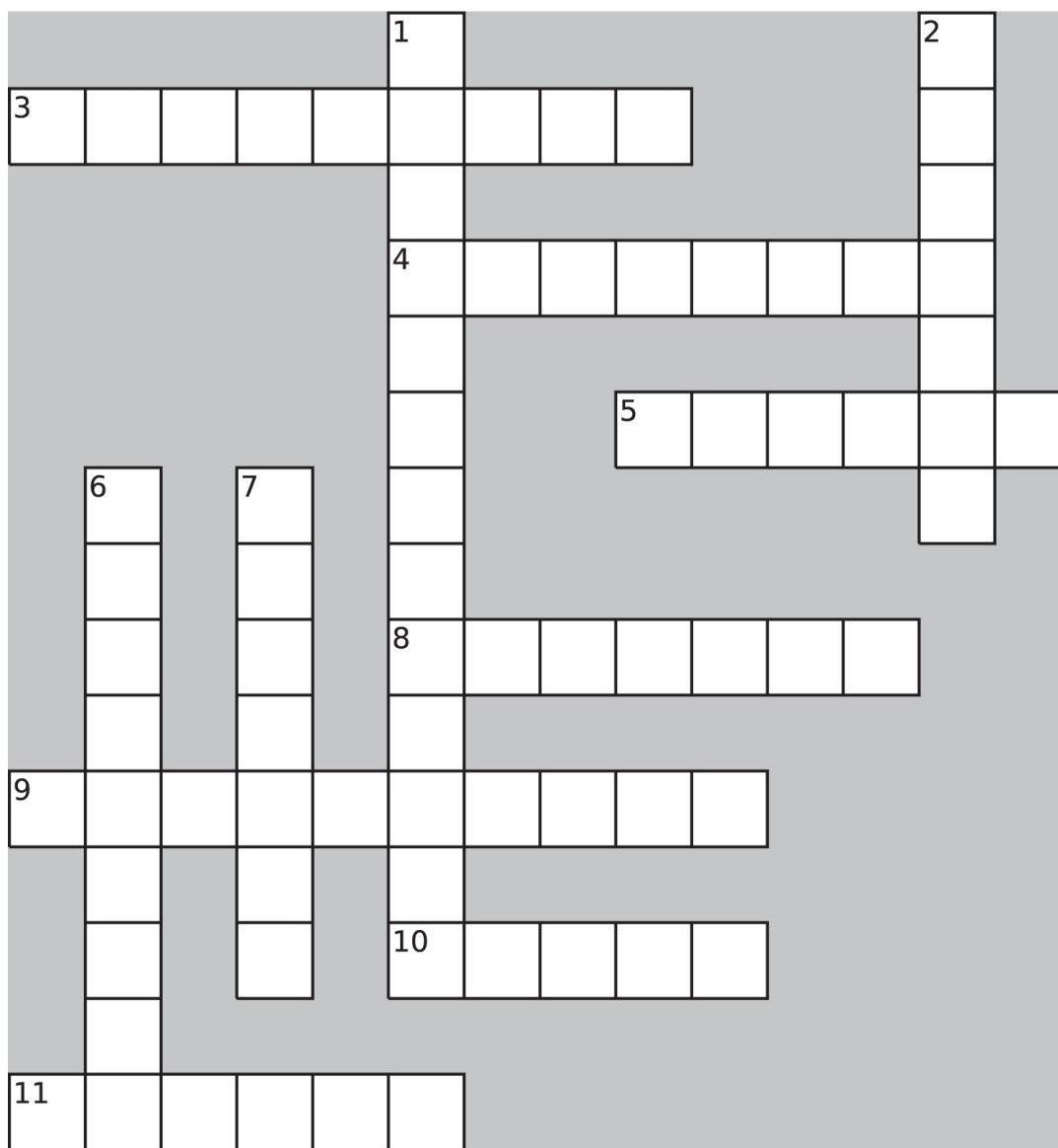
Just the Highlights Structures of the Skin

Link the skin structures by highlighting each of the following sentences as suggested.

- Sentences relating to the epidermis: Pink
 - Sentences relating to the dermis: Blue
 - Sentences relating to the hypodermis: Orange
1. Outermost layer
 2. Helps insulate the body from outside temperature changes
 3. Inner, deeper layer
 4. Contains an abundance of blood vessels
 5. Contains no blood vessels
 6. Composed mostly of adipose tissue
 7. Contains sweat glands, sebaceous glands, and nerve endings
 8. Consists of stratified squamous epithelial tissue
 9. Contains hair follicles
 10. Binds the skin to the underlying tissue
 11. Contains primarily collagen fibers

Puzzle It Out More About the Skin

Complete the following crossword puzzle to test your knowledge of skin structures and terms.



ACROSS

3. The skin is also called _____ the membrane.
4. Excessive hair loss
5. The inner, deeper layer of the skin
8. The outermost layer of the epidermis is called the stratum _____.
9. Inflammation of the skin characterized by itching and redness
10. Oily substance produced by sebaceous glands
11. Dead tissue resulting from a burn

DOWN

1. Flattened cells making up the skin's outermost layer
2. Substance that gives hair and skin its color
6. The outermost layer of the skin
7. Ear wax

Sequence of Events Formation of New Skin Cells

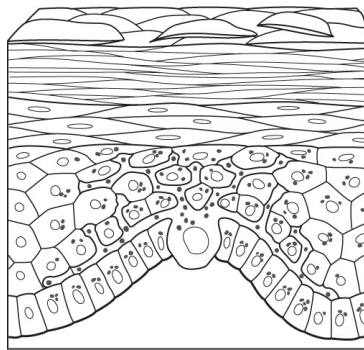
Insert the numbers 1 through 5 in the spaces provided to identify the sequence of events that occur in the formation of new cells.

- _____ **A.** Flattened, dead cells called keratinocytes arrive at the stratum corneum.
- _____ **B.** Cells stop dividing and produce keratin, which replaces the cytoplasm and nucleus of the cell.
- _____ **C.** Stem cells in the stratum basale undergo mitosis.
- _____ **D.** The cells flatten and die.
- _____ **E.** As new cells are produced, they push older cells upward.

Drawing Conclusions Skin Color

Test your knowledge about skin color by coloring the figure below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence.

- Melanocyte: Green
- Keratinocytes: Tan
- Melanin granules: Red
- Cell nucleus: Orange



1. Melanocytes are scattered through the _____ layer of the epidermis.
2. These cells produce a substance called _____.
3. A person's skin color is determined by the amount, and type, of _____.
4. The _____ forms a cap over the top of the cell _____ to protect it from the _____ rays of the sun.

Fill in the Gaps Skin Changes

Fill in the blanks with the appropriate word to complete each sentence correctly. Choose from the words listed in the Word Bank below.

ADRENAL
ALBINISM
BLUE
BRONZING
CYANOSIS
ERYTHEMA
JAUNDICE
MELANIN
PALLOR
YELLOW
RED

1. A deficiency of oxygen in circulating blood gives skin a _____ tint, a condition called _____.
2. Impaired liver function may cause the skin to take on a _____ tone, a condition called _____.
3. A deficiency of hormones from _____ the gland causes the skin to become golden-brown in color, which is called _____.
4. A genetic lack of _____ results in extremely pale skin, white hair, and pink eyes, a condition called _____.
5. Decreased blood flow, such as from exposure to cold, emotional stress, or low blood pressure, produces _____.
3. Increased blood flow in dilated vessels close to the skin's surface makes the skin appear more _____ in color, which is called _____.

List for Learning Functions of the Skin

Using the spaces provided, list five key functions of the skin.

1. _____
1. _____
3. _____
4. _____
5. _____

Fill in the Gaps Hair

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once.

ARRECTOR PILI

BULB

HAIR FOLLICLE

MELANIN

PAPILLA

SHAFT

1. The _____ is the part of the hair that extends above the skin's surface.
2. Each hair lies within a sheath of epidermis called a _____.
3. The hair _____ is buried in the dermis.
4. A cluster of connective tissue and blood vessels at the base of the hair is called the _____.
5. A small bundle of smooth muscle called the _____ is attached to each hair follicle.
6. Hair growth occurs from the _____.
7. Hair obtains its color from _____.
8. The _____ of the hair determines whether it is straight or curly.
9. Contraction of the _____ from cold or fear causes hair to "stand on end."

Fill in the Gaps Thermoregulation

Fill in the blanks with the appropriate word to complete each sentence correctly to describe how the skin helps the body maintain a stable temperature. Choose from the words listed in the Word Bank below.

CONSTRICT
DILATE
EVAPORATION
INCREASES
NERVES
REDUCES
SWEATING

1. The skin contains _____ to cause blood vessels in the skin to dilate or constrict to regulate heat loss.
2. When chilled, the blood vessels _____; this _____ blood flow through the skin and conserves heat.
3. When overheated, the blood vessels in the skin _____; this _____ the flow of blood and increases heat loss.
4. If the body is still overheated, the brain stimulates _____; this results in _____ and cooling occurs.

Illuminate the Truth Nail Changes

Highlight the correct word or phrase that completes each sentence correctly.

1. A condition in which the distal ends of the fingers enlarge, making them look like a drumstick, is called (clubbing)(breaking); it typically results from long-term (iron)(oxygen) deficiency.
2. One of the first signs of oxygen deficiency is when the nail beds appear (dark red)(blue).
3. Flattened or concave nail beds may indicate a deficiency of (protein)(iron).
4. Anemia may cause the nail beds to look (pale)(cyanotic).
5. Dark lines beneath the nail may indicate (melanoma)(basal cell carcinoma).

Make a Connection Skin Glands

In the spaces below, list the four types of skin glands. The first letter of each term is provided to get you started. Then draw a line to link each gland with its particular characteristics.

1. E_____
2. A_____

3. S_____

4. C_____

- a. Contains a duct that empties onto the skin's surface
- b. Produces ear wax
- c. Contains a duct that empties sweat onto a hair follicle
- d. Begin to function at puberty
- e. Secretes an oily substance onto the hair follicle
- f. Located mainly in the axillary and anogenital region
- g. Secretion has a mild antifungal effect
- h. Are widespread throughout the body but are especially abundant on the palms, soles, forehead, and upper torso
- i. Excess secretions may accumulate in gland ducts, leading to pimples and blackheads
- j. Produce sweat to help the body maintain a constant core temperature
- k. Are scent glands that respond to stress and sexual stimulation

Just the Highlights Burns

In the following list, highlight in yellow the sentences that pertain to first-degree burns, the sentences that pertain to second-degree burns in orange, and the sentences that pertain to third-degree burns in pink.

- 1. Known as a partial-thickness burn, this burn only involves the epidermis.
- 2. This burn results in blisters, severe pain, and swelling.
- 3. This burn often results from sunlight.
- 4. Because nerve endings have been destroyed, this burn may not be painful initially.
- 5. Known as a full-thickness burn, this burn extends through the epidermis and dermis and into the subcutaneous tissue.
- 6. This burn, known as a partial-thickness burn, involves the epidermis and part of the dermis.
- 7. This burn results in redness, slight swelling, and pain.
- 8. This burn often requires skin grafts.

Fill in the Gaps Aging and the Skin

The integumentary system may be one of the first body systems to visibly reflect signs of aging. Fill

in the blanks with the appropriate word or words to describe some of the common results of aging on this body system. Choose from the words listed in the Word Bank below. Words may be used more than once.

CONTROL HYDRATION
DECREASES
INCREASES
REGULATE BODY TEMPERATURE
SLOWS
SPEEDS UP
SPOTTING
THICKENS
THINS
WRINKLES

1. With age, the amount of fat in subcutaneous tissue _____. At the same time, the dermis _____, the amount of collagen and elastin _____, and cell replacement _____. All these factors lead to the development of _____ in the skin.
2. Also, the number and output of sweat glands _____, making it difficult for the elderly to _____.
3. Melanocyte production _____, which sensitivity to the sun.
4. Pigment in the hair _____, which causes hair to turn gray.

chapter 7

BONES & BONE TISSUE

The bones forming the human skeleton are dynamic living tissue. Besides providing the framework of the body, bones generate blood cells, regulate blood calcium levels, and join with the muscular system to allow us to move. The activities in this chapter should help you refine your knowledge of both the form and function of this vital tissue.

Make a Connection Bone Classifications

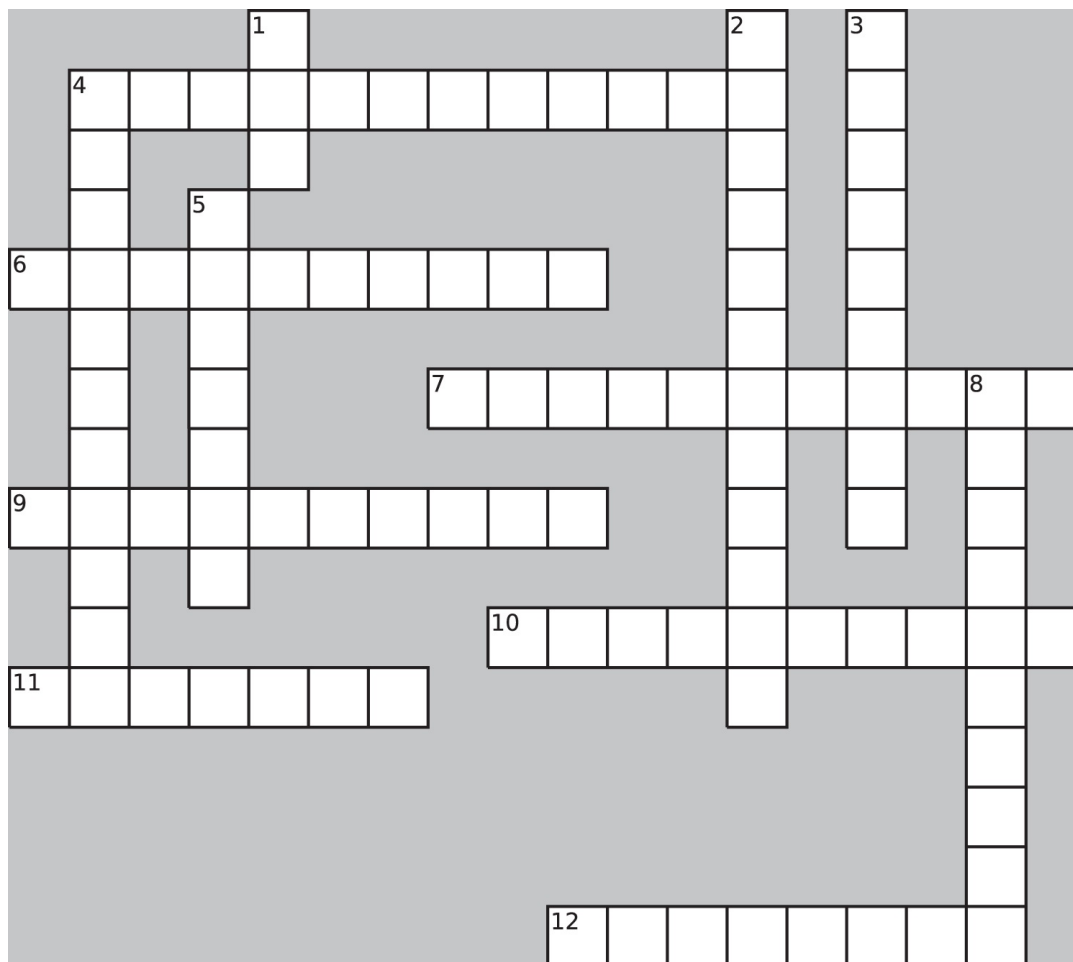
In the spaces below, list the four categories of bones. The first letter of each term is provided to get you started. Then, draw a line to link each category to its specific characteristics.

1. L_____
2. S_____
3. F_____
4. I_____

- a. Serve to protect organs
- b. Tend to be shaped like cubes
- c. Are longer than they are wide
- d. Come in various sizes and shapes
- e. Work like levers to move limbs
- f. Are thin and often curved
- g. Are often clustered in groups
- h. Examples include the femur of the thigh and the humerus of the arm
- i. Are about as broad as they are long
- j. Examples include the carpal bones of the wrist
- k. Examples include the skull and the ribs
- l. Examples include the vertebrae and facial bones

Puzzle It Out Bone Terms

Complete the following crossword puzzle to test your knowledge of bone terms.



ACROSS

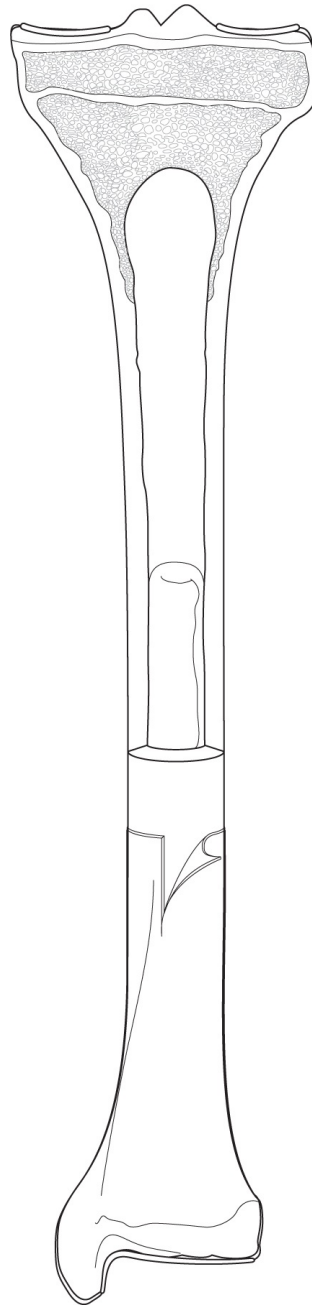
4. Disease meaning “porous bones”
6. Process by which bone cells destroy old bone and deposit new bone
7. Bone cells that dissolve unwanted or unhealthy bone
9. Bone found in the ends of long bones and the centers of most other bones
10. Mature bone cells that have become entrapped in the hardened bone matrix
11. Name for bone tissue
12. Break in a bone

DOWN

1. Type of marrow that produces blood cells
2. Process whereby fetal skeleton becomes bone
3. Substance from which most bones evolve
4. Bone cells that help form bone
5. Type of bone that forms the shafts of long bones and surrounds outer surfaces of other bones
8. Latticework of bone that makes up spongy bone

Conceptualize in Color Parts of a Long Bone

Identify the parts of the long bone by coloring the figure below. Use the suggested colors or choose your own.



1. Articular cartilage: Blue_____
2. Bone marrow: Yellow
3. Medullary cavity: Gold
4. Periosteum: Tan
5. Epiphyseal line: Brown
6. Draw a red line along the endosteum
7. Draw a bracket around each epiphysis

8. Draw a bracket around the diaphysis

Fill in the Gaps About Long Bones

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once.

ARTICULAR
COMPACT
DIAPHYSIS
EPIPHYSIS
MEDULLARY CAVITY
PERIOSTEUM
RED
SPONGY
YELLOW

1. The _____ allows an attachment point for tendons and ligaments.
2. The _____ is composed of compact bone.
3. The _____ gives long bones the strength to bear weight.
4. The central, hollow portion of a long bone is called the _____.
5. A dense fibrous material called the _____ covers the outside of the central, shaft-like portion of the bone.
6. In adults, the medullary cavity is filled with _____ bone marrow.
7. A layer of hyaline cartilage called _____ cartilage covers the surface of the _____.
8. The _____ helps ensure a strong connection between muscle and bone.
9. The interior cavity of long bones in children is filled with _____ bone marrow.
10. _____ bone marrow produces blood cells.
11. The epiphysis of a long bone is composed of _____ bone.

Illuminate the Truth Bone Tissue Basics

Highlight the correct word or phrase that completes each sentence correctly.

1. Bone is a type of (connective)(epithelial) tissue.
2. (Osteoblasts)(Osteoclasts) help form bone by secreting substances that comprise the bone's matrix.
3. (Osteoblasts)(Osteoclasts) dissolve unwanted or unhealthy bone.
4. The matrix of bone is (soft and spongy)(hard and calcified).
5. (Collagen)(Cartilage) fibers in the matrix make bone resistant to stretching forces; this is called (torsional)(tensile) strength.
6. Bone (can)(cannot) resist strong squeezing forces.
7. Most bone fractures occur when (compressional)(torsional) forces are exerted on the bone.
8. Weight-bearing exercise leads to the (dissolution of bone)(creation of new bone).

Describe the Process Bone Growth and Repair

Using the spaces below, describe the role of osteoblasts, osteocytes, and osteoclasts in bone growth and repair.

1. Bone is a type of _____ tissue.
2. The role of osteoblasts is to _____.
3. The role of osteoclasts is to _____.
4. Osteocytes are _____.
5. Osteocytes aid in bone repair by _____.

Conceptualize in Color Cancellous Bone

Identify the parts of cancellous (spongy) bone by coloring the figure below. Use the suggested colors or choose your own.

- Periosteum: Brown
- Compact bone: Gold
- Trabeculae: Yellow



Fill in the Gaps Types of Bone Tissue

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

BLOOD VESSELS

COMPACT

HAVERSIAN

LACUNAE

LAMELLAE

NERVES

OSTEOCYTES

OSTEON

RED

SPONGY

TRABECULAE

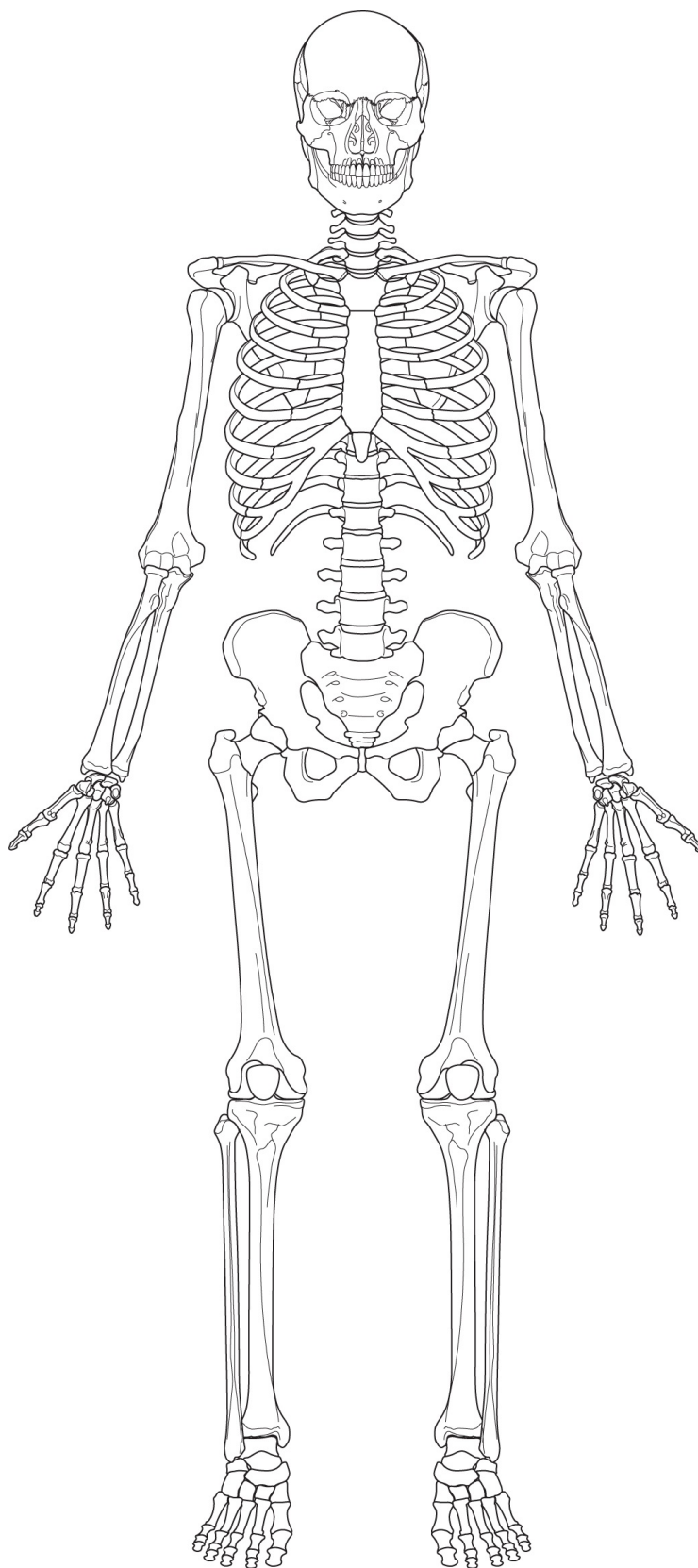
VOLKMANN'S

YELLOW

1. _____ bone is found in the ends of long bones and in the middle of most other bones.
2. _____ bone is dense and solid, offering strength.
3. _____ bone forms the shafts of long bones and the outer surfaces of other bones.
4. _____ is a term for the latticework of spongy bone; it is filled with _____ bone marrow.
5. In compact bone, layers of matrix are arranged in concentric rings called _____ around a central _____ canal. This basic structural unit is called an _____.
6. _____ and _____ run through the center of the canal.
7. Tiny gaps between the rings, called _____, contain _____.
8. Transverse passageways called _____ canals transport blood and nutrients from the bone's exterior to the living cells inside.
9. _____ bone marrow produces red blood cells.

Conceptualize in Color Bone Marrow

Using the following figure, color red all the bones, or portions of bones, containing red bone marrow.



List for Learning Bone Functions

Using the spaces below, list seven functions of bone.

1. _____

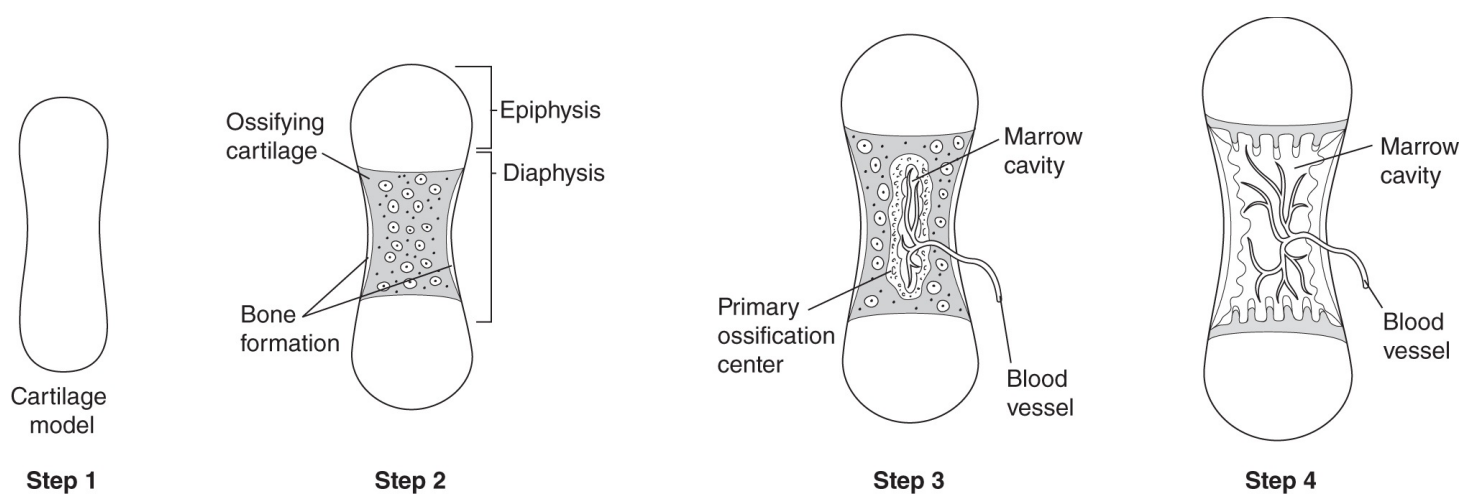
2. _____

3. _____
4. _____
5. _____
6. _____
7. _____

Describe the Process

Ossification

Using the spaces below, describe each step of the endochondral ossification process. Use the figure as a guide.



- Step 1: _____
- _____
- Step 2: _____
- _____
- Step 3: _____
- _____
- Step 4: _____
- _____

Illuminate the Truth

Bone Growth

Highlight the word or phrase that completes each sentence correctly.

1. After birth, bone lengthening occurs at the (epiphyseal plate)(epiphyseal line).
2. (Articular)(Hyaline) cartilage forms the (epiphyseal plate)(epiphyseal line).
3. When bone lengthening stops, (articular cartilage)(the epiphyseal plate) is replaced with (compact bone)(spongy bone).

4. Bone thickening and widening occurs (for a fixed number of years)(throughout the life span).
5. The process by which old bone is destroyed and then replaced with new bone is called (remodeling) (ossification).
6. Physical exercise causes bones to (increase)(decrease) in density.

List for Learning Factors Affecting Bone Growth

Using the spaces below, list four factors that affect bone growth and maintenance.

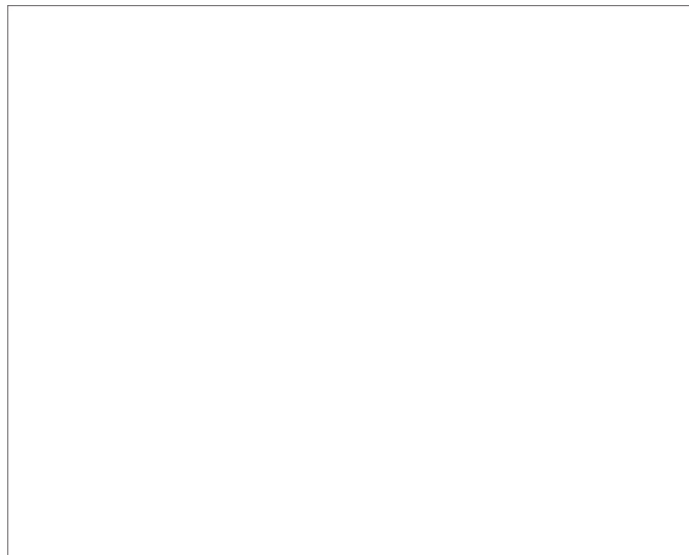
1. _____
2. _____
3. _____
4. _____

Drawing Conclusions Fractures

Test your knowledge of fractures by drawing a bone that illustrates the types of fractures listed below. Then, fill in the blanks of each sentence to correctly describe each fracture. (Hint: Blanks may require more than one word.)

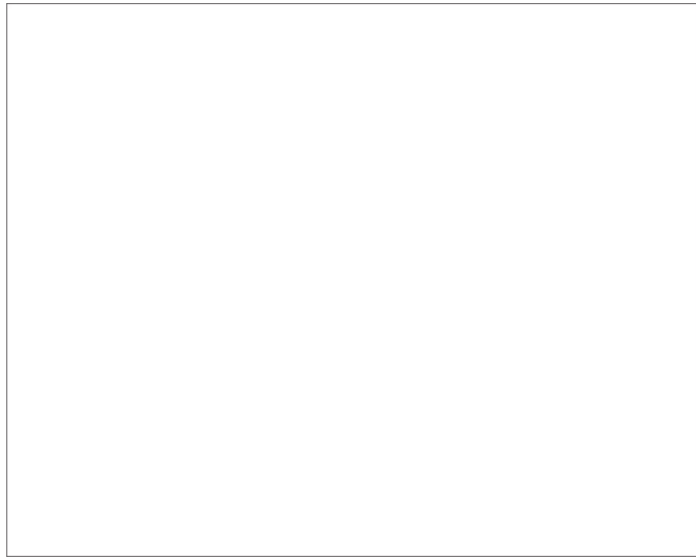
A. Simple fracture

In this type of fracture, the skin and tissue near the fracture is _____.



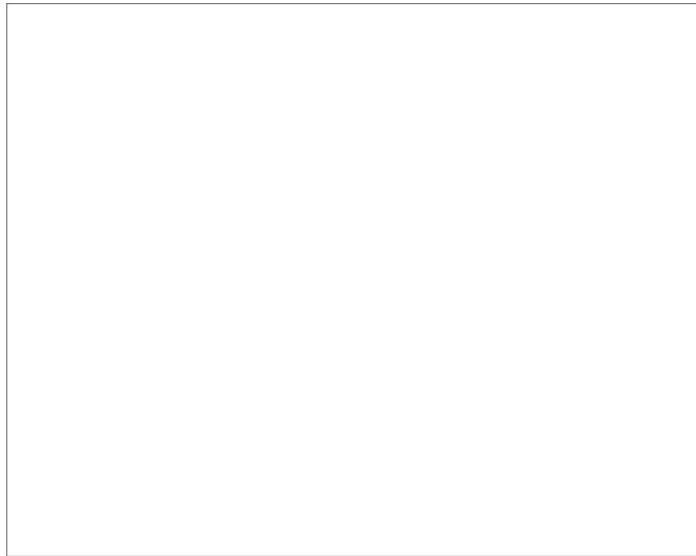
B. Compound fracture

In this type of fracture, the skin near the site has been _____.



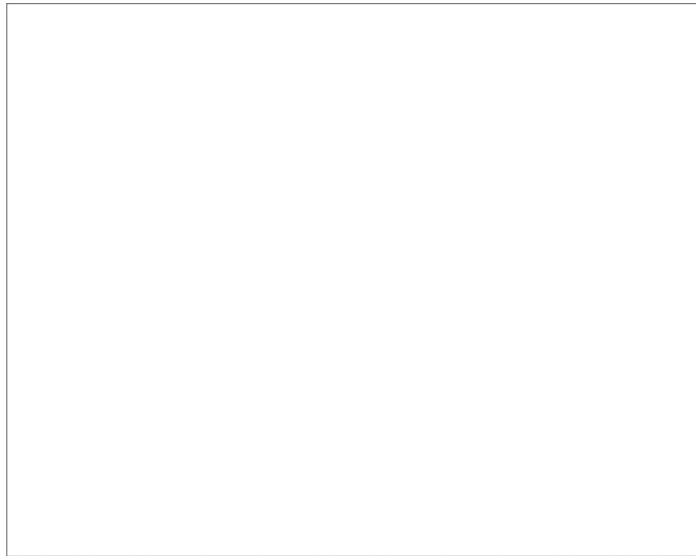
C. Greenstick fracture

This type of fracture usually occurs in _____.



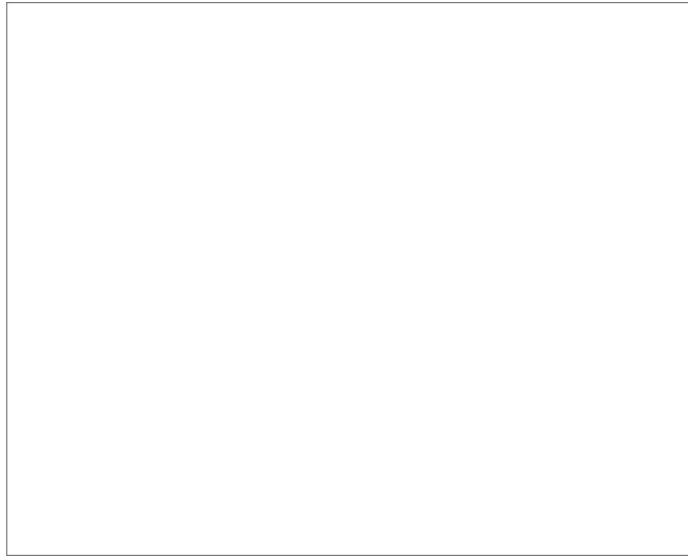
D. Comminuted fracture

This type of fracture is often the result of a _____.



E. Spiral fracture

This type of fracture results from a _____.

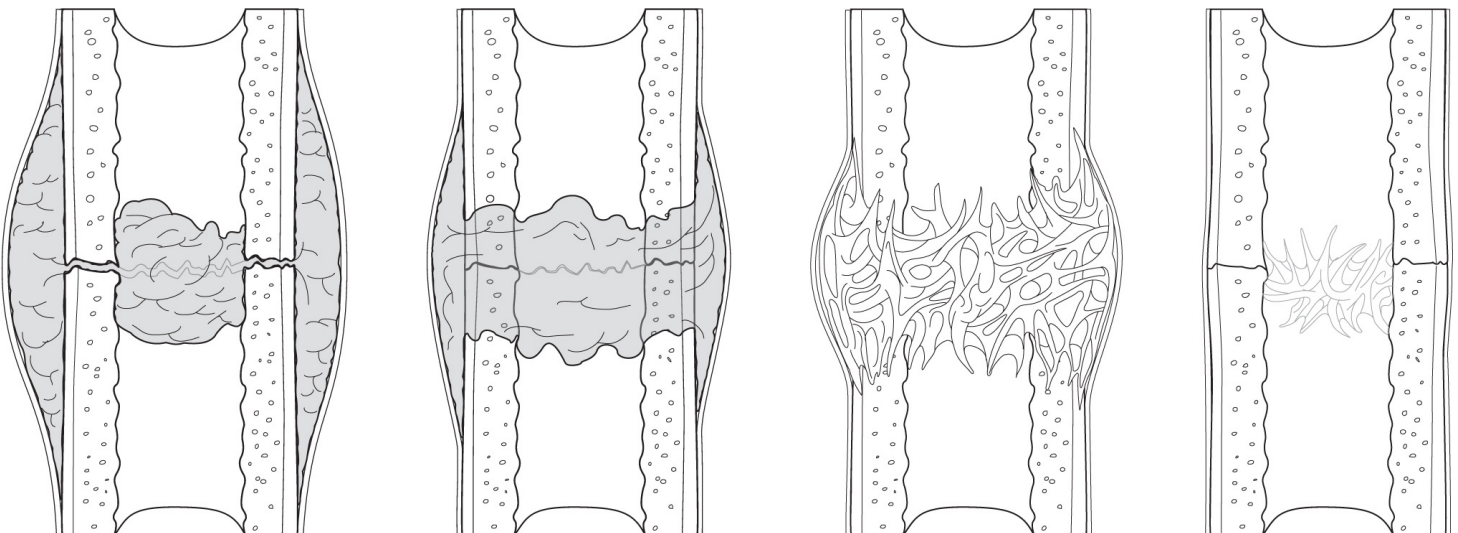


Drawing Conclusions Fracture Repair

Test your knowledge of the stages in fracture repair by coloring the figure below. Use the suggested colors or choose your own.

- Hematoma: Red
- Soft callus: Pink
- Hard callus: Yellow
- Remodeled bone: Tan

Then, using the spaces below, describe each step in the fracture repair process. Use the figure as a guide.



1. _____

2. _____

3. _____

4. _____

chapter 8

SKELETAL SYSTEM

Learning the names of the body's 206 bones, not to mention their locations and landmarks, can prove challenging. Completing the activities in this chapter, however, should help you do just that.

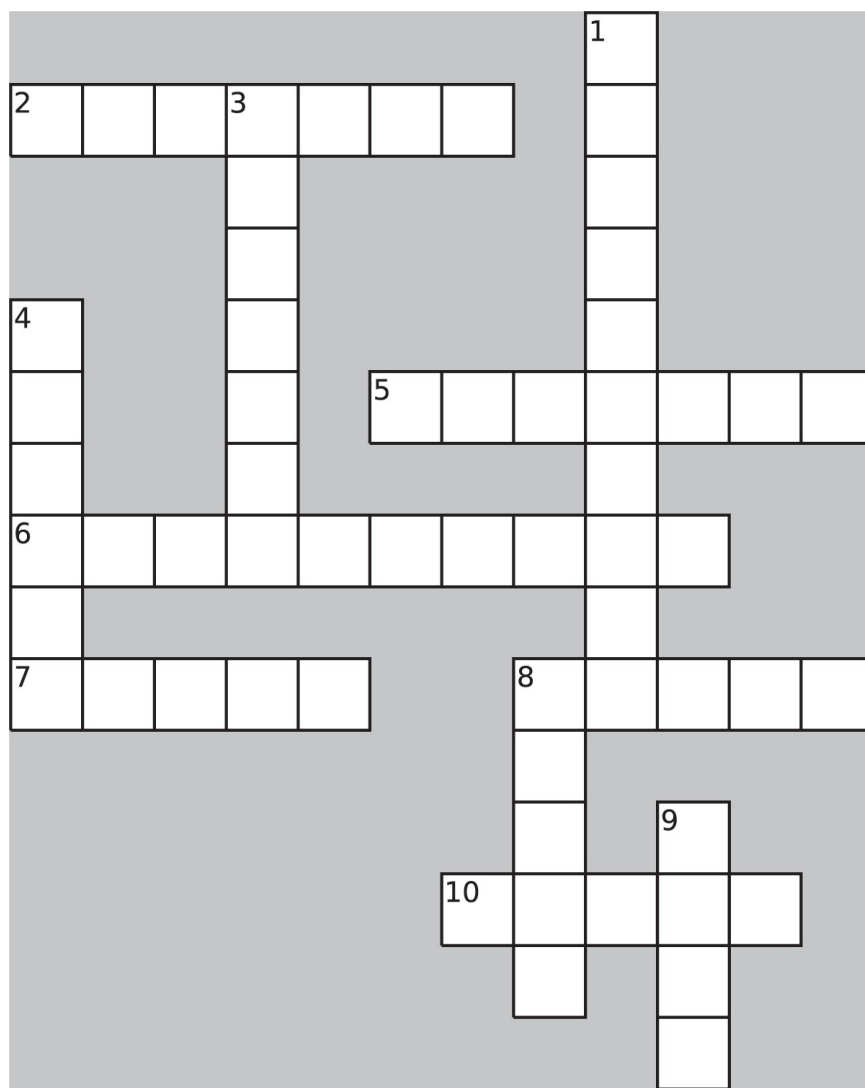
Just the Highlights The Skeleton

In the following list, highlight the bones of the axial skeleton yellow and the bones of the appendicular skeleton blue. Use the suggested colors or choose your own.

1. Skull
2. Femur
3. Ribs
4. Clavicles
5. Vertebrae
6. Radius
7. Os coxae
8. Sacrum
9. Shoulder girdle
10. Mandible

Puzzle It Out Bone Surface Markings

Complete the following crossword puzzle to test your knowledge of bone surface markings.



ACROSS

- 2. A projection or raised area
- 5. A round opening; usually a passageway for vessels and nerves
- 6. A rough, raised bump, usually for muscle attachment
- 7. A cavity within a bone
- 8. A moderately raised ridge
- 10. A flat surface

DOWN

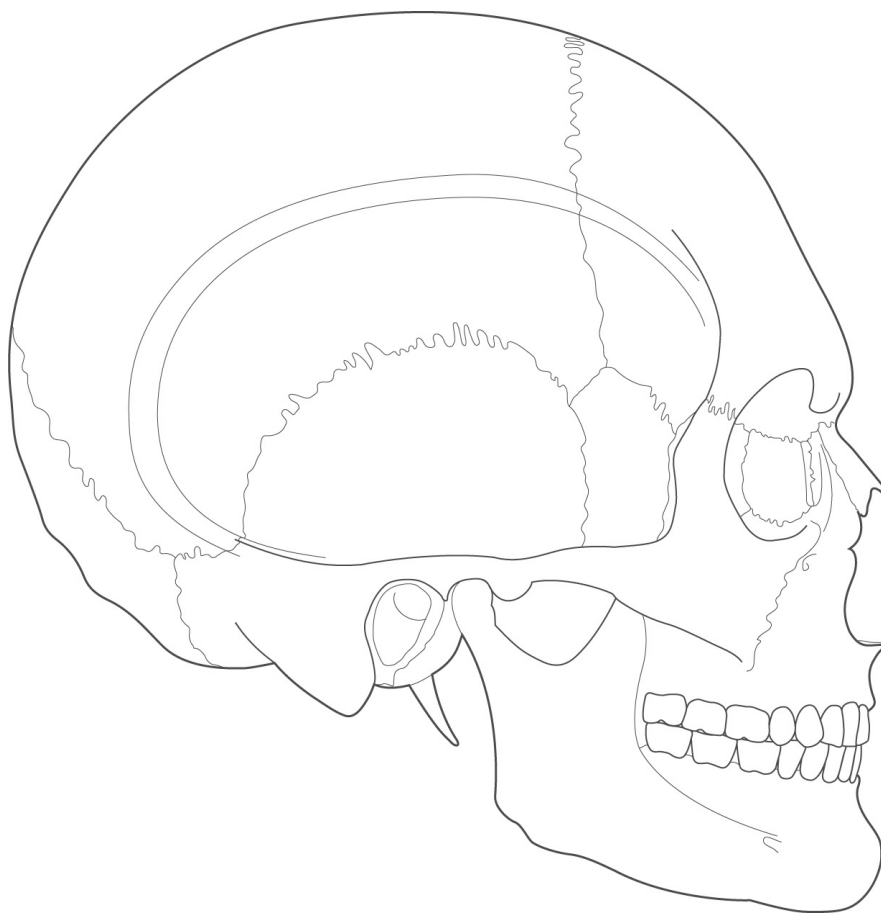
- 1. A large process found only on the femur
- 3. A rounded knob; usually fits into a fossa on another bone to form a joint
- 4. A tube-like opening
- 8. A tunnel through a bone
- 9. The prominent, expanded end of a bone

Conceptualize in Color The Skull

Identify the bones of the skull by coloring the figure below as described. Use the suggested colors or

choose your own.

- Frontal bone: Orange
- Parietal bone: Blue
- Temporal bone: Green
- Occipital bone: Yellow
- Sphenoid bone: Red
- Ethmoid bone: Purple



Fill in the Gaps More Bones of the Skull

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

CRIBRIFORM PLATE
ETHMOID
EXTERNAL AUDITORY MEATUS
FORAMEN MAGNUM
MASTOID
NASAL CAVITY
OLFACTORY
OPTIC
SELLA TURCICA
SPHENOID
SPINAL CORD
ZYGOMATIC ARCH

1. The _____ bone forms a key part of the cranial floor as well as the floor and side walls of the orbits. On top of that bone is an indented area called the _____, which houses the pituitary gland.
2. The top of the _____ bone is called the cribriform plate; it forms part of the roof of the _____.
3. Tiny perforations in the cribriform plate allow the _____ nerve to reach the brain.
4. The temporal bone contains an opening into the ear, which is called the _____.
5. A prominent lump behind the ear is the _____ process of the temporal bone.
6. The cheekbone is called the _____.
7. The base of the skull contains a large opening called the _____ through which the _____ passes.
8. Cerebrospinal fluid leaking out of the nose suggests a fracture to the _____.
9. Severe brain swelling could force the brainstem through the _____, causing respiratory arrest.

Make a Connection Cranial Sutures

In the spaces below, list the four cranial sutures using the blanks provided. The first letter or two of each term has been provided to get you started. Then, draw a line to link each suture to its location.

1. C_____

2. Sa_____

3. Sq_____

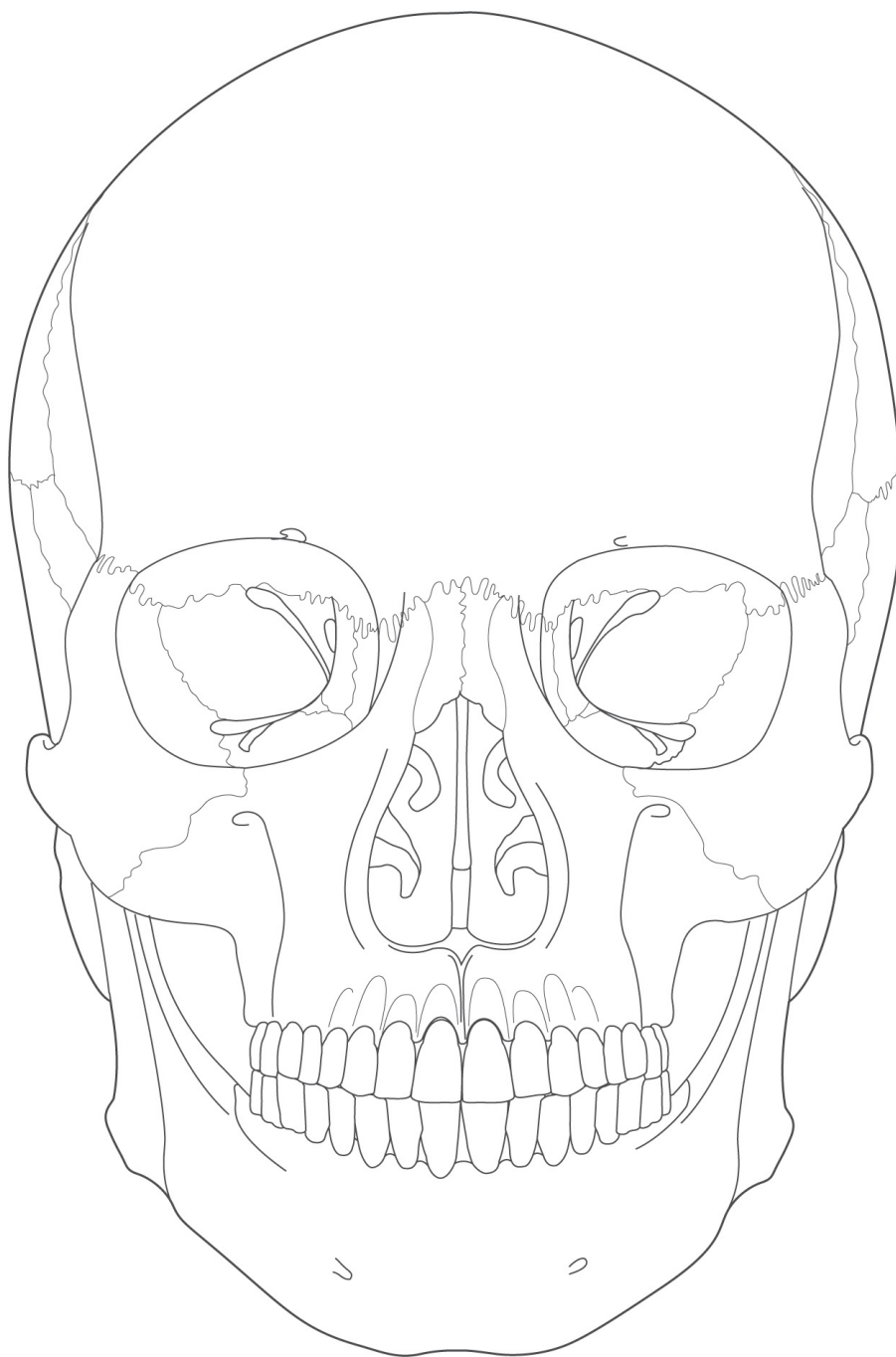
4. L_____

- a. The line of articulation between the parietal bones and the occipital bone
- b. The joint between the parietal bones and the frontal bone
- c. The joint between the right and left parietal bones
- d. The line of articulation that runs along the top edge of the temporal bone

Conceptualize in Color Facial Bones

Identify the facial bones by coloring the figure below. Use the suggested colors or choose your own.

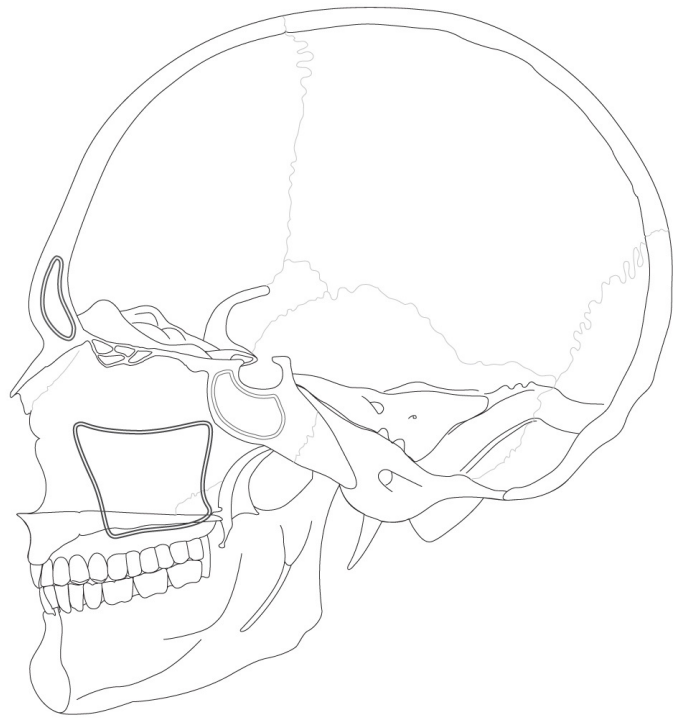
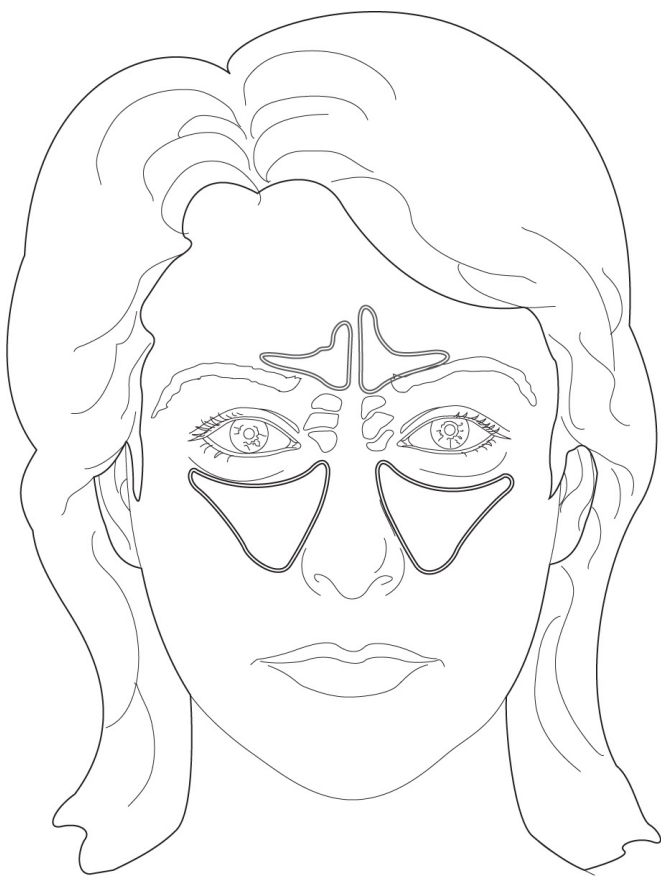
- Mandible: Blue
- Maxillae: Green
- Zygomatic bones: Purple
- Lacrimal bones: Red
- Nasal bones: Yellow
- Inferior nasal conchae: Orange
- Vomer: Brown



Drawing Conclusions Sinuses

Test your knowledge of the various paranasal sinuses by coloring them in the figures below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to further test your knowledge about the sinuses.

- Frontal sinuses: Yellow
- Maxillary sinuses: Blue
- Ethmoid sinuses: Pink
- Sphenoid sinus: Orange

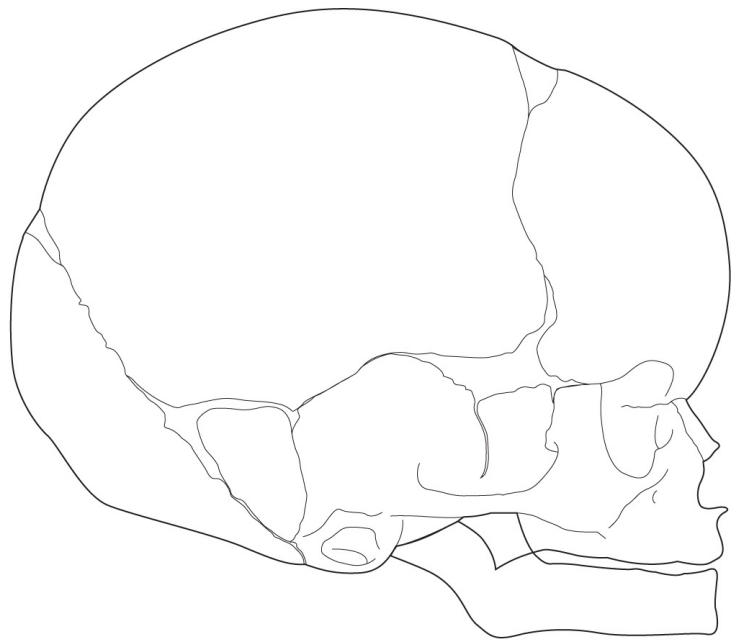
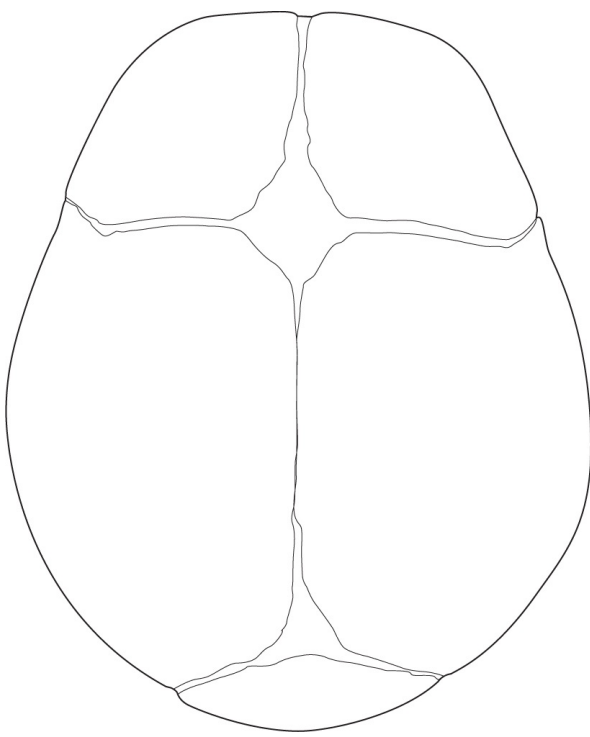


1. The four pairs of sinuses open into the _____.
2. The sinuses are filled with _____.
3. They lighten the skull and also _____.

Drawing Conclusions Infant Skull

Test your knowledge of the infant skull by coloring the figures below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to identify some conditions that can cause changes in the fontanels.

- Anterior fontanel: Pink
- Posterior fontanel: Blue
- Sagittal suture: Yellow
- Lambdoid suture: Green
- Squamous suture: Purple
- Coronal suture: Red

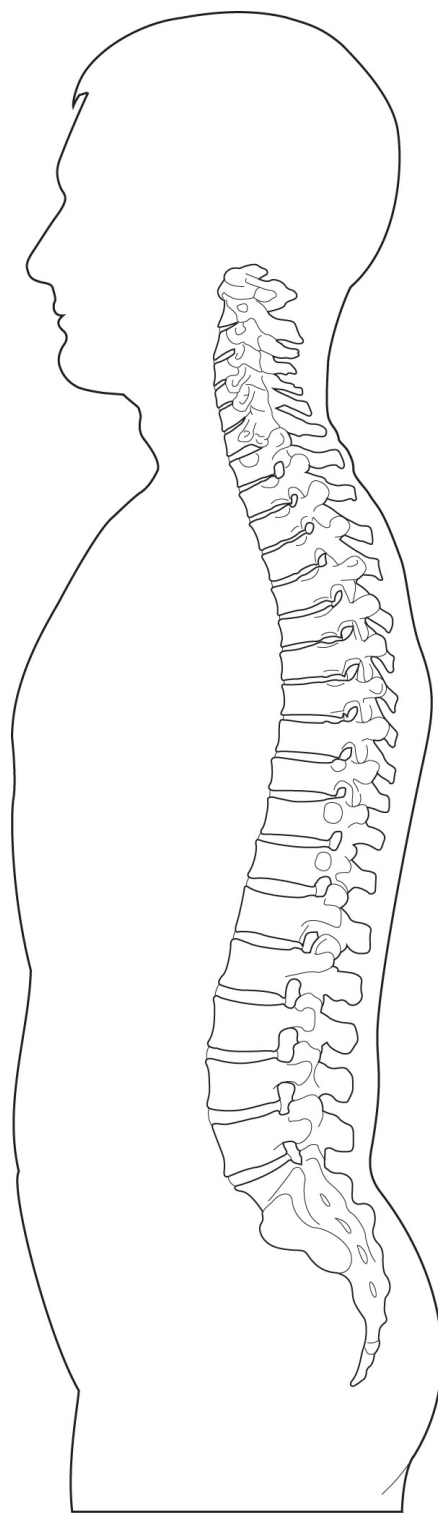


1. A bulging anterior fontanel signals increased _____.
2. A sunken anterior fontanel suggests _____.
3. _____ causes the suture lines to widen abnormally.
4. Unfused suture lines allow for _____ that normally occurs during infancy.
5. The _____ fontanel closes first, usually around age _____.
6. The posterior fontanel closes later, and is normally completely closed by age _____.

Drawing Conclusions The Vertebral Column

Test your knowledge of the vertebral column by coloring the figure below. Use the suggested colors or choose your own. Then, draw lines indicating the cervical curve, the thoracic curve, the lumbar curve, and the sacral curve.

- Cervical vertebrae: Pink
- Thoracic vertebrae: Yellow
- Lumbar vertebrae: Green
- Sacrum: Blue
- Coccyx: Purple

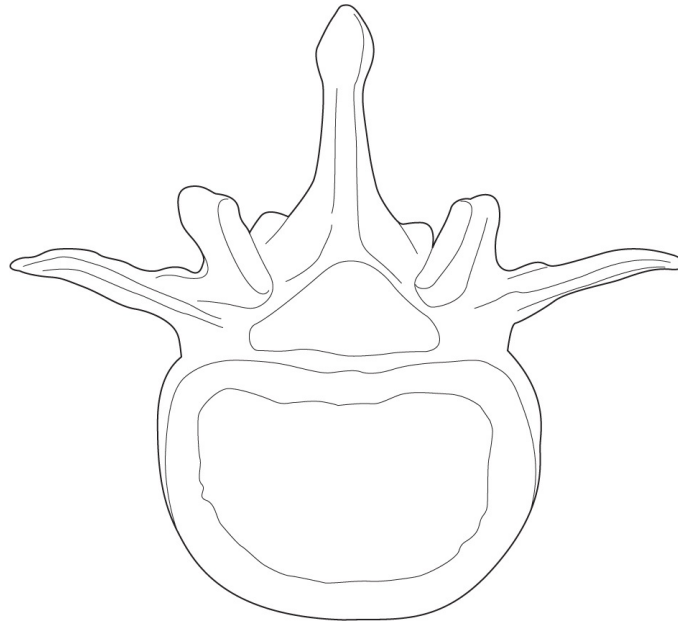


Drawing Conclusions **Vertebrae**

Test your knowledge of vertebrae by coloring each of the structures in the figure below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to further test your knowledge.

- Body: Purple
- Spinous process: Yellow
- Transverse process: Tan

- Lamina: Brown
- Vertebral foramen: Outline in blue



1. The vertebral foramen allows for passage of the _____.
2. The transverse and spinous processes serve as _____.
3. In between each vertebra is a layer of _____ called an _____.
4. Sudden, intense pressure on this layer can cause the _____ to crack and allow the to ooze out from the center.

Fill in the Gaps Specialty Vertebrae

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

ATLAS
AXIS
BODY
DENS
FORAMEN MAGNUM
NOD YES
OCCIPITAL
ODONTOID PROCESS
SWIVEL FROM SIDE TO SIDE
TEMPORAL
TRANSVERSE LIGAMENT
VERTEBRAL FORAMEN

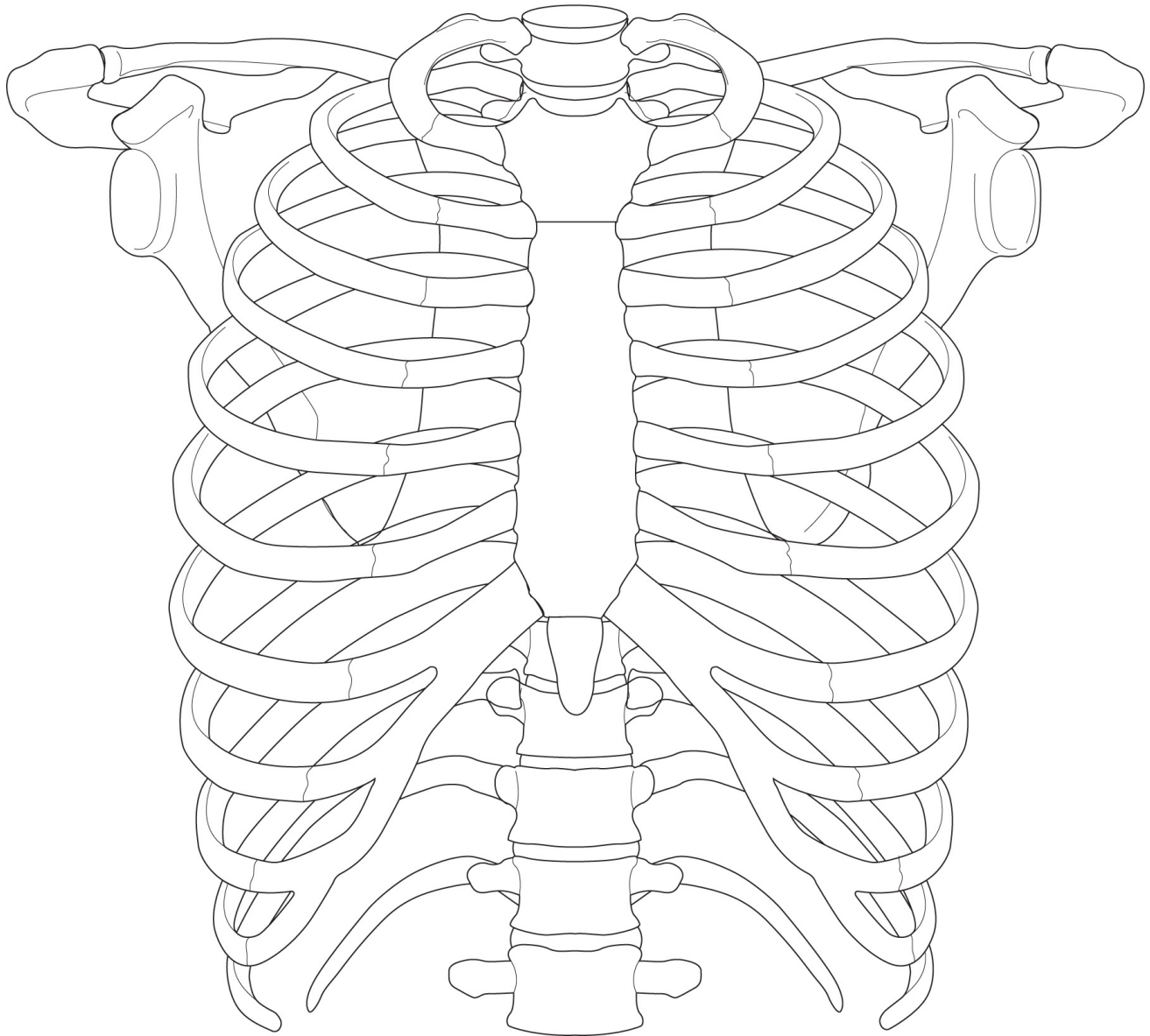
1. The first cervical vertebra is called the _____.
2. This vertebra has no _____ and instead consists of a delicate ring and a large _____.
3. Depressions on each side of this vertebra articulate with bony projections of the _____ bone.
4. These projections rock back and forth to allow the head to _____.
5. The second cervical vertebra is called the _____.
6. This vertebra has a projection called the _____ or _____.
7. This projection extends into the _____ to allow the head to _____.
8. The _____ holds the projection in place to allow the head to move freely.

Conceptualize in Color Thoracic Cage

Identify the structures of the thoracic cage by coloring the figure below. Use the suggested colors or choose your own.

- Manubrium: Brown
- Body of the sternum: Tan
- Xiphoid process: Pink

- True ribs: Blue
- False ribs: Yellow
- Floating ribs: Green
- Draw a red line at the suprasternal notch
- Draw a purple line at the costal margins

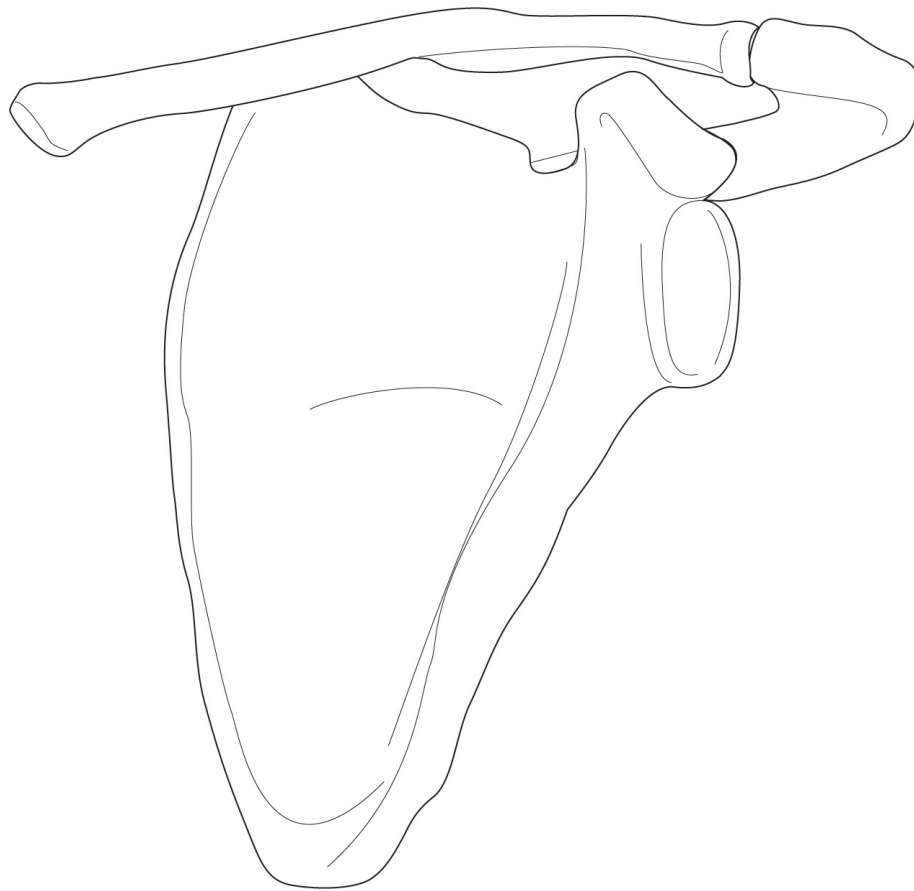


Drawing Conclusions Pectoral Girdle

Test your knowledge of the bones of the pectoral girdle by coloring the structures in the figure below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to describe their function.

- Scapula: Light tan
- Clavicle: Yellow

- Acromion process: Brown
- Coracoid process: Dark tan
- Glenoid cavity: Outline in pink

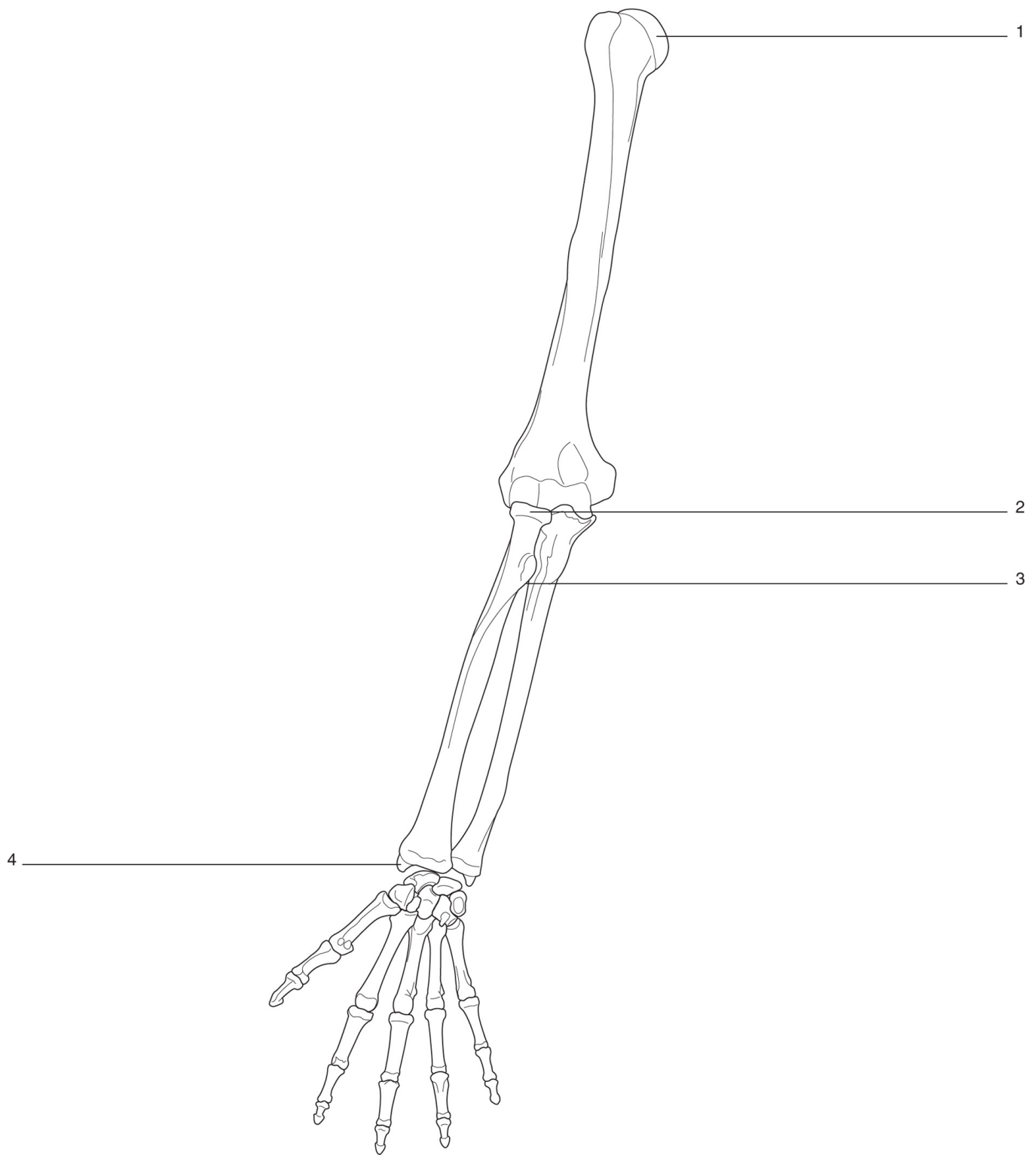


1. The acromion process articulates with the _____; it is the only point where the _____ and _____ attach to the rest of the skeleton.
2. The coracoid process provides a point of attachment for _____.
3. The glenoid cavity articulates with the head of the _____.

Drawing Conclusions Upper Limb

Test your knowledge of the bones of the arm by coloring the figure below. Use the suggested colors or choose your own. Then, identify key markings of those bones by writing the name of each marking in the spaces provided.

- Humerus: Brown
- Radius: Yellow
- Ulna: Pink

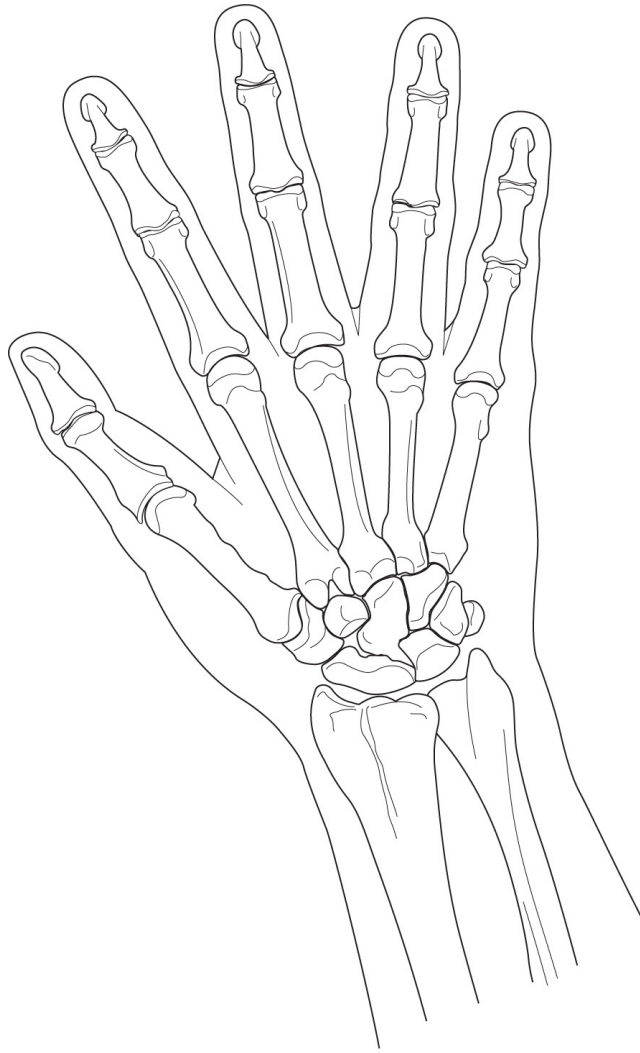


Drawing Conclusions The Hand

Test your knowledge of the bones of the hand by coloring the following structures in the figure below. Use the suggested colors or choose your own. Then, label each digit with the correct Roman numeral.

- Carpal bones: Blue
- Metacarpal bones: Pink
- Proximal phalanges: Yellow

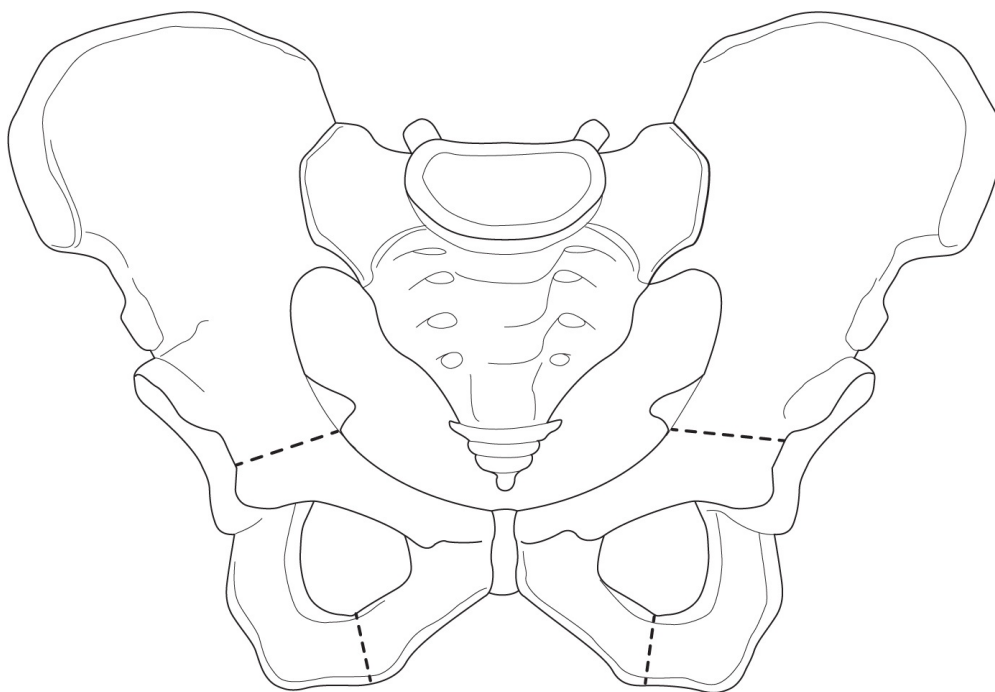
- Middle phalanges: Orange
- Distal phalanges: Green



Conceptualize in Color Pelvic Girdle

Identify the structures of each os coxae, which together form the pelvic girdle, by coloring the figure below. Use the suggested colors or choose your own.

- Ilium: Yellow
- Ischium: Orange
- Pubis: Pink
- Symphysis pubis: Blue
- Acetabulum: Green
- Iliac crest: Outline in red
- Obturator foramen: Outline in purple



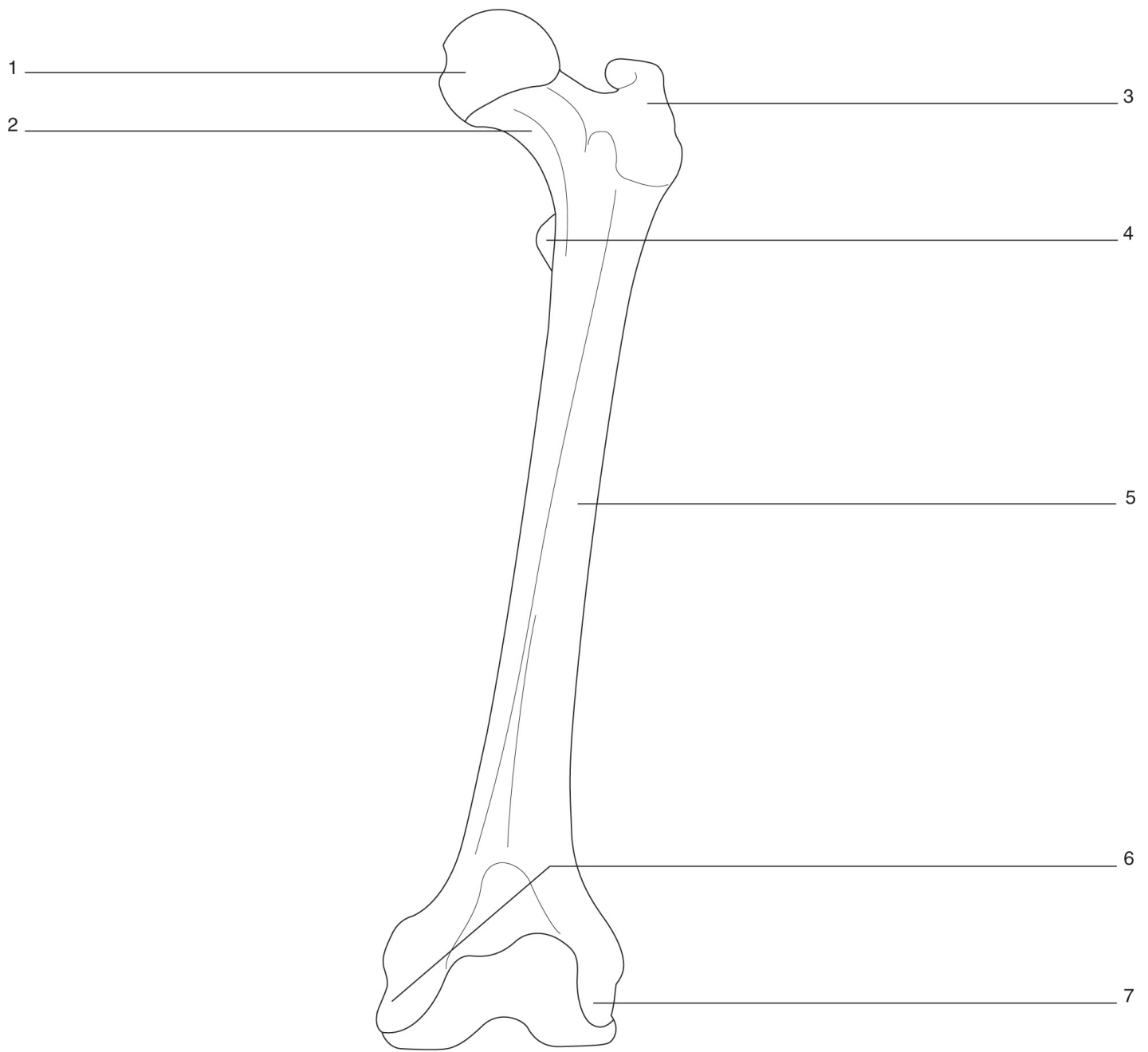
Illuminate the Truth The Pelvis

Highlight the word or phrase that completes each sentence correctly.

1. The (false pelvis)(true pelvis) extends between the outer, flaring edges of the iliac bones.
2. The (false pelvis)(true pelvis) extends between the pelvic brim.
3. The lower edge of the true pelvis is known as the (lesser pelvis)(pelvic outlet).
4. The distance between the two (ischial)(iliac) bones determines the pelvic outlet.
5. In males, the true pelvis is (deep and narrow)(wide and shallow).
6. Females have a pubic arch that is (narrower)(wider) than in males.
7. Females also have a (larger)(smaller) pelvic outlet.

Drawing Conclusions Femur

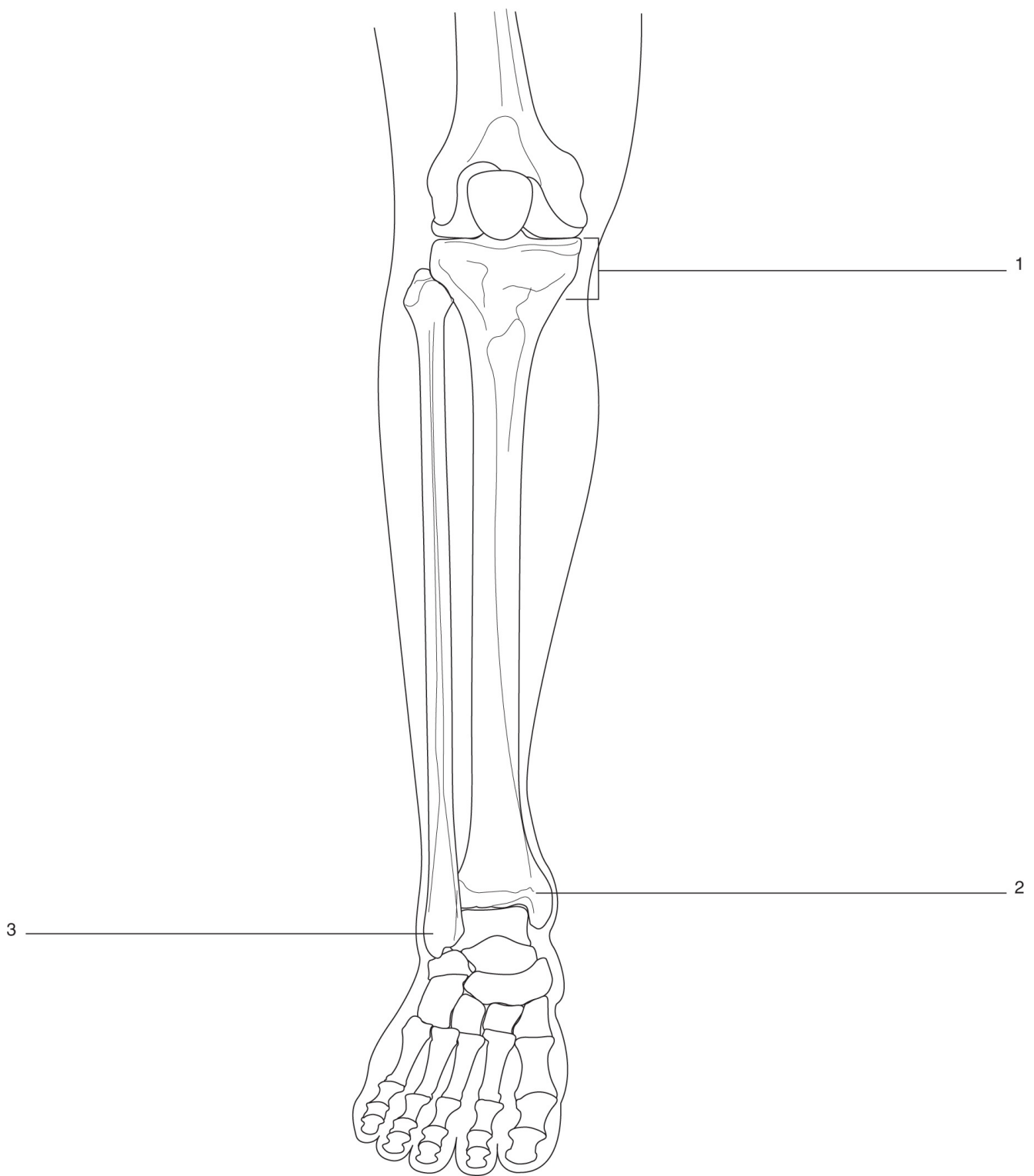
Test your knowledge of the femur by coloring the figure below. Then, identify key markings on the femur by writing the name of each marking in the spaces provided.



Drawing Conclusions Lower Leg

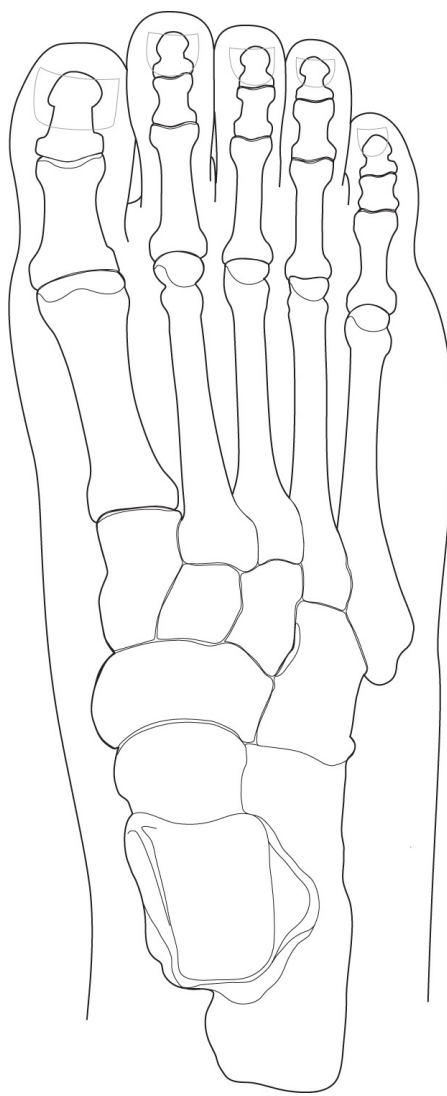
Test your knowledge of the bones of the lower leg by coloring the figure below. Use the suggested colors or choose your own. Then, identify key landmarks by writing the name of each landmark in the spaces provided. Finally, circle the name of the bone or bones that bear weight.

- Patella: Brown
- Tibia: Yellow
- Fibula: Pink



Drawing Conclusions **Foot**

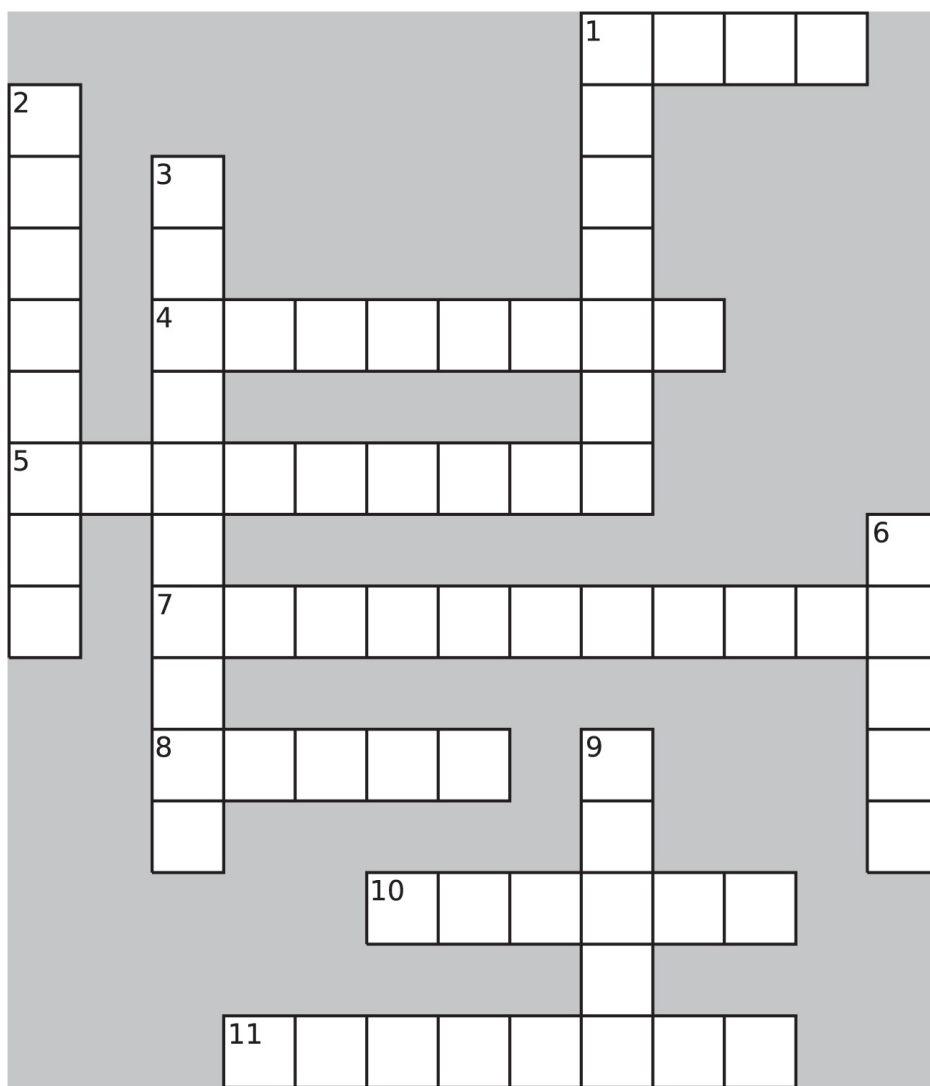
Test your knowledge of the bones of the foot by coloring the figure below. Use the suggested colors or choose your own. Then, number the metatarsals by labeling each with the proper Roman numeral.



- Calcaneus: Green
- Talus: Pink
- Navicular: Orange
- Cuneiforms: Yellow
- Metatarsals: Blue
- Proximal phalanges: Purple
- Middle phalanges: Red
- Distal phalanges: Tan
- Cuboid: Light blue

Puzzle It Out Skeletal Facts

Complete the following crossword puzzle to test your knowledge of the skeletal system.



ACROSS

1. Second cervical vertebra
4. Most frequently broken bone in the body
5. A lateral curvature of the spine
7. Procedure commonly performed following a herniated disc
8. Part of the body formed by the tarsal bones
10. The big toe
11. The gel-like core of the intervertebral disc is called the nucleus _____.

DOWN

1. A herniated disc results when the _____ fibrosus cracks.
2. An exaggerated thoracic curvature
3. The joint formed by the articulation of the os coxae with the sacrum
6. Bone in the neck that doesn't articulate with any other bone
9. The first cervical vertebra

chapter 9

JOINTS

Joints, or articulations, are the points where two bones meet. The body contains a number of different articulations, varying in both size and shape. It's these differences that allow us to perform a wide variety of movements, ranging from walking and running to writing or playing the piano.

Make a Connection Classifications of Joints

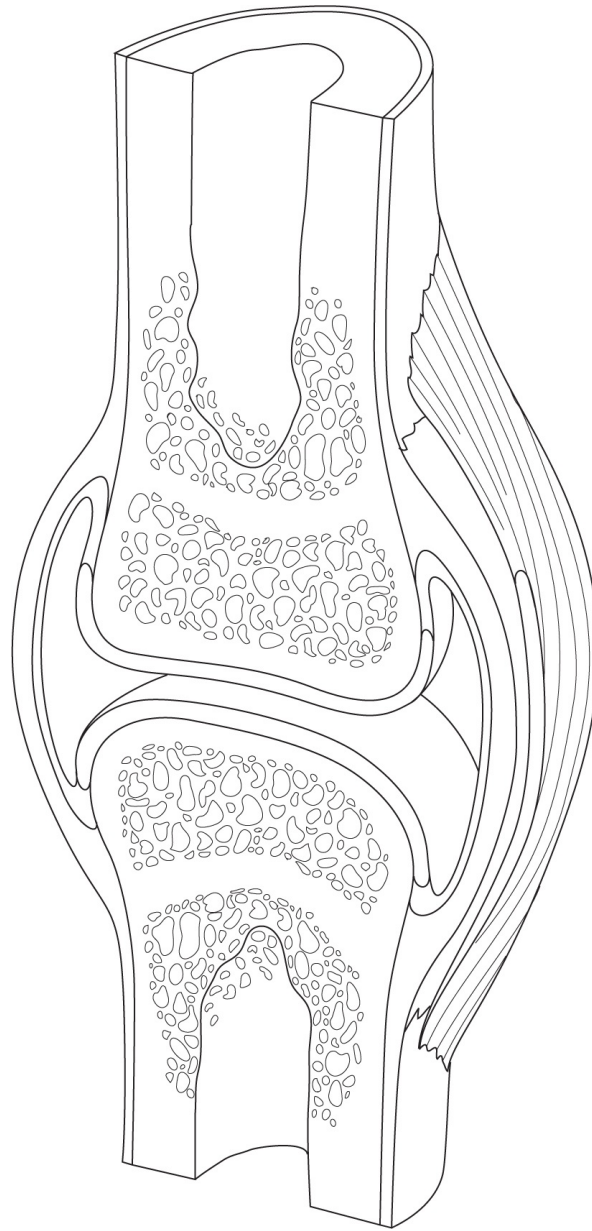
In the spaces below, list the three classifications of joints. The first letter of each term is provided to get you started. Then, draw a line to link each joint classification to its characteristics.

1. S_____
 2. F_____
 3. C_____
- a. Are freely movable
 - b. Result when bones are joined by cartilage
 - c. Result when collagen fibers from one bone penetrate the adjacent bone
 - d. The most numerous of the body's joints
 - e. Are slightly movable
 - f. Also called diarthroses
 - g. Are fixed joints
 - h. Also called amphiarthroses
 - i. An example is the symphysis pubis
 - j. Examples include the knee, hip, and elbow
 - k. An example is the suture joints in the adult skull
 - l. Also called synarthroses

Drawing Conclusions Synovial Joints

Test your knowledge of structures found in synovial joints by coloring the figure below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to further test your knowledge of synovial joints.

- Joint capsule: Green
- Synovial membrane: Purple
- Articular cartilage: Dark blue
- Ligaments: Gray
- Joint cavity: Light blue

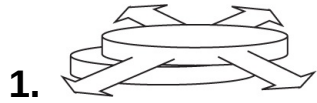


1. The joint capsule extends from the _____ of each of the articulating bones; it consists of _____ tissue.
2. The _____ secretes synovial fluid.
3. Synovial fluid is contained within the _____.

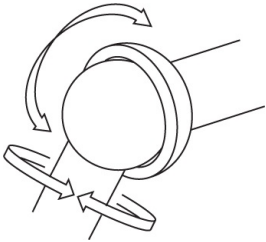
4. Synovial fluid serves to _____, _____, and _____.
5. The purpose of articular cartilage is to _____.
6. Ligaments serve to _____.

Drawing Conclusions Types of Synovial Joints

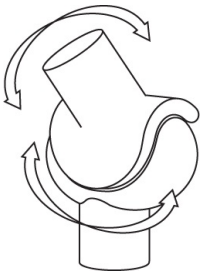
Test your knowledge of each of the “hardware” joints by identifying the type of joint, the movement the joint allows, and at least one location in the body where the joint can be found.



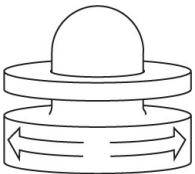
- Type of joint: _____
- Movement: _____
- Location in the body: _____



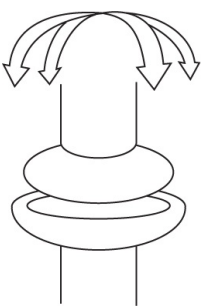
- Type of joint: _____
- Movement: _____
- Location in the body: _____



- Type of joint: _____
- Movement: _____
- Location in the body: _____

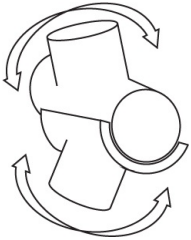


- Type of joint: _____
- Movement: _____
- Location in the body: _____



5.

- Type of joint: _____
- Movement: _____
- Location in the body: _____

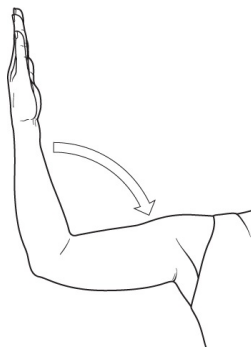


6.

- Type of joint: _____
- Movement: _____
- Location in the body: _____

Drawing Conclusions Movements of Synovial Joints

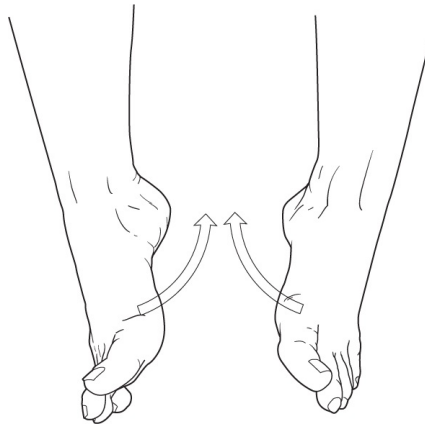
Describing the great variety of movements performed by synovial joints depends upon a specific vocabulary. Test your knowledge of these terms by writing the name of the movement being demonstrated by each of the following figures. Color the arrow signifying the direction of movement.



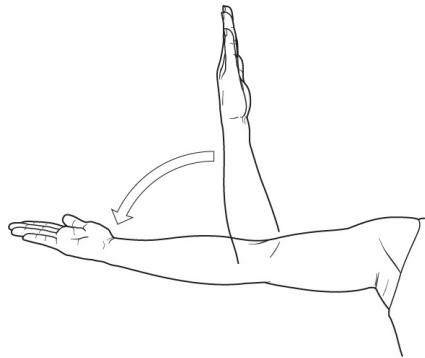
1. _____



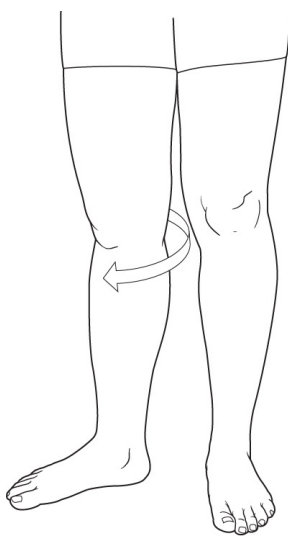
2. _____



3. _____



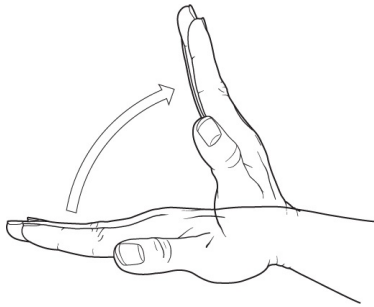
4. _____



5. _____



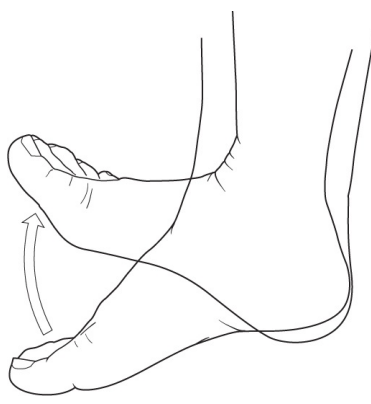
6. _____



7. _____



8. _____



9. _____



10. _____



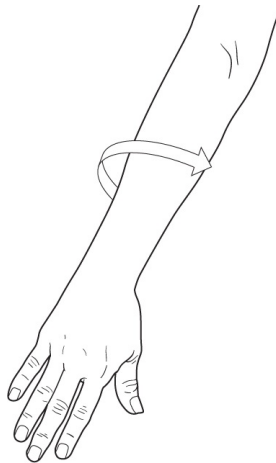
11. _____



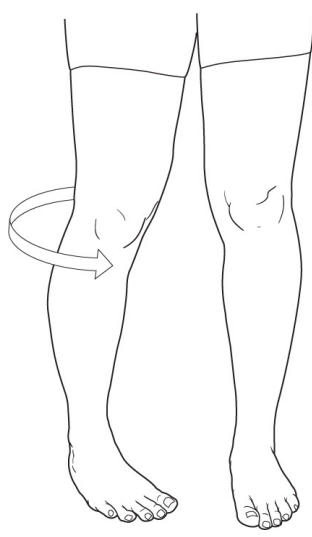
12. _____



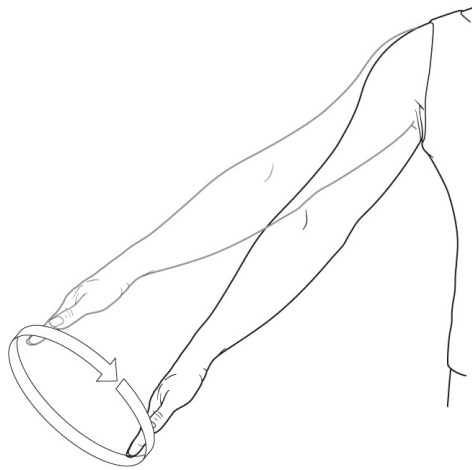
13. _____



14. _____



15. _____

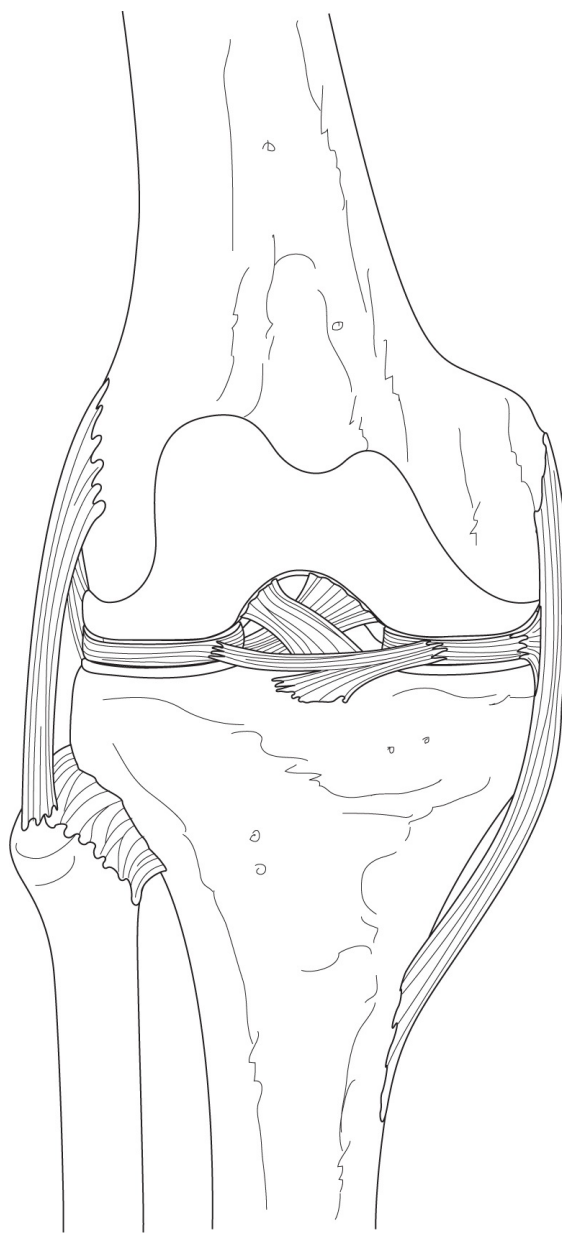


16. _____

Drawing Conclusions The Knee

Test your knowledge of the key structures of the knee by coloring the figure below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to further test your knowledge of the knee.

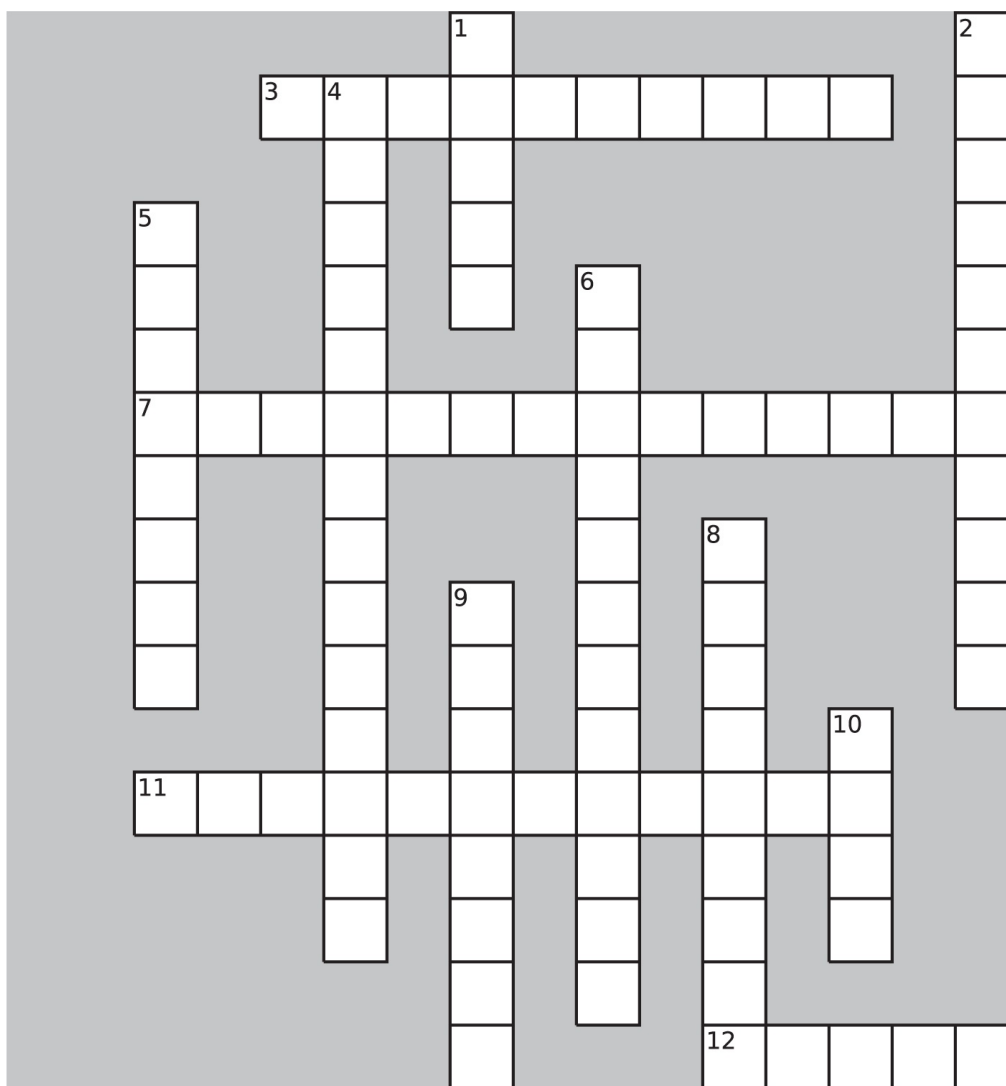
- Femoral condyles: Gray
- Medial meniscus: Light blue
- Lateral meniscus: Dark blue
- Posterior cruciate ligament: Orange
- Anterior cruciate ligament: Green
- Fibular collateral ligament: Tan
- Tibial collateral ligament: Brown



1. The knee contains 13 bursae, which serve _____.
2. The fibular and tibial collateral ligaments keep the knee _____.
3. The anterior cruciate ligament keeps the knee from _____.
4. The posterior cruciate ligament serves to _____.
5. The lateral and medial meniscus consist of _____; they act to _____.

Puzzle It Out Joints

Complete the following crossword puzzle to test your knowledge of the body's joints.



ACROSS

3. Type of arthritis that's an autoimmune disease
7. Type of arthritis attributed to the wear and tear of aging
11. Another name for a joint
12. Body joint consisting of two articulations

DOWN

1. Fluid-filled sac that resides in some joints
2. Type of surgical procedure often performed on the knee
4. The anterior cruciate ligament keeps the knee from doing this
5. Type of fluid that fills the joint capsule and lubricates the joint
6. Joint replacement
8. Meniscus is made of this material
9. Another name for the humeroscapular joint
10. Another name for the tibiofemoral joint

chapter 10

MUSCULAR SYSTEM

The body's more than 600 skeletal muscles give the body its shape and also allow it to move. Attached to bones, muscles produce movement through their ability to contract. Learning the names of key muscles and understanding the physiology behind movement can prove challenging. The activities in this chapter should help you master this important body system.

Make a Connection Types of Muscles

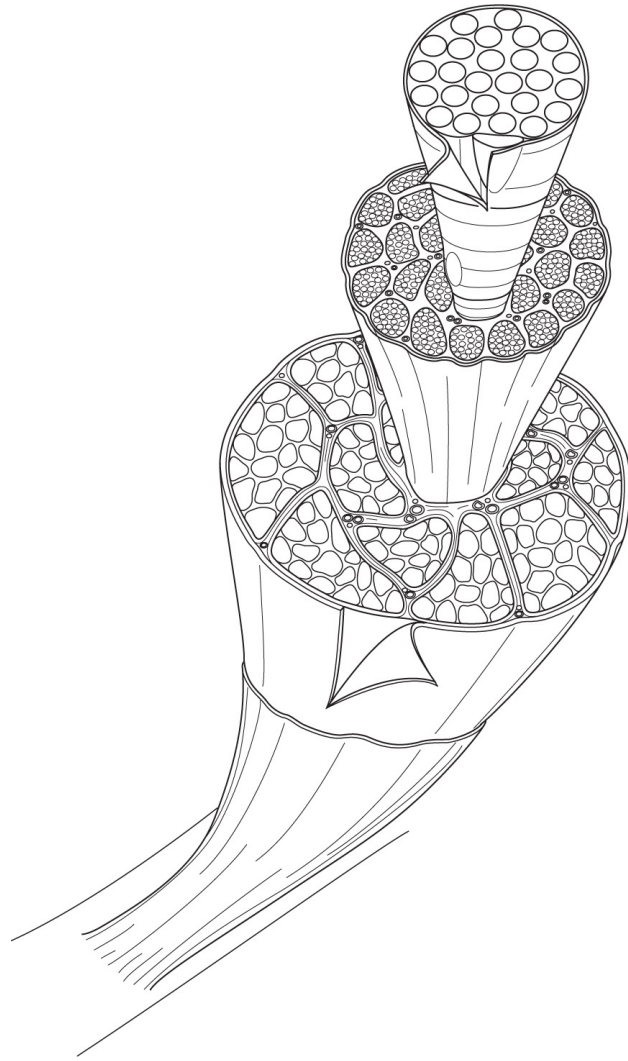
In the spaces below, list the three types of muscles. The first letter or two of each term has been provided to get you started. Then, draw a line to link each muscle type to its particular characteristics. Note that items may link with more than one characteristic.

1. C_____
 2. Sm_____
 3. Sk_____
- a. Found only in the heart
 - b. Does not appear striped, so it is called nonstriated
 - c. Consists of short, branching fibers that fit together at intercalated discs
 - d. Found in the digestive tract, blood vessels, and airways
 - e. Appears striped, or striated, when viewed under a microscope
 - f. Attached to bone and causes movement of the body
 - g. Known as involuntary muscle
 - h. Known as voluntary muscle

Drawing Conclusions Skeletal Muscle Structure

Test your knowledge of the various parts of a skeletal muscle by coloring the following structures in the figure below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to further test your knowledge of muscle structure.

- Endomysium: Blue
- Perimysium: Yellow
- Epimysium: Red
- Fascia: Brown
- Draw a red circle around a single muscle fiber
- Draw a green circle around a fascicle



1. A muscle fiber is the name for a _____.
2. A delicate connective tissue called _____ covers each muscle fiber.
3. Muscle fibers are grouped in bundles called _____.
4. A sheath of connective tissue called the _____ encases those bundles of muscle fibers.
5. Another layer of connective tissue called the _____ surrounds the muscle as a whole.
6. Outside of that layer, another layer of connective tissue called _____ surrounds the muscle; the layer lying between muscles is called _____ and the layer residing under the skin is called _____.

Describe the Process Muscle Attachment

Using the spaces below, describe the ways muscles attach to bone.

Muscle may attach to bone directly or indirectly. In direct attachment, a) _____

_____.

In indirect attachment, b) _____.

_____.

Occasionally, instead of attaching to bone, a muscle attaches to c) _____.

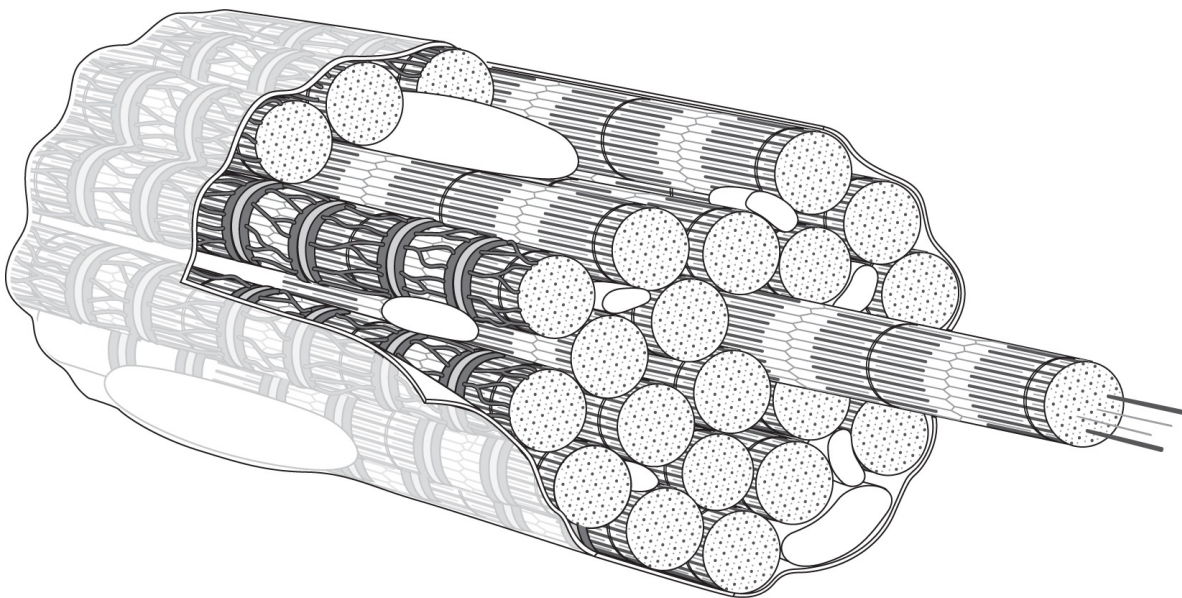
_____ In these instances,

d) _____

_____.

Drawing Conclusions Muscle Fiber Structure

Test your knowledge of the inner workings of a muscle by filling in the blanks of each sentence. Then, color each structure in the figure below. Use the suggested colors or choose your own colors.



1. The membrane surrounding each fiber is called a _____.
In the figure, color this structure pink.
2. Long protein bundles called fill the sarcoplasm. These structures store (which is used for energy) as well as oxygen.
Color this structure yellow.
3. The smooth endoplasmic reticulum of a muscle fiber is called the _____; this is where _____ are stored.
Color this structure blue.

4. A system of tubules called _____ allows _____ to travel deep into the cell.

Color these structures green.

5. Myofibrils consist of even finer fibers called _____.

Color these structures brown.

Drawing Conclusions Myofilaments

Test your knowledge of the sliding-filament model of contraction by filling in the blanks of each sentence. Then, in the space below, draw two myofilaments: one displaying muscle relaxation and the second, muscle contraction.

1. Myofibrils consist of thin myofilaments (made of a protein called _____) and thick myofilaments (made of a protein called _____).
2. Myofibrils are arranged to form units called _____.
3. A plate or disc called a _____ is the anchor point for the thin myofilaments.
4. When a muscle begins to contract, the heads of the _____ myofilament latch onto the _____ myofilament, forming a _____.
5. The heads of the first myofilament then pull the second myofilament forward, shortening the _____ and pulling the _____ closer together.

Sequence of Events Muscle Contraction

Insert the numbers 1 through 8 in the spaces provided to identify the sequence of events that occur during muscle contraction and relaxation.

- _____ A. An electrical impulse travels over the sarcolemma and inward along the T tubules, causing sacs in the sarcoplasmic reticulum to release calcium.
- _____ B. The release of ACh stops and acetylcholinesterase breaks down any remaining ACh.
- _____ C. Troponin and tropomyosin prevent the myosin heads from grasping the thin filament, and the muscle fiber relaxes.
- _____ D. An electrical impulse causes small vesicles at the end of a motor neuron to bind with the cell wall and release the neurotransmitter acetylcholine (ACh).
- _____ E. Calcium binds with the troponin on the actin filament, exposing attachment points.
- _____ F. ACh diffuses across the synaptic cleft, where it stimulates receptors in the sarcolemma.
- _____ G. Calcium ions are pumped back into the sarcoplasmic reticulum.
- _____ H. The myosin heads of the thick filaments grab onto the thin filaments and muscle contraction occurs.

Describe the Process Muscle Fiber Contraction

Using the spaces below, describe how muscle fiber length influences the strength of contraction.

1. The strength of a contraction depends on the length of the fibers before the contraction begins; this is called the _____.
2. In overly contracted fibers, the sarcomeres are _____, which means that fibers _____. As a result, contraction is _____.
3. In overly stretched fibers, the thick and thin filaments _____. Only a _____ portion of the thin filament is accessible for the _____ heads to grab. This causes a _____ contraction.
4. The strongest contraction occurs when the thin and thick filaments _____.
5. The nervous system stimulates muscle fibers to cause a continuous state of _____ contraction, which is called _____.

Illuminate the Truth Contraction of an Entire Muscle

Highlight the word or phrase that correctly completes each sentence.

1. One motor neuron stimulates a (single muscle fiber)(group of muscle fibers).
2. The neuron and all the fibers it stimulates are called a (motor unit)(myofilament).
3. Contraction can spread over a wide area because (multiple nerves stimulate multiple fibers simultaneously)(the muscle fibers in a motor unit are scattered throughout the muscle).
4. The nervous system responds to demands for varying demands for muscle strength by varying the (intensity and frequency of the stimulus)(quantity of neurotransmitters released).
5. The minimum voltage needed to cause a muscle fiber to contract is called a (twitch)(threshold).
6. A single brief contraction followed by relaxation is called a (threshold)(twitch).
7. When a muscle contracts several times in a row, the last contraction will be (stronger)(weaker) than the first contraction; this is known as (tetanus)(treppe).
8. The condition of rapid contraction with only partial relaxation is called (incomplete tetanus)(treppe).
9. Complete tetanus occurs when (impulses fail to arrive and the muscle cannot relax)(impulses arrive so fast that the muscle cannot relax).
10. Most muscles normally remain in a state of (treppe)(incomplete tetanus).
11. A strong stimulus elicits a stronger contraction because it (causes a single muscle fiber to contract more forcefully)(stimulates more fibers to contract at once).

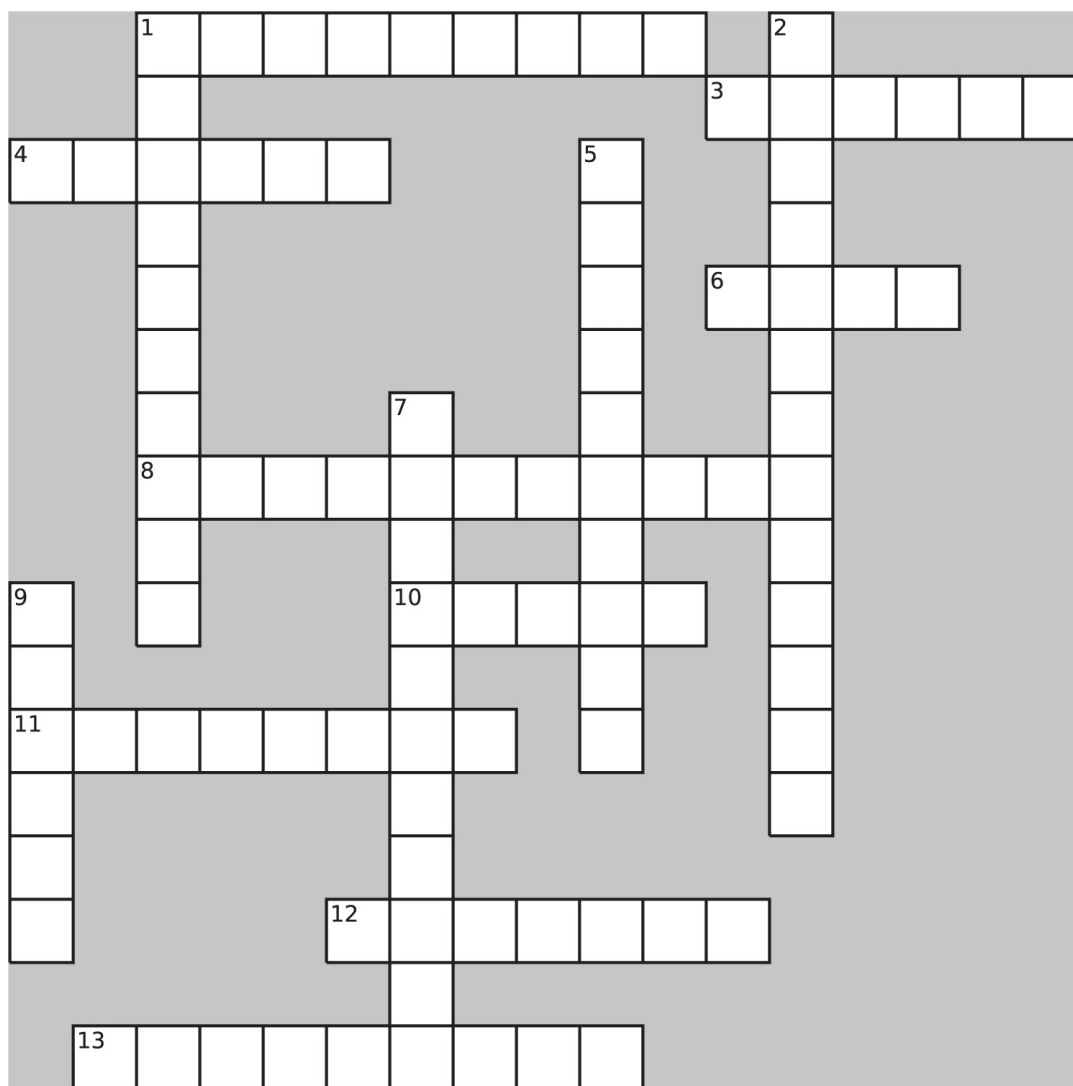
Describe the Process Energy Source for Contraction

Using the spaces below, describe how muscles obtain their energy to contract.

1. All muscles require energy in the form of _____, which must be constantly synthesized.
2. At rest, muscles obtain most of their energy by metabolizing _____.
3. Because oxygen is plentiful, it uses the process of _____ to break down _____.
4. When beginning to exercise, the demand for oxygen _____. When this happens, muscles break down _____ to quickly restock _____.
5. If exercise continues, muscles switch to _____ of _____.
6. This can generate energy quickly, and is therefore useful for _____ of activity. It also produces _____ which leads to _____.
7. After about 10 minutes of moderate activity, muscles shift to _____, which produces more _____. The byproducts of this process are _____ and _____.

Puzzle It Out Muscle Terms

Complete the following crossword puzzle to test your knowledge of the terms associated with muscles.



ACROSS

1. Muscle that assists another muscle
3. A strong, fibrous cord that attaches muscle to bone
4. In _____ attachment, muscle fibers merge with the periosteum of the bone.
6. The continuous state of partial muscle contraction is called muscle _____.
8. A flat sheet of connective tissue that attaches a muscle to another muscle
10. A lack of ATP, such as occurs following death, causes muscles to become _____.
11. Contraction in which the muscle changes length while the tension remains the same
12. The condition of rapid contraction with only partial relaxation is called incomplete _____.
13. Contraction in which the tension within a muscle increases while its length remains the same

DOWN

1. The cytoplasm of a muscle cell
2. The connection between a motor neuron and a muscle fiber is called a _____ junction.
5. Muscle that opposes the action of a prime mover
7. The process by which an increasing number of motor units are called into action, increasing the force of contraction
9. A single, brief contraction resulting when a muscle fiber receives a stimulus at or above threshold

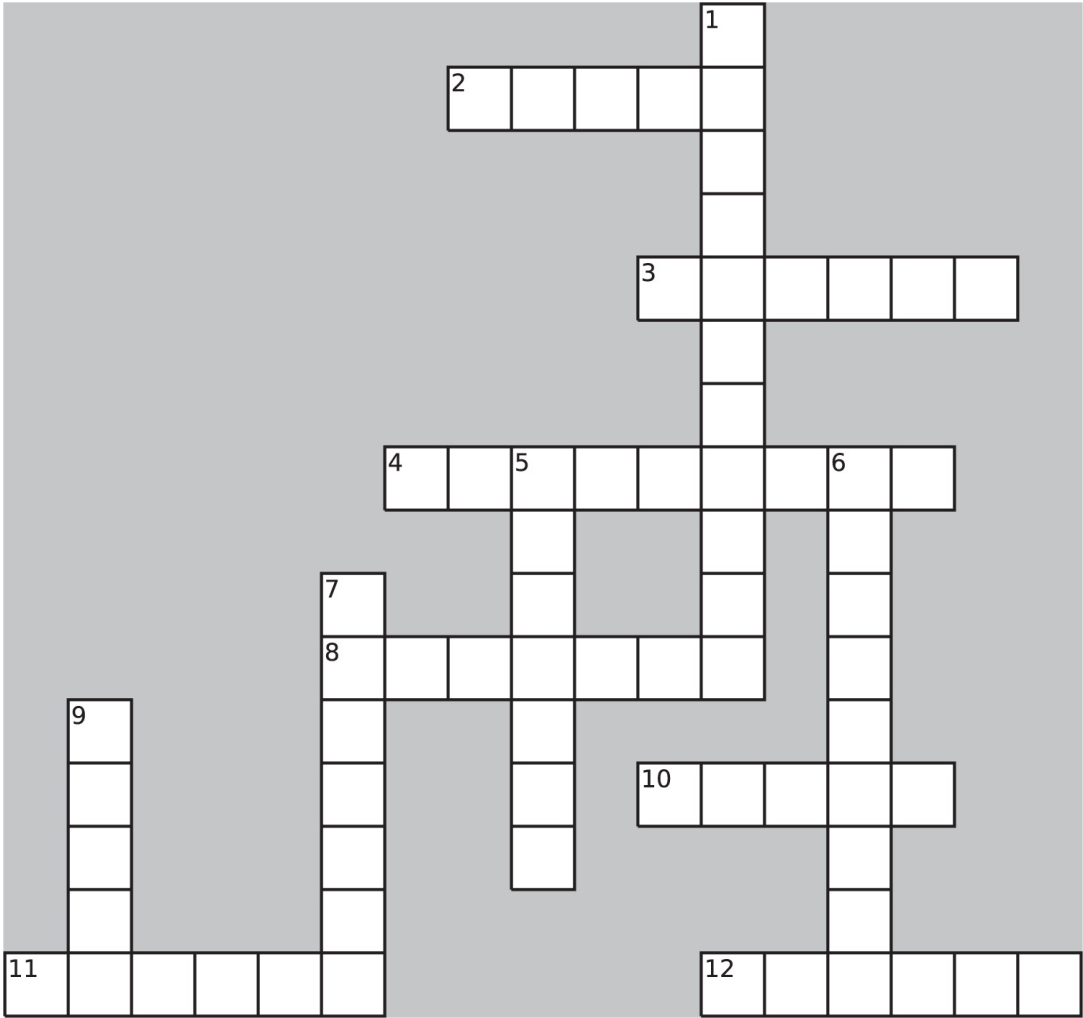
List for Learning How Muscles Are Named

Using the spaces below, list the six characteristics of muscles that form the basis for muscle names.

- 1. _____
- 2. _____
- 3. _____
- 4. _____
- 5. _____
- 6. _____

Puzzle It Out More Muscle Terms

Complete the following crossword puzzle to test your knowledge of the muscular system.



ACROSS

- 2. Thick midsection of a muscle

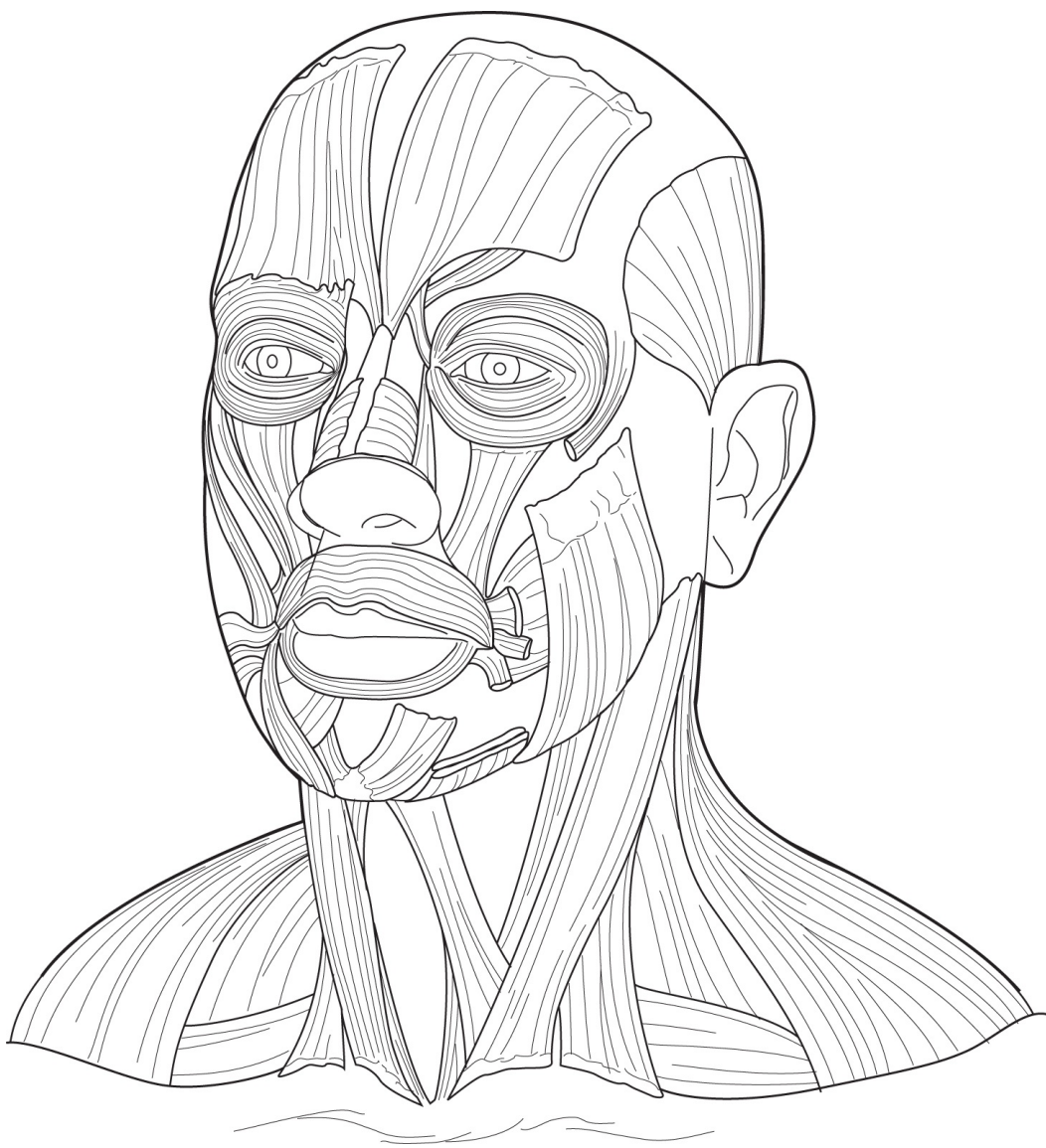
3. The end of a muscle that attaches to the more stationary bone
4. Type of muscle fermentation that takes place without oxygen
8. Disuse causes a muscle to do this
10. At rest, muscles obtain most of their energy by metabolizing acids.
11. Muscle term meaning shortest
12. Muscle term meaning longest

DOWN

1. Strength training causes a muscle to do this
5. Type of muscle respiration that uses oxygen
6. The muscle attachment that's more mobile
7. Muscle term meaning largest
9. Muscle term meaning small

Drawing Conclusions Muscles of the Head and Neck

Test your knowledge of the head and neck muscles by coloring the figure below. Use the suggested colors or choose your own. Next, link each muscle to its function by using the same color to highlight the sentence describing that muscle's function. For example, color the frontalis muscle brown; then, locate the sentence describing the function of the frontalis muscle and highlight it in brown.



Color the following muscles:

- Frontalis: Brown
- Orbicularis oculi: Pink
- Zygomaticus: Yellow
- Orbicularis oris: Orange
- Buccinator: Green
- Temporalis: Purple
- Masseter: Blue
- Sternocleidomastoid: Tan
- Trapezius: Red

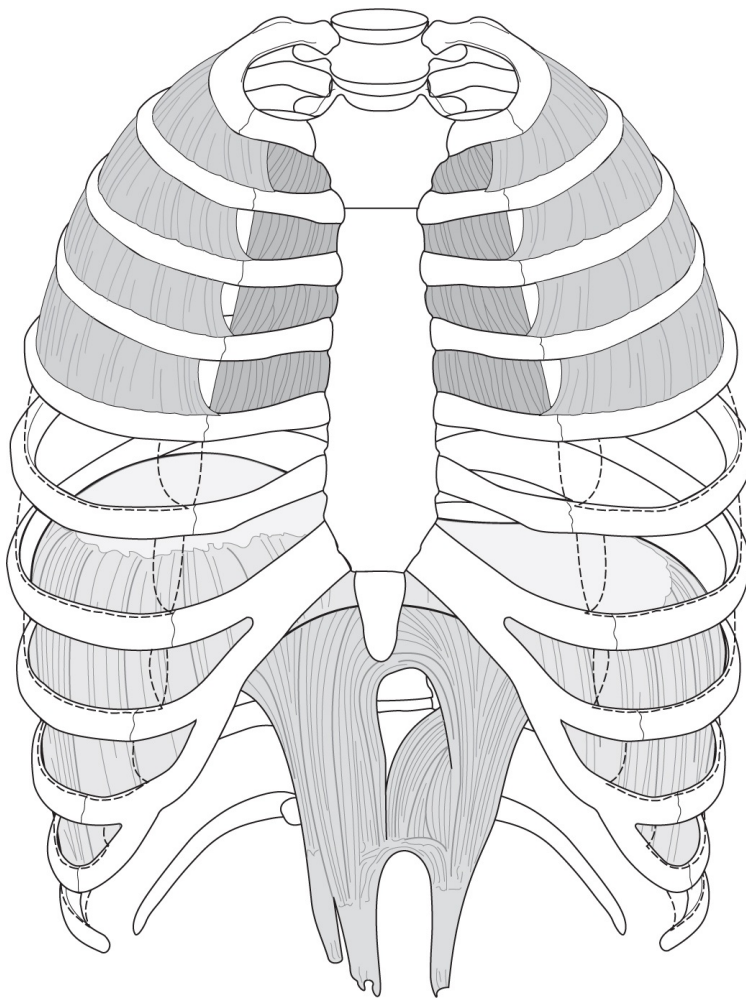
Muscle function:

- Extends head when looking upward; elevates shoulder
- Closes eye when blinking or squinting

- Assists in smiling or blowing, such as when playing trumpet
- Aids in closing jaw
- Raises eyebrows when glancing upward or when showing surprise
- Closes mouth and purses lips, such as when kissing
- Closes jaw
- Flexes head downward; called “praying muscle”
- Draws mouth upward when laughing

Drawing Conclusions Muscles of the Trunk

Test your knowledge of the trunk muscles by coloring the figure below. Use the suggested colors or choose your own. Next, link each muscle to its function by using the same color to highlight the sentence describing the muscle’s function. For example, color the external intercostals pink; then, locate the function of the external intercostals in the list below and highlight it in pink.



Color the following muscles:

- External intercostals: Pink

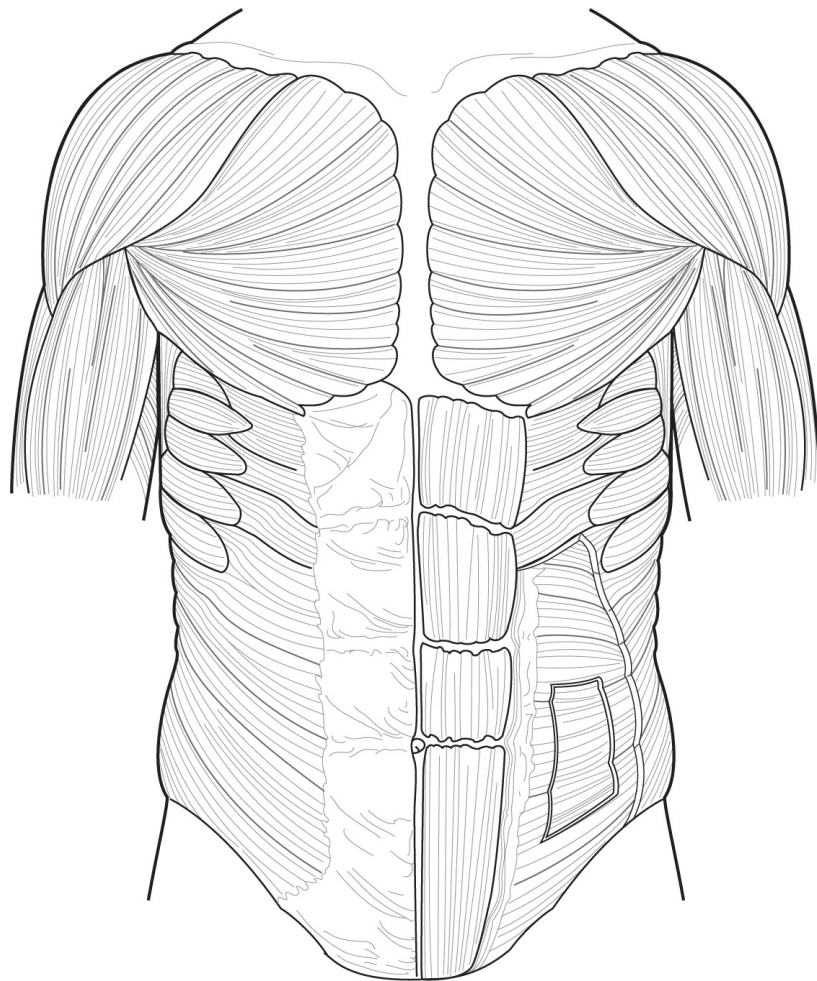
- Internal intercostals: Red
- Diaphragm: Brown

Muscle function:

- Enlarges the thorax to trigger inspiration
- Elevate the ribs during inspiration
- Depress the ribs during forced exhalation

Drawing Conclusions Muscles Forming the Abdominal Wall

Test your knowledge of the abdominal wall muscles by coloring the figure below. Use the suggested colors or choose your own. Next, link each muscle to its function by using the same color to highlight the sentence describing the muscle's function. For example, color the rectus abdominis pink; then, locate the sentence describing the function of the rectus abdominis and highlight it in pink.



Color the following muscles:

- Rectus abdominis: Pink
- Transverse abdominal: Yellow

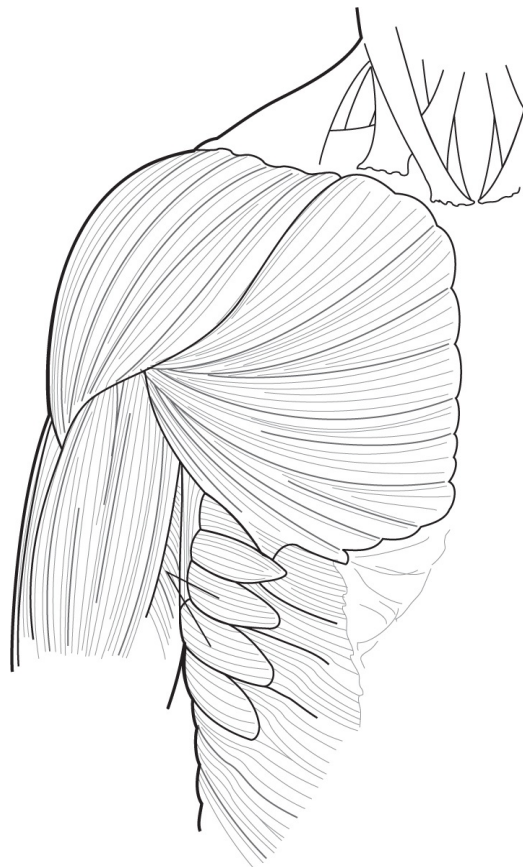
- Internal oblique: Green
- External oblique: Purple
- Linea alba: Red

Muscle function:

- Compresses the contents of the abdomen
- Tough band of connective tissue; where the aponeuroses of muscles that form the abdominal wall meet
- Flexes the lumbar region of the spinal column to allow bending forward at the waist
- Stabilizes the spine and permits rotation at the waist
- Stabilizes the spine and aids in forceful expiration

Drawing Conclusions Muscles of the Shoulder and Upper Arm

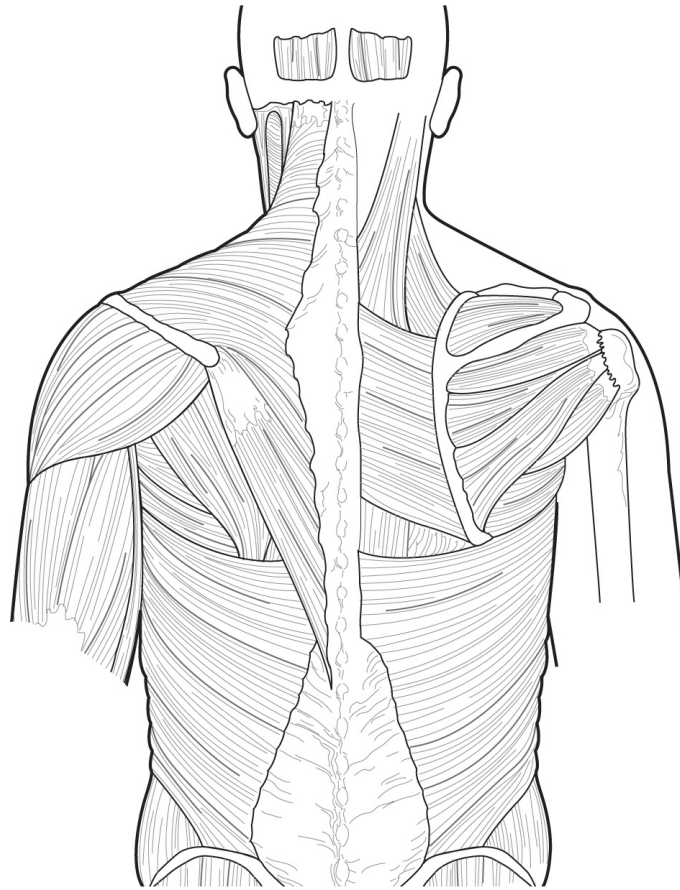
Test your knowledge of the shoulder and upper arm muscles by coloring the figure below. Use the suggested colors or choose your own. Next, link each muscle to its function by using the same color to highlight the sentence describing the muscle's function. For example, color the deltoid muscle yellow; then, locate the sentence describing the function of the deltoid muscle and highlight it in yellow.



Anterior

Color the following muscles:

- Deltoid: Yellow
- Pectoralis major: Green
- Serratus anterior: Pink
- Trapezius: Purple
- Latissimus dorsi: Blue



Posterior

Muscle function:

- Raises and lowers shoulder
- Flexes and adducts upper arm, such as when hugging
- Abducts, flexes, and rotates arm, such as when swinging the arm (walking); also raises arm to perform tasks, such as writing on an elevated surface
- Pulls shoulder down and forward to drive forward-reaching and pushing movements
- Involved in activities such as swimming to adduct the humerus and extend upper arm backward

Drawing Conclusions Muscles of the Arm

Test your knowledge of the arm muscles by coloring the figure below. Use the suggested colors or choose your own. Next, link each muscle to its function by using the same color to highlight the

sentence describing the muscle's function. For example, color the brachialis pink; then, locate sentence describing the function of the brachialis muscle and highlight it in pink.



Color the following muscles:

- Brachialis: Pink
- Biceps brachii: Yellow
- Triceps brachii: Blue
- Brachioradialis: Green
- Pronator muscle: Purple
- Flexors: Orange

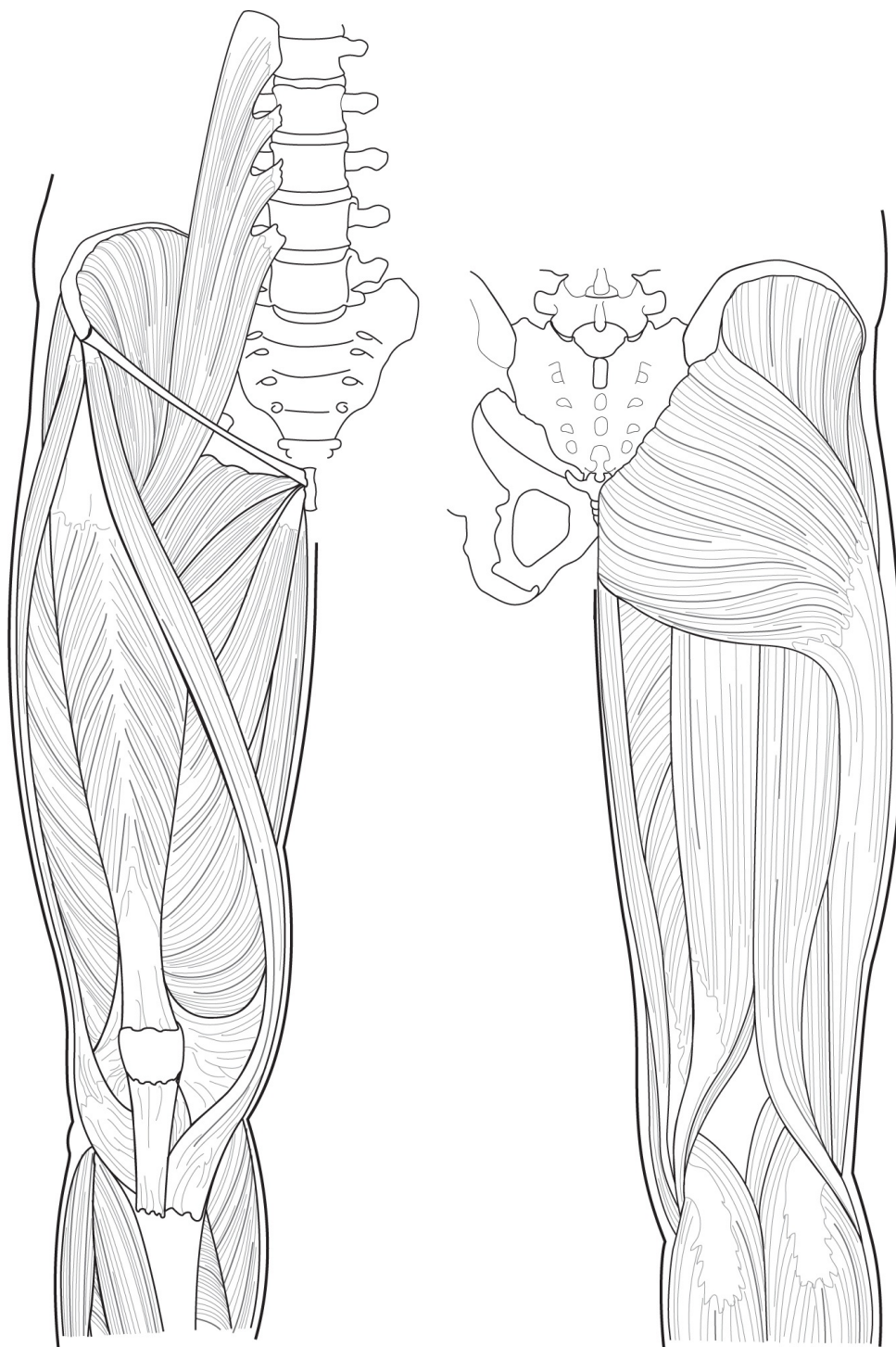


Muscle function:

- Prime mover when extending forearm
- Allows arm to pronate (palms down)
- Flexes wrist
- Prime mover when flexing forearm
- Assists with flexion of forearm
- Also assists with flexing forearm

Drawing Conclusions Muscles Acting on the Hip and Thigh

Test your knowledge of the hip and thigh muscles by coloring the figure below. Use the suggested colors or choose your own. Next, link each muscle to its function by using the same color to highlight the sentence describing the muscle’s function. For example, color the iliacus red; then, locate the sentence describing the function of the iliacus muscle and highlight it in red.



Color the following muscles:

- Iliacus: Red
- Psoas major: Green
- Sartorius: Dark blue
- Gracilis: Pink
- Adductor muscle group: Orange
- Gluteus maximus: Brown
- Gluteus medius: Yellow

- Hamstring group: Purple
- Quadriceps femoris: Light blue

Muscle function:

- Adducts thigh (two muscles)
- Extends hip at thigh and flexes knee
- Prime mover for knee extension
- Flexes thigh (two muscles)
- Produces backswing of leg when walking; powers climbing up stairs
- Abducts and rotates thigh outward
- Aids in sitting cross-legged

List for Learning Quadriceps Femoris

Using the spaces below, list the four muscles comprising the quadriceps femoris.

1. _____
2. _____
3. _____
4. _____

List for Learning Hamstring Group

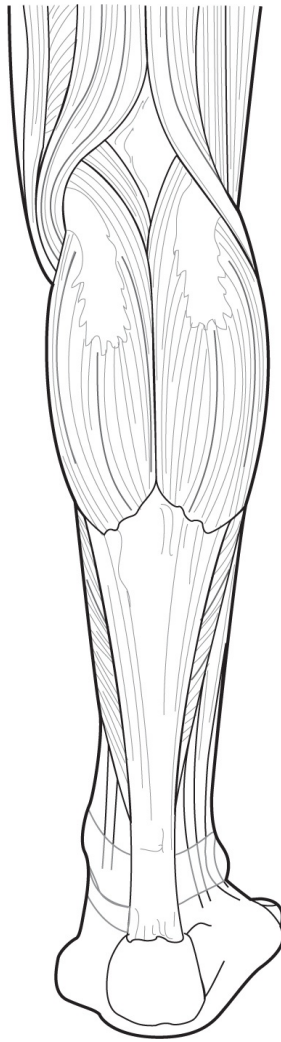
Using the spaces below, list the three muscles comprising the hamstrings.

1. _____
2. _____
3. _____

Drawing Conclusions Muscles of the Lower Leg

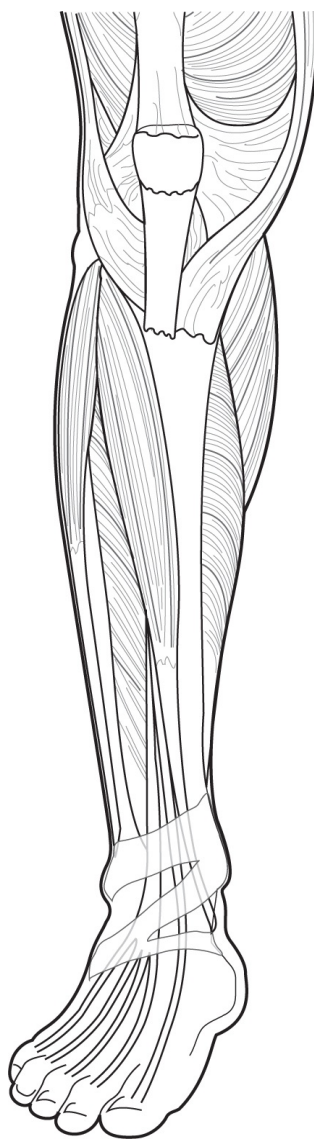
Test your knowledge of the lower leg muscles by coloring the figure below. Use the suggested colors or choose your own. Next, link each muscle to its function by using the same color to highlight the sentence describing the muscle's function. For example, color the gastrocnemius green; then, locate the sentence describing the function of the gastrocnemius muscle and highlight it in red.

(Hint: Muscles may be used more than once.)



Color the following muscles:

- Gastrocnemius: Green
- Soleus: Pink
- Calcaneal (Achilles) tendon: Yellow
- Tibialis anterior: Purple
- Extensor digitorum longus: Blue



Muscle function:

- Causes dorsiflexion of foot
- Extends toes and turns foot outward; also causes dorsiflexion of foot
- Cause plantar flexion (two muscles)

chapter 11

NERVOUS SYSTEM

The nervous system oversees and coordinates the activities of all of the body's systems. It receives millions of signals each day about changes within the body as well as the external environment. It processes that information, decides what actions need to occur, and then sends messages telling the various cells and organs how to respond. The nervous system is as complex as it is fascinating, and mastering its intricacies will require extra study. Doing the activities in this chapter will help.

Make a Connection Cells of the Nervous System

In the spaces below, list the five types of glial cells. The first letter of each term is provided to get you started. Then, draw a line to link each cell to its characteristics. Note that items may link with more than one characteristic.

1. O_____
2. E_____
3. M_____
4. S_____
5. A_____

- a. Attach neurons to blood vessels
- b. Some secrete cerebrospinal fluid
- c. Form myelin sheath around nerve fibers in the brain and spinal cord
- d. Engulf microorganisms and cellular debris
- e. Form myelin sheath around nerves in the peripheral nervous system
- f. Line spinal cord and cavities of the brain
- g. Help form blood–brain barrier
- h. Form neurilemma
- i. Most numerous of all glial cells
- j. Only glial cell found in the peripheral nervous system

Just the Highlights Central and Peripheral Nervous Systems

In the following list, highlight all the statements pertaining to the central nervous system in blue, and all the statements pertaining to the peripheral nervous system in yellow.

1. Consists of nerves that branch off from the spinal cord and extend to parts of the body
2. Carries signals from nerve endings to CNS
3. Transmits information from CNS to rest of body
4. Spinal cord transmits information for the brain to process
5. Allows voluntary movement of skeletal muscles
6. Provides “automatic” activities such as control of blood pressure and heart rate
7. Includes brain and spinal cord
8. Contains sympathetic and parasympathetic divisions of the nervous systems
9. Carries signals from skin bones, joints, and muscles
10. Carries signals from viscera of heart, lungs, stomach, and bladder

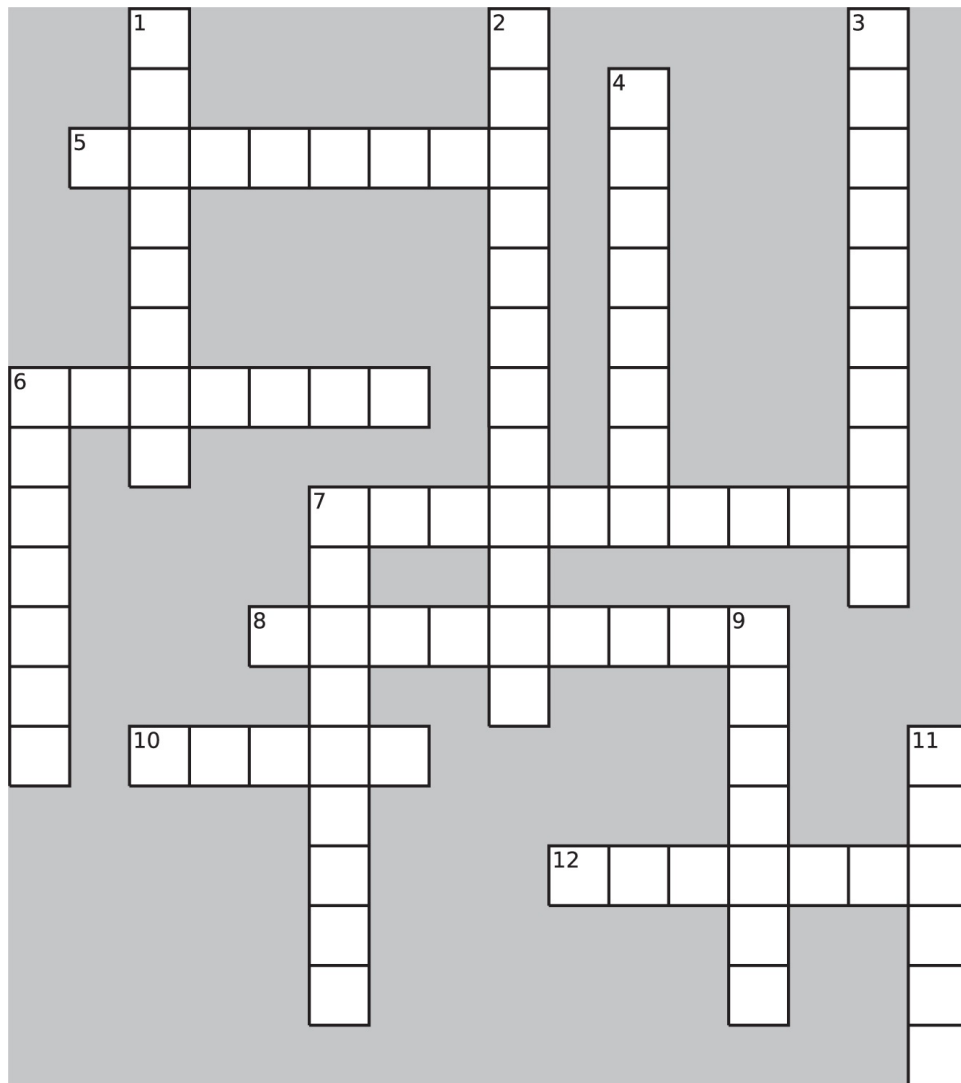
Make a Connection Roles of the Nervous System

In the spaces below, list the three essential roles of the nervous system. The first letter of each term is provided to get you started. Then, draw a line to link each role to its characteristics.

1. S_____
 2. I_____
 3. R_____
- a. Uses sense organs and nerve endings to detect changes inside and outside the body
 - b. Uses interneurons to evaluate, compare, and respond to incoming sensory signals
 - c. Relates information to past experiences to determine appropriate response
 - d. Issues commands to muscles and glands to initiate changes based on information
Example: Removing finger from hot flame
 - e. Collects information from sensory receptors and transmits it to the central nervous system
Example: Feeling hot when touching a hot flame
 - f. Uses motor neurons to relay messages from brain to muscles and glands
Example: Remembering that fire burns the skin

Puzzle It Out Overview of the Nervous System

Complete the following crossword puzzle to test your knowledge of the basics about the nervous system.



ACROSS

5. Another name for sensory neurons
6. Type of neuron that detects stimuli and transmits impulses to the brain and spinal cord
7. Essential for an injured nerve to regenerate
8. Division of the nervous system that provides for the body's "automatic" activities
10. Type of neuron that relays messages from the brain to muscles or gland cells
12. Impulse conducting cells of the nervous system

DOWN

1. Another name for motor neurons
2. Connect incoming sensory pathways with outgoing motor pathways in the CNS
3. The _____ nervous system consists of the network of nerves throughout the body.
4. Division of the nervous system that carries signals from the organs
6. Division of the nervous system that carries impulses to and from skeletal muscles

7. Supportive cells of the nervous system
9. The _____ nervous system consists of the brain and spinal cord.
11. Myelinated nerve fibers transmit impulses _____ than unmyelinated fibers.

Just the Highlights Types of Neurons

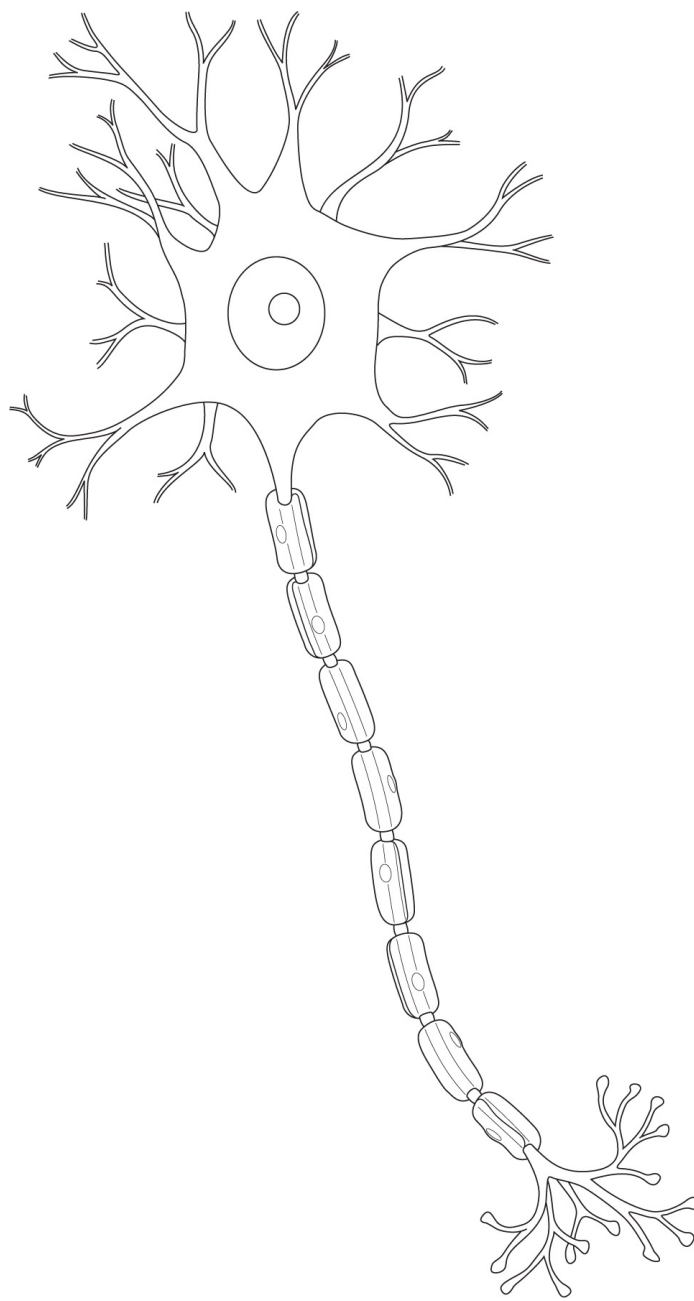
Neurons vary greatly in size and shape. They also vary according to type, number and length of projections. In the following list, highlight characteristics of multipolar neurons in yellow, bipolar neurons in blue, and unipolar neurons in pink.

1. Have one axon and multiple dendrites
2. Includes most neurons of the brain and spinal cord
3. Have two processes: an axon and a dendrite with the cell body in between the two processes
4. Have one process (an axon) that extends from the cell body before branching in a T shape
5. Most common type of neuron
6. Reside in the sensory nerves of the peripheral nervous system
7. Can be found in the retina of the eye and olfactory nerve in the nose

Drawing Conclusions Neuron Structure

Test your knowledge of neuron structure and function by filling in the blanks of each sentence. Next, color the neuron figure below. Use the suggested colors or choose your own.

1. The cell body, also called the _____, is the control center of the neuron and contains the _____.
(Color the cell body blue.)
2. Dendrites receive signals from other _____ and transmit the information _____ the cell body.
(Color the dendrites green.)
3. The axon carries signals _____ the cell body.
(Color the axon yellow.)
4. Gaps in the myelin sheath are called _____.
(Color these areas red.)
5. The synaptic knobs, which lie at the terminal point on each branch of the axon, secrete a _____.
(Color the synaptic knobs brown.)



Illuminate the Truth Myelin

Highlight the word or phrase that completes each sentence correctly.

1. (All)(Some) nerve fibers are myelinated.
2. Myelin serves to (slow)(speed) impulse conduction.
3. Unmyelinated fibers conduct impulses (rapidly)(more slowly), so perform functions in which speed (is)(is not) essential.
4. Myelinated fibers perform functions in which speed (is)(is not) essential.
5. Nerve fibers stimulating skeletal muscles are (unmyelinated)(myelinated).
6. In the peripheral nervous system, a myelin sheath is formed when (oligodendrocytes)(Schwann cells) wrap themselves around the axon, leaving the nucleus and most of the cytoplasm of the glial cell in the

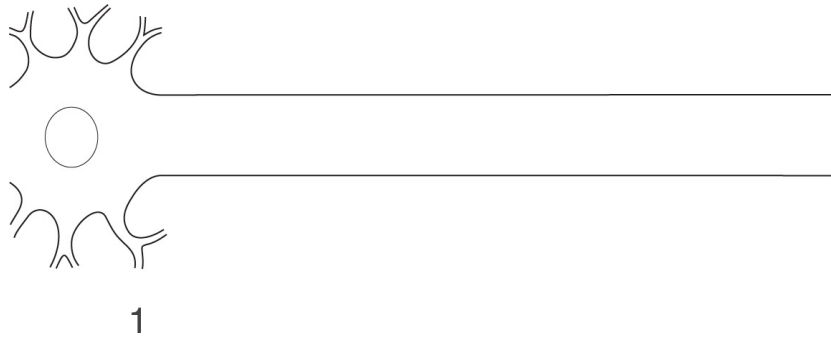
(inner)(outer) layer; this forms the (blood-brain barrier)(neurilemma).

7. In the CNS, the myelin sheath is formed when (oligodendrocytes)(Schwann cells) wrap themselves around the axon.
8. Schwann cells wrap themselves around (one)(multiple) axon(s), whereas oligodendrocytes wrap themselves around (one)(multiple) axon(s).
9. In the CNS, myelinated fibers (have)(do not have) a neurilemma, which means that injured cells (can)(cannot) regenerate.
10. Myelination is complete (shortly after birth)(in late adolescence).

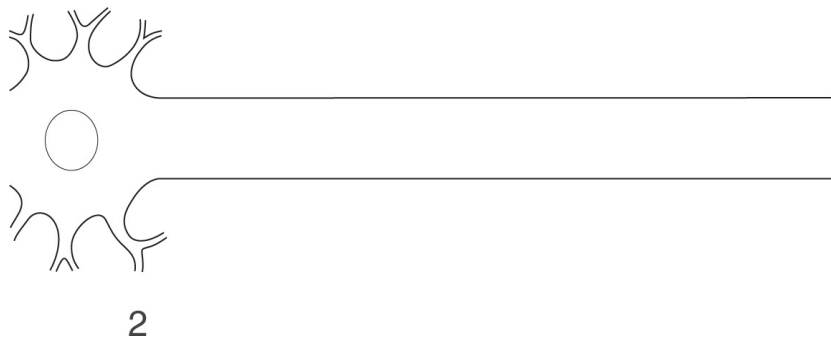
Drawing Conclusions Nerve Impulse Conduction

Test your knowledge of the process of neural transmission by filling in the blanks of each sentence. Then, illustrate the process described using the corresponding figures.

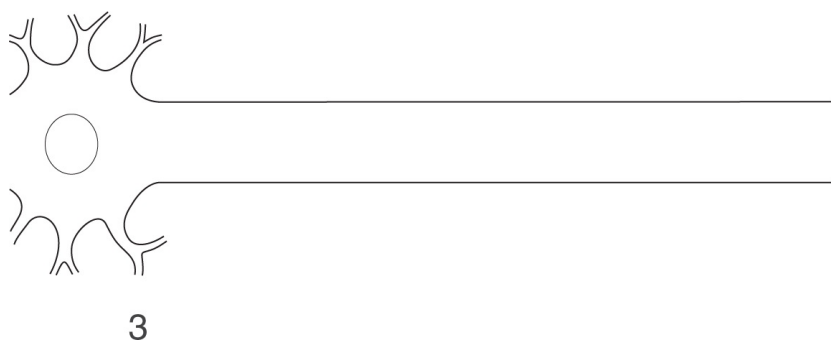
1. The phase in which the nerve is resting but has the potential to react if a stimulus comes along is called _____. In this phase, the inside of the cell has a _____ charge while the outside has a _____ charge. The interior is rich in _____ ions while the exterior is rich in _____ ions.



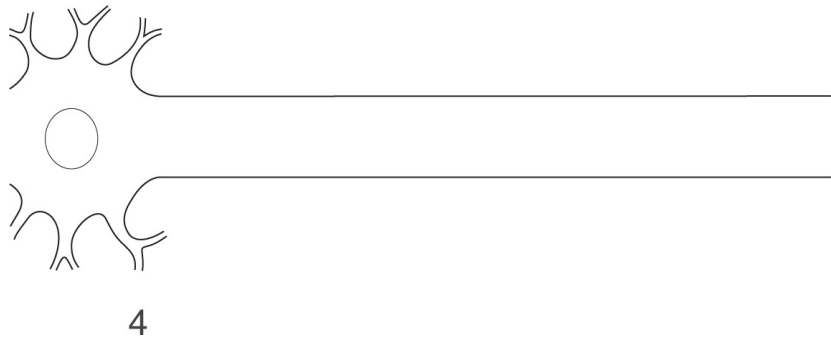
2. In depolarization, a stimulus causes _____ ions to enter the cell, and the interior changes from _____ to _____.



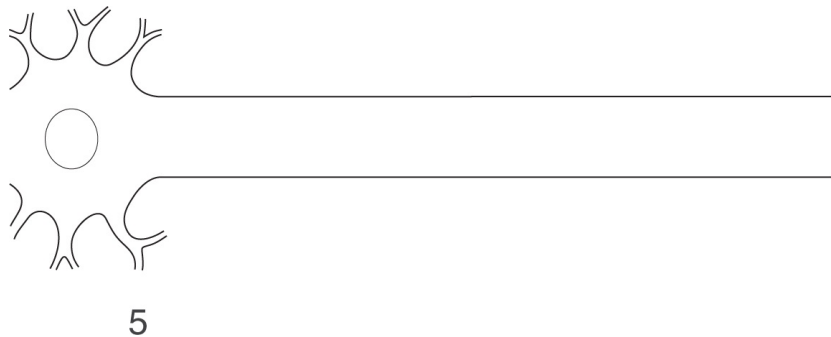
3. In _____ potential, the nerve becomes active and conducts an impulse along the axon. When this happens, more _____ ions enter the cell, and the nerve impulse continues down the axon.



4. In repolarization, _____ ions flow out of the cell. When this happens, the interior assumes a _____ charge while the exterior has a _____ charge.

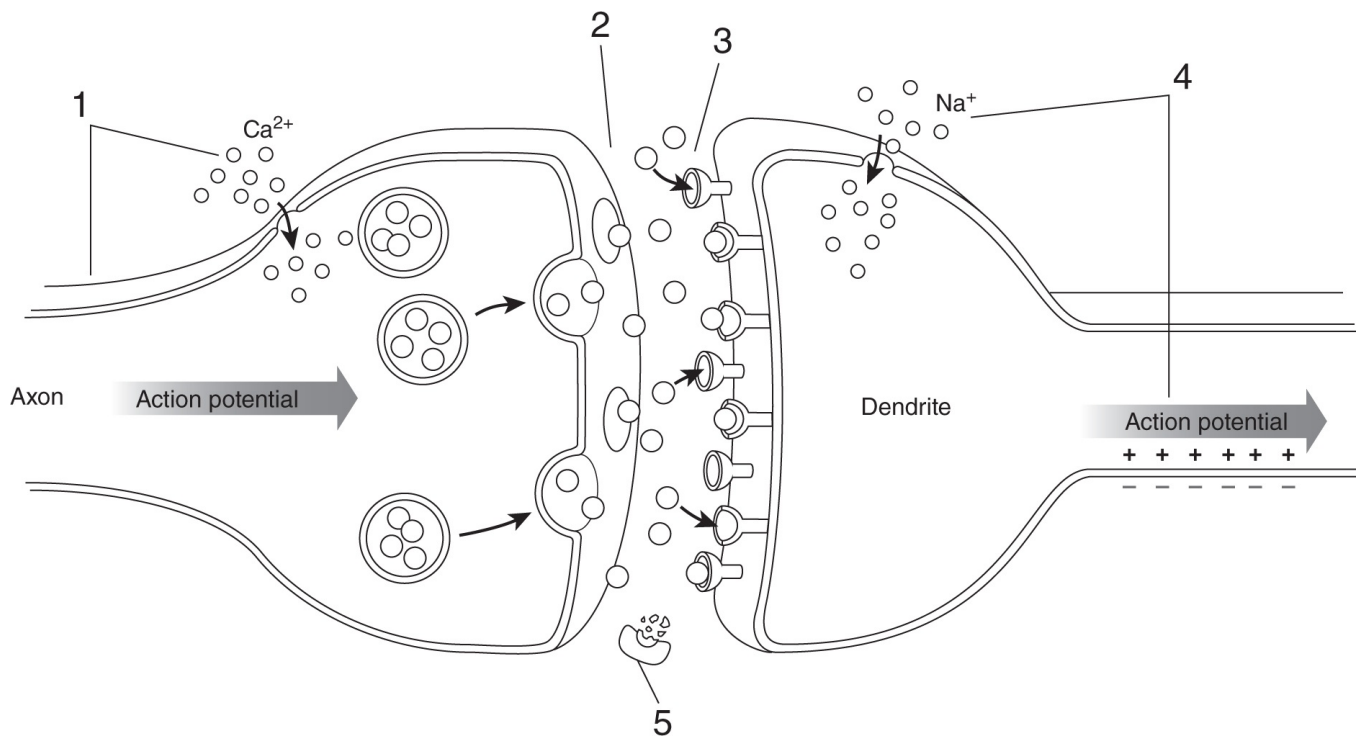


5. During the _____ period, the neuron is polarized but won't respond to a stimulus until the sodium-potassium pump restores _____ ions to the outside of the membrane and _____ ions to the inside.



Drawing Conclusions Synapses

The transmission of an impulse from one neuron to the next follows a precise sequence of events, represented by the numbers in the figure below. Test your knowledge of this process by describing each step in the corresponding spaces below the figure. Color the portion of the figure illustrating each step as you go along.



1. _____
2. _____
3. _____
4. _____
5. _____

Illuminate the Truth The Spinal Cord

Highlight the word or phrase that completes each sentence correctly.

1. The spinal cord extends from the base of the brain until about the (first lumbar vertebra)(last lumbar vertebra).
2. Extending from the end of the spinal cord is a bundle of nerve roots called the (cauda equina) (ganglion).
3. Gray matter appears gray because of its (abundance of myelin)(lack of myelin).
4. The (white matter)(gray matter) contains bundles of axons called tracts that carry impulses from one part of the nervous system to another.
5. The small space between the outer covering of the spinal cord and the vertebrae is called the

(subdural space)(epidural space).

6. Gray matter contains mostly the cell bodies of (sensory neurons)(motor neurons and interneurons).
7. The (epidural space)(central canal) carries cerebrospinal fluid through the spinal cord.

List for Learning Meninges

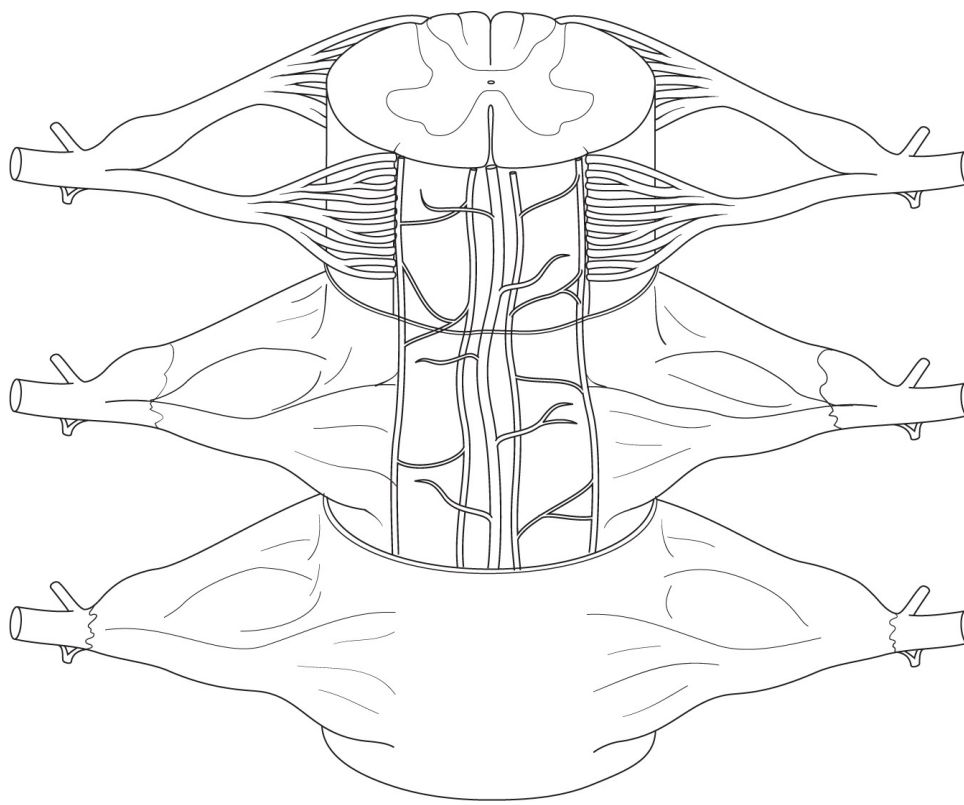
Using the spaces below, list the three layers of the meninges, starting with the innermost layer.

1. _____
2. _____
3. _____

Drawing Conclusions Spinal Nerves and Meninges

Test your knowledge of spinal nerves and the meninges by coloring the structures on the figure below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to further test your knowledge.

- Dorsal nerve root: Green; insert a red arrow to depict the direction the impulse is traveling
- Ventral nerve root: Blue; insert a red arrow to depict the direction the impulse is traveling
- Ganglia: Yellow
- Spinal nerve: Orange
- Pia mater: Beige
- Dura mater: Purple
- Arachnoid mater: Pink
- Subarachnoid space: Dark blue
- Gray matter: Gray
- White matter: White



1. The dorsal (posterior) nerve root contains fibers that carry _____ information _____ the spinal cord.
2. Cell bodies of the dorsal neurons are clustered in knot-like structures called _____.
3. A spinal nerve is _____.
4. Spinal nerves contain _____ (Hint: type of fiber) fibers and is called a _____ nerve.
5. Fibers in the _____ nerve roots carry information out of the spinal cord.
6. The _____ is the layer of meninges that clings to the surface of the brain and spinal cord.
7. The _____ is the space between the arachnoid mater and pia mater that is filled with cerebrospinal fluid.
8. The _____ lies between the dura mater and pia mater.
9. The tough outer layer of meninges is the _____.

Just the Highlights Spinal Tracts

In the following list, highlight all the names and characteristics of sensory tracts in yellow and the names and characteristics of motor tracts in blue.

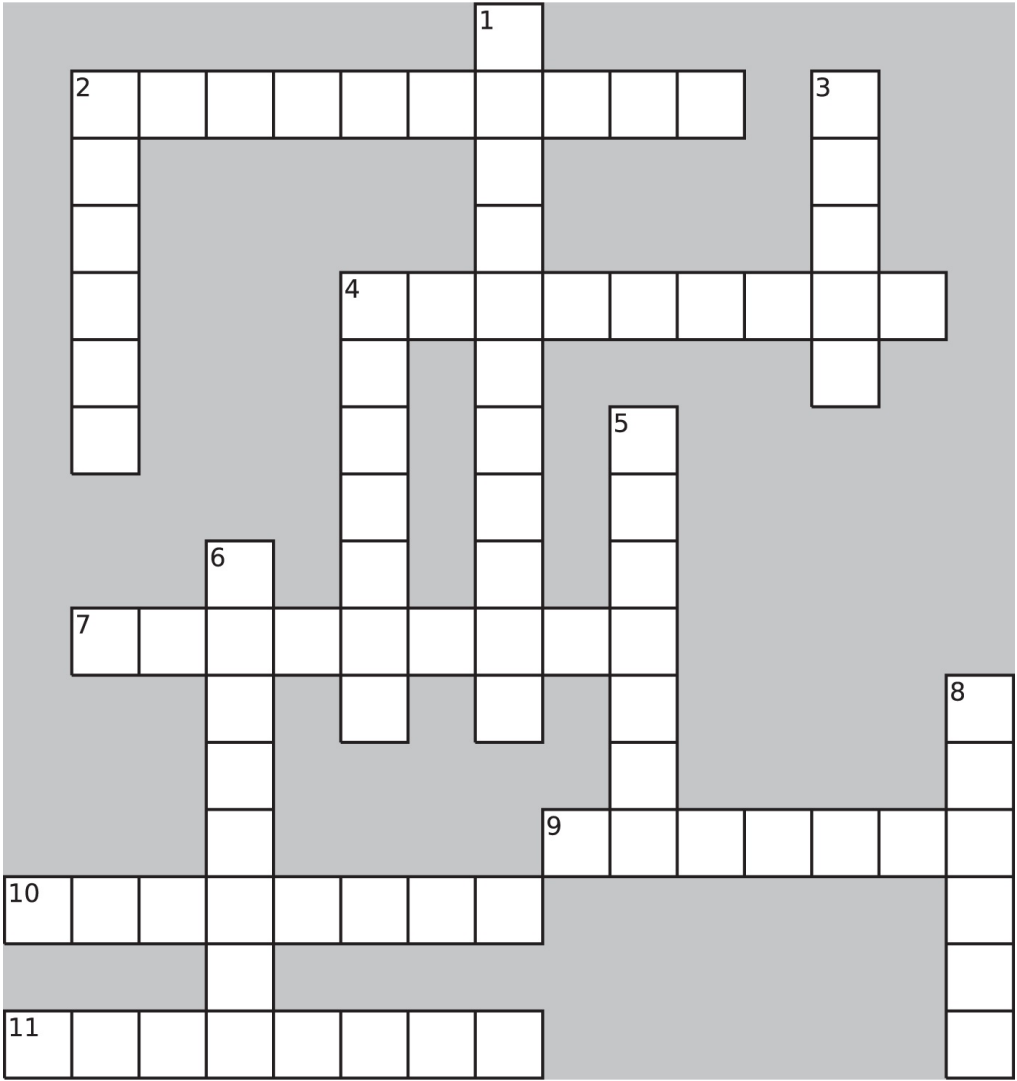
1. Ascending tracts
2. Descending tracts

3. Impulses travel down the spinal cord to skeletal muscles
4. Impulses travel up the spinal cord to the brain
5. Dorsal column (which relays sensations of deep pressure, proprioception, and vibration)
6. Extrapyramidal tracts (associated with balance and muscle tone)
7. Spinocerebellar tract (responsible for proprioception)
8. Corticospinal (responsible for fine movements of hands, feet, fingers, and toes)
9. Spinothalamic tract (relays sensations of temperature, pressure, pain, and touch)
10. Pyramidal tracts

Puzzle It Out

Spinal Nerves

Complete the following crossword puzzle to test your knowledge of some of the key terms related to spinal nerves.



ACROSS

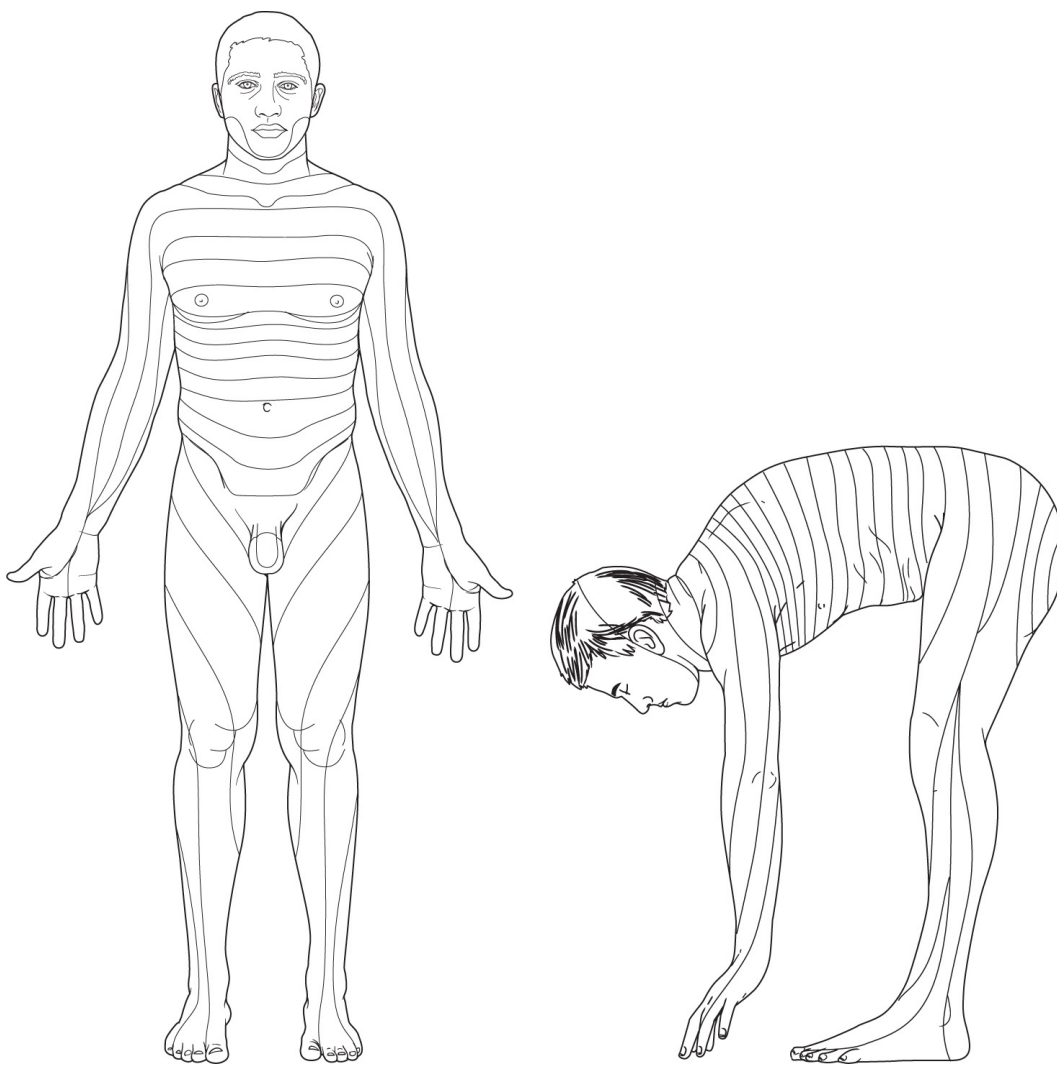
2. Paralysis of the legs resulting from a spinal cord injury between levels T1 and L1
4. Bundles of nerve fibers
7. Area innervated by a spinal nerve
9. Largest nerve in the body
10. Fibrous connective tissue that covers the spinal cord
11. Nerve susceptible to damage from improper use of crutches

DOWN

1. The crossing of spinal cord tracts from one side of the body to the other in the brainstem
2. A network of spinal nerves
3. Term used for nerves that carry both sensory and motor fibers
4. Key nerve of the lumbar plexus
5. Nerve that stimulates the diaphragm
6. Plexus that innervates the lower part of the shoulder and arm
8. Plexus formed from fibers from nerves L4, L5, and S1 through S4

Conceptualize in Color Dermatomes

Identify the dermatomes by coloring the area innervated by cervical nerves blue, thoracic nerves pink, lumbar nerves orange, and sacral nerves green.



Sequence of Events Somatic Reflex

Insert the numbers 1 through 5 in the spaces provided to identify the sequence of events that occur in a somatic reflex.

- _____ A. The motor neuron sends an impulse to a muscle.
- _____ B. Somatic receptors detect a sensation.
- _____ C. The impulse immediately passes to a motor neuron.
- _____ D. Afferent fibers send a signal to the spinal cord.
- _____ E. The muscle contracts.

Illuminate the Truth Overview of the Brain

Highlight the word or phrase that completes each sentence correctly.

1. The largest portion of the brain is the (cerebrum)(cerebellum).
2. The structure residing deep inside the brain that contains the thalamus and hypothalamus is the

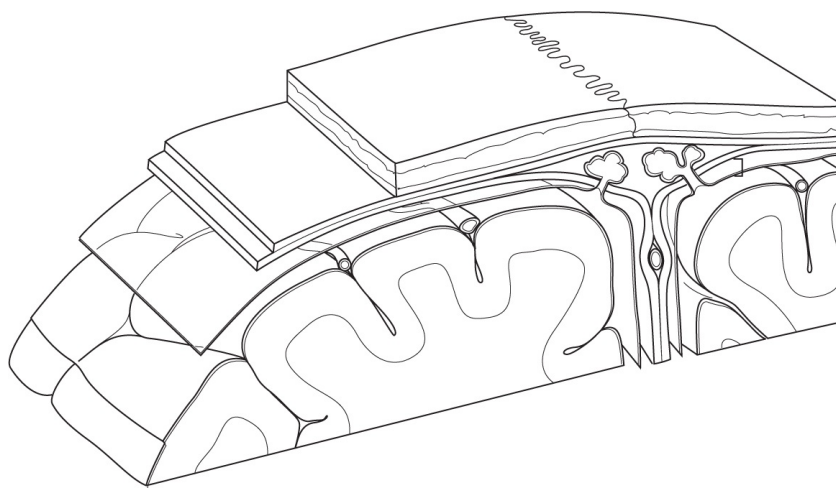
(corpus callosum)(diencephalon).

3. The area of the brain that contains more neurons than the rest of the brain combined is the (cerebrum) (cerebellum).
4. The deep groove that divides the cerebrum into right and left hemispheres is the (corpus callosum) (longitudinal fissure).
5. The thick ridges covering the surface of the brain are called (sulci)(gyri).
6. The shallow grooves along the surface of the brain are called (sulci)(gyri).
7. (Gray matter)(White matter) covers the surface of the brain while in a layer called the (sulci)(cortex).
8. Chambers inside the brain that are filled with cerebrospinal fluid are called (sinuses)(ventricles).
9. The bundle of nerves that connects the brain's two hemispheres is the (longitudinal fissure)(corpus callosum).
10. Patches of gray matter inside the brain are called (ganglia)(nuclei).
11. The part of the brain charged with thought, learning, and reasoning is the (gray)(white) matter.
12. Gray matter contains (bundles of axons)(cell bodies and interneurons).
13. (Gray)(White) matter contains axons that connect one part of the brain to another.

Drawing Conclusions Meninges

Test your knowledge of the meninges by coloring the key structures in the figure below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to further test your knowledge.

- Dura mater: Pink
- Arachnoid mater: Orange
- Pia mater: Tan
- Dural sinus: Blue
- Arachnoid villi: Yellow
- Falx cerebri: Purple
- Draw a red line to identify the subdural space
- Draw a green line to identify the subarachnoid space
- Color the gray matter gray and the white matter either white or light gray

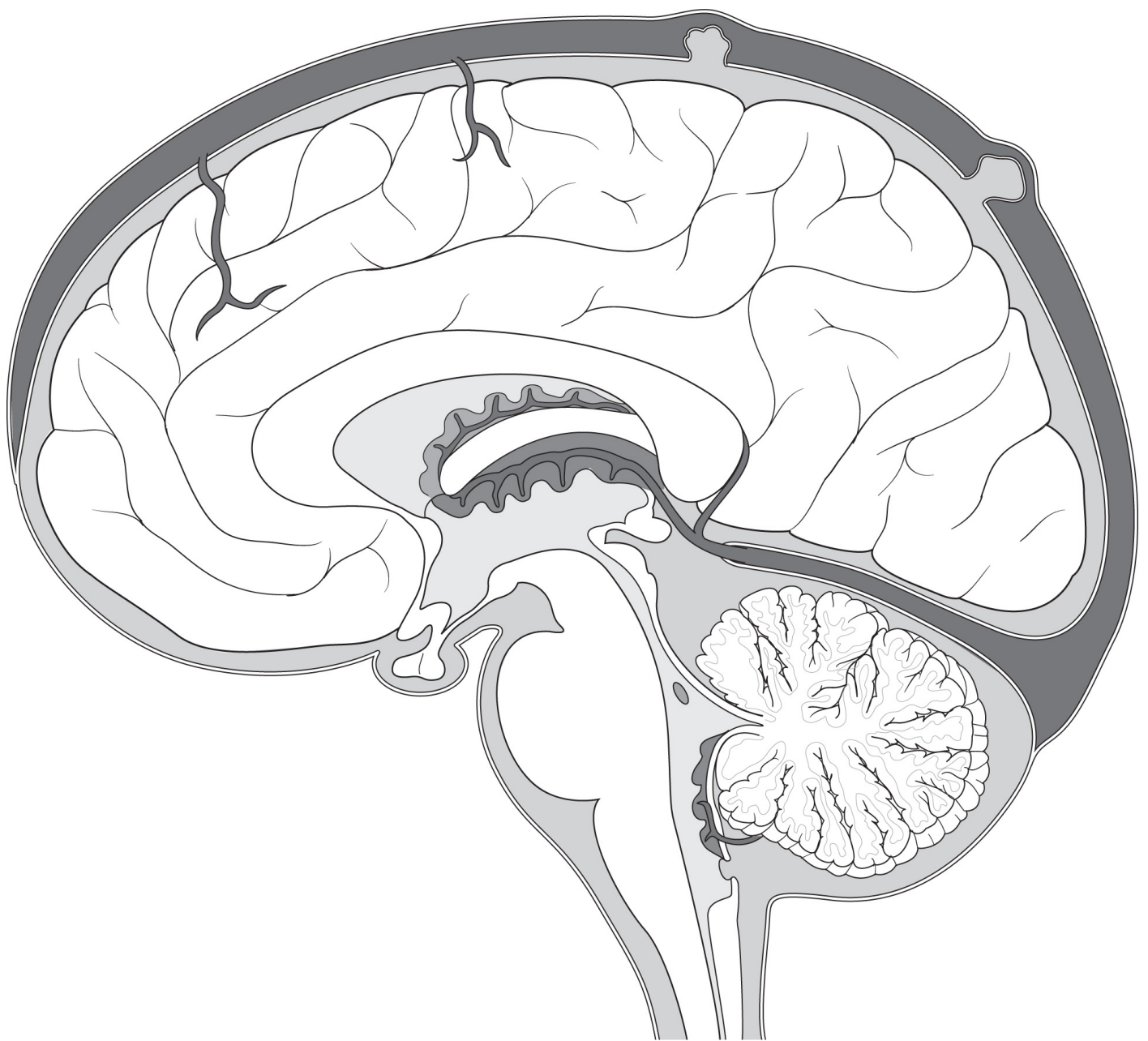


1. The _____ consists of two layers: the _____ layer is attached to the inner surface of the skull and the _____ layer forms the outer covering of the brain.
2. The _____ clings to the surface of the brain.
3. In some locations the dura mater separates to contain spaces called _____; the function of these spaces is to _____.
4. The subarachnoid space lies between the _____ and _____.

Sequence of Events Cerebrospinal Fluid

Insert the numbers 1 through 5 in the spaces provided to identify the sequence of events that occur in the formation of cerebrospinal fluid (CSF). Then, insert the numbers in the figure below to trace the flow of CSF. Lastly, color the ventricles and insert arrows to show the direction of flow.

- _____ A. Some of the CSF flows through two tiny openings (foramina).
- _____ B. The CSF is reabsorbed into the venous bloodstream by arachnoid villi.
- _____ C. The choroid plexus in each lateral ventricle secretes CSF.
- _____ D. The CSF flows through the subarachnoid space, up the back of the brain, down around the spinal cord, and up the front of the brain.
- _____ E. The CSF flows into the third ventricle, where the choroid plexus adds more fluid.
- _____ F. The CSF flows into the fourth ventricle, where a choroid plexus adds more CSF.



Make a Connection Brainstem

In the spaces below, list the three components of the brainstem. The first letter of each term is provided to get you started. Then, draw a line to link each structure to its characteristics.

1. M _____
2. P _____
3. M _____
O _____

- a. Attaches brain to spinal cord
- b. Contains centers for auditory and visual reflexes
- c. Cranial nerves V (trigeminal), VI (abducens), VII (facial), and VIII (vestibulocochlear) arise here

- d. Contains cardiac center (which regulates heart rate) as well as vasomotor center (which controls blood vessel diameter)
- e. Contains two respiratory centers, which regulate breathing
- f. Contains clusters of neurons integral to muscle control
- g. Houses reflex centers for coughing, sneezing, swallowing, and vomiting.

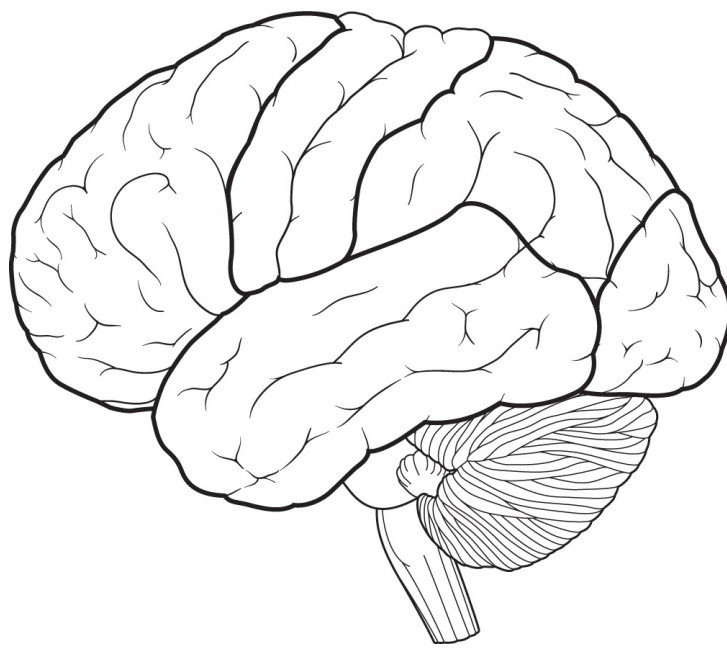
Illuminate the Truth Brain Structures

Highlight the word or phrase that completes each sentence correctly.

1. The (cerebrum)(cerebellum) contains more neurons than any other portion of the brain.
2. The (hippocampus)(diencephalon) lies in the central portion of the brain and consists of several structures, including the thalamus and hypothalamus.
3. The (reticular activating system)(limbic system) is charged with maintaining a state of wakefulness.
4. The ability to think and use judgment is attributed to the (cerebellum)(cerebrum).
5. The thalamus is a gateway for nearly every (motor)(sensory) impulse traveling to the cerebral cortex.
6. Sometimes called the “emotional brain,” the (hypothalamus)(limbic system) is the seat of emotion and learning.
7. The (amygdala) (hippocampus) converts short-term to long-term memory, making it crucial for memory and learning.
8. Cerebellar dysfunction often causes (stiffness and muscle pain)(poor balance and a spastic gait).
9. The (cerebral cortex)(hypothalamus) contains control centers for hunger, thirst, and temperature regulation.
10. The cerebrum is divided into five lobes by obvious (sulci)(gyri).
11. Two almond-shaped masses of neurons on either side of the thalamus, the (amygdala)(hippocampus) stores and can recall emotions from past events.
12. The hippocampus and amygdala are components of the (thalamus)(limbic system).
13. The surface of the cerebrum is called the (corpus callosum)(cerebral cortex).
14. The (hypothalamus)(hippocampus) controls the autonomic nervous system.

Drawing Conclusions Cerebrum

Test your knowledge of the cerebrum by coloring the figure below. Use the suggested colors or choose your own. Then, in the spaces provided, list some of the key functions of each lobe.



- Frontal lobe: Green
Frontal lobe functions: _____

- Occipital lobe: Pink
Occipital lobe functions: _____

- Parietal lobe: Blue
Parietal lobe functions: _____

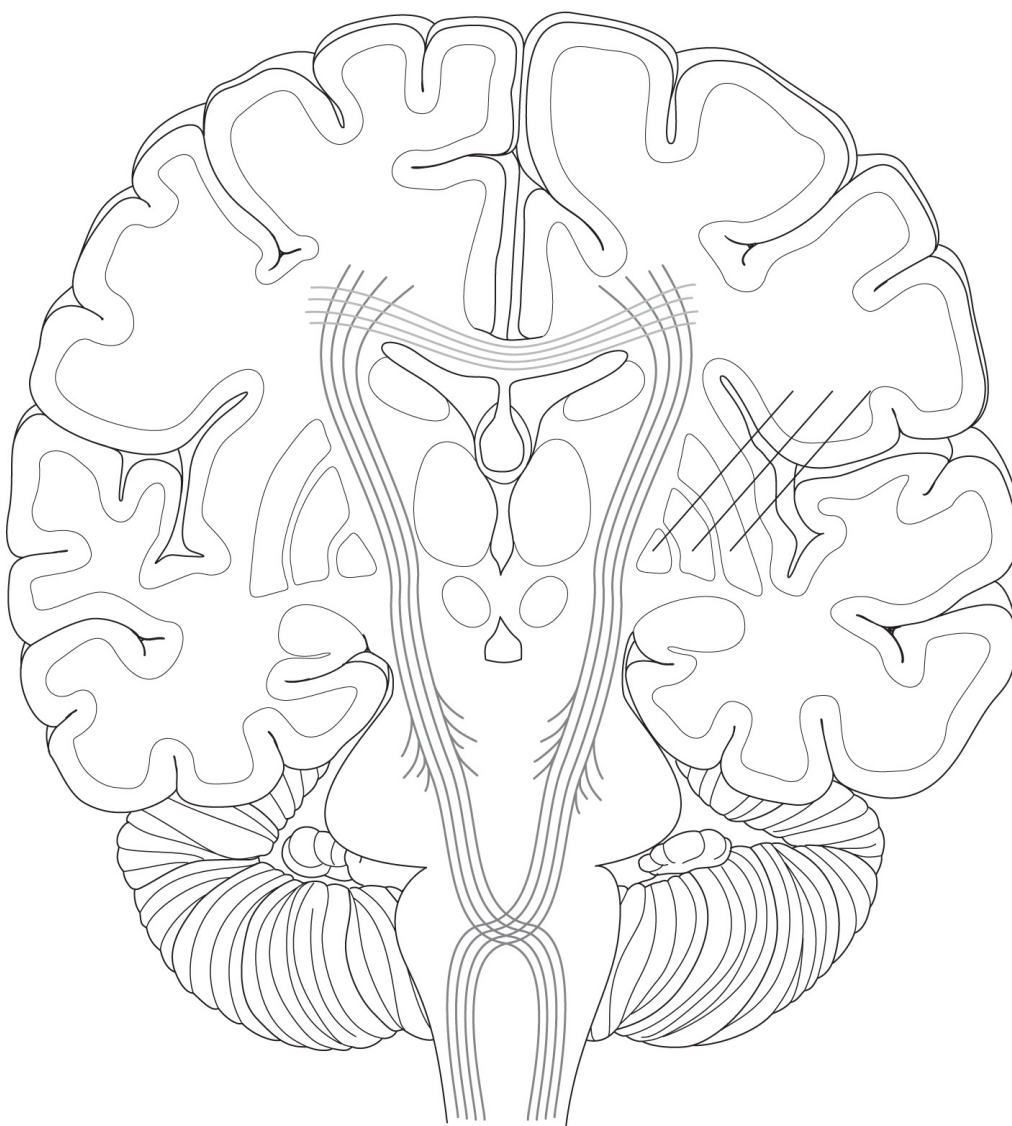
- Temporal lobe: Yellow
Temporal lobe functions: _____

- Draw a red line along the central sulcus
- Draw a purple line along the lateral sulcus

Drawing Conclusions Inside the Cerebrum

Test your knowledge of the inside of the cerebrum by coloring the figure below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to further test your knowledge.

- Cerebral cortex: Gray
- Basal nuclei: Gray
- Corpus callosum: Blue
- Tracts in the brainstem: Green

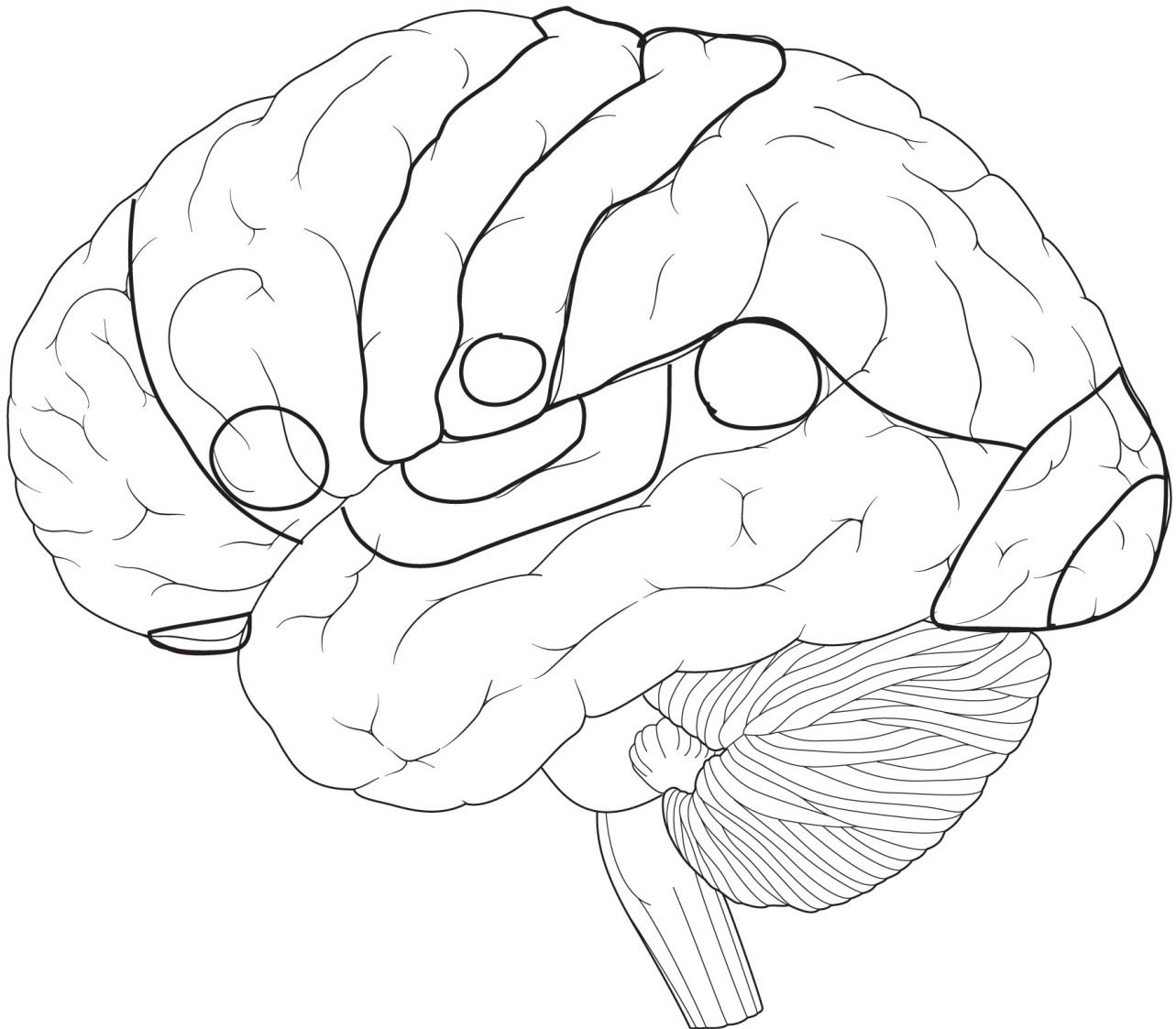


1. Tracts consist of _____; they serve to _____.
2. Most tracts pass from one hemisphere to the other through the _____; this allows _____.
3. Other tracts carry information _____.
4. Basal ganglia consist of _____.
5. Basal ganglia lie _____ and play a role in _____.

Conceptualize in Color Functional Areas of the Cerebral Cortex

Identify the functional areas of the cerebral cortex by coloring the figure below. Use the suggested colors or choose your own.

- Primary motor cortex: Dark blue
- Motor association area: Light blue
- Primary somatic sensory area: Dark green
- Somatic sensory association area: Light green
- Olfactory association area: Orange
- Primary auditory area: Red
- Auditory association area: Pink
- Primary visual cortex: Dark purple
- Visual association area: Light purple
- Primary gustatory complex: Yellow
- Wernicke's area: Brown
- Broca's area: Fuchsia



Fill in the Gaps Functions of the Cerebral Cortex

Fill in the blanks with the appropriate word or words to describe the functions of specific areas in the cerebral cortex. Choose from the words listed in the Word Bank below. Not all words may be used.

ANGULAR GYRUS
AUDITORY ASSOCIATION AREA
BROCA'S AREA
LEFT
MOTOR ASSOCIATION AREA
POSTCENTRAL GYRUS
PRECENTRAL GYRUS
PRIMARY AUDITORY COMPLEX
PRIMARY GUSTATORY COMPLEX
PRIMARY VISUAL CORTEX
RIGHT
SOMATIC SENSORY ASSOCIATION AREA
VISUAL ASSOCIATION AREA
WERNICKE'S AREA

1. The _____ is the primary somatic sensory area, receiving impulses of heat, cold, and touch from all over the body.
2. The _____ is the area that allows us to pinpoint the location of pain, identify a texture, and be aware of how our limbs are positioned.
3. Neurons in the _____ determine which movements are required to perform a specific task.
4. Neurons in the _____ send impulses through the motor tracts in the brainstem and spinal cord to skeletal muscles to trigger movement.
5. The _____ is responsible for hearing, while the _____ gives us the ability to recognize familiar sounds.
6. The _____ is responsible for sight while the _____ interprets the visual information and allows us to recognize familiar objects.
7. _____ is responsible for language comprehension; an injury here affects one's ability to understand what others are saying.

8. _____ controls the muscle movements required for speech; an injury here will impair a person's ability to form words.
9. Because of decussation, the right side of the cerebral cortex receives signals from the _____ side of the body.

Make a Connection Cranial Nerves

In the spaces below, list each cranial nerve next to the Roman numeral representative of that nerve. Then, draw a line to link each nerve to its characteristics. Note that nerves may link with more than one characteristic.

I _____

II _____

III _____

IV _____

V _____

VI _____

VII _____

VIII _____

IX _____

X _____

XI _____

XII _____

- a. Mixed branch controls chewing and detects sensations in lower jaw
- b. Links the retina to the brain's visual cortex; damage causes blindness in part or all of a visual field
- c. Regulates voluntary movements of the eyelid and eyeball
- d. Damage to sensory branch causes loss of sensation in upper face
- e. Governs tongue movements, swallowing, and gagging
- f. Damage causes tongue to deviate toward injured side
- g. Damage here can cause a drooping eyelid and dilated pupil
- h. Damage causes sagging facial muscles and distorted sense of taste
- i. Longest and most widely distributed cranial nerve
- j. Concerned with hearing and balance

- k.** Plays a key role in many heart, lung, digestive, and urinary functions
- l.** Controls movement in the head, neck, and shoulders
- m.** Ophthalmic branch triggers corneal reflex
- n.** Governs sense of smell
- o.** Damage causes deafness, dizziness, nausea, and loss of balance

Fill in the Gaps
Comparing Somatic and Autonomic Nervous Systems

Fill in the blanks in the following chart to compare these two divisions of the nervous system.

SOMATIC	AUTONOMIC
Innervates _____ muscle	Innervates _____, _____ muscle, and cardiac muscle
Consists of _____ nerve fiber leading from CNS to target (<i>Hint: A number</i>)	Consists of _____ nerve fibers that synapse at a _____ before reaching target
Secretes the neurotransmitter _____	Secretes _____ and _____ as neurotransmitters
Has an _____ effect on target cells	Has an _____ or _____ effect on target cells
Operates under _____ control	Operates _____

Just the Highlights
Actions of Sympathetic and Parasympathetic Divisions

In the following list, highlight the effects of the sympathetic division in pink and those of the parasympathetic division in yellow.

1. Increases alertness
2. Increases heart rate
3. Constricts bronchial tubes to decrease air flow in lungs

4. Dilates bronchial tubes to increase air flow in lungs
5. Stimulates secretion of thick salivary mucus
6. Has a calming effect
7. Has no effect on blood vessels of skeletal muscles
8. Stimulates sweat glands
9. Stimulates intestinal motility and secretion to promote digestion
10. Causes “fight or flight” response
11. Has no effect on sweat glands
12. Has no effect on the urinary bladder or internal sphincter
13. Stimulates the bladder wall to contract and the internal sphincter to relax to cause urination
14. Stimulates adrenal medulla to secrete epinephrine
15. Causes the “resting and digesting” state
16. Dilates blood vessels of skeletal muscles to increase blood flow
17. Inhibits intestinal motility

Make a Connection Divisions of the Autonomic Nervous System

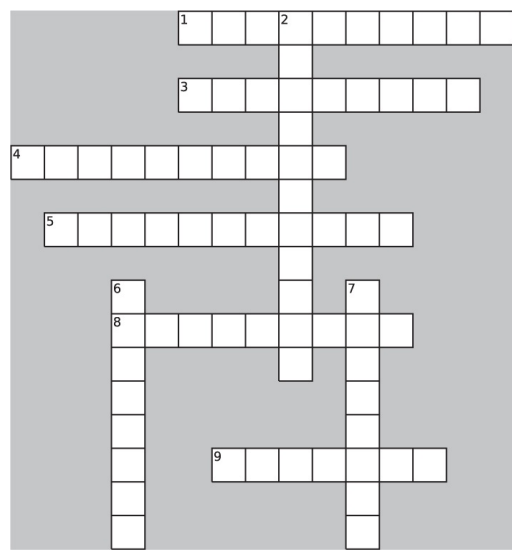
In the spaces below, list the two divisions of the autonomic nervous system. The first letter of each term is provided to get you started. Then, draw a line to link each division with its characteristics.

1. T_____
 2. C_____
- a. Another name for the sympathetic division
 - b. Employs mostly norepinephrine as a neurotransmitter
 - c. Originates in the brain and sacral region
 - d. Fibers leave brainstem by joining with cranial nerve III, VIII, IX, or X
 - e. Produces widespread, generalized effects
 - f. Ganglia lie in or near target organ
 - g. Has long preganglionic and short postganglionic fibers
 - h. Employs acetylcholine as a neurotransmitter
 - i. Arises from the thoracic and lumbar regions of the spinal cord

- j. Ganglia lie in a chain alongside spinal cord
- k. Produces local effects
- l. Has short preganglionic and long postganglionic fibers
- m. Another name for the parasympathetic division

Puzzle It Out Autonomic Nervous System Terms

Complete the following crossword puzzle to test your knowledge of the autonomic nervous system.



ACROSS

1. These receptors have a variable response to acetylcholine.
3. These receptors are excited by acetylcholine.
4. Fibers that secrete norepinephrine
5. The adrenal medulla secretes hormones that help prolong the effects of this division of the autonomic nervous system.
8. Beta-adrenergic receptors are _____ by norepinephrine.
9. Alpha-adrenergic receptors are _____ by norepinephrine.

DOWN

2. Fibers that secrete acetylcholine
6. The autonomic nervous system is sometimes called the _____ motor system.
7. The effect of a neurotransmitter is determined mainly by the _____.

Fill in the Gaps Sympathetic and Parasympathetic Pathways

The two divisions of the autonomic nervous system employ two different neurotransmitters. After being released, neurotransmitters bind to different types of receptors. Fill in the blanks with the appropriate word or words to correctly describe the neurotransmitters and receptors of the

sympathetic and parasympathetic pathways. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

ACETYLCHOLINE (ACh)

ADRENERGIC

ALPHA-ADRENERGIC

BETA-ADRENERGIC

CHOLINERGIC

MUSCARINIC

NICOTINIC

NOREPINEPHRINE (NE)

RECEPTOR

TARGET ORGAN

1. The autonomic nervous system employs the neurotransmitters and _____.
2. Fibers that secrete ACh are called fibers; fibers that secrete NE are called fibers.
3. The preganglionic fibers of both the sympathetic and parasympathetic divisions as well as the postganglionic fibers of the parasympathetic division are fibers. They secrete the neurotransmitter _____.
4. Most of the postganglionic fibers of the sympathetic division are fibers. They secrete the neurotransmitter _____.
5. ACh binds to receptors and NE binds to receptors.
6. The effect produced by a neurotransmitter is determined by the type of _____.
7. ACh may bind to either receptors or receptors.
8. All cells with receptors are excited by ACh.
9. All cells with receptors exhibit a variable response to ACh.
10. Cells with receptors are excited by NE.
11. Cells with receptors are inhibited by NE.

chapter 12

SENSE ORGANS

The sense organs allow us to see, hear, taste, and feel. These sensations not only allow us to derive pleasure from the environment, they also protect us from danger and contribute to our mental well-being. Complete the activities in this chapter to review this system.

List for Learning Sensations

Using the spaces below, list the three kinds of information sensory receptors transmit about each sensation.

1. _____
2. _____
3. _____

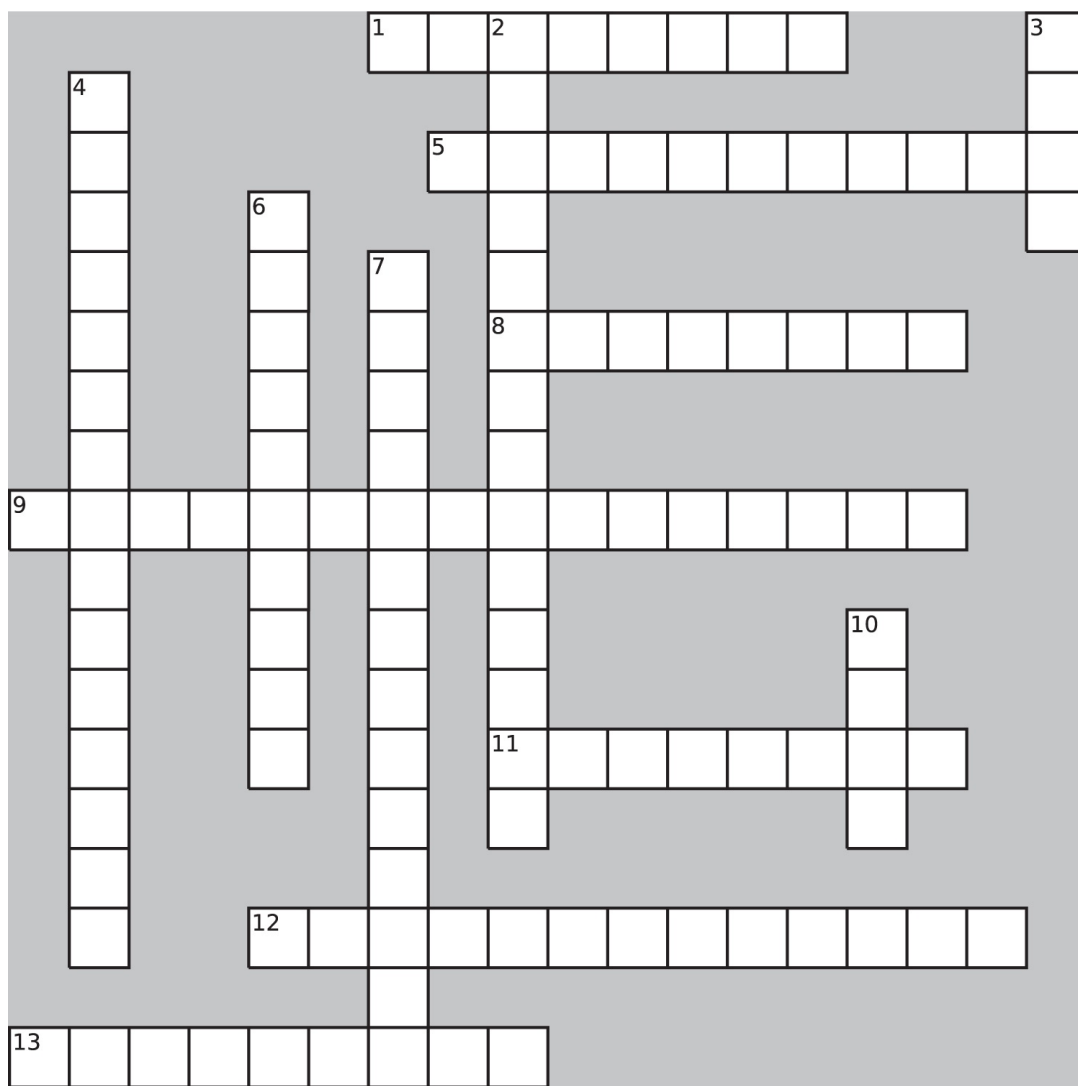
List for Learning Taste

Using the spaces below, list all five primary taste sensations.

1. _____
2. _____
3. _____
4. _____

Puzzle It Out Terms of the Sensory System

Complete the following crossword puzzle to test your knowledge of the sensory system.



ACROSS

1. Protrusions of the tongue on which taste buds are located
5. Pain receptors
8. Pain originating in a deep organ that's sensed on the body's surface
9. Receptors that respond to stretch
11. Specialized nerve cells that detect physical or chemical events outside the cell membrane
12. Receptor that allows you to orient your body in space
13. Drug used to relieve pain

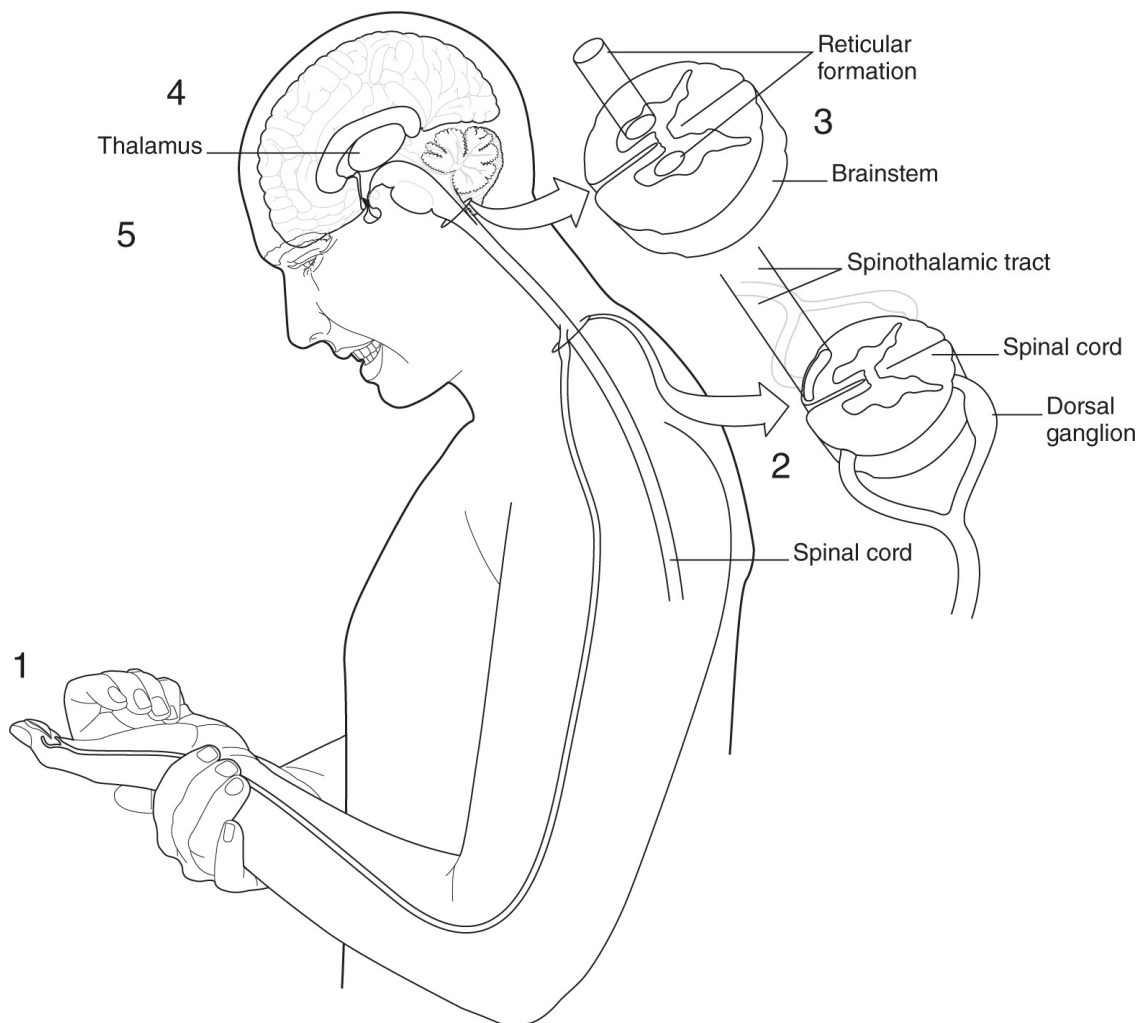
DOWN

2. Receptors found only in the eyes
3. Type of pain fiber that produces sharp, localized pain
4. Receptors activated by a change in temperature
6. When a stimulus is continuous, the firing frequency of the nerve begins to slow, causing the sensation to diminish; this is known as _____.
7. Receptors that react to odors
10. Type of pain fiber found on deep body organs

Drawing Conclusions Pain Pathway

Test your knowledge of the body's main pain pathway by filling in the blanks of each sentence. Then, insert arrows in the figure to identify the pathway. Lastly, color the key structures in the figure below.

1. Injured tissues release several chemicals that stimulate the _____ and trigger pain.
2. A neuron conducts a pain signal to the _____ horn of the spinal cord and then up the _____ tract to the _____.
3. At the same time, the _____ tract carries pain signals to the reticular formation of the _____.
4. The thalamus relays the signal from the _____ tract to the _____ of the _____. At that point, the person becomes aware of the pain.
5. The impulse from the spinothalamic tract bypasses the _____ and travels to the _____ and _____ system. These areas trigger _____ and _____ responses to pain, such as fear and nausea.



Fill in the Gaps Sense of Taste

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

BRAIN
CRANIAL NERVES
FILIFORM PAPILLAE
FOLIATE PAPILLAE
FUNGIFORM PAPILLAE
GESTATION
GUSTATION
GUSTATORY
PAPILLAE
SPINAL CORD
SPINAL NERVES
TASTE BUDS
VALLATE PAPILLAE

1. The sense of taste is called _____.
2. Taste buds are located around protrusions on the tongue called _____.
3. _____ reside at the rear of the tongue.
4. _____ form ridges at the sides of the tongue.
5. _____ are thread-like structures.
6. _____ are concentrated at the tip and sides of the tongue.
7. _____ contain up to half of taste buds.
8. _____ contain no taste buds.
9. _____ help distinguish the texture of food.
10. _____ reside along and between the papillae and contain 25 to 50 chemoreceptors called _____ cells.
11. Chemicals dissolved in saliva stimulate _____ cells which, in turn, stimulate certain _____.
12. Taste buds send impulses directly to the _____.

Describe the Process How Taste Occurs

Using the spaces below, describe how taste occurs.

1. The sense of taste, also called _____, occurs when _____ come in contact with _____.
2. Most taste buds are located around _____ called _____.
3. Taste buds look similar to _____, which has segments that contain _____.
4. Projecting into an opening called a _____ is a _____, which is bathed in saliva.
5. Chemicals dissolved in saliva stimulate _____, which, in turn, stimulate _____.
6. Taste buds send _____ directly to the _____ by either the _____ nerve, the _____ nerve, or the _____ nerve.
7. The nerve used depends on _____.

Fill in the Gaps Sense of Smell

Fill in the blanks with the appropriate word or words to describe how the sense of smell occurs. Choose from the words listed in the Word Bank below. Not all words may be used.

CILIA
CRANIAL
ETHMOID
NASAL
OLFACTORY
OLFACTORY BULBS
PAPILLAE
PRIMARY OLFACTORY
SPHENOID

1. Receptors for the sense of smell, called _____ receptors, are buried in the roof of the _____ cavity.
2. Incoming odor molecules bind to _____ projecting from the ends of the receptor cells.
3. This triggers a nerve impulse along nerve fibers leaving the nasal cavity through pores in the

_____ bone.

4. The fibers synapse with other neurons in _____, a pair of structures underneath the brain's frontal lobe.
5. After being partially processed here, the signals continue to the _____ cortex in the brain.

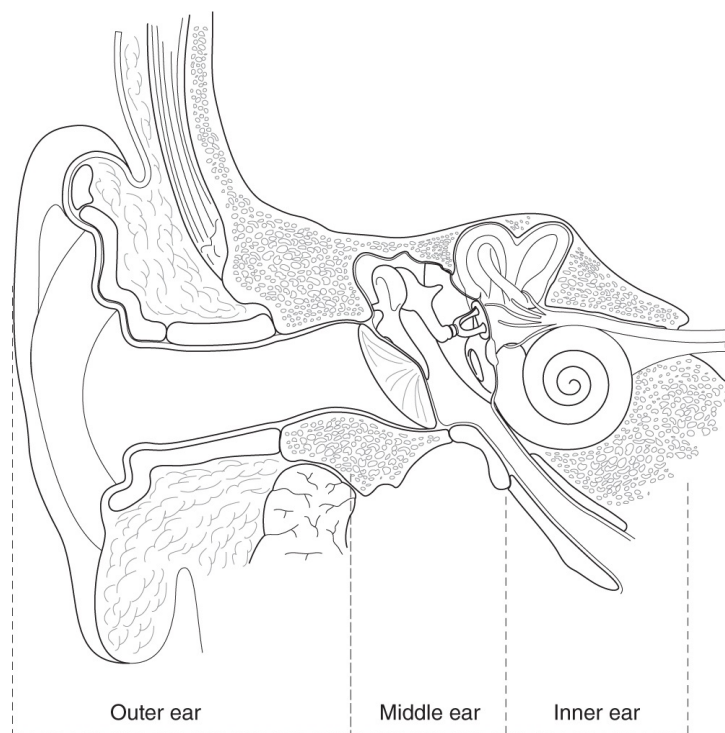
Just the Highlights Sections of the Ear

The ear has three sections: the outer ear, the middle ear, and the inner ear. In the following list, highlight the structures of the outer ear pink, the middle ear blue, and the inner ear yellow.

1. Eustachian tube _____
2. Bony labyrinth
3. Auricle
4. Vestibule
5. Auditory canal
6. Cochlea
7. Auditory ossicles
8. Tympanic membrane
9. Semicircular canals

Drawing Conclusions The Ear

Test your knowledge of ear structures and functions by filling in the blanks of each sentence. Then, color the structures in the figure below. Use the suggested colors or choose your own.



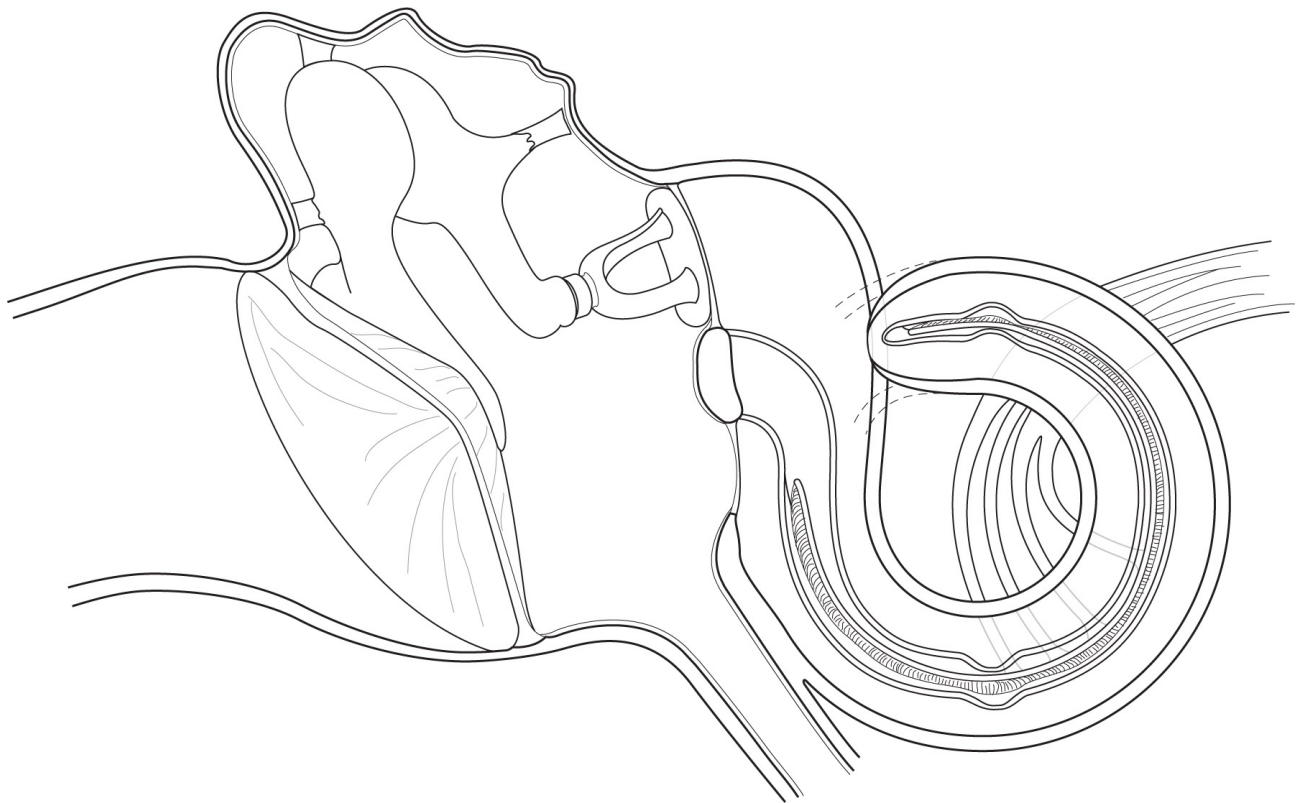
1. The _____ is the visible part of the ear. Its main function is to funnel _____ into the ear. (*Color this part of the ear tan.*)
2. The _____ leads through the temporal bone to the eardrum. Glands in this part of the ear secrete _____. (*Outline this structure in red.*)
3. The malleus, incus, and stapes are called the _____; they connect the _____ to the _____ ear. (*Color the malleus pink, the incus blue, and the stapes green.*)
4. The stapes fits in the _____ window of the _____. (*Outline this window in dark blue.*)
5. The _____ separates the outer ear from the middle ear. It vibrates in response to _____. (*Color this structure orange.*)
6. The _____ tube is a passageway from the middle ear to the nasopharynx. Its purpose is to equalize on both sides of the tympanic membrane. (*Color this structure purple.*)
7. The _____ lie at right angles to each other and are crucial for the maintenance of balance. (*Color this structure green.*)
8. The _____ marks the entrance to the labyrinths and contains organs necessary for the sense of balance. (*Color this structure light blue.*)
9. The _____ is a snail-like structure that contains the organ of Corti. (*Color this structure brown.*)
10. The two nerves leading from the ear are the _____ nerve, which is linked to the vestibule, and the _____ nerve, which leaves from the cochlea. (*Color these two nerves pink and yellow, respectively.*)

Drawing Conclusions How Hearing Occurs

The structures of the inner ear are essential for hearing. Test your knowledge of these structures by coloring them in the figure below. Use the suggested colors or choose your own.

- Cochlear duct: Green
- Tectorial membrane: Orange
- Basilar membrane: Purple
- Hair cells on the organ of Corti: Yellow
- Cochlear nerve: Tan

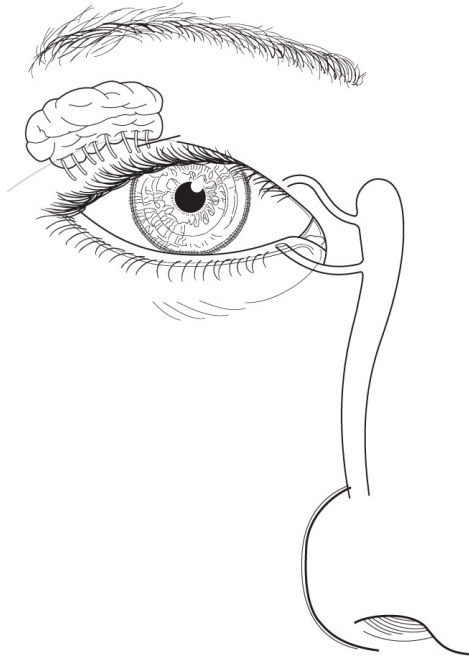
Then, fill in the blanks of each sentence to describe the process of hearing. Lastly, draw arrows to show the progression of sound waves.



1. Sound waves enter the ear and travel down the _____. The waves strike the _____, causing it to vibrate.
2. The vibration spreads through the _____, the _____, and the _____.
3. The movement of the stapes against the _____ shakes the _____ on either side of the _____.
4. The ripples in the _____ are transmitted through the roof of the _____ to the _____. This causes nerve impulses to be transmitted along the _____ nerve. The impulses reach the _____ in the brain's _____ lobe, where it's

5. The ripples continue through the _____ and dissipate by striking the _____ window.

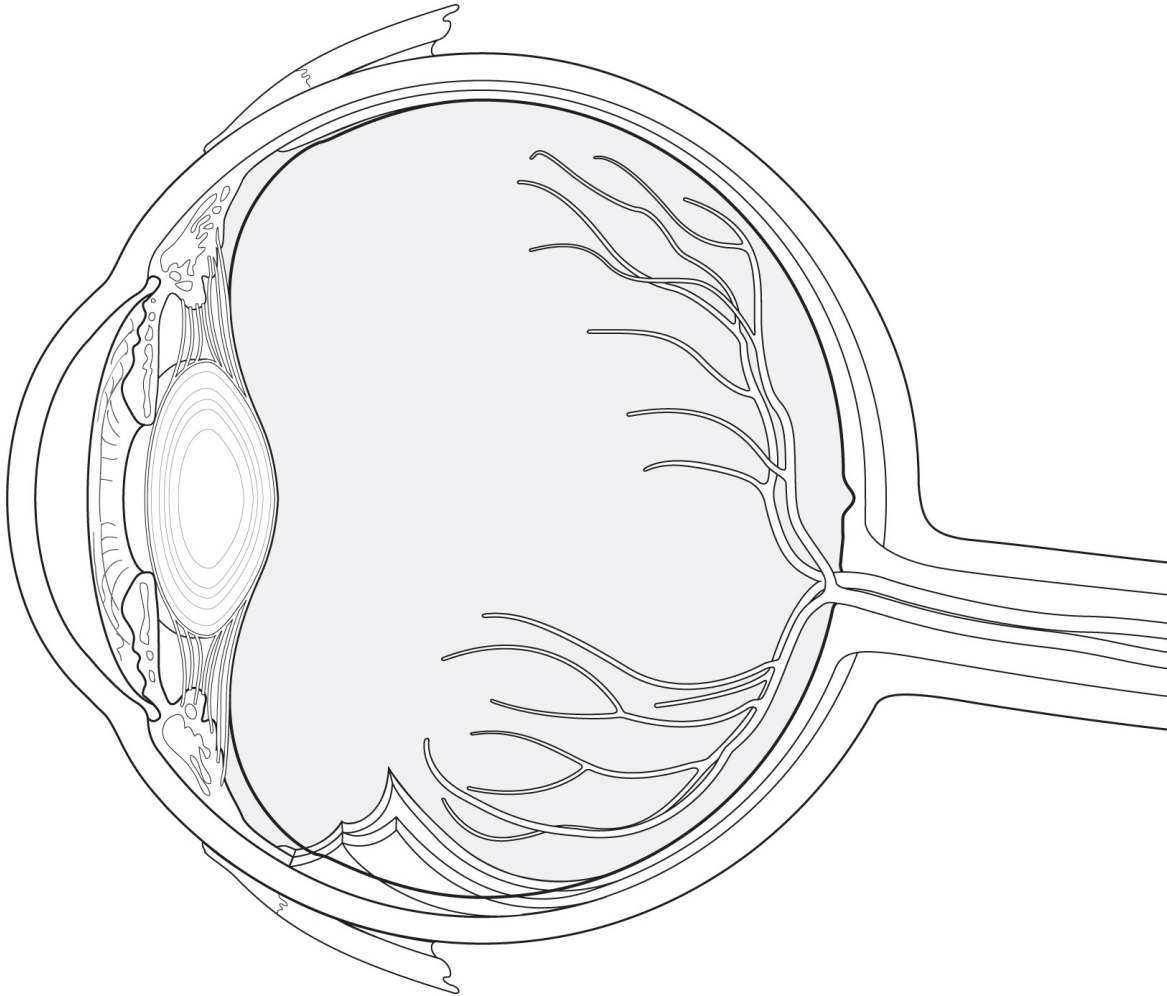
Test your knowledge of the key accessory structures of the eye by filling in the blanks of each sentence. Then, color the figure below as described. Use the suggested colors or choose your own.



1. The most significant role of the _____ is to enhance facial expression.
(Color this structure black.) _____
2. The _____ protect the eye from foreign bodies and block light to allow for sleeping.
(Color this structure pink.)
3. The thickened edge along the lower eyelid is called the _____ it secretes _____ to slow the evaporation of tears.
(Draw a black line along this structure.)
4. The _____ gland secretes _____ that flow onto the surface of the conjunctiva.
(Color this structure blue.)
5. Tears drain through a tiny pore called the _____.
(Draw red dots at each of these locations.)
6. The passageway that carries tears into the nasal cavity is called the _____ duct.
(Color this structure yellow.)

Conceptualize in Color Eye Anatomy

Test your knowledge of the anatomy of the eye by coloring the figure below as described. Use the suggested colors or choose your own.



- Sclera: Tan
- Cornea: Light blue
- Iris: Green
- Ciliary body: Red
- Choroid: Brown
- Retina: Gold
- Optic nerve: Purple
- Part of the eye containing vitreous humor: Orange
- Part of the eye containing aqueous humor: Pink
- Lens: Gray

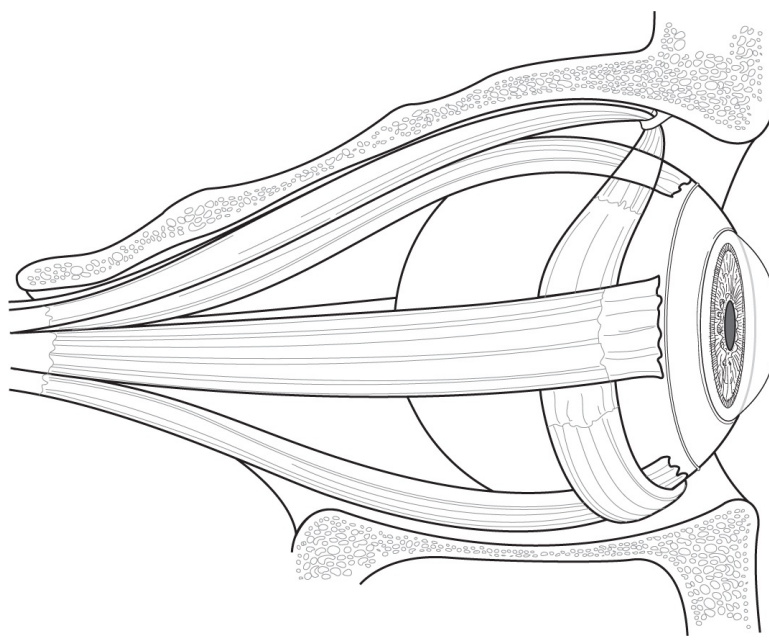
Illuminate the Truth Eye Structures

Highlight the word or phrase that completes each sentence correctly.

1. The opening between the eyelids is called the (palpebral fissure)(palpebrae).
2. The transparent mucous membrane lining the inner surface of the eyelid and most of the anterior surface of the eyeball is the (sclera)(conjunctiva).
3. Most of the muscles charged with moving the eyeball are innervated by the (facial nerve)(oculomotor nerve).
4. The (cornea)(sclera) is transparent tissue that sits at the anterior portion of the eye and admits light into the eye.
5. The (choroid)(ciliary body) secretes aqueous humor.
6. The (choroid)(sclera) supplies oxygen and nutrients to the retina and sclera.
7. The (oculomotor)(optic) nerve exits from the posterior portion of the eyeball.
8. Photoreceptors in the eye are located in the (cornea)(retina).
9. The center point of the retina when viewed through an ophthalmoscope is the (macula lutea)(fovea centralis).
10. The area that produces the sharpest vision is the (macula lutea)(fovea centralis).
11. Nerve fibers leave the retina at the (optic disc)(fovea centralis).

Conceptualize in Color Extrinsic Eye Muscles

Identify the extrinsic eye muscles by coloring the figure below. Use the suggested colors or choose your own. Then, underline the names of the muscles that help rotate the eyes to the side and downward. Circle the names of the muscles that move the eye up, down, medially, and laterally.



- Superior oblique: Yellow
- Superior rectus: Blue
- Inferior oblique: Purple
- Inferior rectus: Green
- Medial rectus: Orange
- Lateral rectus: Pink

Illuminate the Truth Eye Chambers and Fluids

Highlight the word or phrase that completes each sentence correctly.

1. The space between the lens and the cornea is the (anterior chamber)(anterior cavity); in turn, this space is further divided into an anterior (cavity)(chamber) and posterior (cavity)(chamber).
2. A clear, watery fluid called (aqueous humor)(vitreous humor) fills the (anterior cavity)(anterior chamber).
3. The (iris)(lens) is a transparent disc of tissue just behind the (retina)(pupil).
4. The posterior (cavity)(chamber) sits behind the (lens)(retina) and is filled with a substance called (aqueous humor)(vitreous humor).
5. The (canal of Schlemm)(ciliary body) secretes aqueous humor, which drains into the (canal of Schlemm)(ciliary body) and into surrounding blood vessels.

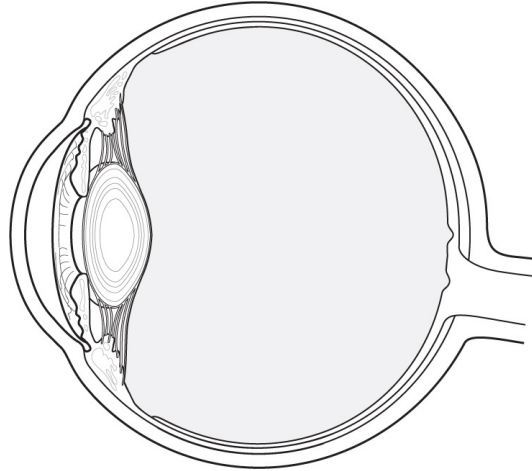
Drawing Conclusions The Process of Vision

Test your knowledge of how vision occurs by filling in the blanks of each sentence. Then, follow the

drawing activity for each step.

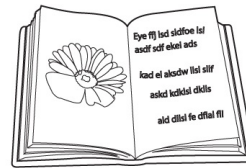
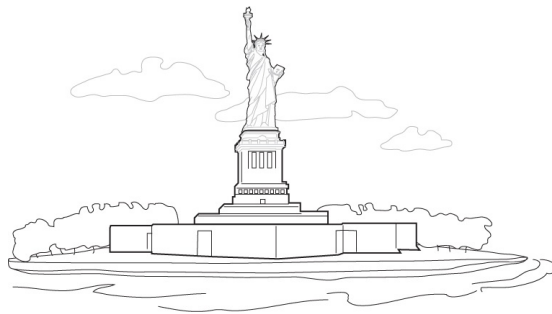
1. Light rays entering the eye must be _____ so they focus on the retina. This process is called _____. The curved surface of the _____ allows much of this to happen.

(In the figure provided, insert lines and arrows to symbolize light rays entering the eye and focusing on the retina as described in the sentence above.)



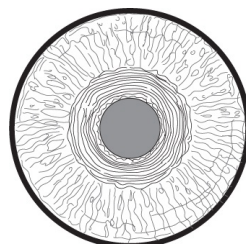
2. The eyes also must be aligned so that the light rays from an object fall on the _____ of each retina. This is called _____.

(In the space provided below the figures, draw a set of eyeballs focusing on a distant object [the Statue of Liberty] and a second set of eyeballs focusing on a nearby object [the book]. Insert lines to signify light rays from the objects entering the eye and focusing on the retina.)



3. When focusing on a nearby object, the pupil _____. To accomplish this, the _____ muscle constricts.

(Insert arrows into the figure below to illustrate this process.)



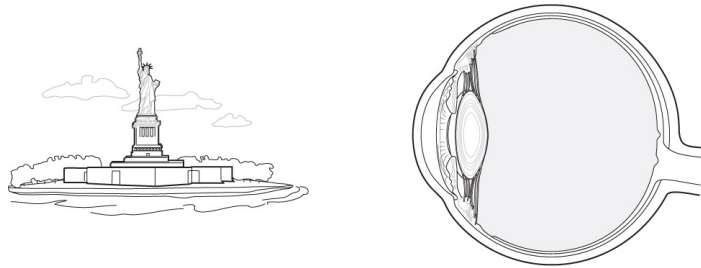
4. The opposite of this reaction is pupillary _____, which is accomplished when the

_____ muscle contracts.

(In the space beside the iris above, draw a second iris. Insert arrows to illustrate the process described here.)

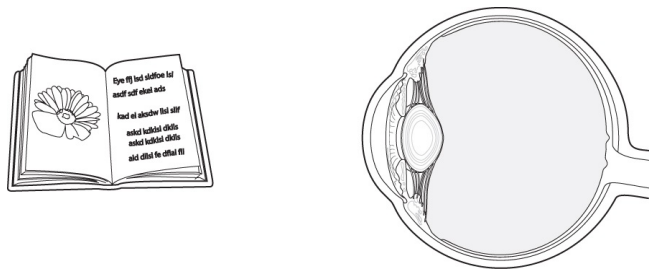
5. To fine-tune for sharper focus, the lens also changes shape, a process called _____. When focusing on a distant object, the _____ muscle _____ and the lens _____.

(Illustrate this process using the figures provided. Insert light rays; also insert arrows to show the actions occurring within the eye.)



6. When focusing on a nearby object, the _____ muscle _____ and the lens _____.

(Illustrate this process using the figures provided. Insert light rays; also insert arrows to show the actions occurring within the eye.)



Make a Connection Photoreceptors

In the spaces below, list the names of the photoreceptors of the eye. The first letter of each term is provided to get you started. Then, draw a line to link each receptor to its characteristics.

1. R _____

2. C _____

- a. Concentrated in the center of the retina
- b. Concentrated at the periphery of the retina
- c. Active in dim light
- d. Active in bright light
- e. Responsible for color vision

- f.** Responsible for night vision
- g.** Cannot distinguish colors from each other
- h.** Primarily responsible for sharp vision

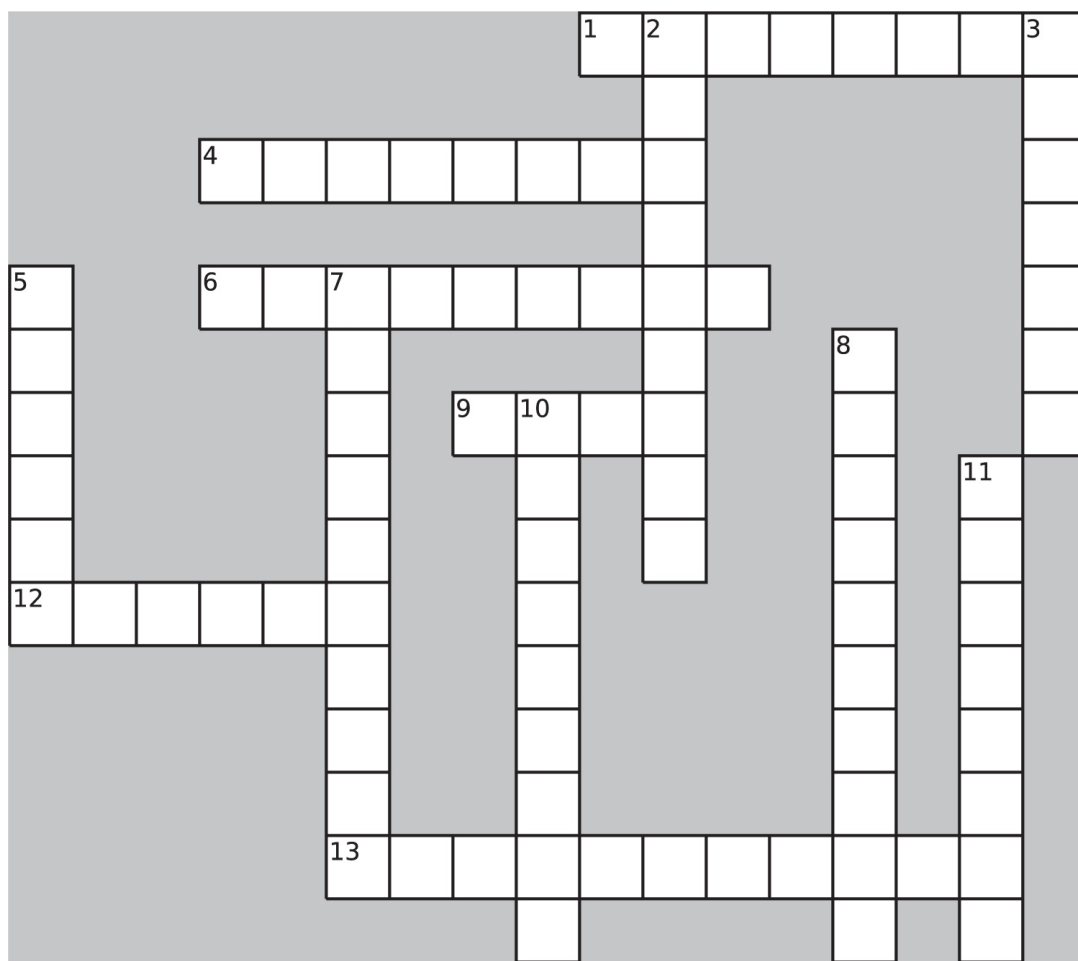
Illuminate the Truth Vision Neural Pathway

The final step in the visual process involves relaying nervous impulses to the brain, where images are interpreted as sight. Highlight the word or phrase that completes each sentence correctly, identifying the steps in the vision neural pathway.

- 1.** Nerve impulses generated by the rods and cones leave the eye via the (optic)(oculomotor) nerve.
- 2.** Nerve fibers from the nasal side (remain on the same side)(cross to the opposite side) of the brain at the (foramen magnum)(optic chiasm).
- 3.** Nerve fibers on the temporal side (remain on the same side)(cross to the opposite side) of the brain at the (foramen magnum)(optic chiasm).
- 4.** The impulses travel to the (primary visual cortex)(accessory visual cortex) in the (frontal)(occipital) lobe for interpretation.

Puzzle It Out Eye Terms

Complete the following crossword puzzle to test your knowledge of the eye.



ACROSS

1. The jelly-like substance filling the posterior cavity is called _____ humor
4. Clouding of the lens of the eye
6. Farsightedness
9. Eye structure that changes shape for near and far vision
12. Sharpness of vision is called visual _____.
13. Condition resulting from uneven curvature of the cornea

DOWN

2. Group of eye muscles arising from within the eye
3. Aqueous humor drains into the canal of _____
5. Nearsightedness
7. Difficulty focusing on near objects due to a loss of lens flexibility as a result of aging
8. Normal vision
10. Group of eye muscles that move the eyeball
11. Condition caused by increased intraocular pressure

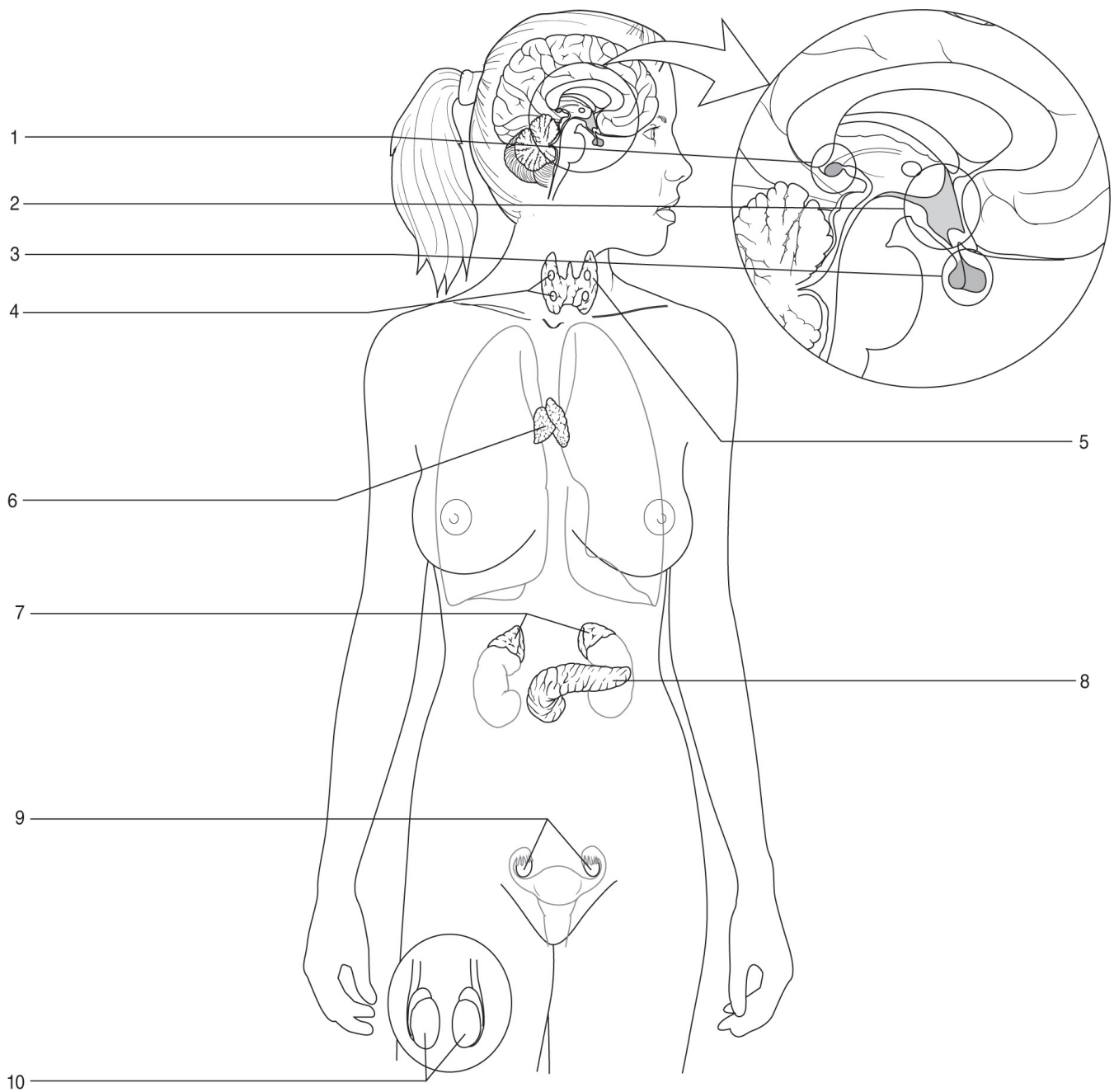
chapter 13

ENDOCRINE SYSTEM

Like the nervous system, the endocrine system promotes communication between cells, allowing them to coordinate and integrate their activities. Complete the exercises in this chapter to improve your knowledge of this important system.

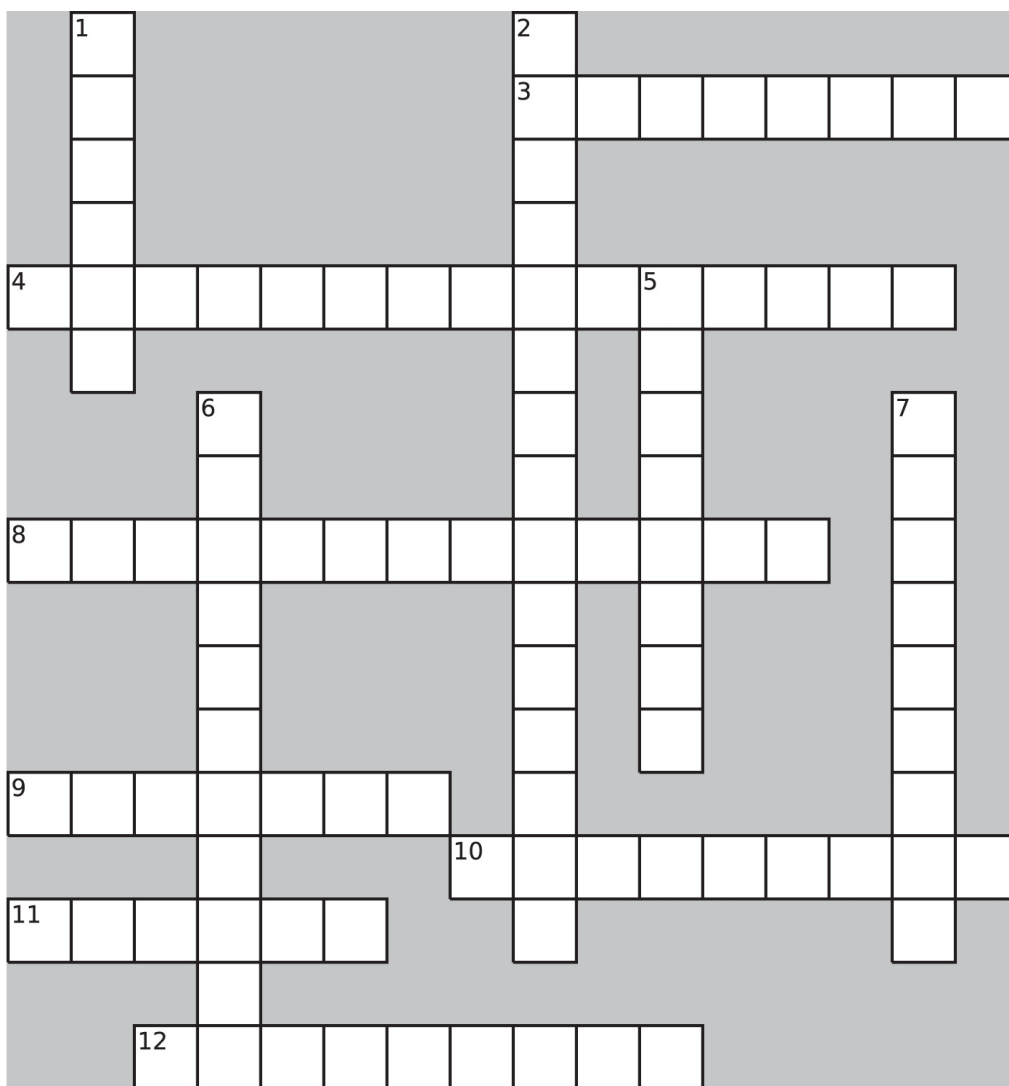
Drawing Conclusions Organs of the Endocrine System

Test your knowledge of the endocrine system by coloring each of the organs in the figure below. Then, write the name of the organ next to each number.



Puzzle It Out Endocrine System Overview

Complete the following crossword puzzle to test your knowledge of the endocrine system.



ACROSS

3. Endocrine glands are known as _____ glands.
4. Name for the posterior pituitary
8. Field of medicine that diagnoses and treats disorders of the endocrine system
9. Nonsteroid hormones are based on this substance.
10. Gland that exerts more influence over body processes than any other gland
11. Type of tissue making up the posterior pituitary
12. Type of tissue making up the anterior pituitary

DOWN

1. Cells having receptors for a particular hormone are called _____ cells.
2. Name for the anterior pituitary
5. Chemical messengers secreted by the endocrine system
6. Substance from which steroid hormones are made
7. Cells with more of these are more sensitive to a hormone's influence

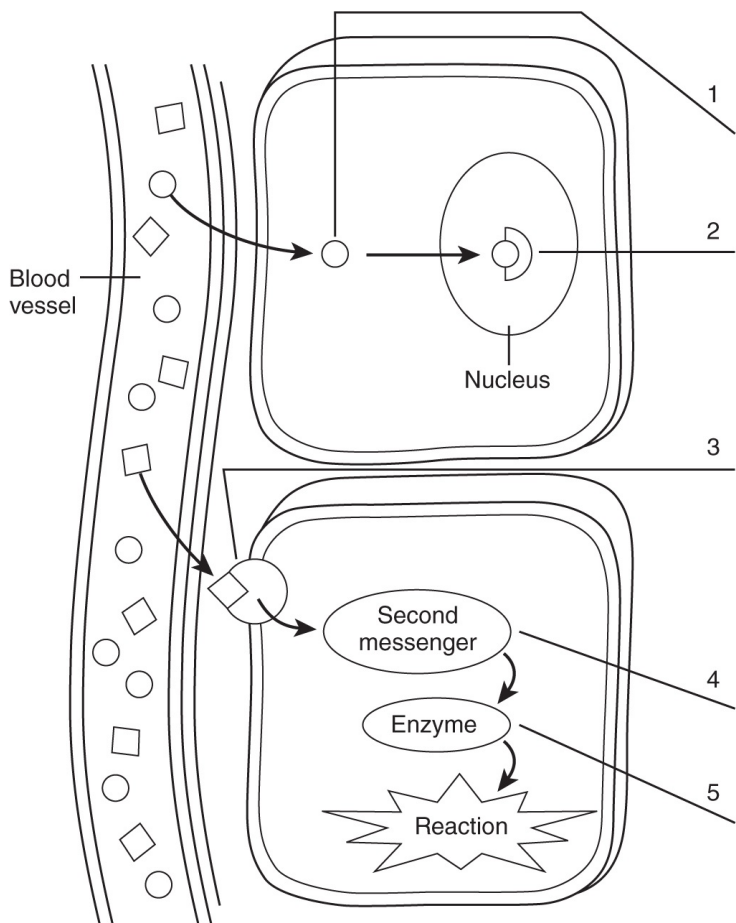
Just the Highlights Comparison of Endocrine and Nervous Systems

While both the endocrine and nervous systems work toward the same goal—homeostasis—their methods differ. In the following list, highlight the actions of the endocrine system in blue and the actions of the nervous system in yellow.

1. Employs hormones to relay messages
2. Secretes neurotransmitters into tiny space of a synapse
3. Adapts slowly to continual stimulation
4. Responds to stimuli quickly (milliseconds)
5. Exerts short-lived effects
6. Adapts quickly to continual stimulation
7. Responds slowly to stimuli (seconds to days)
8. Distributes hormones throughout the body via the bloodstream
9. Exerts long-lasting effects
10. Employs neurotransmitters to relay messages

Drawing Conclusions Hormones

Test your knowledge of hormones by filling in the blanks in the boxes below. Use the figure as a guide.



_____ hormones, which are derived from _____, pass easily through a cell's membrane.

Once inside the cell, they bind to _____ in the _____ associated with the DNA. This triggers the synthesis of new _____, which then alters the _____ in the cell.

_____ hormones can't penetrate the cell wall. Consequently, they bind to _____.

This activates a _____ which involves a cascade of processes that results in the production of a _____.

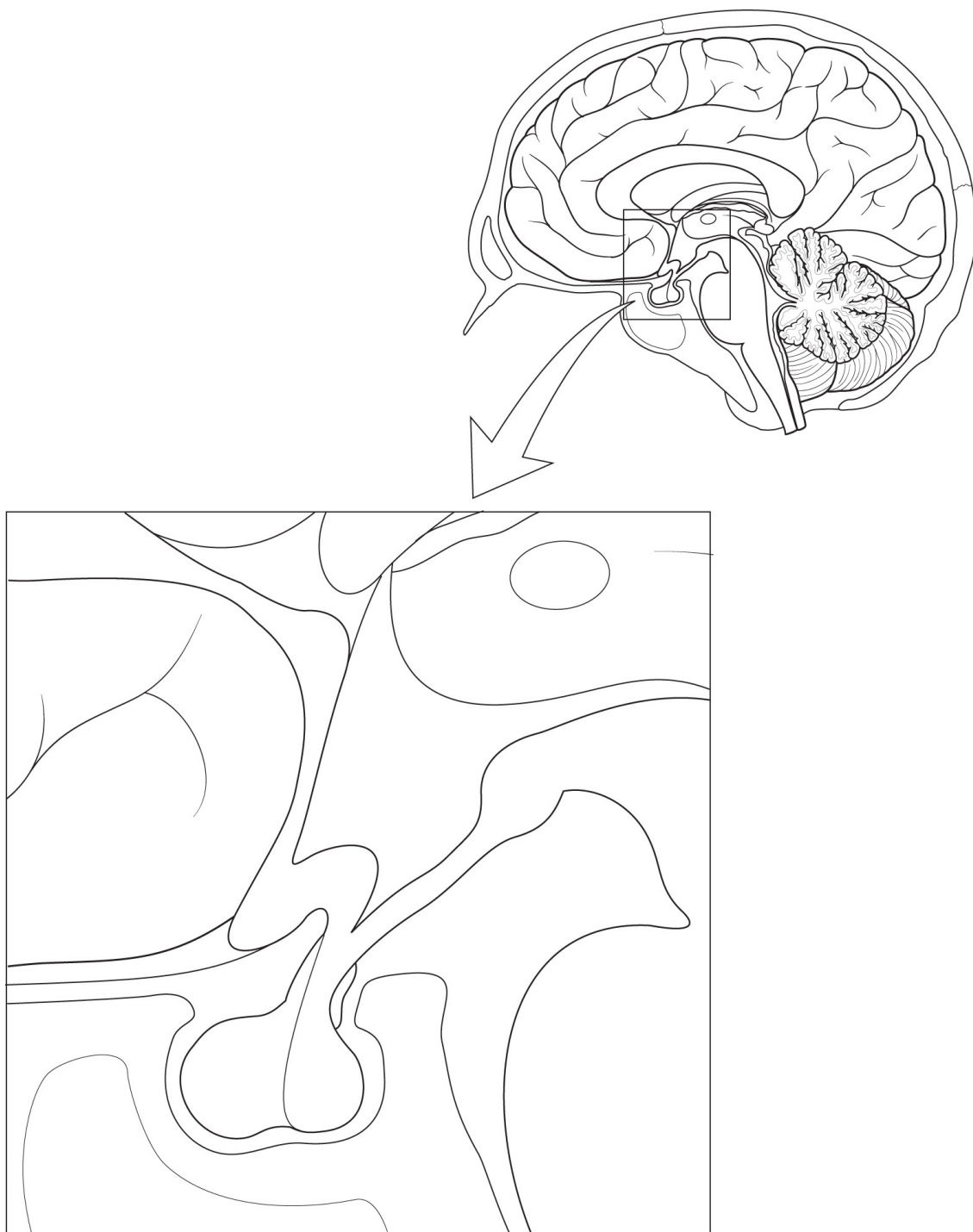
The second messenger activates _____.

The _____ influence _____ which produces the cell's response to the hormone.

Conceptualize in Color Pituitary Gland Anatomy

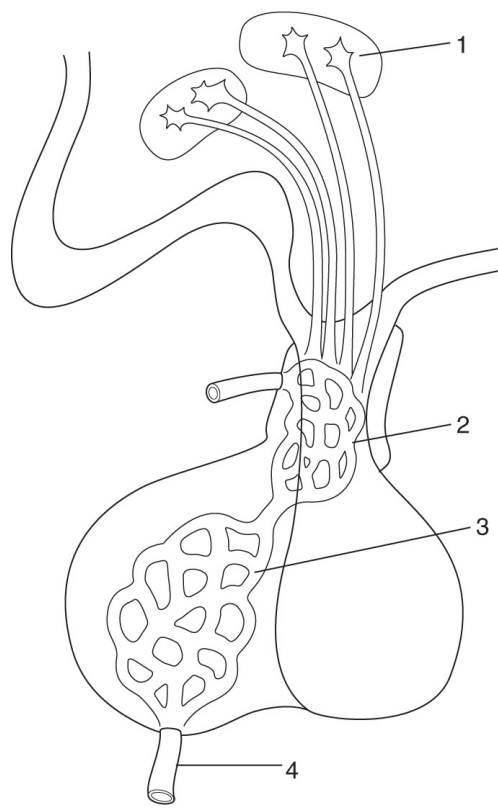
Identify the anatomy of the pituitary gland by coloring the structures in the following figure. Use the suggested colors or choose your own.

- Hypothalamus: Orange
- Anterior pituitary: Blue
- Posterior pituitary: Yellow
- Sphenoid bone: Brown
- Optic chiasm: Red
- Infundibulum: Pink



Drawing Conclusions Anterior Pituitary

Test your knowledge of the function of the anterior pituitary by filling in the blanks of each sentence, which correspond to the numbered structures in the figure. Then, color and label the figure below as described. Use the suggested colors or choose your own.



1. Neurons within the _____ synthesize various hormones that act on the anterior pituitary. Some of these hormones stimulate the anterior pituitary to secrete its hormones; these hormones are called _____ hormones. Others suppress hormone secretion by the anterior pituitary; these hormones are called _____ hormones.
(In the figure, color the neurons yellow.)
2. These neurons release their hormones into a system of blood vessels called the _____.
(Color the structure described in this sentence light blue.)
3. From there, the blood travels straight to the _____, where the hormones act on target cells. (Insert a series of small red dots to show the path traveled by the hormones. Insert small black arrows to show where the hormones are acting on target cells.)
4. This stimulates the _____ to release certain hormones into _____.
(Insert red arrows to show the release of the hormones.)

Fill in the Gaps Hormones of the Anterior Pituitary

Fill in the the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Not all words may be used.

ADRENOCORTICOTROPIC HORMONE (ACTH)

CARBOHYDRATES

CORTICOSTEROIDS

ESTROGEN

FOLLICLE-STIMULATING HORMONE (FSH)

GROWTH HORMONE (GH)

LIPIDS

LUTEINIZING HORMONE (LH)

MILK

OVULATION

PROGESTERONE

PROLACTIN

SOMATOTROPIN

SPERM

TESTOSTERONE

THYROID HORMONE

THYROID-STIMULATING HORMONE

THYROTROPIN

1. The thyroid gland is stimulated by _____ (also called _____) prompting it to secrete _____.
2. The mammary glands are stimulated by _____ to secrete _____.
3. The adrenal cortex is stimulated by _____ to secrete _____.
4. _____ (also called _____) acts on the entire body to promote growth in bones and muscles and to metabolize _____ and _____.
5. The secretion of the female hormones estrogen and progesterone is triggered by the release of _____; this same hormone stimulates in females and the synthesis of the hormone _____ by the testes in males.
6. _____ stimulates the production of eggs in the ovaries of females and _____ in the testes of males.

Illuminate the Truth Posterior Pituitary

Highlight the word or phrase that completes each sentence correctly.

1. Unlike the anterior pituitary, which is composed of (glandular)(neural) tissue, the posterior pituitary is made of (glandular)(neural) tissue.
2. Nerve fibers forming the posterior pituitary originate in the (anterior pituitary)(hypothalamus).
3. Hypothalamic neurons (store)(synthesize) hormones, which they send down to the posterior pituitary to be (refined)(stored).
4. The posterior pituitary releases the hormones (continually)(when stimulated by the nervous system).
5. The hormones associated with the posterior pituitary are (somatotropin)(oxytocin) and (ACTH) (ADH).

List for Learning Control of Pituitary Secretions

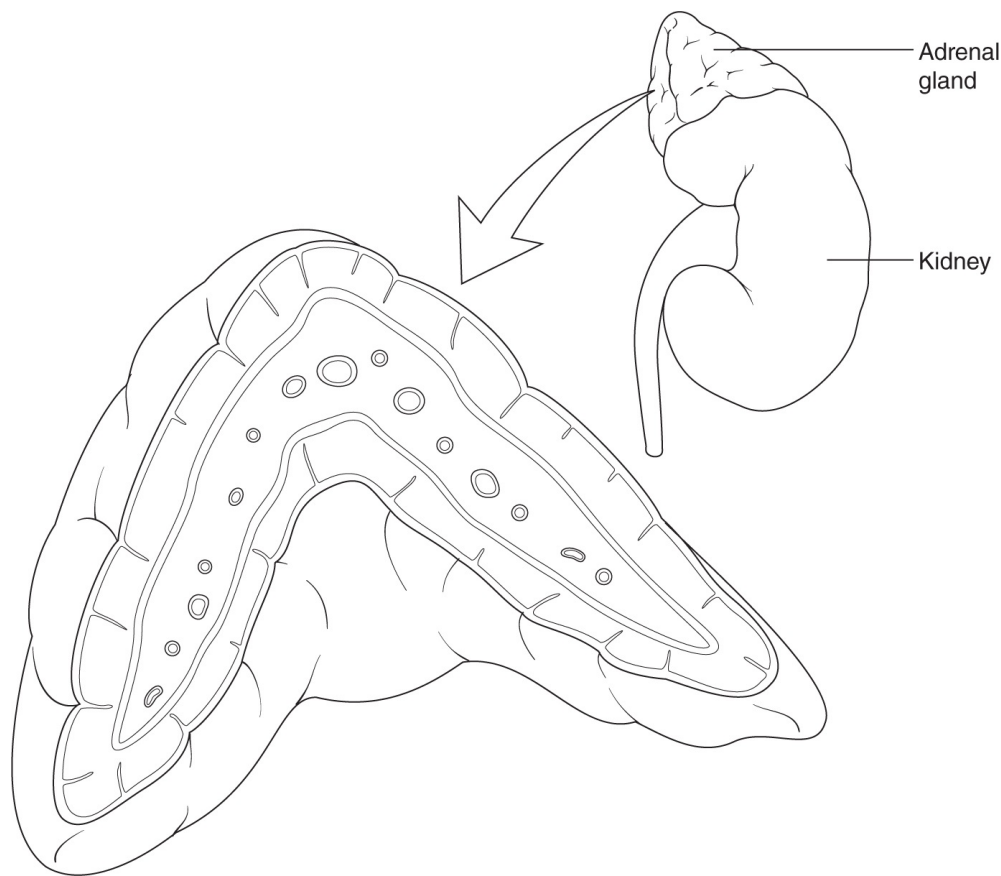
Using the spaces below, list and then describe the two methods used to control the secretion of pituitary hormones.

1. Control by: _____
In this method, _____

2. Control by: _____
In this method, _____

Drawing Conclusions Adrenal Glands

Test your knowledge of the two key structures of the adrenal cortex by coloring the adrenal medulla yellow and the adrenal cortex brown in the figure below. Then, fill in the blanks of each sentence to further test your knowledge of the adrenal gland's actions. Finally, circle the sentences related to the adrenal cortex in brown and those related to the adrenal medulla in yellow.



1. The adrenal medulla is part of the _____ nervous system; it secretes hormones called _____. These hormones prepare the body for _____. They also boost levels of _____ in the blood.
2. The adrenal cortex secretes hormones known as _____.
3. The adrenal cortex secretes a hormone that causes the kidneys to retain sodium (and excrete potassium), which leads to water retention. The name of this hormone is _____; it belongs to a class of hormones known as _____.
4. The adrenal cortex also secretes a hormone that helps the body adapt to stress and repair damaged tissue; the name of this hormone is _____; it belongs to a class of hormones known as _____. If secreted over the long term, this hormone will suppress _____.
5. The adrenal cortex secretes two sex steroids: _____, which is converted into _____, and small amounts of _____.

Illuminate the Truth Thyroid, Parathyroid, and Pineal Glands

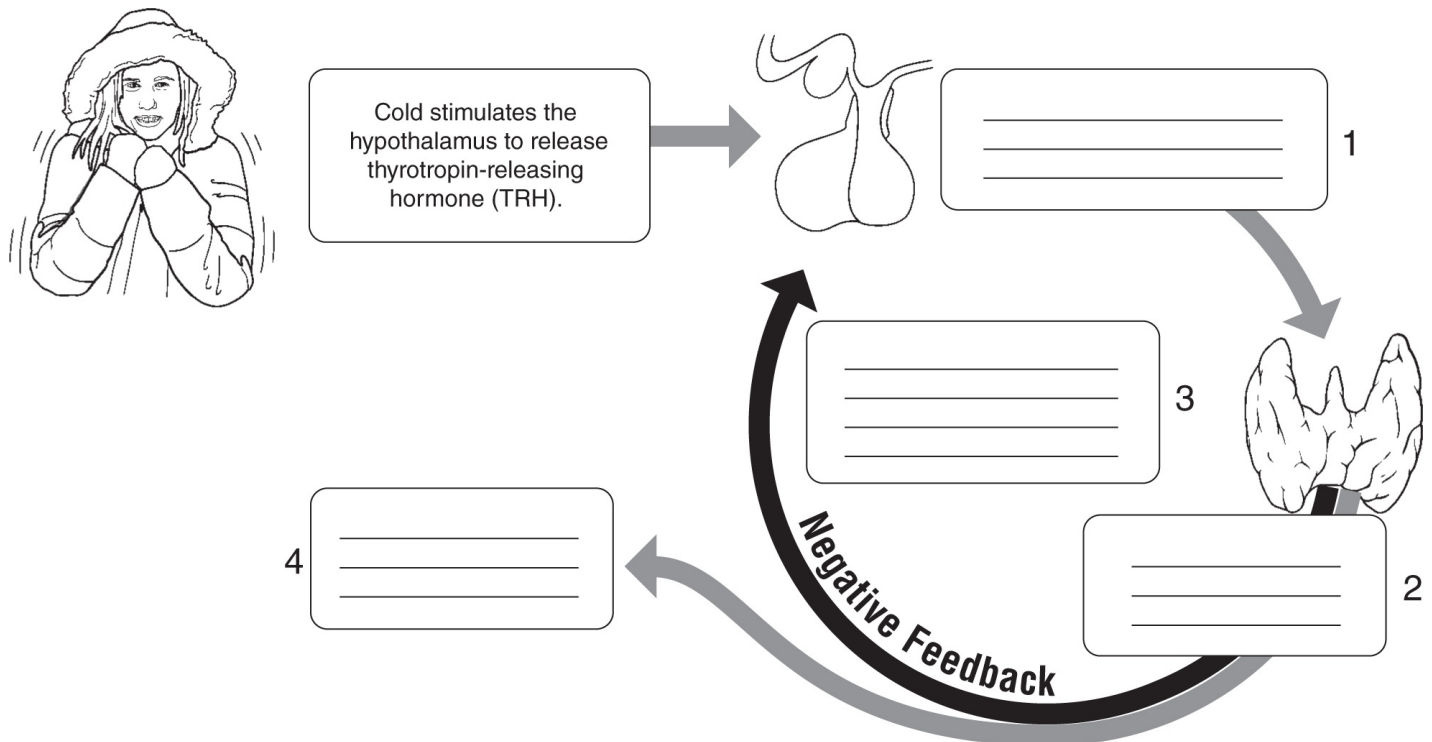
Highlight the word or phrase that completes each sentence correctly.

1. The pineal gland produces (melatonin)(calcitonin), a hormone that rises (at night)(during the day) to trigger (alertness)(sleepiness).
2. The thyroid gland secretes (thyroid-stimulating hormone)(thyroid hormone), which (suppresses) (boosts) the body's metabolic rate.

3. The two lobes of the thyroid are connected by the (isthmus)(infundibulum).
4. The parathyroid glands are located on the (anterior)(posterior) side of the thyroid.
5. The parathyroid glands secrete parathyroid hormone in response to low levels of (thyroid hormone) (calcium).
6. An excess of thyroid hormone would cause (increased heart and respiratory rate and an increased appetite)(weight gain, hair loss, and fatigue).
7. Parathyroid hormone (PTH) activates (vitamin A)(vitamin D) to promote the absorption of calcium by the intestines.

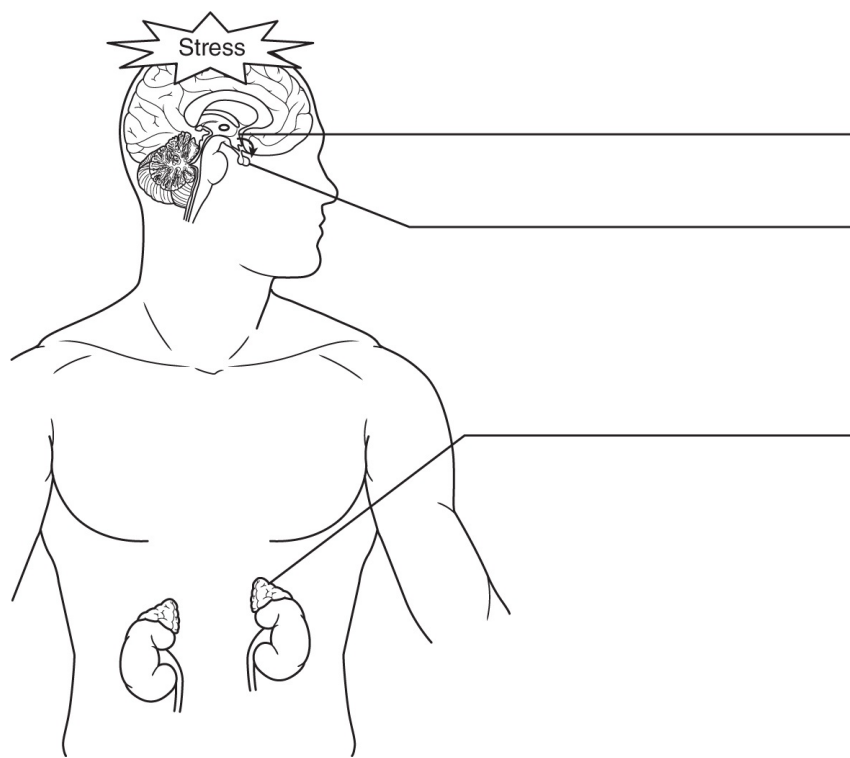
Describe the Process Negative Feedback

Negative feedback loops are used extensively to regulate hormones in the hypothalamic-pituitary axis. Using the spaces in the figure below, below to describe how the negative feedback process is used to regulate body temperature.



Drawing Conclusions Hypothalamic-Pituitary-Adrenal Axis

The hypothalamic-pituitary-adrenal axis is activated when the body experiences prolonged stress. Test your knowledge of the organs involved in this process by labeling the figure below. Then, draw arrows to indicate the sequence. Finally, fill in the blanks of each sentence to describe the process.



1. When a stressful event occurs, the _____ in the brain signals the _____ to activate the sympathetic nervous system.
2. After about ten _____, the _____ axis is stimulated to help the body continue to cope.
3. When that occurs, _____ the releases _____.
4. _____ prompts the _____ to release _____.
5. _____ travels through the bloodstream to the _____.
6. The _____ secrete _____.
7. The hormone _____ causes changes designed to give the body _____.
8. Physiological changes include elevations in _____, _____, and _____.

Sequence of Events Regulation of Blood Calcium Levels

Calcium balance is crucial to homeostasis. Review how the body achieves calcium balance by drawing arrows between the boxes to place the events in the proper sequence. (Note: There are two separate chains of events. One is for a blood calcium excess, and one is for a blood calcium deficiency.)

Blood calcium **EXCESS**

Parathyroid releases PTH

Calcium moves from blood to bone

Blood calcium levels decrease

Blood calcium **DEFICIENCY**

Thyroid releases calcitonin

Calcium moves from bones, kidneys, and intestines to the blood

Blood calcium levels increase

Illuminate the Truth Disorders of the Endocrine System

Highlight the word or phrase that completes each sentence correctly.

1. The secretion of too much growth hormone after epiphyseal plates have fused causes (gigantism) (acromegaly).
2. Low levels of (thyroid hormone)(melatonin) have been linked to mood disorders, particularly seasonal affective disorder.
3. Hypersecretion of thyroid hormone causes (simple goiter)(Graves' disease).
4. (Hypocalcemia)(Hypercalcemia) can lead to tetany.
5. Cushing syndrome results from (hyposecretion)(hypersecretion) of cortisol.
6. Hyposecretion of mineralocorticoids and glucocorticoids causes a disorder called (Addison's disease)(Graves' disease).

7. A lack of iodine results in (simple goiter)(hypoparathyroidism).
8. A diminished number of normal insulin receptors results in (hypoglycemia)(hyperglycemia).
9. In diabetes mellitus, the cells suffer from a(n) (insufficient)(surplus) amount of glucose.
10. If a child is born without a thyroid, he will develop a disorder called (dwarfism)(cretinism), which is characterized by retarded growth and sexual development, a low metabolic rate, and mental retardation.

Fill in the Gaps The Pancreas

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

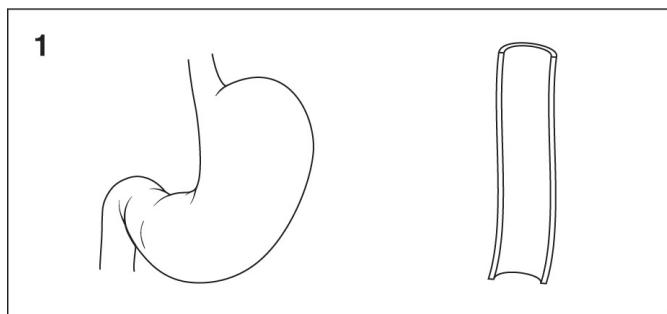
AMINO ACIDS
DIGESTIVE ENZYMES
ENDOCRINE
EXOCRINE
GLUCAGON
GLUCOSE
GLYCOGEN
INSULIN
ISLETS OF LANGERHANS
LIVER
PANCREATIC ISLETS
SMALL INTESTINE
SOMATOSTATIN
STOMACH

1. Most of the pancreas acts as a _____ gland, but a small percentage serves an important _____ function.
2. The pancreas lies just behind the _____.
3. Exocrine cells called acini secrete _____ into ducts that drain into the _____.
4. Clusters of endocrine cells interspersed with the acini are called _____ or _____.

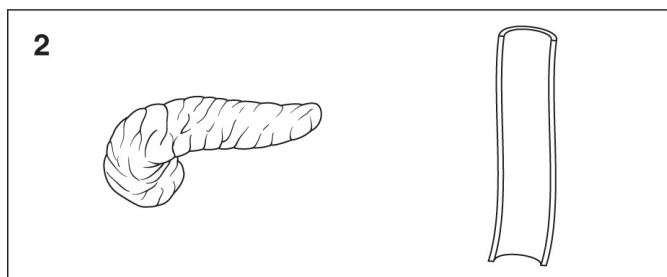
5. Alpha cells, Beta cells, and Delta cells reside with the _____.
6. Alpha cells secrete _____, a hormone that stimulates the liver to convert _____ into _____.
7. It also stimulates the conversion of fatty acids and amino acids into _____, which is then released into the bloodstream.
8. Beta cells secrete the hormone _____, which stimulates cells to absorb _____ and _____.
9. Delta cells secrete _____, which helps regulate the other endocrine cells.

Drawing Conclusions Blood Glucose Regulation

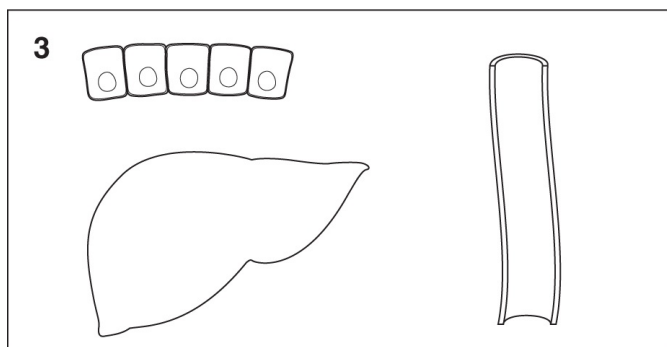
The body must constantly work to keep blood glucose levels steady so as to provide cells with a steady supply of fuel. Test your knowledge of this process by filling in the blanks of each sentence. Then, draw arrows and hormone "dots" to illustrate what's happening.



1. After eating, blood glucose levels _____.

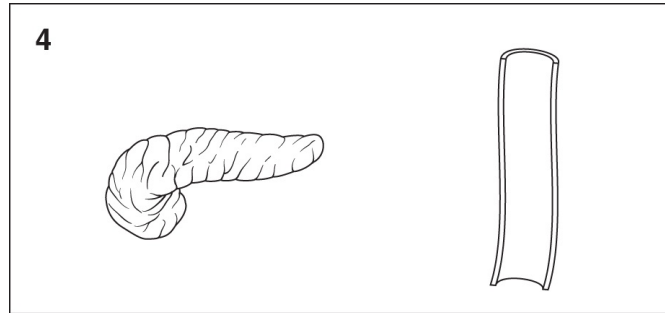


2. This stimulates the _____ cells of the pancreas to secrete _____.

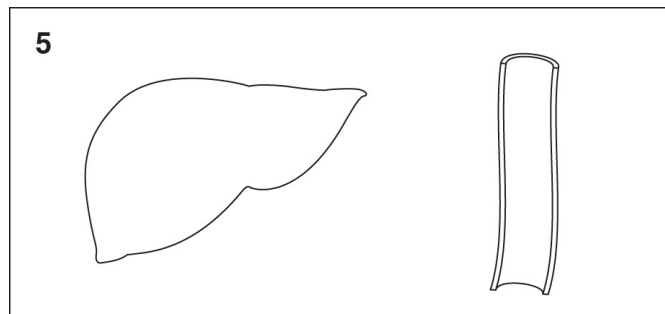


3. Insulin triggers two key reactions:

- It stimulates cells to take up _____.
- It causes the liver to take up _____ and store it as _____.



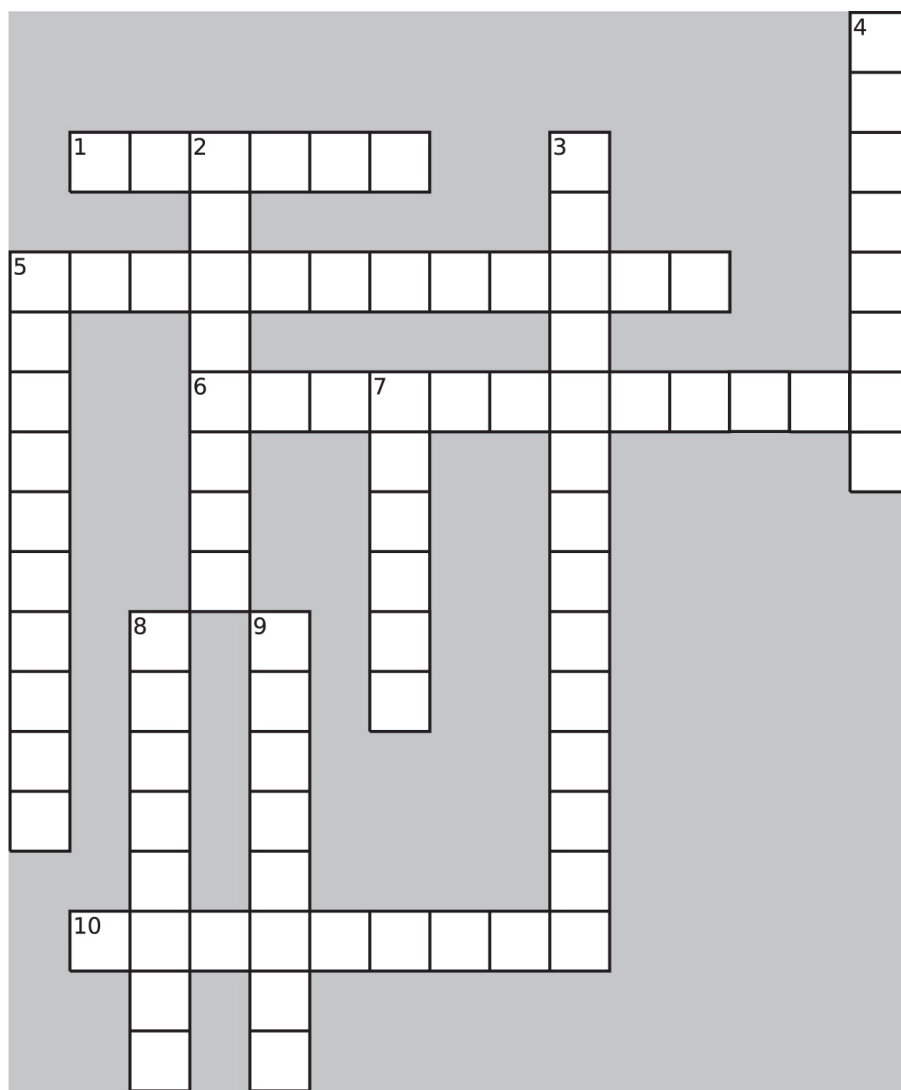
4. When blood glucose levels drop, the cells of the pancreas release into the blood.



5. This stimulates the liver to break down into _____, which it then releases into the bloodstream. This causes blood glucose levels to _____.

Puzzle It Out More Endocrine Information

Complete the following crossword puzzle to test your knowledge of the endocrine system.



ACROSS

1. Primary sex organs
5. Hormone secreted by the corpus luteum after ovulation
6. Hormone that stimulates the development of secondary sexual characteristics in males
10. Antidiuretic hormone _____ urine volume.

DOWN

2. Hormone secretion is often controlled by _____ feedback.
3. Chemical messengers released within the tissues where they are produced
4. Hormone secreted by the cells of the ovarian follicle
5. Term for excessive thirst (often a symptom of diabetes)
7. Gland that helps in the development of the immune system
8. Endocrine gland containing cell clusters called the islets of Langerhans
9. Term for excessive urination (often a symptom of diabetes)

Illuminate the Truth The Microbiome as an Endocrine Organ

Highlight the word or phrase that completes each sentence correctly.

1. A compelling argument for classifying the intestinal microbiota as an endocrine organ includes the fact that the microorganisms comprising the microbiota (outnumber human cells)(release hormones into the bloodstream).
2. The microbes comprising the intestinal microbiota secrete (a small number)(hundreds) of products.
3. The microbiota (overpowers)(responds to) hormones secreted elsewhere.
4. The biochemical complexity of the intestinal microbiota is (greater than)(less than) other endocrine organs.
5. One way the intestinal microbiota influences the stress response is by exerting control over the (parasympathetic nervous system)(HPA axis).
6. The intestinal microbiota has been shown to alter insulin sensitivity, which affects (anxiety) (inflammation).
7. Microbes in the gut influence production of hormones that reduce body weight (by triggering loss of appetite)(without a change in food intake).

chapter 14

BLOOD

Blood is actually a connective tissue. Unique because of its fluid matrix, blood serves as the body's transport medium: It delivers oxygen and removes waste products from the body's cells; it transports nutrients, hormones, and enzymes; it helps protect the body against infection; and it helps stabilize body temperature. What's more, analyzing blood components gives clues about the body's state of health. Use the exercises in this chapter to improve your understanding of this vital fluid.

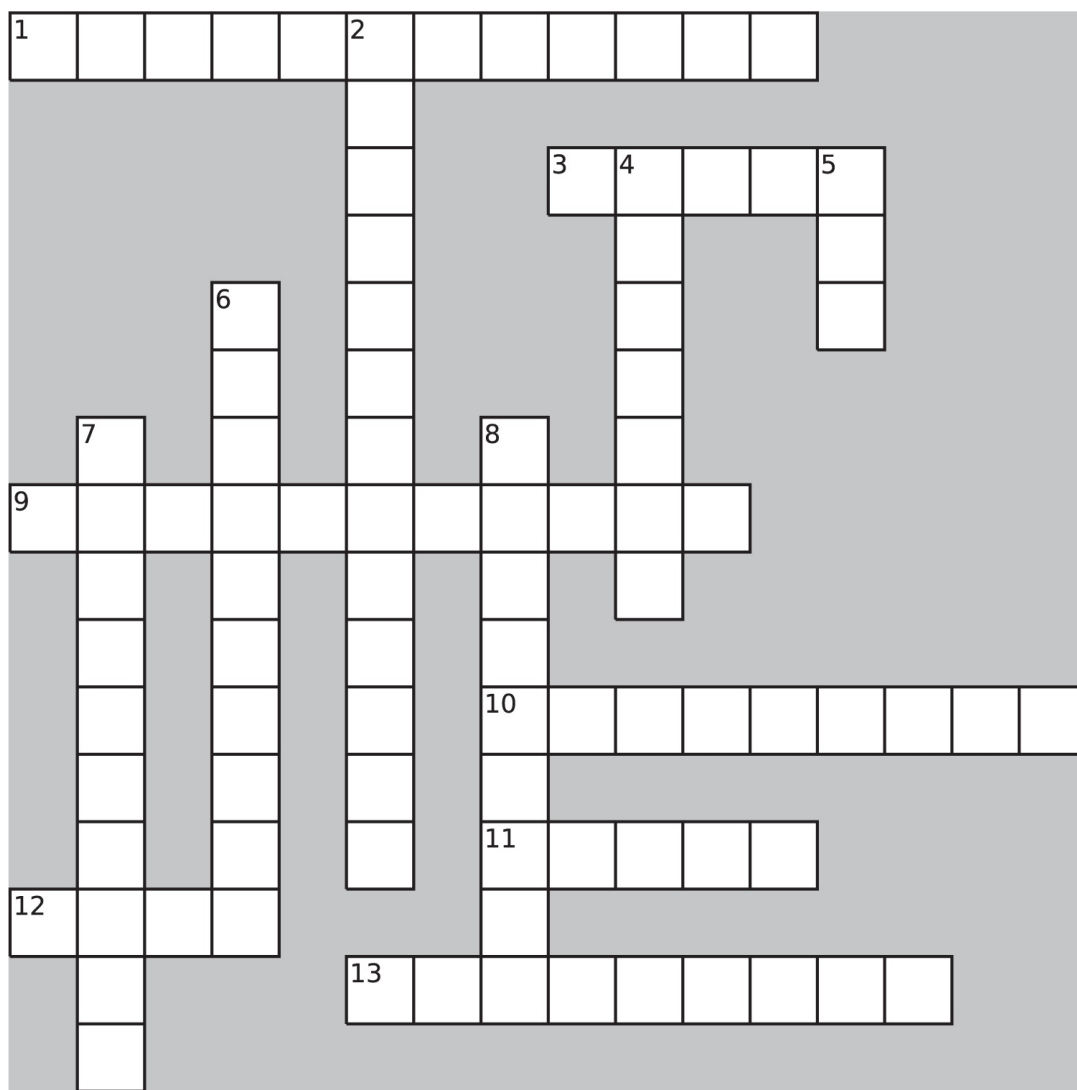
Illuminate the Truth Blood Cells

Highlight the word or phrase that completes each sentence correctly.

1. Red bone marrow produces (only red blood cells)(all types of blood cells).
2. Lymphatic tissue produces (all types of white blood cells)(lymphocytes).
3. Immature red blood cells—as well as white blood cells and platelet-producing cells—arise from (pluripotent stem cells)(lymphatic tissue).
4. Red blood cells (have a fixed shape)(are flexible).
5. Red blood cells (have a large nucleus)(have no nucleus), which means they (cannot replicate) (replicate easily).
6. How much oxygen the blood can carry depends on the quantity of (plasma)(red blood cells).
7. Red blood cells affected by sickle cell disease are (overly flexible)(overly stiff), causing them to elongate when they enter narrow vessels.
8. Each red blood cell contains (millions of hemoglobin molecules)(a single molecule of hemoglobin).
9. Red blood cells have a life span of about (365 days)(120 days).

Puzzle It Out Blood Basics

Complete the following crossword puzzle to test your knowledge of the blood.



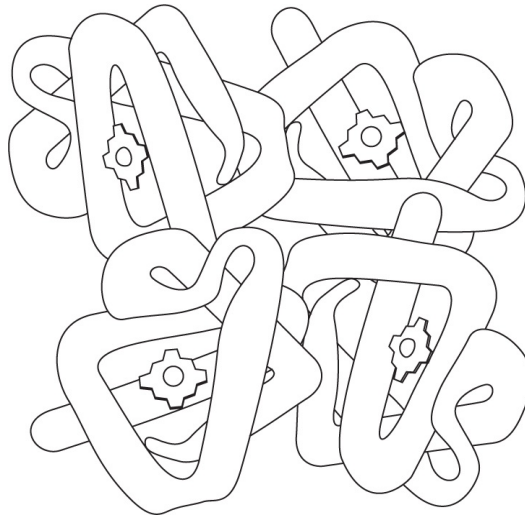
ACROSS

1. Blood contains more of this formed element than any other
3. Main component of plasma
9. Production of blood
10. White blood cell
11. Plasma without the clotting proteins
12. Necessary in the diet for hemoglobin synthesis
13. Property of blood determined by the combination of plasma and blood cells

DOWN

2. An increased number of these cells reflects an increase in the production of RBCs
4. The main protein in plasma
5. Most blood cells are created in _____ bone marrow
6. Red pigment that gives blood its color
7. Concentration of RBCs in a sample of blood
8. Excessive destruction of red blood cells

Over one-third of the interior of a red blood cell is filled with hemoglobin. Test your knowledge of hemoglobin by filling in the blanks of each sentence. Then, color the figure below as described.



1. Globin is made up of _____. (Color the globin pink.) _____
2. Heme contains _____. (Color the heme green.) _____
3. One hemoglobin molecule can bind with _____ molecules of oxygen. (Draw blue circles around the oxygen-binding sites.) _____
4. When hemoglobin is saturated with oxygen, it is called _____.

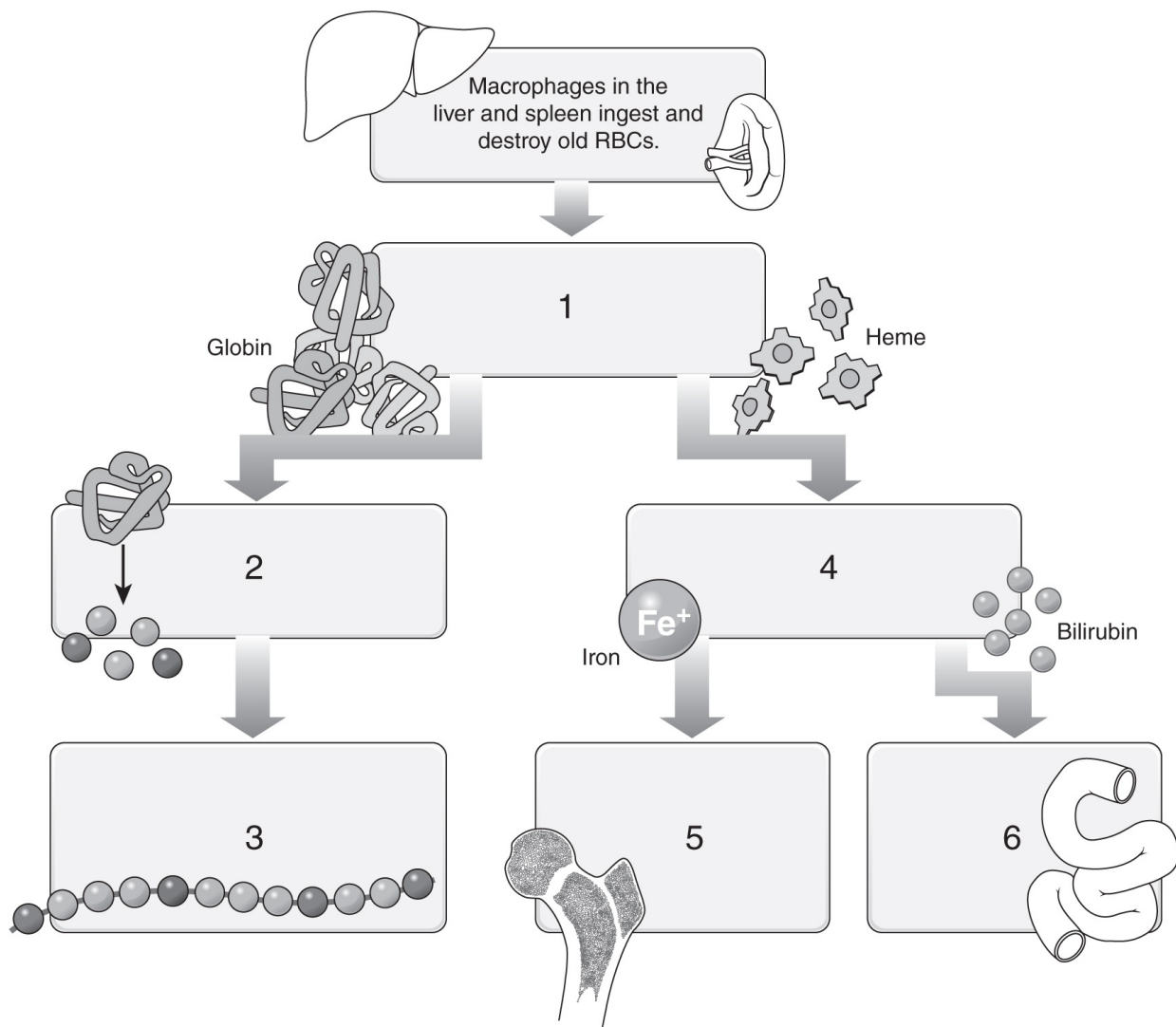
Sequence of Events Life Cycle of Red Blood Cells

Insert the numbers 1 through 6 in the spaces provided to identify the sequence of events that occur in the red blood cell's life cycle.

- _____ A. An immature form of an erythrocyte, called a reticulocyte, is released into the circulation.
- _____ B. EPO stimulates stem cells in red bone marrow to begin creating new erythrocytes.
- _____ C. After one to two days, the reticulocyte becomes a mature erythrocyte.
- _____ D. The kidneys detect the declining levels of oxygen and respond by secreting a hormone called erythropoietin (EPO).
- _____ E. As the number of RBCs increases, oxygen levels rise. Less EPO is produced, and RBC production declines.
- _____ F. As damaged RBCs are removed from circulation, oxygen levels fall.

Describe the Process The Breakdown of Red Blood Cells

Just as new red blood cells are continually formed, old blood cells are recycled. Using the spaces below, describe this process. Use the figure as a guide. The first step in the process has been provided to get you started.



1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Fill in the Gaps Red Blood Cell Disorders

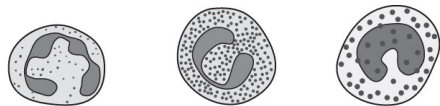
Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Not all words may be used.

ANEMIA
HEMOLYTIC ANEMIA
IRON DEFICIENCY ANEMIA
JAUNDICE
PERNICIOUS ANEMIA
POLYCYTHEMIA
PROTEINURIA
SICKLE CELL ANEMIA

1. The disease caused by an excess of RBCs is called _____.
2. A deficiency of RBCs is called _____.
3. A disorder that causes the excessive destruction of RBCs is _____.
4. A dietary deficiency of iron will cause _____.
5. A lack of vitamin B₁₂ causes _____.
6. A disorder common to African Americans that causes RBCs to elongate and clump together is called _____.

Just the Highlights Granulocytes

Granulocytes—one of the two classifications of white blood cells—can be one of three types. In the figure below, color the neutrophil yellow, the eosinophil blue, and the basophil green. Then, in the following list, link each characteristic to each type of granulocyte by highlighting each with its corresponding color.



Neutrophil Eosinophil Basophil

1. The fewest of the WBCs, making up 0.5% to 1% of the WBC count
2. Numerous in the lining of the respiratory and digestive tract
3. Most abundant of the WBCs, making up 60% to 70% of all the WBCs in circulation
4. Kill parasites
5. Account for 2% to 5% of circulating WBCs
6. Are sometimes called band cells or stab cells

7. Secrete heparin
8. Quickly move out of blood vessels into tissue spaces to engulf and digest foreign materials
9. Possess little to no phagocytic ability
10. Form the main component of pus
11. Involved in allergic reactions
12. Secrete histamine

Make a Connection Agranulocytes

Agranulocytes—the second classification of white blood cells—can be one of two types. In the spaces below, list the names of those two types. The first letter of each term is provided to get you started. Then, draw a line to link each cell to its particular characteristics. Note that items may link with more than once characteristic.

1. L_____
 2. M_____
- a. Are the smallest WBCs
 - b. Comprise 3% to 8% of the WBC count
 - c. Responsible for long-term immunity
 - d. May mature in the bone marrow or may migrate to the thymus to finish developing
 - e. Are largest WBCs
 - f. Are highly phagocytic; can engulf large bacteria as well as virus-infected cells
 - g. Colonize the organs and tissues of the lymph system when mature
 - h. May survive a few weeks to decades
 - i. Transform into macrophages in the tissues, where they ingest bacteria, cellular debris, and cancerous cells
 - j. May survive for several years
 - k. Are the second most numerous WBCs, making up 25% to 33% of the WBC count

Sequence of Events Formation of a Blood Clot

Blood clotting involves a complex series of events. Insert the numbers 1 through 6 in the spaces provided to identify the sequence of events that occur in the formation of a blood clot.

_____ A. Sticky fibrin threads form a web at the site of the injury.

_____ **B.** Both the intrinsic and extrinsic pathways result in the production of the enzyme prothrombin activator.

_____ **C.** Thrombin transforms the soluble plasma protein fibrinogen into insoluble fibrin.

_____ **D.** Red blood cells and platelets become ensnared in the fibrin web to create a clot of fibrin, blood cells, and platelets.

_____ **E.** Prothrombin is converted to the enzyme thrombin.

_____ **F.** Prothrombin activator acts on the globulin prothrombin (factor II).

List for Learning Preventing Clot Formation

Using the spaces below, list three factors that discourage blood clot formation.

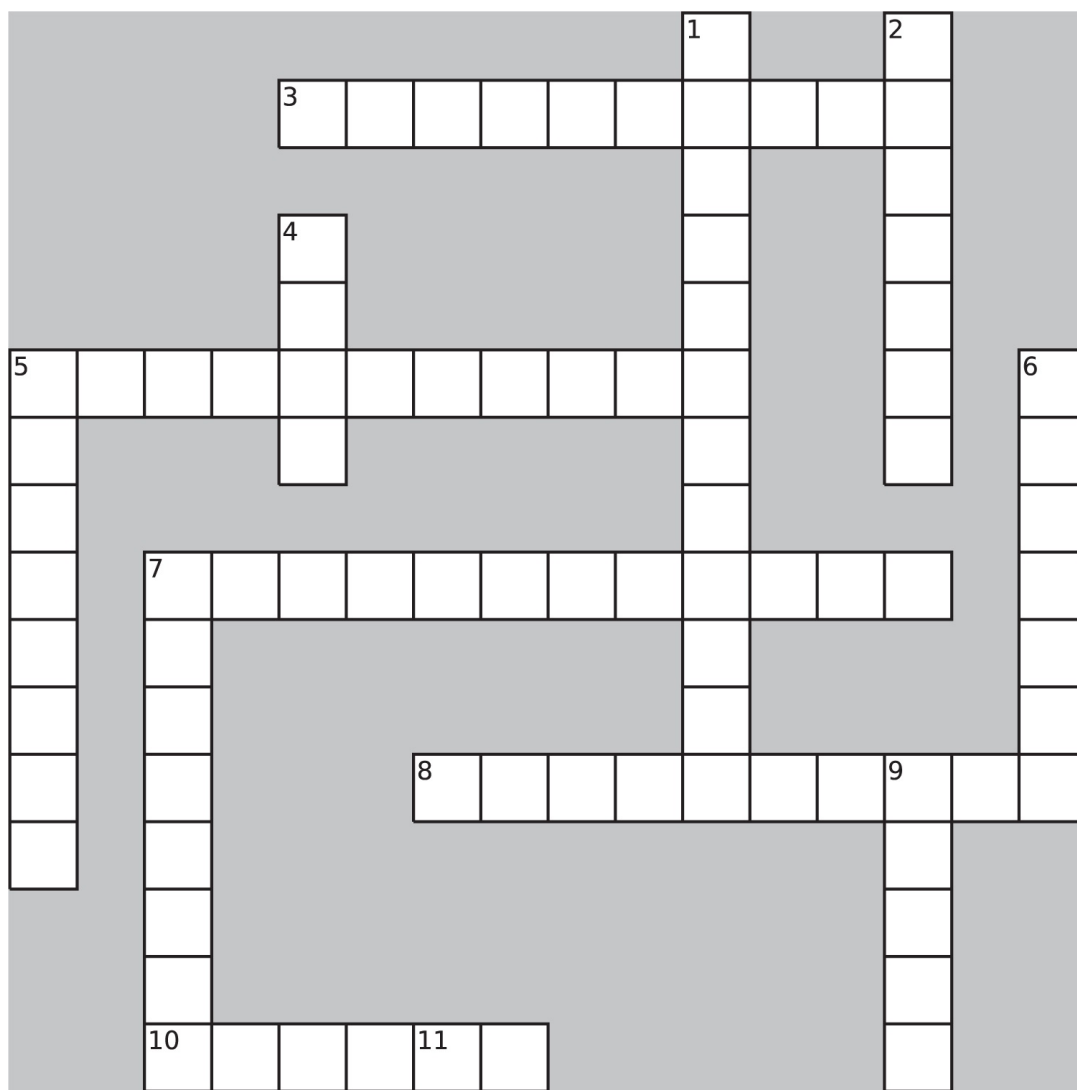
1. _____

2. _____

3. _____

Puzzle It Out Blood Clotting

Complete the following crossword puzzle to test your knowledge of key concepts in blood clotting.



ACROSS

3. Rare disorder resulting from a deficiency of one of the clotting factors
5. Term for blood clotting
7. Another name for platelets
8. Stopping bleeding
10. A rough spot inside a blood vessel makes platelets become this

DOWN

1. Process of breaking up a blood clot
2. Adequate blood level of this mineral is required for clotting
4. A mass of platelets that forms a temporary seal on a vessel wall is called a platelet
_____.
5. Fibers that are exposed when a vessel is injured
6. When a piece of a clot breaks off and circulates through the bloodstream
7. Unwanted blood clot inside a vessel
9. The first thing a blood vessel does when cut.
11. Vitamin necessary for clotting

Fill in the Gaps Blood Types

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

AGGLUTINATION
ANTIBODIES
ANTIGEN
BURST
CELLS
CLUMP TOGETHER
HEMOLYSIS
NEGATIVE
PLASMA
POSITIVE
RED BLOOD CELLS
A
B
O
AB

1. Each red blood cell carries a protein called a(n) _____, of which there are two types (A and B).
2. Plasma carries _____ against the _____ of the other blood types.
3. A transfusion reaction occurs when the _____ of one blood type attack the _____ of the other blood type.
4. This causes the cells to _____, a process called _____.
5. During a reaction, red blood cells may burst; this is called _____.
6. Blood type _____ is sometimes called the universal donor, although the term is not completely accurate. Reactions usually don't occur because only the _____ are being transfused.
7. Blood type _____ is sometimes called the universal recipient, although this is not completely accurate either.

8. Many people also carry another antigen, called the Rh antigen; when this is the case, they are said to have Rh- _____ blood.

Describe the Process Rh Factor and Transfusions

Using the spaces below, describe the significance of Rh factor in blood transfusion.

1. If a person with Rh-negative blood receives a transfusion of Rh-positive blood, _____

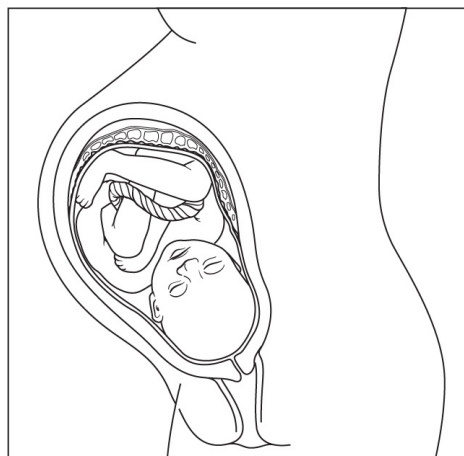
_____.
2. The body responds by _____
_____.
3. Difficulty arises when _____.
4. If that occurs, _____

_____.

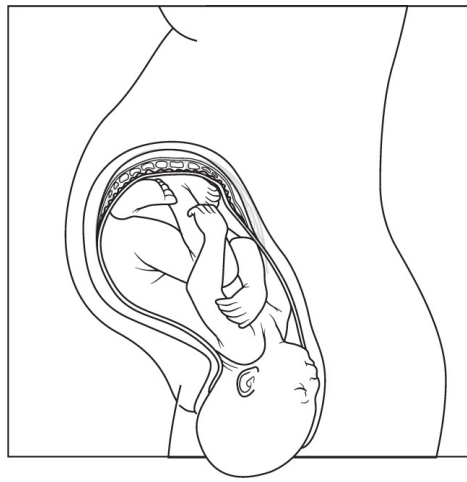
Drawing Conclusions Rh Factor and Pregnancy

Test your knowledge of what happens when a woman with Rh-negative blood becomes pregnant with an Rh-positive fetus by highlighting the correct word or phrase in the sentences underneath each figure.

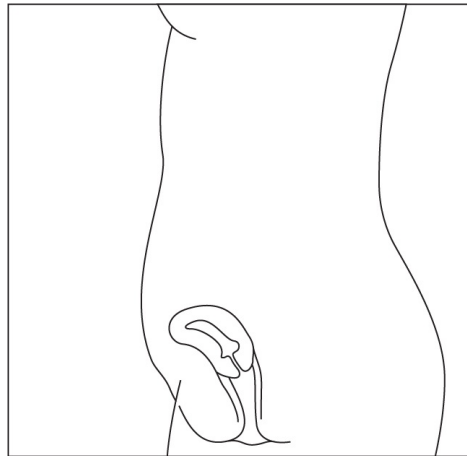
Then, illustrate what is occurring by inserting symbols for Rh-negative blood, Rh-positive blood, and anti-Rh antibodies. Use arrows to indicate the movement of the blood and antibodies. Finally, draw any reaction that may occur.



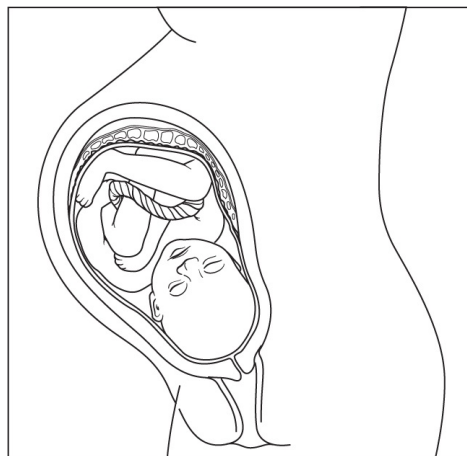
- A. The first pregnancy of an Rh-negative mother with an Rh-positive fetus is (normal)(complicated).



- B.** During delivery, or miscarriage, the fetus' blood often (separates from)(mixes with) that of the mother, thus introducing (Rh antibodies)(Rh antigens) into the mother's bloodstream.



- C.** The mother's body responds by forming (anti-Rh antibodies)(Rh antigens).



- D.** If the mother becomes pregnant with another Rh-positive fetus, the (anti-Rh antibodies)(Rh antigens) in her body can pass through the placenta and attack the fetal RBCs, causing (hemophilia) (agglutination).

chapter 15

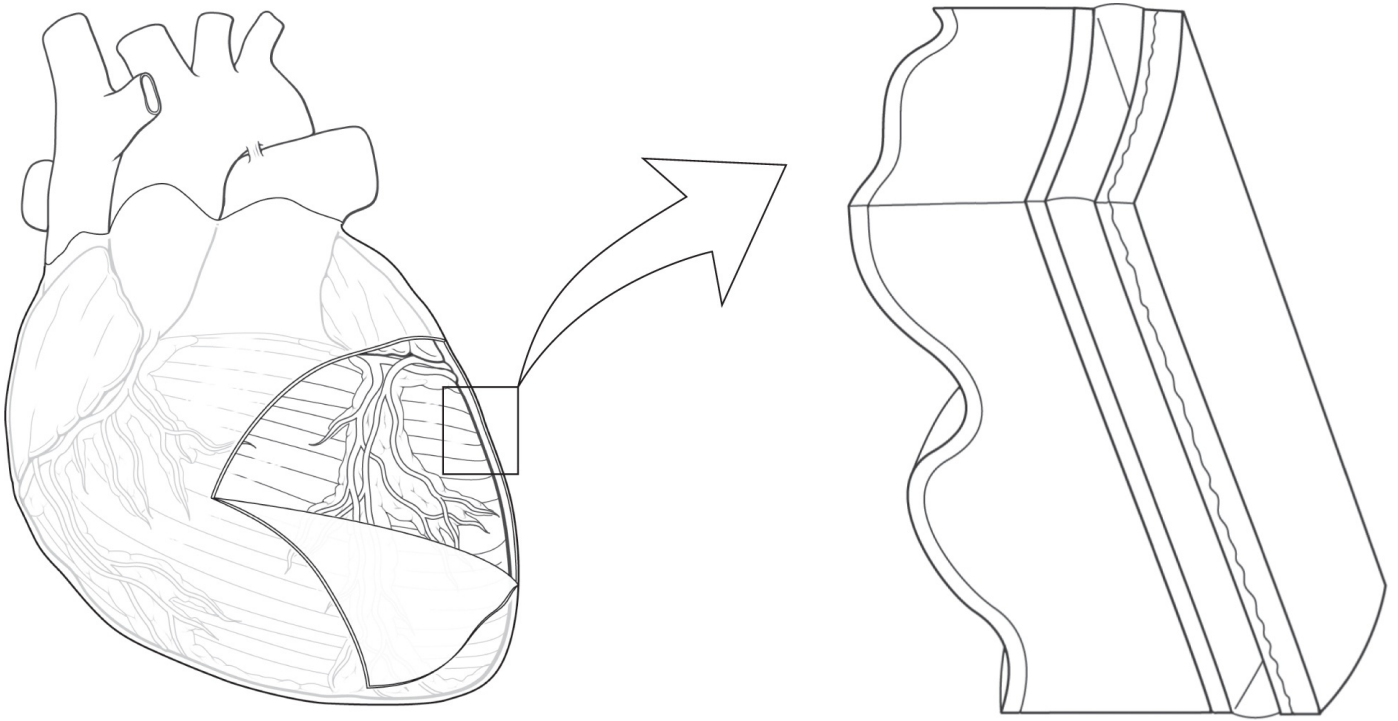
HEART

The structure of the heart allows it to serve as two distinct pumps. One side of the heart pumps blood to the lungs while the other side propels oxygenated blood throughout the body. The heart is unique in other ways as well. For example, it consists of muscle tissues found nowhere else in the body. What's more, cardiac cells can generate and transmit electrical impulses spontaneously. Learn more about the characteristics of this vital organ by completing the activities in this chapter.

Conceptualize in Color Heart Layers

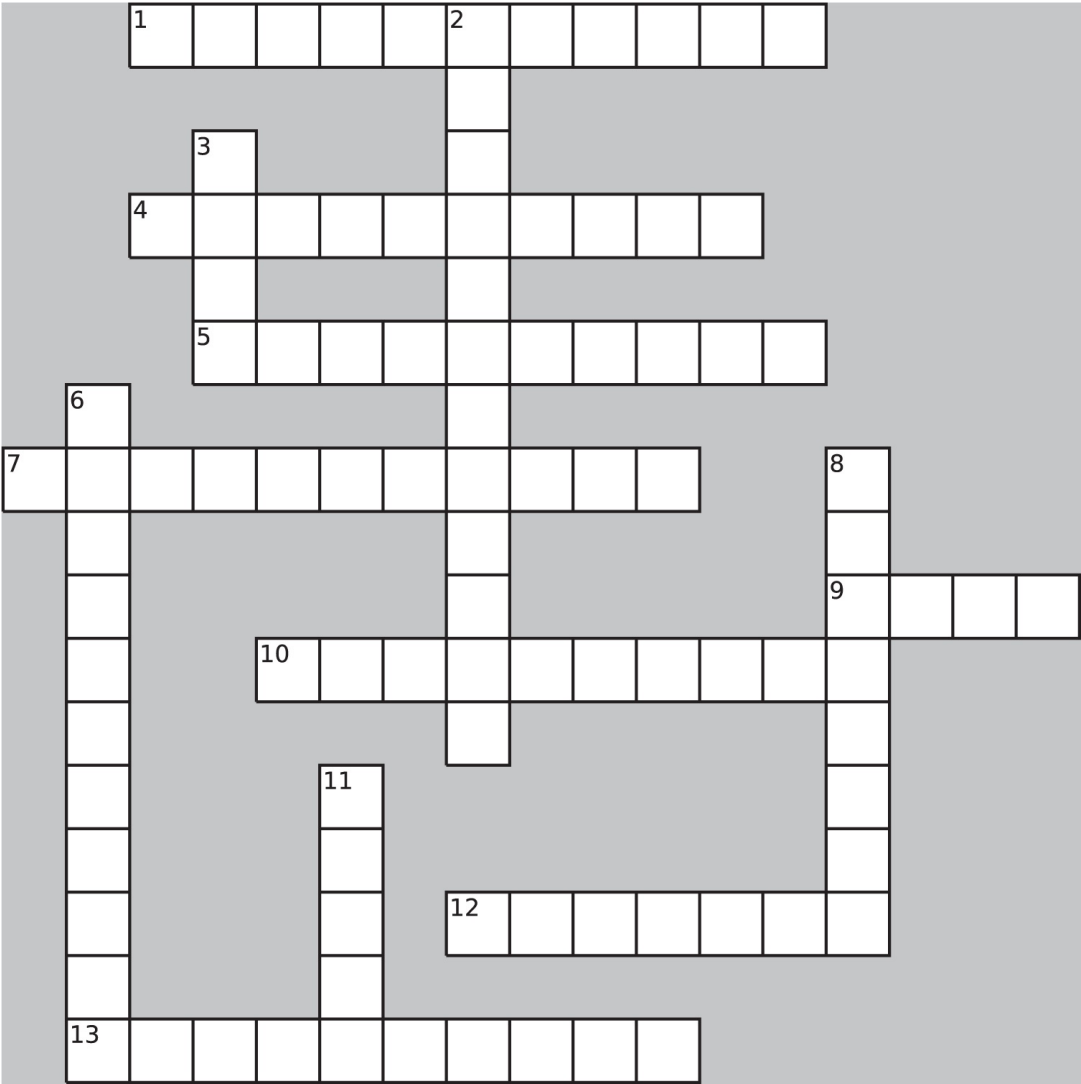
Identify the layers of the heart's wall and the pericardium by coloring the figure below. Use the suggested colors or choose your own.

- Endocardium: Light pink
- Myocardium: Dark pink
- Fibrous pericardium: Orange
- Serous pericardium: Light blue
- Place green Xs in the pericardial space.
- Draw a bracket linking the layers that make up the serous pericardium.



Puzzle It Out Cardiac Terms

Complete the following crossword puzzle to test your knowledge of the heart.



ACROSS

1. The heart's inner layer
4. The study of the heart and the treatment of related disorders
5. Thin layer of squamous epithelial cells covering the heart's surface
7. Space between the lungs and beneath the sternum where the heart resides
9. Pointed end of the heart
10. Two lower chambers of the heart
12. Phase of the cardiac cycle when the ventricles contract
13. Middle layer of the heart wall

DOWN

2. Unique ability of the cardiac muscle to contract without nervous stimulation
3. Where the great vessels enter and leave the heart
6. Double-walled sac surrounding the heart and root of the great vessels
8. The period of cardiac muscle relaxation
11. Two upper chambers of the heart

Drawing Conclusions Heart Structures

Test your knowledge of the heart's structures by coloring the figure below. Use the suggested colors or choose your own. Then, describe the function of each of the heart's four valves (notated with A through D in the figure) in the spaces provided.

- Right atrium: Dark blue
- Right ventricle: Light blue
- Left atrium: Light red
- Left ventricle: Dark red
- Interatrial septum: Orange
- Interventricular septum: Yellow
- Tendinous cords (chordae tendineae): Black
- Papillary muscle: Brown

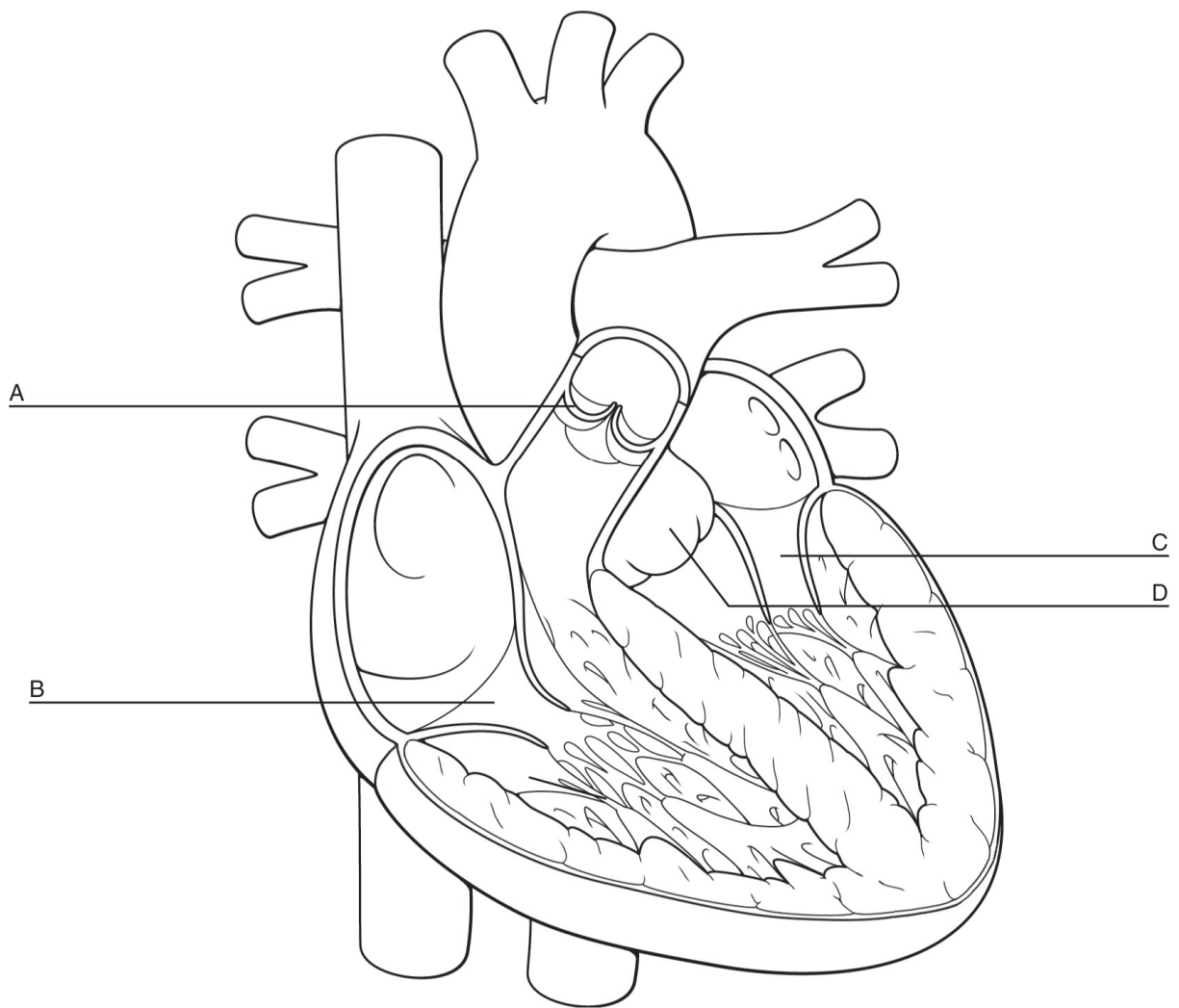
Heart valves and functions:

A. _____

B. _____

C. _____

D. _____



Illuminate the Truth Heart Valves

Highlight the word or phrase that completes each sentence correctly.

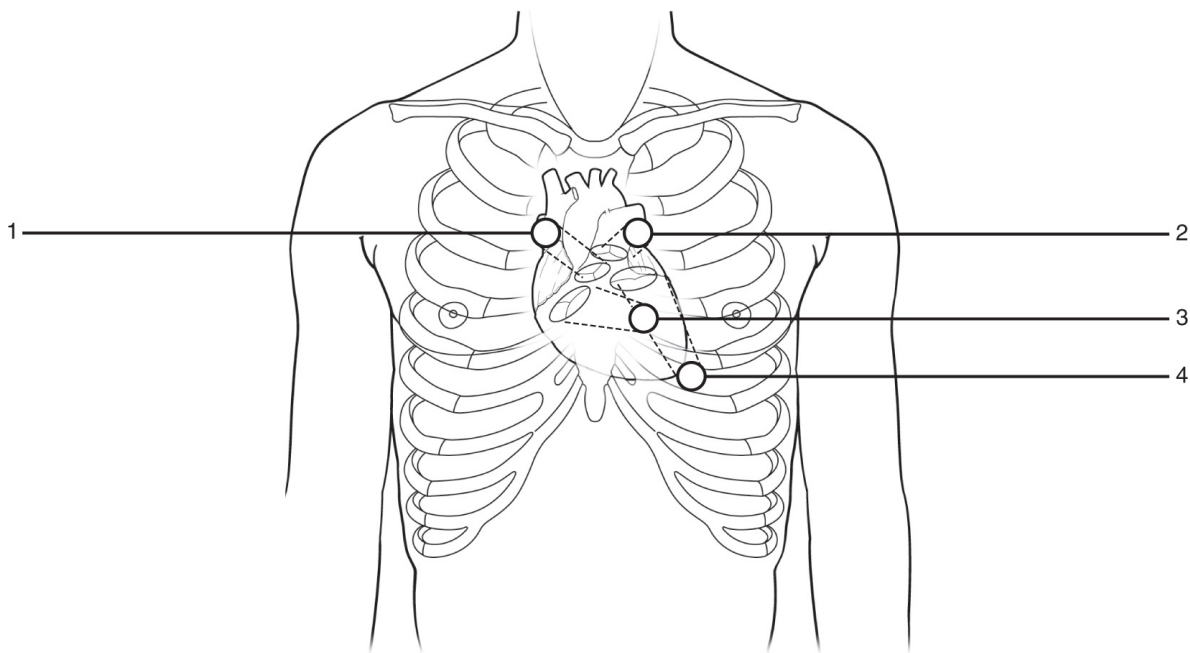
1. (Nerve impulses)(Pressure changes within the heart) trigger the opening and closing of the heart's valves.
2. A heart valve that fails to prevent the backflow of blood during contraction is called (incompetent) (stenotic), and the condition it causes is called valvular insufficiency.
3. (Valvular stenosis)(Regurgitation) is a condition resulting when a heart valve becomes narrowed, such as from scar tissue.
4. The mitral valve consists of (three)(two) cusps or leaflets.
5. The tricuspid valve consists of (two)(three) cusps or leaflets.
6. The (tricuspid)(mitral) valve prevents backflow from the right ventricle to the right atrium.
7. The (tricuspid)(mitral) valve prevents backflow from the left ventricle to the left atrium.
8. The pulmonary valve prevents backflow from the (pulmonary artery to the right ventricle)(pulmonary veins to the right ventricle.)

9. The pulmonary and aortic valves are also called (semilunar)(tricuspid) valves.
10. The valves regulating flow between the atria and the ventricles are called (atrioventricular) (semilunar) valves.
11. The semi-rigid, fibrous connective tissue encircling each valve is called the (skeleton)(epicardium) of the heart.
12. Tendinous cords called chordae tendineae work to (pull the valves open when the heart contracts) (keep the tricuspid valve from inverting during ventricular contraction).

Drawing Conclusions Heart Sounds

When heart valves close, they produce vibrations that can be heard with a stethoscope on the body's surface. Test your knowledge of the areas where each valve can be heard by filling in the blanks in the figure below with the name of each valve. Then, color the corresponding circles in the figure. Use the suggested colors or choose your own.

- Pulmonic area: Blue
- Mitral area: Yellow
- Tricuspid area: Green
- Aortic area: Orange



Sequence of Events Blood Flow Through the Heart

Test your knowledge of the flow of blood through the heart by placing the following cardiac events in the proper order. The first step has been provided to get you started, indicated by the number 1. Arrange the subsequent events by inserting the numbers 2 through 18 in the spaces provided.

1. Deoxygenated blood flows through the superior and inferior vena cava and into the right atrium.

- _____ A. Blood fills the left atrium.
- _____ B. The right atrium contracts.
- _____ C. The pulmonary valve closes.
- _____ D. Blood leaves the lungs via the pulmonary veins.
- _____ E. The left atrium contracts.
- _____ F. The pulmonary valve opens.
- _____ G. Blood flows into the aorta for distribution throughout the body.
- _____ H. The mitral valve closes.
- _____ I. The left ventricle contracts.
- _____ J. The aortic valve opens.
- _____ K. The right ventricle contracts.
- _____ L. The tricuspid valve opens.
- _____ M. Blood is pumped into the right and left pulmonary arteries and into the lungs.
- _____ N. Blood fills the left ventricle.
- _____ O. The mitral valve opens.
- _____ P. Blood flows into the right ventricle.
- _____ Q. The tricuspid valve snaps closed.

List for Learning Heart Valve Sequence

Using the spaces below, list the heart valve sequence during normal blood flow.

- 1. _____
- 2. _____
- 3. _____
- 4. _____

Fill in the Gaps Coronary Circulation

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Not all words may be used.

ANTERIOR DESCENDING
ASCENDING AORTA
CIRCUMFLEX
CONTRACTION
CORONARY SINUS
INTERVENTRICULAR SEPTUM
LEFT
LEFT VENTRICLE
RELAXATION
RIGHT
SUPERIOR VENA CAVA

1. The right and left coronary arteries arise from the _____.
2. The _____ coronary artery supplies blood to the right atrium, part of the left atrium, most of the right ventricle, and the inferior part of the left ventricle.
3. The left coronary artery branches into the _____ and _____ arteries.
4. The left coronary artery supplies blood to the left atrium, most of the left ventricle, and most of the _____.
5. Most cardiac veins empty into the _____, a large transverse vein on the heart's posterior, which returns blood to the right atrium.
6. The coronary arteries receive their supply of blood during ventricular _____.
7. The most abundant blood supply goes to the myocardium of the _____.

List for Learning Pacemakers of the Heart

Using the spaces below, list the heart's three possible pacemakers (the primary as well as the "backups") along with their firing rates.

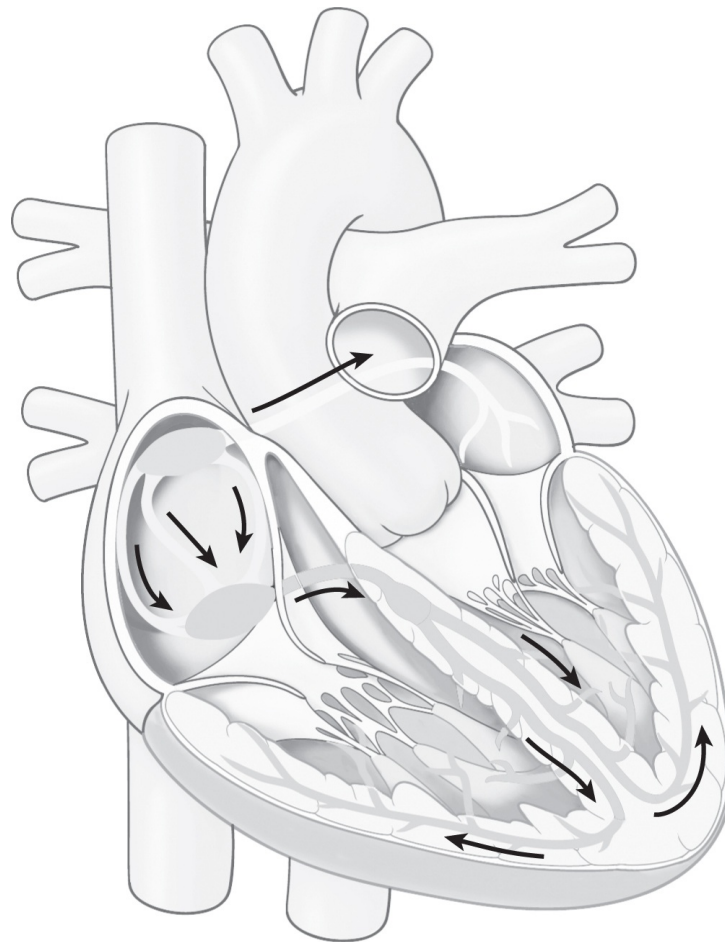
1. _____
2. _____
3. _____

Drawing Conclusions Cardiac Conduction System

Test your knowledge of the cardiac conduction system by coloring and labeling listed structures in the figure below. Use the suggested colors or choose your own.

- SA node: Red
- AV node: Green
- Bundle of His: Purple
- Right and left bundle branches: Blue
- Purkinje fibers: Pink
- Interatrial tracts: Brown
- Internodal tracts: Orange

Then, insert the numbers 1 through 7 by each of the labels to indicate the conduction pathway. The number 1 indicates where the impulse begins and the number 7 indicates where the impulse ends.



Conceptualize in Color Electrocardiogram

Identify each part of the ECG by coloring the figure below as described. Use the suggested colors of choose your own.

- P wave: Green

- QRS complex: Yellow
- PR interval: Purple
- ST segment: Brown
- T wave: Blue

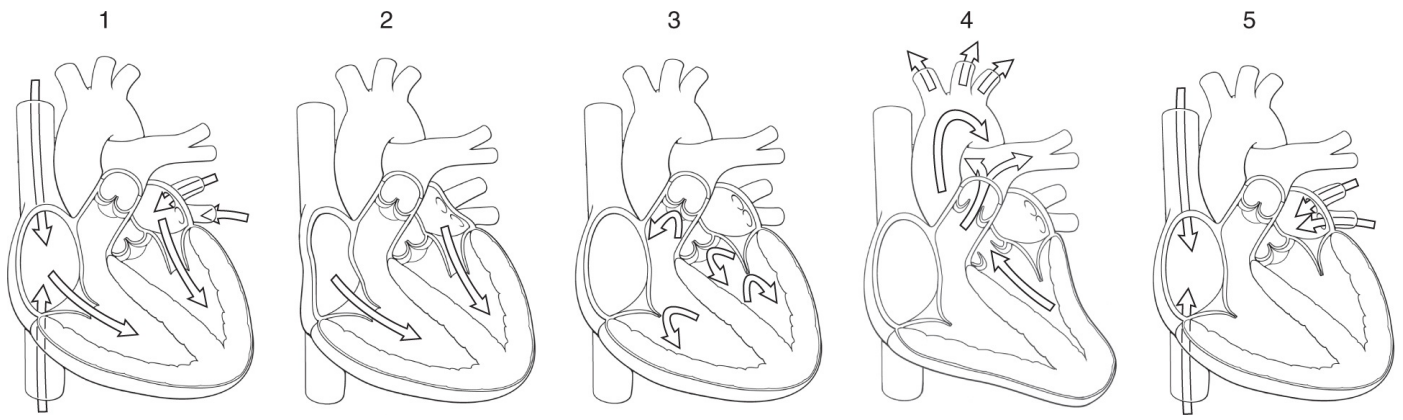
Then, link each part of the waveform to the cardiac activity it represents by underlining each particular statement with the corresponding waveform color. For example, if you colored the P wave green, underline in green the statement describing what the P wave represents.



1. This part of the waveform represents ventricular repolarization.
2. This part of the waveform represents atrial depolarization.
3. This part of the waveform represents the time it takes for the cardiac impulse to travel from the atria to the ventricles.
4. This part of the waveform represents ventricular depolarization.
5. This part of the waveform represents the end of ventricular depolarization and the beginning of ventricular repolarization.

Describe the Process Cardiac Cycle

The following illustrations show the five events of the cardiac cycle. Test your knowledge of these events by filling in the blanks with the event names that corresponds to the figures. Then, circle the name of the event when the first heart sound can be heard and underline the name of the event when the second heart sound can be heard.



1. _____
2. _____
3. _____
4. _____
5. _____

Fill in the Gaps Cardiac Output

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

CARDIAC OUTPUT
CEREBELLUM
DECREASES
EIGHT
FIVE
HEART RATE
HIGH BLOOD PRESSURE
INCREASES
MEDULLA
PARASYMPATHETIC
SIX
STRESS
STROKE VOLUME
SYMPATHETIC
TEN

1. The amount of blood ejected with each heartbeat is called _____.
2. The amount of blood the heart pumps in 1 minute is called _____.
3. To determine cardiac output, you would multiply _____ by _____.
4. The average resting cardiac output is between _____ and _____ liters per minute.
5. When heart rate increases, cardiac output _____.
6. The nervous system can cause the heart rate to increase by sending impulses via the _____ nervous system.
7. The _____ nervous system sends signals to slow the heart rate.
8. Factors such as _____ stimulate the acceleratory center in the brain's _____ to increase heart rate.

Illuminate the Truth Stroke Volume

Highlight the word or phrase that completes each sentence correctly.

1. (Preload)(Afterload) is the amount of tension, or stretch, in the ventricular muscle just before it contracts.

2. (Contractility)(Stroke volume) is the force with which ventricular ejection occurs.
3. Starling's law of the heart states that the more the ventricle is stretched—within limits—the (less) (more) forcefully it will contract.
4. The force against which the heart must work to eject its volume of blood is called the (cardiac output) (afterload).
5. Factors that affect contractility are called (chronotropic)(inotropic) agents.
6. Factors that affect heart rate are called (diastolic)(chronotropic) agents.

Make a Connection Congestive Heart Failure

In the spaces below, list the two types of heart failure. The first letter of each term is provided to get you started. Then, draw a line to link each type to its symptoms.

1. R_____

2. L_____

- a. Shortness of breath
- b. Swelling of ankles, feet, and fingers
- c. Enlargement of the liver and spleen
- d. Pulmonary edema
- e. Distention of jugular veins
- f. Generalized swelling
- g. Coughing
- h. Pooling of fluid in the abdomen

Illuminate the Truth Cardiac Muscle

Highlight the word or phrase that completes each sentence correctly.

1. Cardiac muscle cells are (striated, long, and cylindrical)(striated, short, and branched).
2. Each cardiac muscle cells connect with (multiple)(one other) cardiac cell(s).
3. Cells are joined end to end by connections called (gap junctions)(intercalated discs).
4. Small channels called (gap junctions)(intercalated discs) allow impulses to pass quickly from one cell to the next.
5. Intercalated discs serve to (increase the strength of contractions)(hold cardiac cells tightly together).

6. The interconnecting pattern of cardiac cells is one factor that allows (the entire atria to contract in unison)(the atria and ventricles to contract separately).
7. Cardiac muscle has especially (large)(small) mitochondria.
8. Cardiac muscle depends almost exclusively on (anaerobic)(aerobic) respiration.
9. Damaged cardiac muscle is repaired almost entirely through (fibrosis)(regeneration).
10. Cardiac muscle contraction depends on the presence of (magnesium)(calcium).

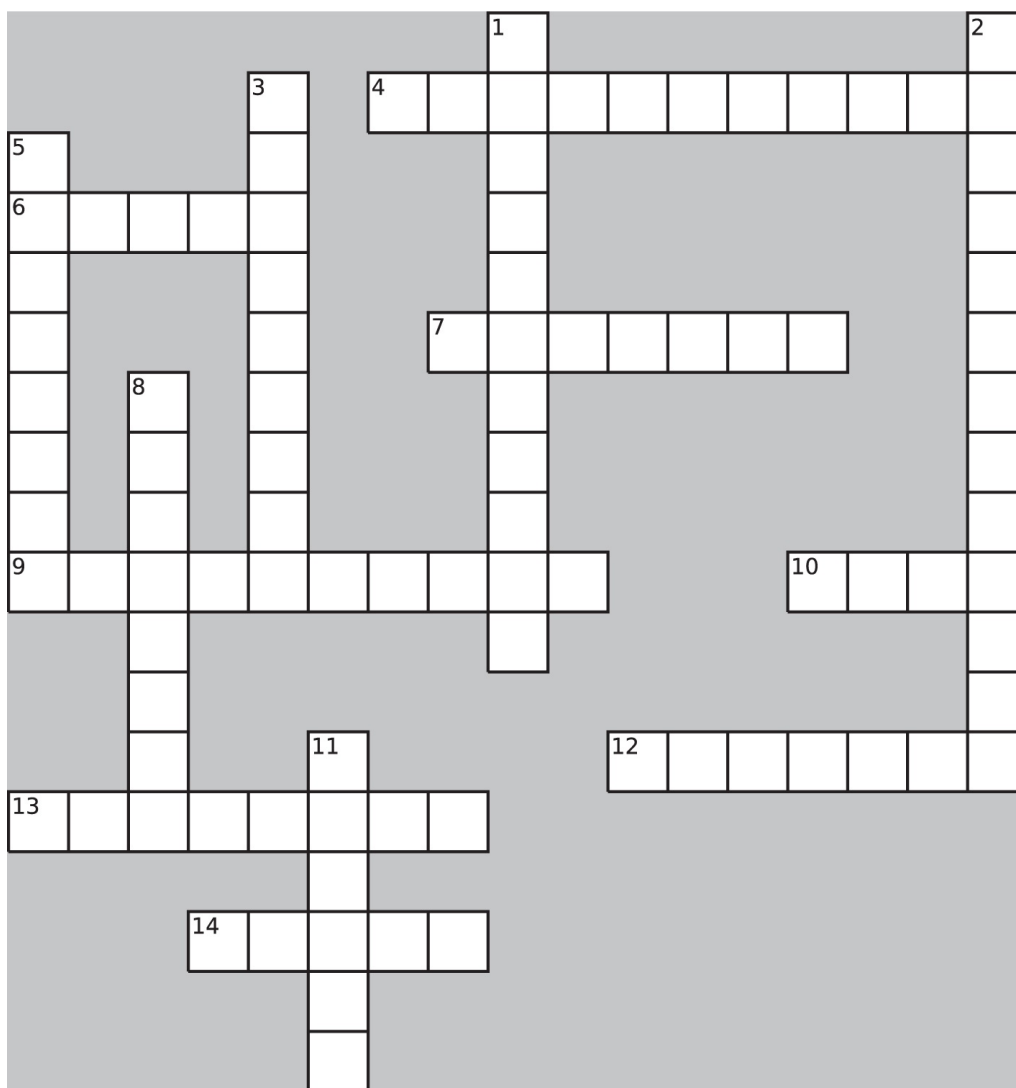
Illuminate the Truth Aging and the Heart

Highlight the word or phrase that completes each sentence correctly.

1. With advanced age, the aorta (loses elasticity)(becomes more elastic), making it (harder)(easier) for the left ventricle to expel blood.
2. The heart valves (thin)(thicken) with age, making heart murmurs (more)(less) common.
3. Heart rate tends to (increase)(decrease) with age.
4. Baroreceptors and chemoreceptors become (more)(less) reactive in older adults and the heart becomes (more)(less) responsive to adrenergic stimulation.

Puzzle It Out More Heart Facts

Complete the following crossword puzzle to test your knowledge of the heart.



ACROSS

4. A persistent pulse rate slower than 60 beats per minute
6. An ECG that appears normal is called normal _____ rhythm.
7. Pacemakers other than the SA node are called this
9. An irregular heartbeat
10. The ventricle with the thickest walls
12. Pooling of fluid in the abdomen
13. The blood remaining in the ventricles at the end of the ejection period is the _____ volume.
14. The gender most likely to die from a first heart attack

DOWN

1. A persistent, resting heart rate greater than 100 beats per minute
2. Pressure sensors in the aorta and internal carotid arteries that detect changes in blood pressure
3. The right and left ventricles receive 70% of their blood _____.
5. Results from an interruption of blood to the myocardium
8. Cell death
11. Heart sound that results from turbulent blood flow through a stenotic valve

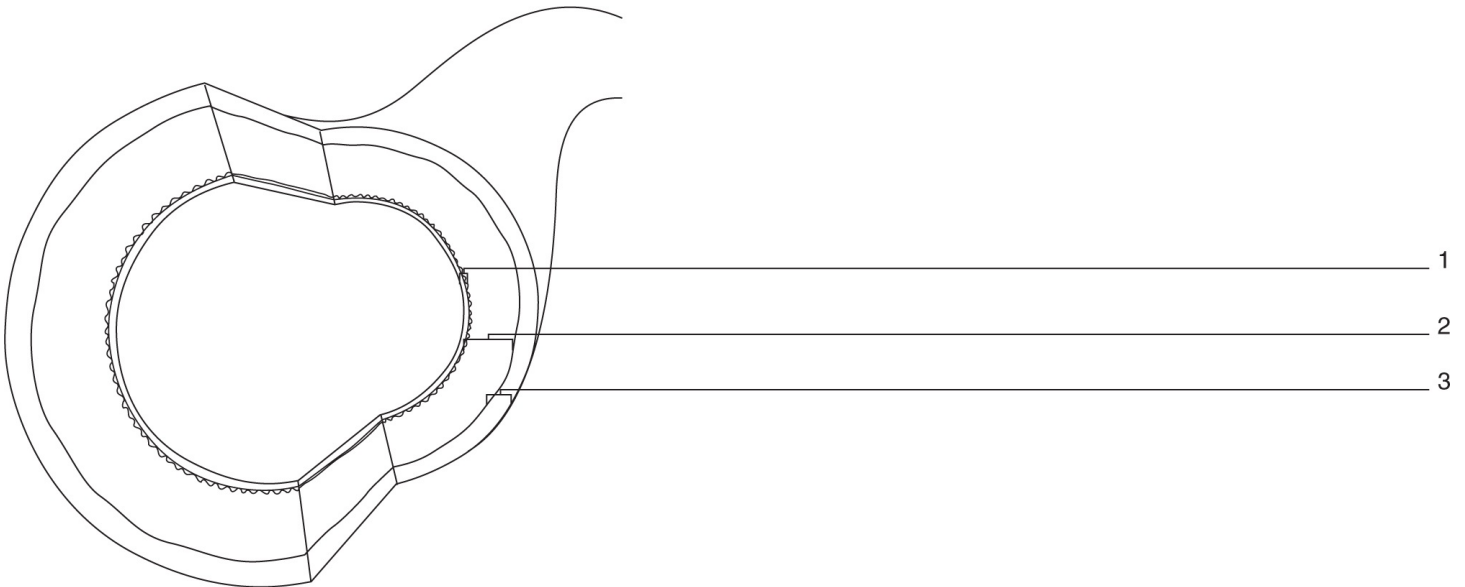
chapter 16

VASCULAR SYSTEM

The vascular system consists of an elaborate network of vessels designed to deliver oxygen and nutrients to the body's cells, remove waste products, and carry hormones from one part of the body to another. Varying in size and structure according to their purpose, many of these vessels have names that are important to remember. Use this chapter to learn the names of the various vessels and also to review their structure and function.

Drawing Conclusions Vessel Structure

Test your knowledge of the walls of arteries and veins by coloring each of the three layers in the figure below. Then, label each layer in the spaces provided for the figure. Finally, in the corresponding spaces below the figure, identify the type of tissue that makes up each layer, as well as the mechanism that allows the vessel to change diameter (if applicable).



1. _____
2. _____
3. _____

Make a Connection Arteries

In the spaces below, list the three types of arteries found in the body. The first letter of each term is provided to get you started. Then, draw a line to link each artery to its characteristics. Note that items may link with more than one characteristic.

1. C_____

2. D_____

3. A_____

- a. These are the body's largest arteries.
- b. Also called muscular arteries, these arteries have names.
- c. These are the smallest arteries.
- d. These are also called resistance vessels.
- e. Also called elastic arteries, these arteries have names.
- f. These vessels are too numerous to be named.
- g. Examples include the aorta, common carotid, and subclavian arteries.
- h. Examples include the brachial, femoral, and renal arteries.
- i. These are connected to capillaries by short connecting vessels called metarterioles.
- j. These arteries expand as blood surges into them and recoil when ventricles relax.
- k. These arteries carry blood to specific organs and areas of the body.

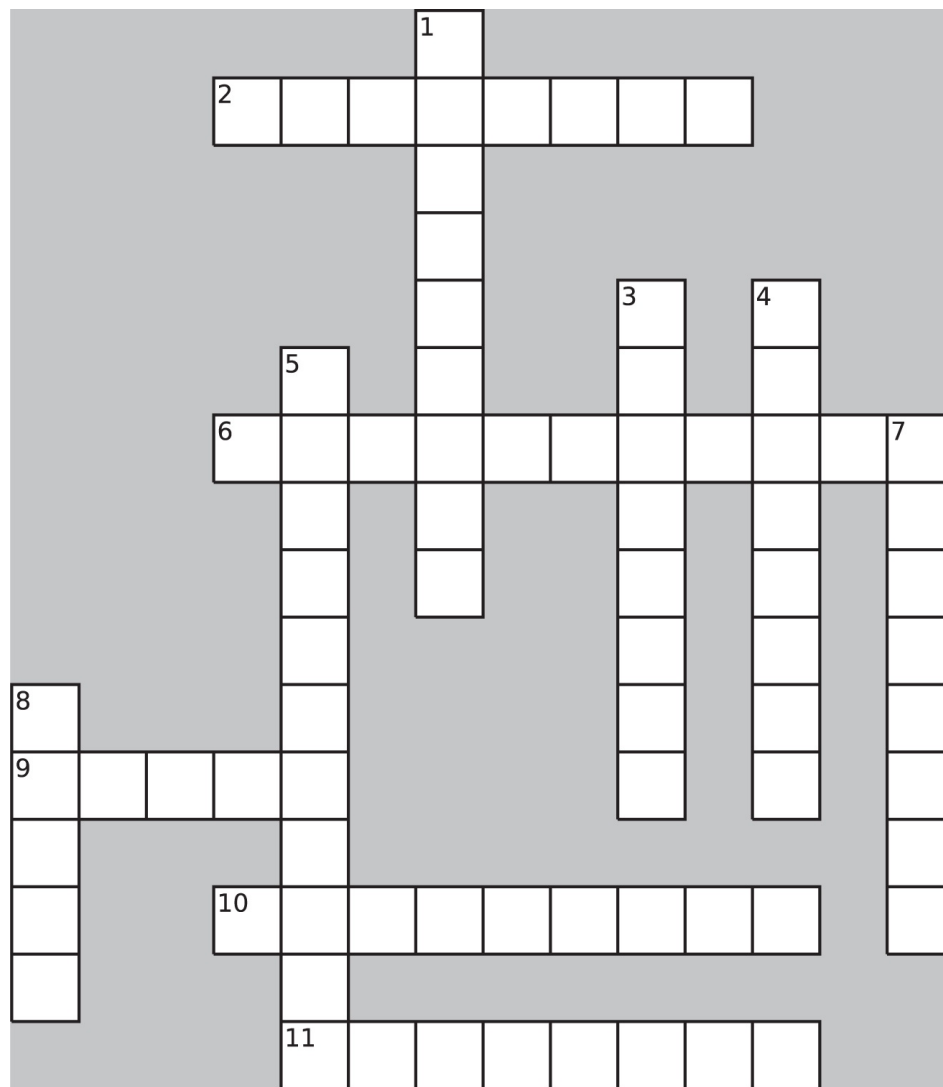
Just the Highlights Veins

In the following list, highlight the sentences that pertain to large veins in orange, the sentences that pertain to medium-sized veins in blue, and the sentences that pertain to venules in pink.

- 1. Contain one-way valves_____
- 2. Include the vena cavae, pulmonary veins, and internal jugular veins
- 3. Have a tunica media that is poorly developed, resulting in very thin vessel walls
- 4. Include the radial and ulnar veins of the forearm and the saphenous veins in the legs
- 5. Collect blood from the capillaries
- 6. Formed by the convergence of medium-sized veins
- 7. Formed by the convergence of venules on their route toward the heart
- 8. Are porous and can exchange fluid with surrounding tissue

Puzzle It Out Vascular Terms

Complete the following crossword puzzle to test your knowledge of vascular terms.



ACROSS

2. Results from the pressure of blood against a weakened area in the wall of an artery
6. Veins are sometimes called vessels because of their capacity for storing blood.
9. Results when fluid filters out of the capillaries faster than it's reabsorbed and accumulates in the tissues
10. The most important mechanism of capillary exchange
11. The circulatory system that begins at the left ventricle and involves the circulation of blood through the body

DOWN

1. The circulatory system that begins at the right ventricle and involves the circulation of blood through the lungs
3. Vessels that carry blood away from the heart
4. Unique capillary found in liver and bone marrow that allows for passage of large substances, such as proteins

5. Where nutrients, wastes, and hormones are transferred between the blood and tissues
7. Capillaries are called the vessels of the circulatory system.
8. Vessels that return blood to the heart

Illuminate the Truth Capillaries

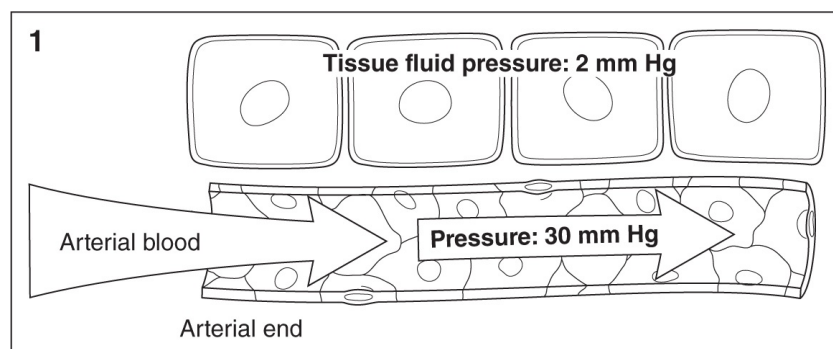
Highlight the word or phrase that completes each sentence correctly.

1. Capillaries (are)(are not) evenly distributed throughout the body.
2. The majority of the capillaries in skeletal muscles are (constantly filled with blood)(shut down during periods of rest).
3. Capillaries (take up)(release) wastes, such as carbon dioxide and ammonia.
4. Water (flows into)(moves into and out of) capillaries.
5. In diffusion, substances move from areas of (greater)(lesser) to (greater)(lesser) concentration.
6. The concentration of oxygen within capillaries is (greater than)(less than) the concentration of oxygen in the surrounding tissue fluid; therefore, oxygen diffuses (into)(out of) the capillaries.
7. (Osmosis)(Filtration) occurs close to the arterial side of the capillary bed, while (colloid osmotic pressure)(diffusion) operates toward the venous side.
8. Of all the fluid filtered at the arterial end of the capillary bed, about (85%)(15%) is reabsorbed at the venous end.

Drawing Conclusions Filtration and Osmotic Pressure

Test your knowledge of the two methods of capillary exchange by filling in the blanks of each sentence. Then, illustrate the process described by each sentence in the spaces provided. The first illustration and sentence are completed for you.

1. Blood enters the capillary through the metarteriole. The pressure here is about 30–35 mm Hg, while the pressure in the surrounding tissue fluid is about 2 mm Hg.



2. The higher pressure in the capillary pushes _____ and _____ through the

capillary wall and into the surrounding fluid. This is called _____.

2

3. Meanwhile, as the blood moves toward the venous end of the capillary, blood pressure inside the capillary _____.

3

4. This allows the proteins in the blood, such as albumin, to exert _____, in which the albumin in the blood pulls _____ along with _____ into the capillaries.

4

List for Learning Edema

Using the spaces below, list three main causes of edema.

1. _____

2. _____

3. _____

Sequence of Events Pulmonary Circulation

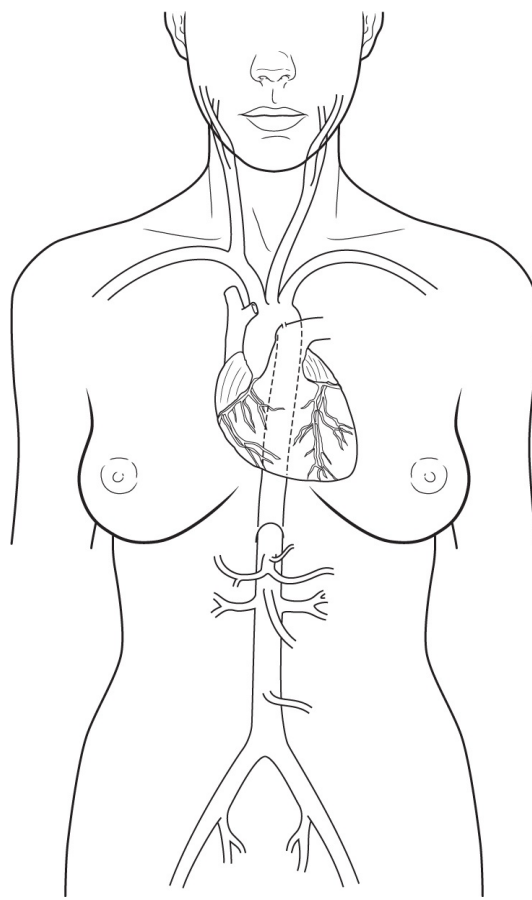
Blood follows a specific route as it circulates through the lungs. Insert the numbers 1 through 9 in the spaces provided to identify the route. (Hint: Begin with the right ventricle.)

- _____ A. Left atrium
- _____ B. Venules
- _____ C. Arterioles
- _____ D. Lobar arteries in the lungs
- _____ E. Pulmonary vein
- _____ F. Veins
- _____ G. Right ventricle
- _____ H. Pulmonary arteries
- _____ I. Lung capillaries

Conceptualize in Color The Aorta

Identify the regions of the aorta and its branches by coloring the figure below. Use the suggested colors or choose your own.

- Ascending aorta: Blue
- Aortic arch: Green
- Descending aorta: Pink
- Abdominal aorta: Red
- Right common carotid: Orange
- Left common carotid: Orange
- Left subclavian artery: Purple
- Right subclavian artery: Purple
- Brachiocephalic artery: Brown
- Right and left common iliac arteries: Yellow

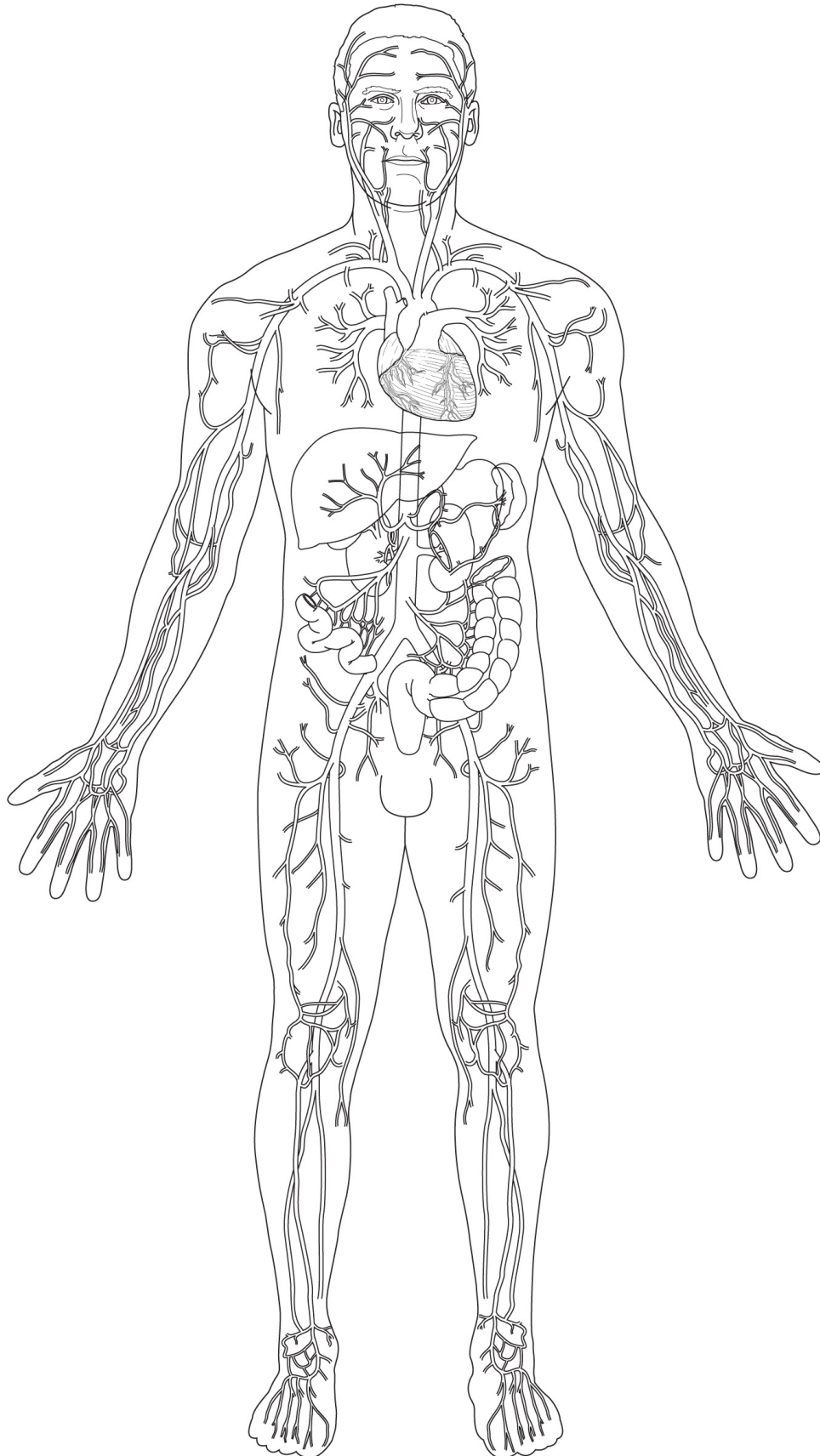


Conceptualize in Color Principal Arteries

Identify the principal arteries by coloring the figure below. Use the suggested colors or choose your own.

- Subclavian: Red
- Axillary: Green
- Brachial: Orange
- Radial: Purple
- Celiac trunk: Red
- Superior mesenteric: Blue
- Inferior mesenteric: Yellow
- Renal: Brown
- Common iliac: Pink
- Internal iliac: Green
- External iliac: Orange
- Femoral: Purple

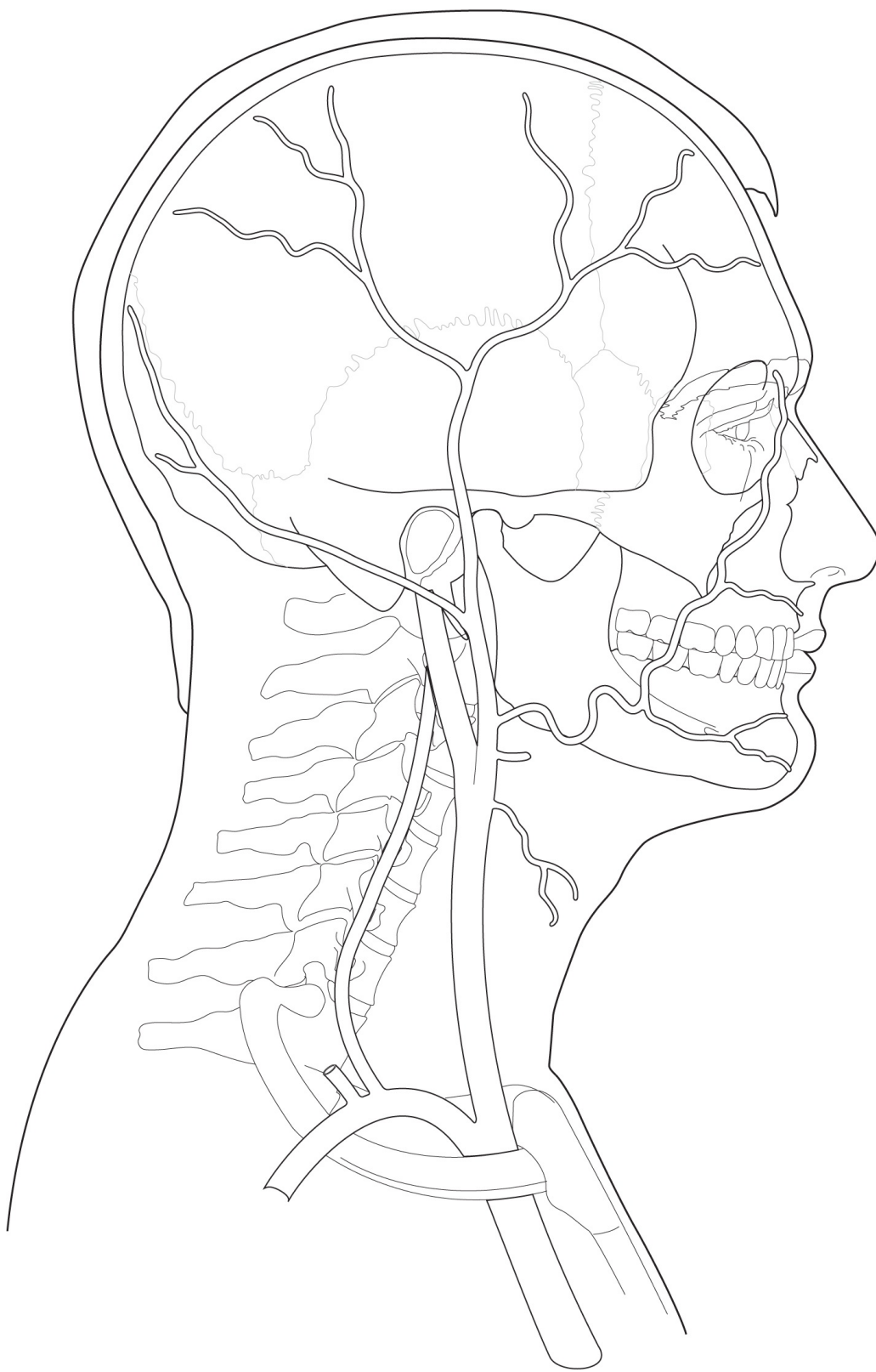
- Popliteal: Green
- Anterior tibial: Blue
- Posterior tibial: Orange
- Dorsalis pedis: Red



Conceptualize in Color Arteries of the Head and Neck

Identify the key arteries in the head and neck by coloring the figure below. Use the suggested colors or choose your own.

- Subclavian artery: Red
- Brachiocephalic: Orange
- Vertebral artery: Blue
- Common carotid: Yellow
- Internal carotid: Green
- External carotid: Purple

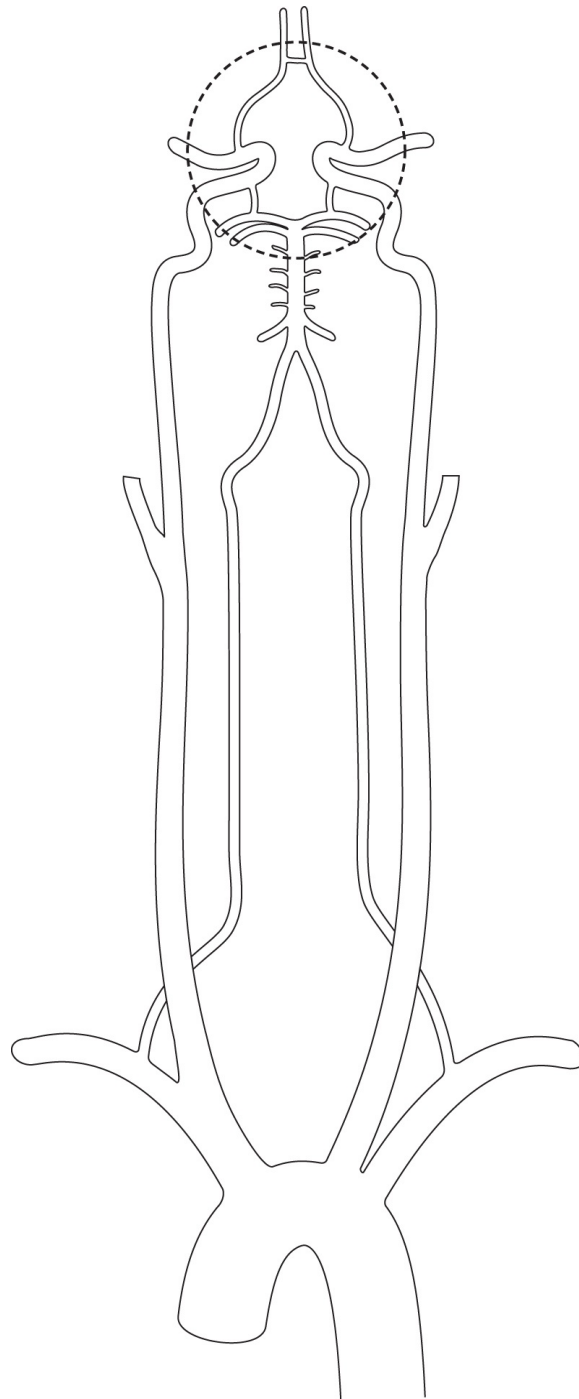


Conceptualize in Color The Circle of Willis

Identify arteries in the circle of Willis by coloring the figure below. Use the suggested colors or choose your own.

- Anterior cerebral arteries: Red
- Anterior communicating artery: Green

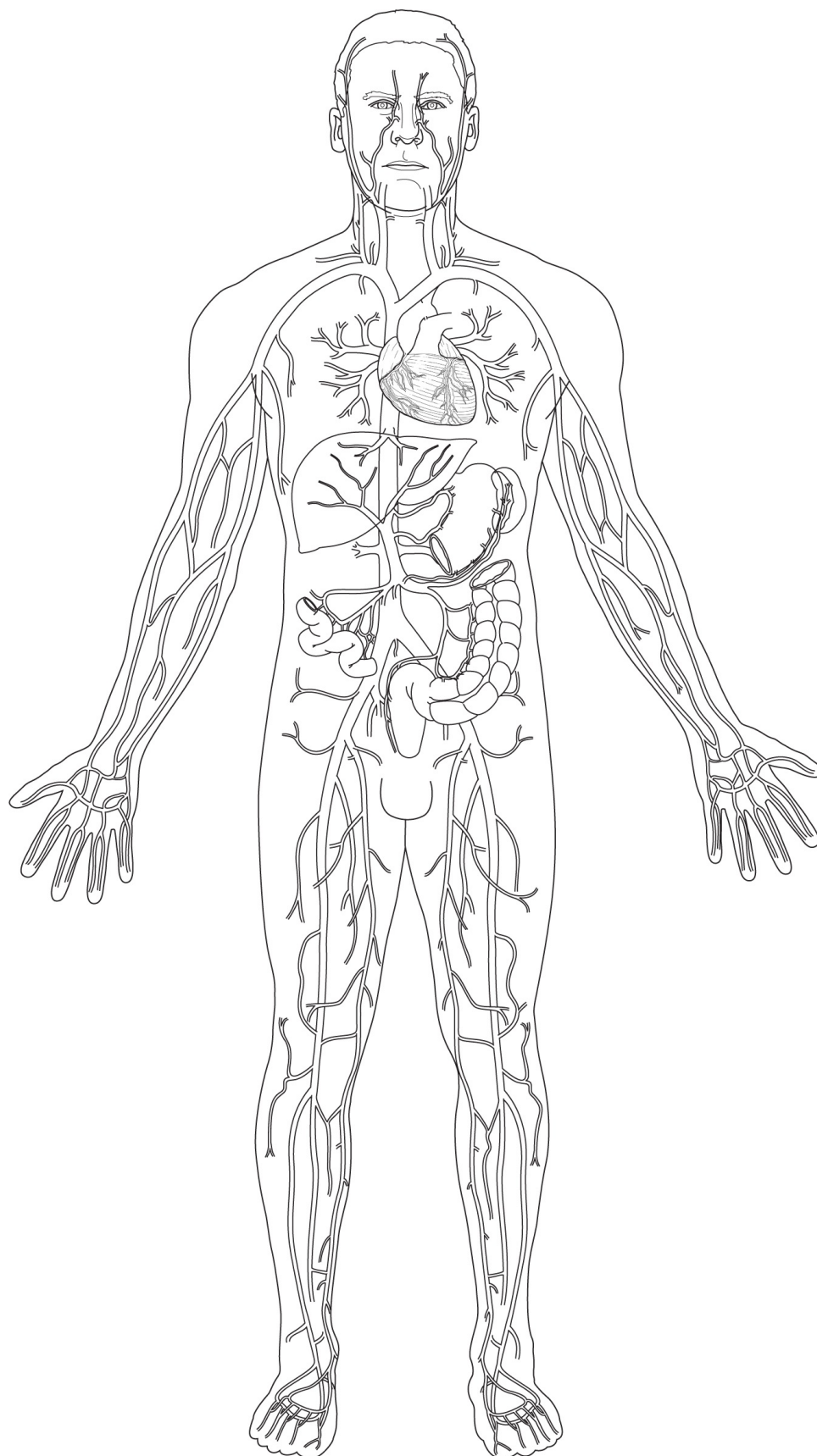
- Posterior communicating arteries: Orange
- Posterior cerebral arteries: Purple
- Basilar artery: Yellow
- Internal carotids: Dark blue
- Vertebral arteries: Brown
- Common carotid arteries: Pink
- Right and left subclavian arteries: Gray
- Brachiocephalic artery: Light blue
- Aortic arch: Dark red



Conceptualize in Color Principal Veins

Identify the principal veins by coloring the figure below. Use the suggested colors or choose your own.

- Basilic: Purple
- Cephalic: Orange
- Axillary: Pink
- Subclavian: Blue
- Brachiocephalic: Green
- Superior vena cava: Dark red
- Internal jugular: Orange
- External jugular: Purple
- Median cubital: Green
- Inferior vena cava: Tan
- External iliac: Red
- Internal iliac: Dark blue
- Common iliac: Yellow
- Hepatic: Light red
- Great saphenous: Brown
- Posterior tibial: Orange
- Anterior tibial: Gold
- Popliteal: Pink
- Femoral: Purple

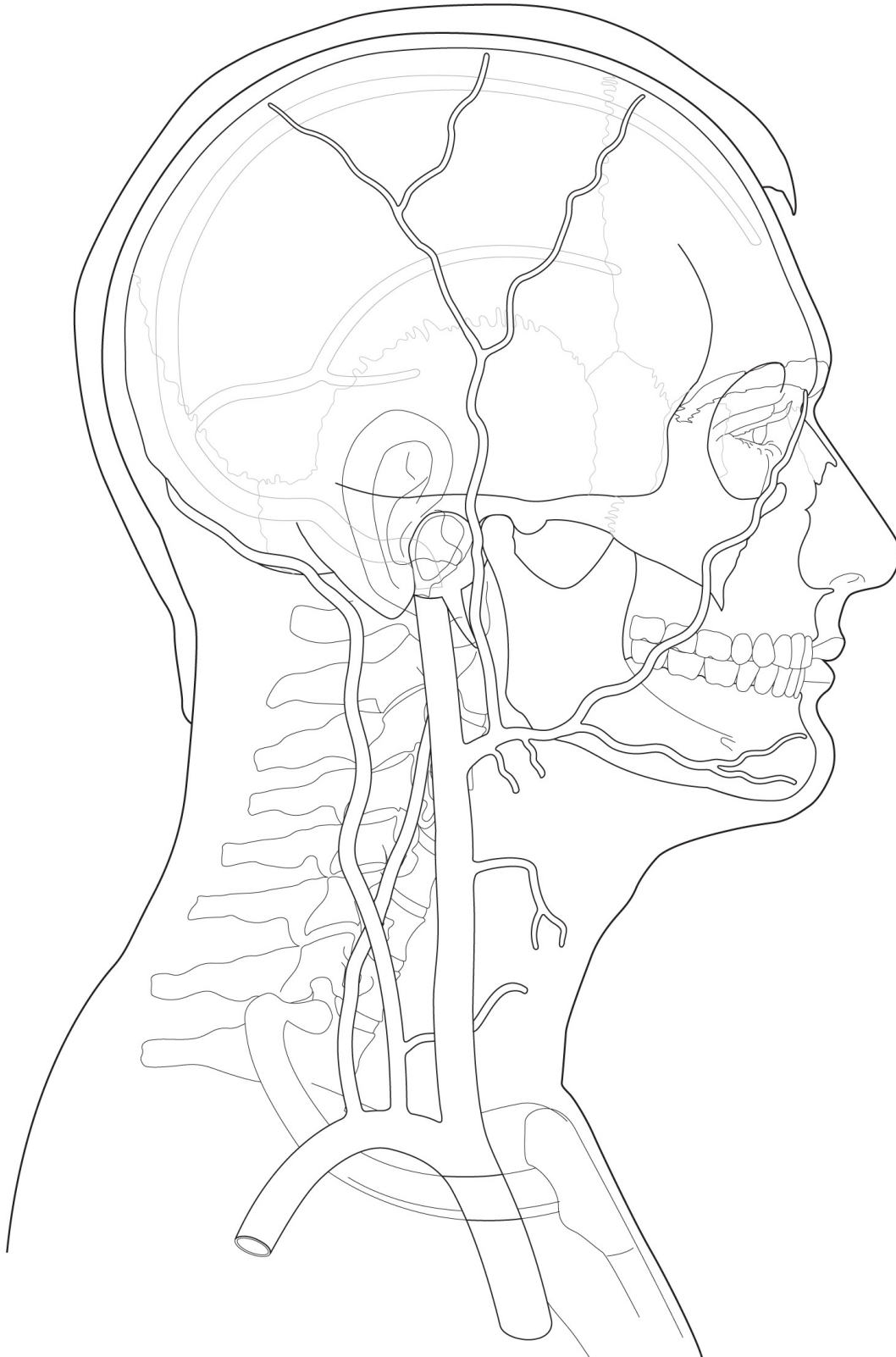


Conceptualize in Color Veins of the Head and Neck

Identify the key veins of the head and neck by coloring the figure below. Use the suggested colors or choose your own.

- Internal jugular: Red

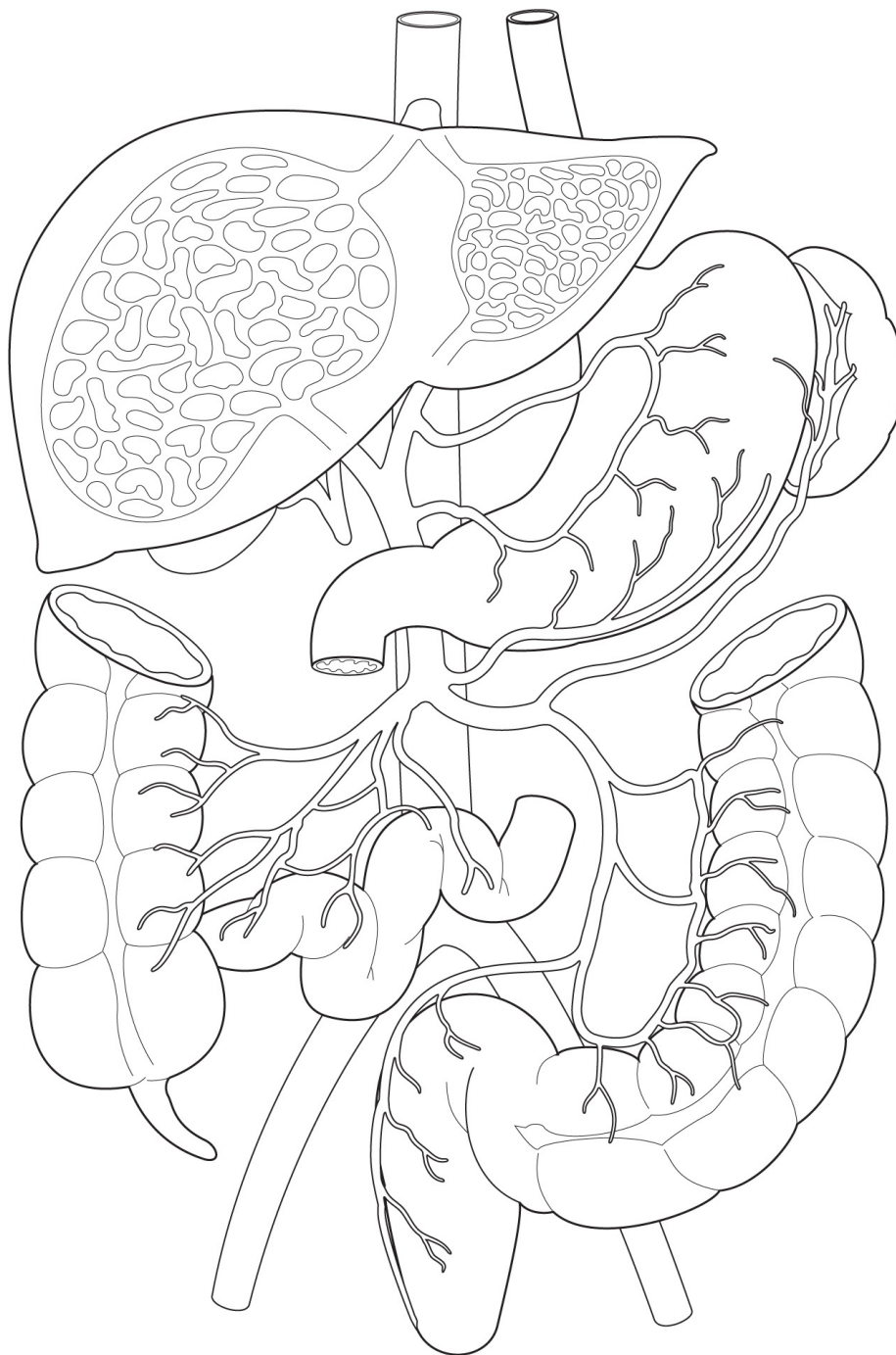
- Right subclavian: Yellow
- Brachiocephalic: Brown
- External jugular: Purple
- Vertebral: Green



Conceptualize in Color Hepatic Portal Circulation

Identify the key veins of the hepatic portal circulation by coloring the figure below. Use the suggested colors or choose your own.

- Inferior vena cava: Red
- Hepatic veins: Orange
- Portal vein: Purple
- Superior mesenteric vein: Green
- Splenic vein: Yellow
- Inferior mesenteric vein: Pink



Illuminate the Truth Circulation and Blood Pressure

Highlight the word or phrase that completes each sentence correctly.

1. A (portal)(venous) network is one in which blood flows through two sets of capillaries.
2. Blood always flows from an area of (higher)(lower) pressure to an area of (higher)(lower) pressure.
3. This difference in pressure is called a pressure (resistance)(gradient).
4. When the left ventricle contracts, it ejects blood into the aorta, producing a typical, normal blood pressure of (140 mm Hg)(110 mm Hg); this is called the (diastolic)(systolic) pressure.
5. When the ventricle relaxes, the pressure drops to an average of (70 mm Hg)(90 mm Hg); this is called the (diastolic)(systolic) pressure.
6. As blood moves away from the heart, blood pressure (remains constant)(continues to decline).
7. The greater the (pressure difference)(resistance) between two points, the greater the flow.
8. A lower than normal blood pressure is called (hypotension)(hypertension), while higher than normal blood pressure is called (hypotension)(hypertension).
9. A blood pressure of 128/78 mm Hg would be considered (normal)(elevated).
10. A blood pressure of 152/89 mm Hg would be considered (stage I hypertension)(stage II hypertension).
11. The opposition to flow resulting from the friction of moving blood against the vessel walls is called (high blood pressure)(peripheral resistance).

Describe the Process Maintenance of Blood Pressure

The maintenance of blood pressure is crucial for normal body functioning. The following chart lists three factors that determine blood pressure. Using the spaces below, describe how each factor influences blood pressure and provide formulas for each. Formulas for cardiac output have been provided to get you started.

FACTOR		HOW FACTOR INFLUENCES BLOOD PRESSURE	FORMULA
1.	Cardiac output		$\uparrow \text{CO} = \uparrow \text{BP}$ $\downarrow \text{CO} = \downarrow \text{BP}$
2.	Blood volume		
3.	Resistance		

Just the Highlights High and Low Blood Pressure

In the following list, highlight the factors that would cause blood pressure to rise in yellow and the factors that would cause a drop in blood pressure in blue.

1. Increased blood viscosity
2. Vasodilation
3. Vasoconstriction
4. Hemorrhage
5. Atherosclerosis
6. Decreased number of red blood cells
7. Dehydration
8. Exercise

List for Learning Capillary Blood Flow

Using the spaces below, list four reasons why blood flow is slower in capillaries than in other parts of the vascular system.

1. _____
2. _____
3. _____
4. _____

Fill in the Gaps Neural Regulation of Blood Pressure

The vascular system can quickly adjust blood pressure and alter the flow of blood to respond to the body's changing needs. Fill in the blanks with the appropriate word or words to describe how the nervous system affects blood pressure. Choose from the words listed in the Word Bank below.

AORTIC ARCH
CAROTID SINUS
DROPS
GLOSSOPHARYNGEAL
MEDULLA
PARASYMPATHETIC
RISES
SYMPATHETIC
VAGUS
VASOCONSTRICTION
VASODILATION

1. Baroreceptors in the _____ and _____ detect changes in blood pressure and transmit signals along the _____ and _____ nerves to the cardiac control center and the vasomotor center in the _____.
2. If the pressure is too high:
 - a. The medulla increases its output of _____ impulses.
 - b. _____ occurs; heart rate and stroke volume decrease.
 - c. Blood pressure _____.
3. If the blood pressure is too low:
 - a. The medulla increases its output of _____ impulses.
 - b. _____ occurs; heart rate and stroke volume increase.
 - c. Blood pressure _____.

Just the Highlights Hormonal Regulation of Blood Pressure

In the following list, highlight the names of the hormone(s) that cause blood pressure to rise in pink and the names of the hormone(s) that cause blood pressure to fall in blue. (Hint: Not all the hormones listed will be highlighted.)

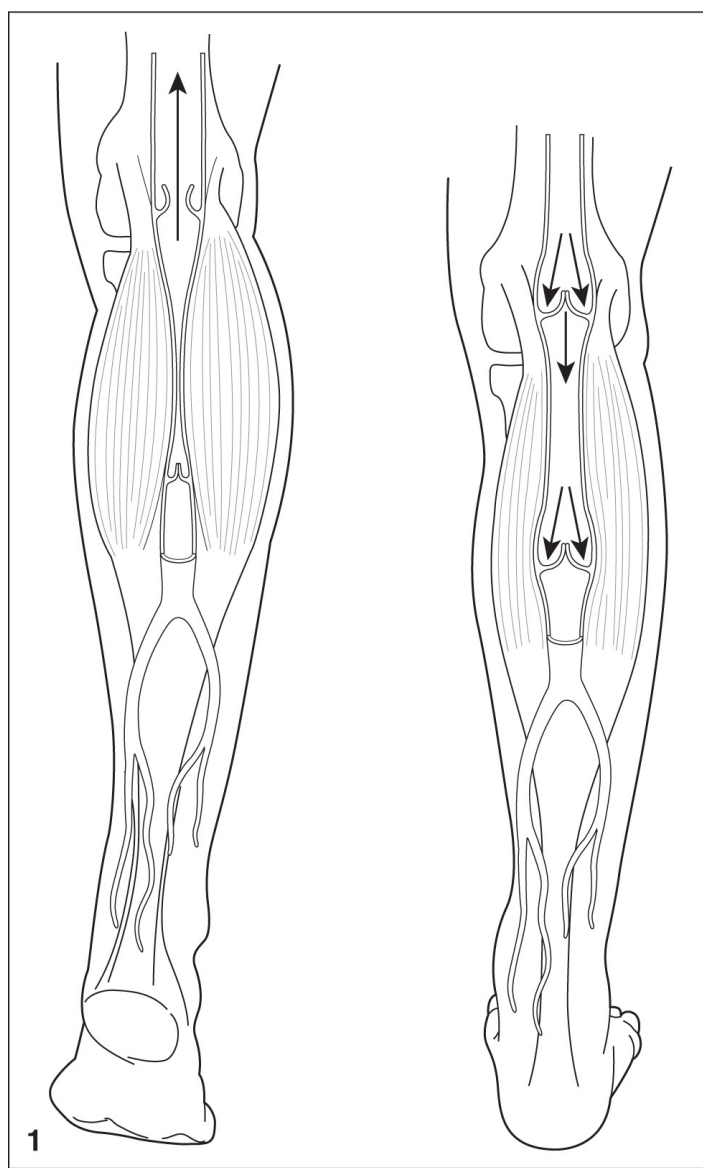
1. Epinephrine
2. Aldosterone
3. Insulin
4. Antidiuretic hormone (ADH)
5. Atrial natriuretic peptide (ANP)
6. Gastrin
7. Renin, angiotensin I, and angiotensin II
8. Norepinephrine
9. Estrogen

Describe the Process Venous Return

Using the spaces below, identify and describe the two key mechanisms that aid in venous return. Use the figures as a guide.

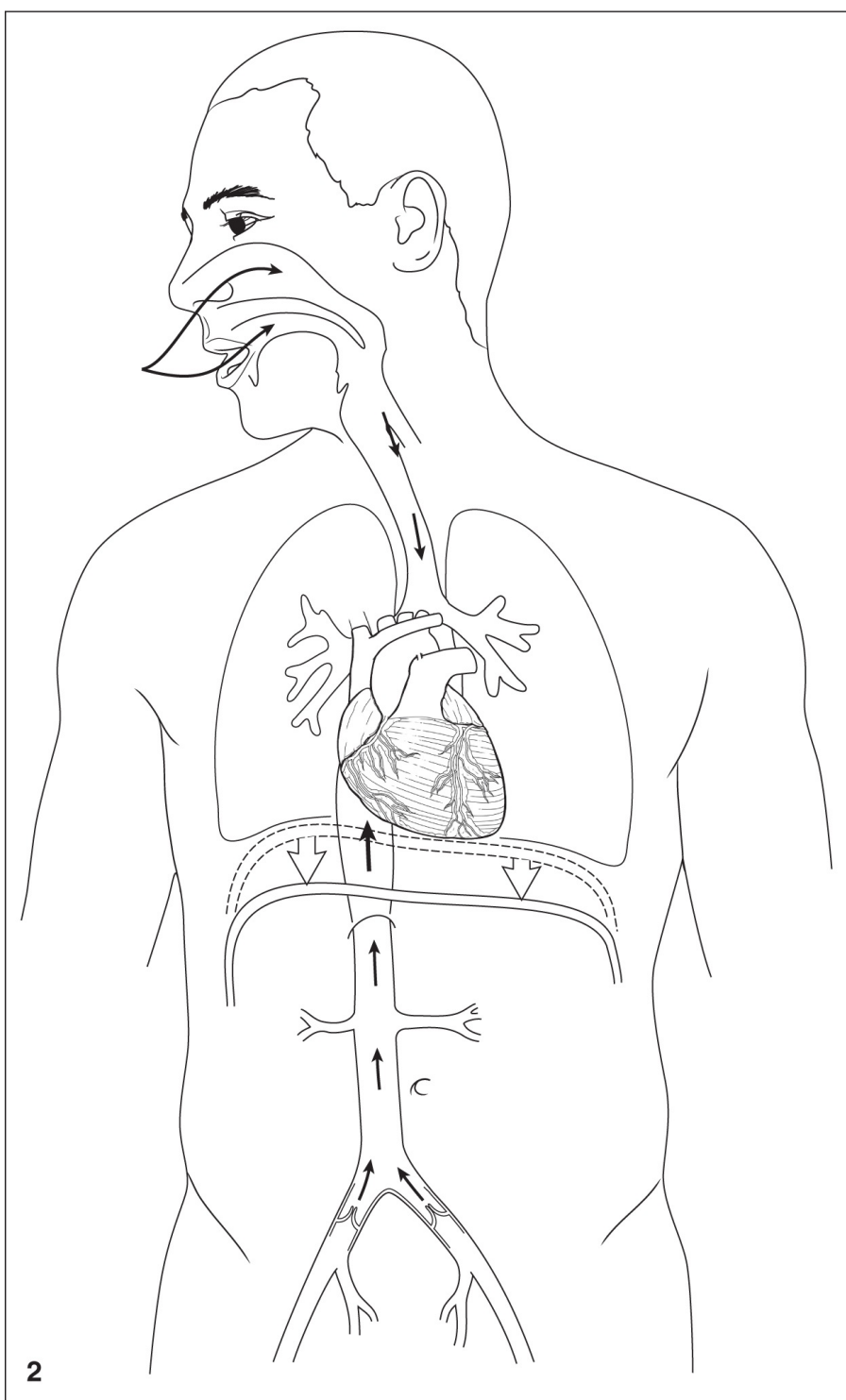
1. What mechanism is illustrated by the figure below?

How does this mechanism function? _____



1

2. What mechanism is illustrated by the figure below?
How does this mechanism function? _____



chapter 17

LYMPHATIC & IMMUNE SYSTEMS

The lymphatic and immune systems work together to protect the body against disease. The immune system consists primarily of a population of cells that defend the body against invasion by viruses, bacteria, and other disease-causing agents. These cells inhabit the lymphatic system: a network of organs and vessels that extend throughout the body.

Make a Connection Lymphatic Organs and Tissues

Patches of specialized tissue containing lymphocytes exist throughout the body. Lymphatic organs, however, are well defined. In the spaces below, list the names of the lymphatic organs and tissues. The first letter or two of each term is provided to get you started. Then, draw a line to link each tissue or organ to its description or function. Note that items may link with more than one characteristic.

1. Th _____
2. L _____
N _____
3. To _____
4. S _____
5. A _____
6. P _____
P _____

- a. Consists of masses of lymphoid tissue that form a protective circle at the back of the throat
- b. Analyzed to determine whether cancer has metastasized
- c. May serve as reservoir for beneficial gut bacteria
- d. The body's largest lymphatic organ
- e. Small masses of lymphatic tissue scattered throughout the intestines
- f. Large in children, this organ shrinks to a fraction of its former size by adulthood.
- g. Besides cleansing lymph, also serve as sites for final maturation of some types of lymphocytes and

monocytes

- h. Provides a location for B and T lymphocytes to mature
- i. Monitor bacterial populations within the intestine and help prevent growth of harmful bacteria.
- j. Prone to injury, rupture of this organ could result in a fatal hemorrhage
- k. Provides a spot where immune cells phagocytize bacteria and other harmful substances from lymph before it returns the fluid to the bloodstream

List for Learning Functions of the Lymphatic System

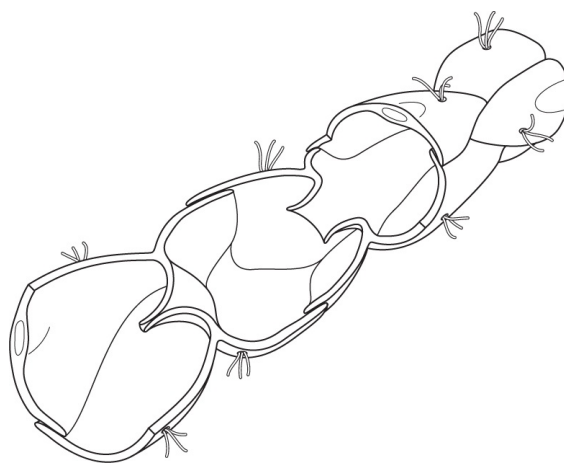
Using the spaces below, list the three functions of the lymphatic system.

1. _____
2. _____
3. _____

Drawing Conclusions Lymphatic Vessels

Although lymphatic vessels are similar to veins, they have some key differences. Test your knowledge of lymphatic vessels by filling in the blanks of each sentence. Then, color the figure below as described.

1. Lymphatic vessels originate in _____ as microscopic, blind-ended sacs within a bed of _____.
(Color the lymphatic vessel shown in the figure green.)
2. Lymphatic vessels are filled with _____, a clear, colorless fluid that originates in _____ as the fluid left behind after _____.
3. _____ flows into lymphatic vessels through gaps between cells. _____, _____, and _____ flow in with the fluid.
(Insert arrows in the figure to illustrate how fluid enters the vessel.)
4. Valves prevent backflow, ensuring that lymph moves _____ from tissues and _____ the heart.
(Color the valves in the figure dark blue; insert arrows to show the direction of flow.)
5. _____ anchor the lymphatic vessels to surrounding cells, which helps to keep the vessels from collapsing.
(Color these structures in the figure purple.)



Illuminate the Truth Lymph Flow

Highlight the word or phrase that completes each sentence correctly.

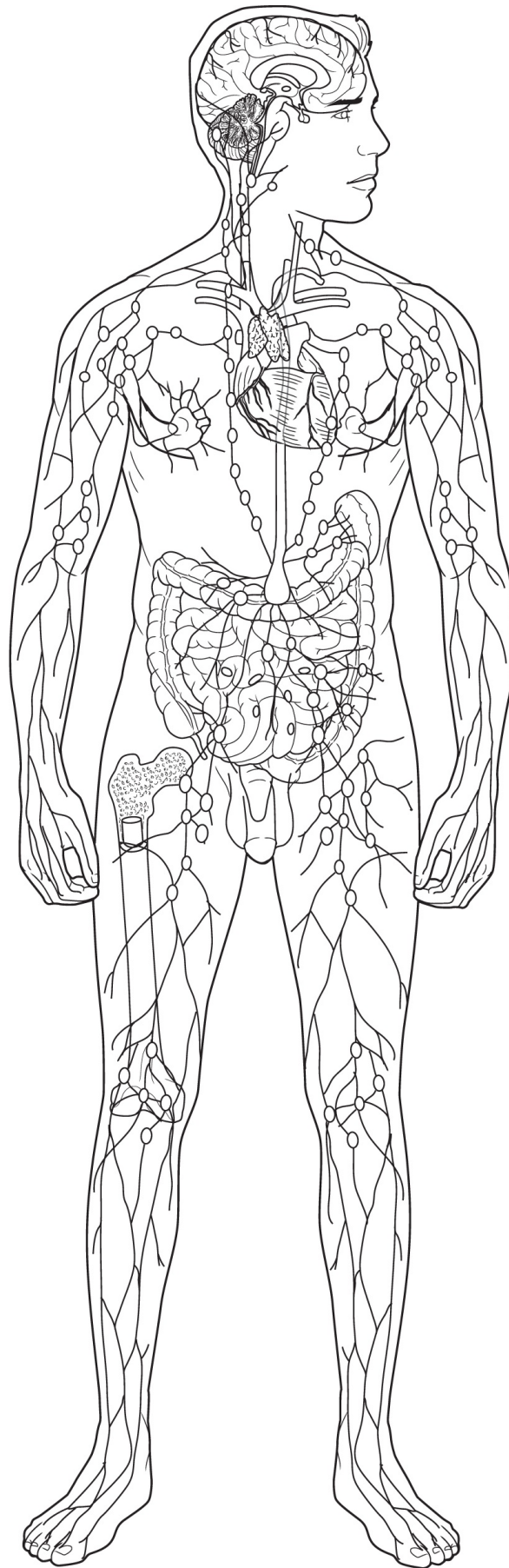
1. Lymph moves (rapidly)(slowly) and (actively)(passively).
2. The primary way lymph is propelled through lymphatic vessels is by (contractions of the heart) (contractions of the lymphatic vessels).
3. Flow is further aided by (contraction of skeletal muscles)(contraction of the spleen).
4. Another aid to propelling lymph from the abdominal to the thoracic cavity is (intestinal contractions) (respirations).

Conceptualize in Color Overview of the Lymphatic System

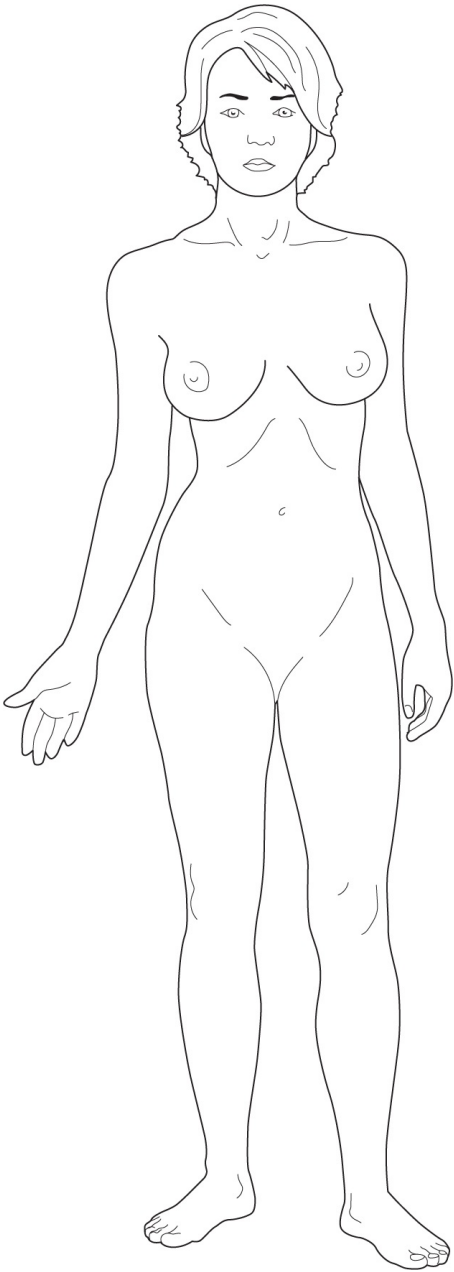
The lymphatic system consists of lymphatic vessels, lymph, lymphatic tissue, and lymphatic organs. Identify the structures of the lymphatic system by coloring the figure below. Use the suggested colors or choose your own.

- Spleen: Red
- Red bone marrow: Pink
- Cervical lymph nodes: Green
- Axillary lymph nodes: Purple
- Inguinal lymph nodes: Orange
- Tonsils: Brown
- Thymus gland: Tan
- Appendix: Light blue
- Peyer's patches: Gold
- Trace the lymphatic vessels in blue
- Shade the area drained by the right lymphatic duct yellow

- Shade the area drained by the thoracic duct light purple



Test your knowledge of lymphatic drainage by filling in the blanks of each sentence. Then, color the areas drained by each duct a different color in the figure below.



- 1. The lymphatic system has _____ (Hint: a number) collecting ducts.
- 2. The _____ duct drains lymph from the upper quadrant of the body into the _____.
- 3. The _____ duct drains lymph from the rest of the body into the _____.

Fill in the Gaps Lymphatic Tissues

Throughout the body are patches of specialized tissue that play a role in defense and immunity. Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

APPENDIX
GUT-ASSOCIATED LYMPHATIC TISSUE (GALT)
LYMPHOCYTES
MUCOSA-ASSOCIATED LYMPHATIC TISSUE (MALT)
MUCOSA LINING
PEYER'S PATCHES
RED BLOOD CELLS
THREE
TONSILS
TWO

1. Lymphatic tissues house a variety of _____.
2. Passages that open to the exterior of the body contain a scattering of _____ throughout their _____.
3. This is known as _____.
4. The _____ are masses of lymphatic tissue at the back of the throat and consist of _____ (Hint: A number) sets.
5. The _____ is a narrow pouch projecting off the lower end of the large intestine; it is densely populated with _____.
6. Scattered throughout the small intestine are small masses of lymphatic tissue called _____; these are part of what's known as _____.

Fill in the Gaps Primary and Secondary Lymphatic Organs

Fill in the blanks with the appropriate word or words to describe the primary and secondary lymphatic organs. Choose from the words listed in the Word Bank below. Not all words may be used.

ACTIVATED
BODY CELLS
CAPSULE
DESTROYED
IMMATURE
LYMPH NODES
LYMPHOCYTES
MATURE
ORGANS
PATHOGENS
RED BONE MARROW
SPLEEN
STEM CELLS
T AND B LYMPHOCYTES
THYMUS
TISSUES

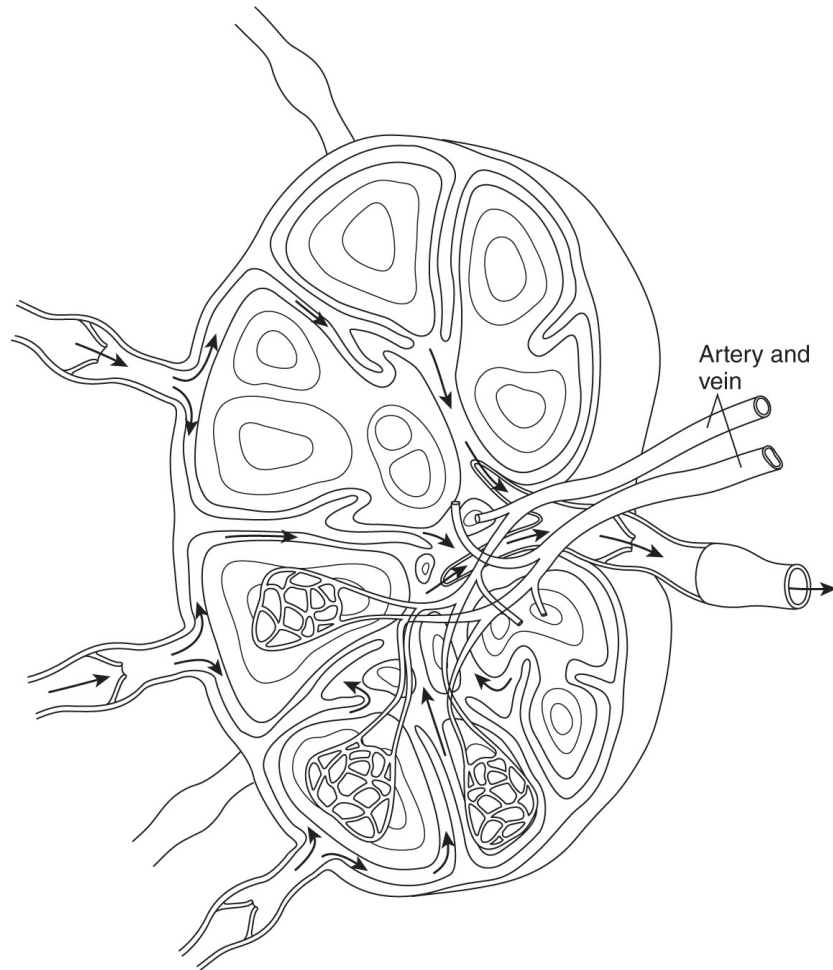
1. Lymphatic _____ are well defined and are surrounded by a _____ of connective tissue.
2. Primary lymphatic organs include the _____ and _____.
3. These organs provide a location for _____ to divide and mature into _____.
4. This is also where _____ learn to recognize _____.
5. Secondary lymphatic organs include the _____ and _____.
6. This is where _____ lymphocytes become _____.

Conceptualize in Color Lymph Node

As lymph flows through lymphatic vessels, it passes through multiple lymph nodes. Identify the structures of the lymph node by coloring the figure below. Use the suggested colors or choose your own.

- Fibrous capsule: Tan
- Trabeculae: Green

- Sinuses: Light blue
- Cortical nodules: Purple
- Germinal centers: Pink
- Afferent vessels: Brown
- Efferent vessel: Orange
- Insert arrows showing direction of lymph flow



List for Learning Functions of the Spleen

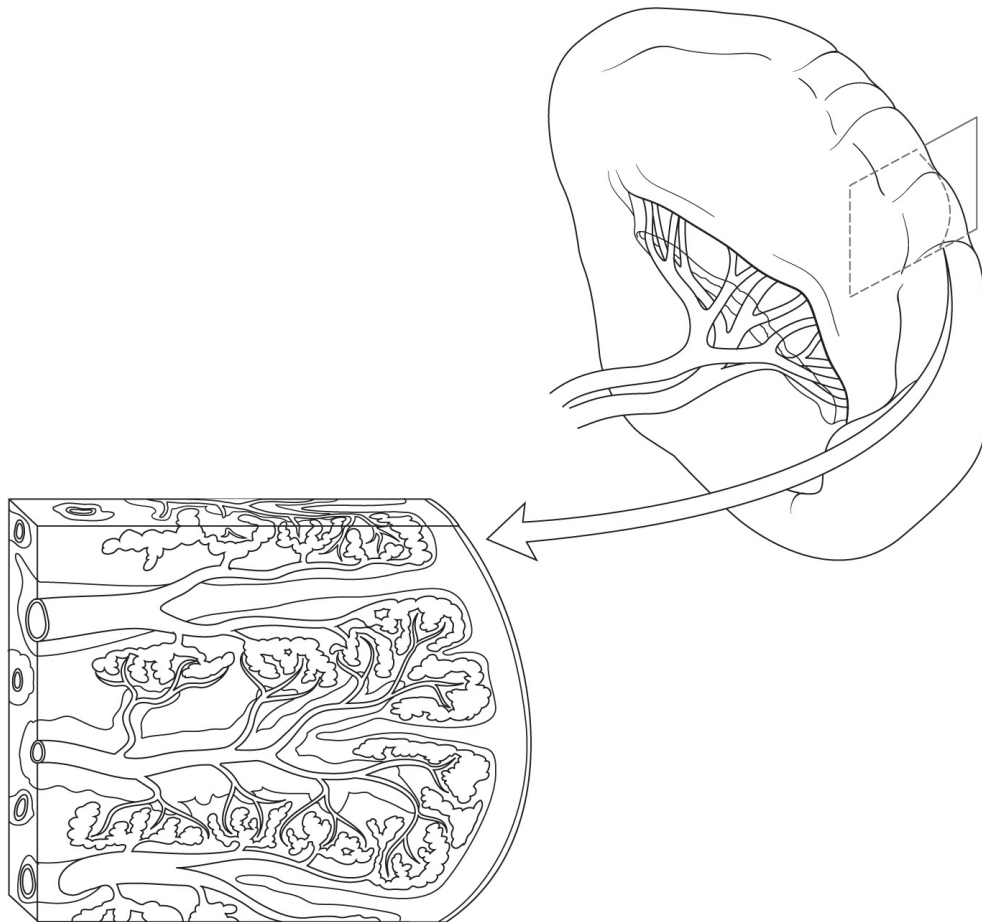
The spleen is the body's largest lymphatic organ. Using the spaces below, list four functions of this major lymphatic organ.

1. _____
2. _____
3. _____
4. _____

Drawing Conclusions The Spleen

Test your knowledge of the spleen by filling in the blanks of each sentence. Then, color the splenic structures in the figure below. Use the suggested colors or choose your own.

1. The spleen lies in the upper quadrant of the abdomen.
2. The spleen is structurally similar to the _____.
3. Lymphocytes and macrophages in the pulp screen the passing blood for foreign antigens.
4. Macrophages in the remove and digest worn-out blood cells.
5. The spleen stores 20% to 30% of the body's _____.
6. The spleen produces in the fetus.



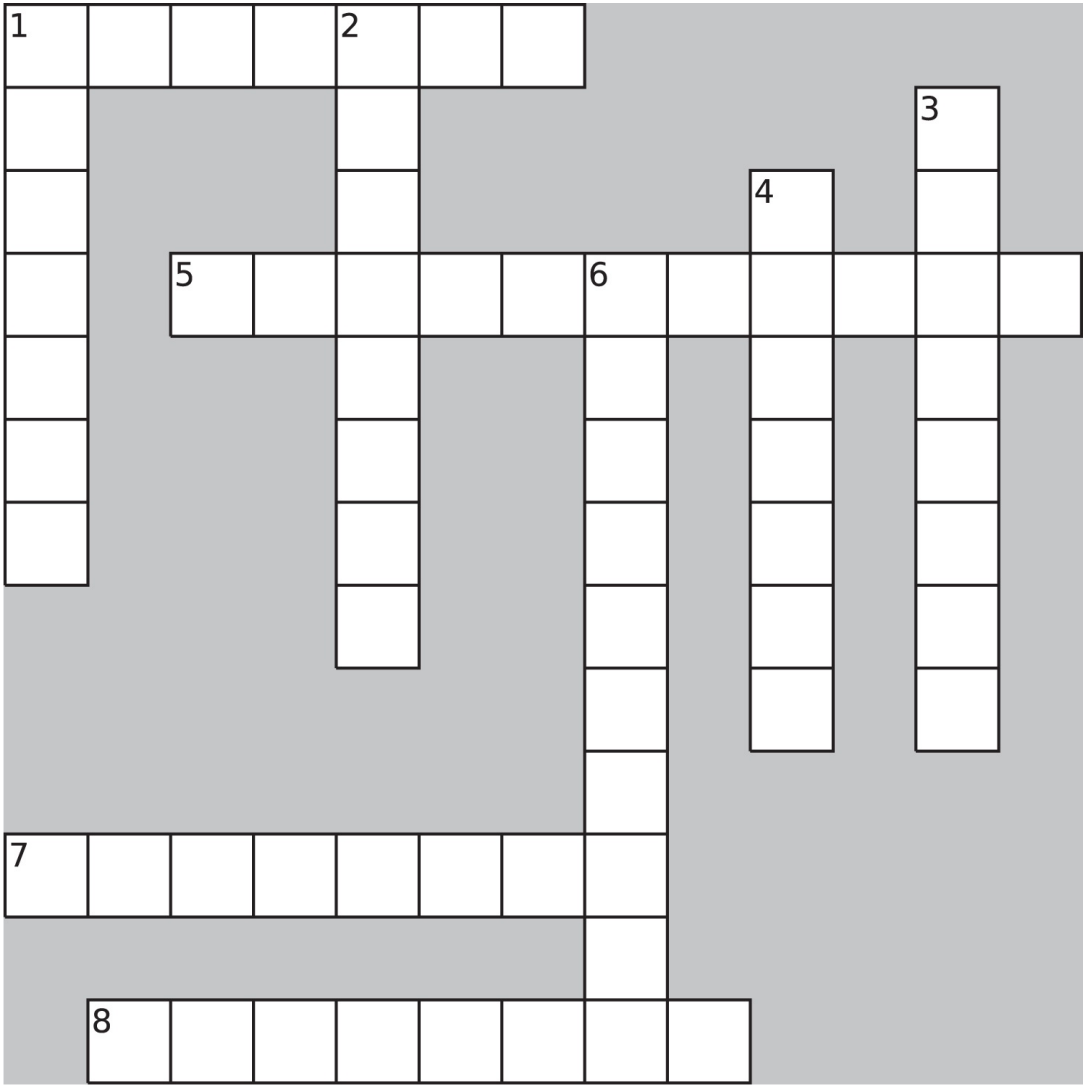
Color the following structures:

- Spleen: Brown
- Venous sinuses: Purple
- White pulp: Yellow
- Red pulp: Pink
- Capsule: Tan

- Artery: Red
- Veins: Blue
- Splenic artery: Red
- Splenic vein: Blue

Puzzle It Out The Lymphatic System

Complete the following crossword puzzle to test your knowledge of the lymphatic system.



ACROSS

- Red bone marrow and the thymus are known as _____ lymphatic organs because they provide a location for B and T lymphocytes to mature.
- An acute inflammation of the tonsils
- The tonsils most likely to become infected
- Location of lymph nodes that monitor lymph coming from the head and neck

DOWN

1. Lymph has a lower _____ content than does plasma.
2. Term for pharyngeal tonsils
3. Lymph nodes through which most breast cancers metastasize
4. Tonsils concentrated in patches on either side of the tongue
6. Swelling that results when the lymphatic vessel is obstructed

List for Learning Innate Immune System

Using the spaces below, list four barriers used by the innate immune system as a first line of defense against pathogens.

1. _____
2. _____
3. _____
4. _____

Then, list five measures used by the innate immune system as a second line of defense.

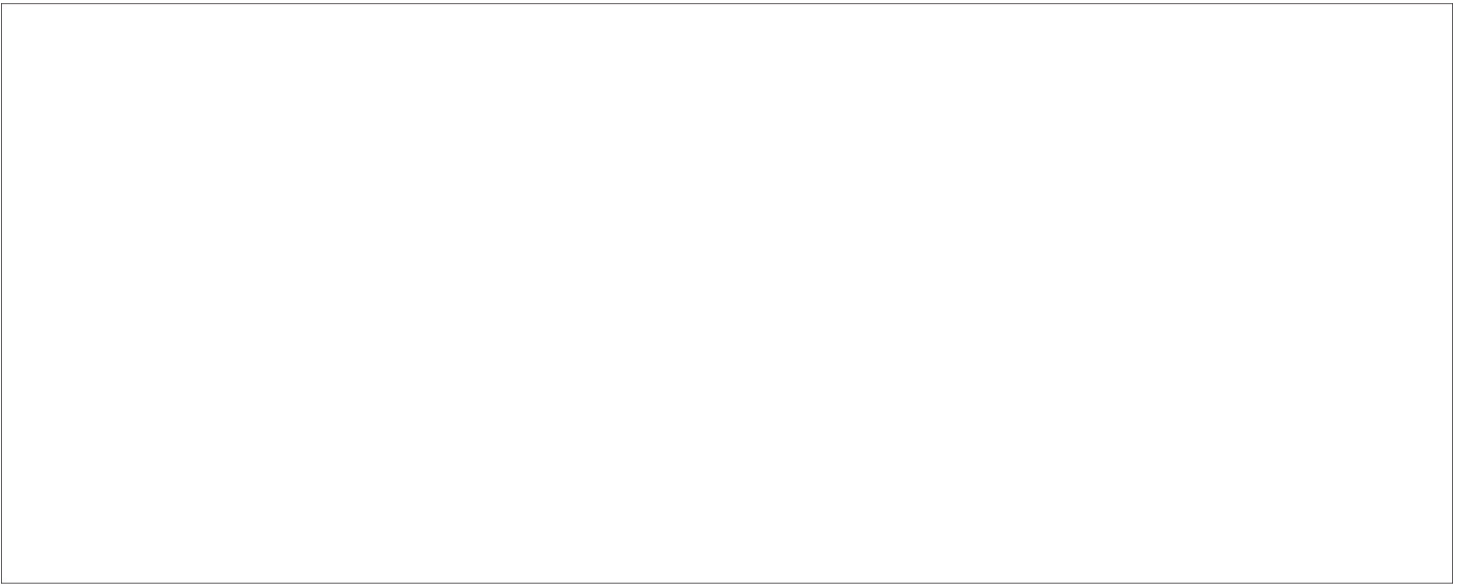
5. _____
6. _____
7. _____
8. _____
9. _____

Drawing Conclusions Phagocytosis

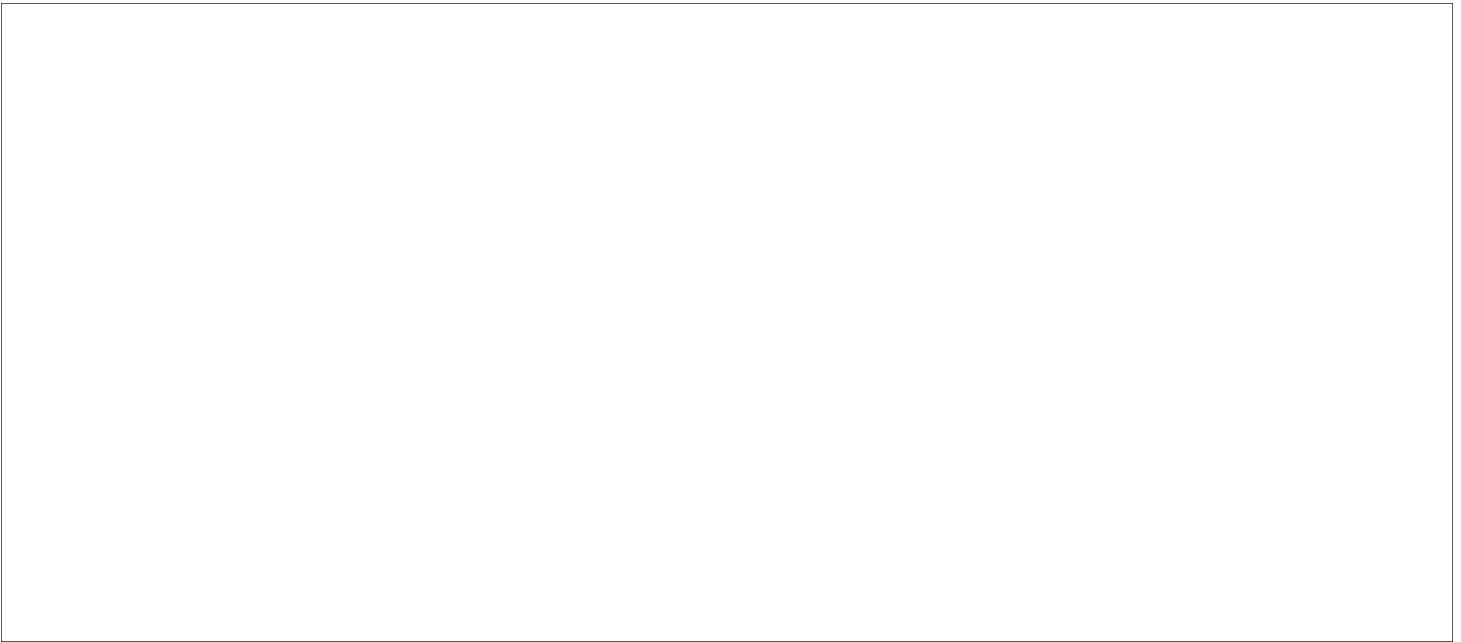
Phagocytes are cells whose sole job is to ingest and destroy microorganisms. Test your knowledge of phagocytosis by filling in the blanks of each sentence. Then, illustrate the process in the spaces provided as described.

1. When a phagocyte encounters a microorganism, it sends out membrane projections called _____.

(In the space below, draw a cell sending out projections as described in sentence 1. Be sure to include a nucleus and lysosomes inside the cell. Then, draw structures symbolizing bacteria outside the cell.)



- 2.** The envelops the organism, forming a complete sac called a _____.
(Draw the second step in phagocytosis as described in sentence 2. Be sure to include a bacterium inside the second cell.)



- 3.** The travels to the interior of the cell and fuses with a _____.
(Draw a third cell showing the process of phagocytosis as described in sentence 3.)

4. from the destroy the microorganism.

(Draw the final step in phagocytosis as described in sentence 4.)

Make a Connection Types of Phagocytes

In the spaces below, list the two most important phagocytes. The first letter of each term is provided to get you started. Then, draw a line to link each type of phagocyte to its characteristics.

1. M_____

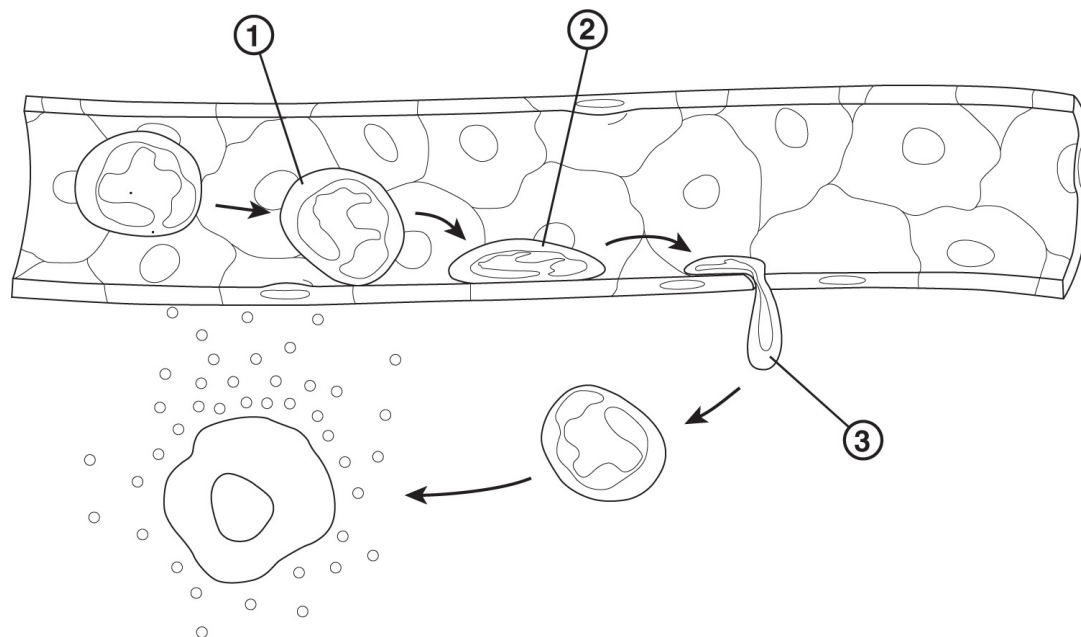
2. N_____

- a. Evolve from monocytes
- b. Secrete toxic chemicals to form a “killing zone” around its perimeter

- c. Roam the body, seeking out bacteria
- d. Congregate in areas where microbial invasion is likely
- e. Squeeze through spaces in vessel walls to enter inflamed tissue
- f. Tend to remain fixed in such areas as the lungs, liver, and spleen

Drawing Conclusions Neutrophils

Neutrophils are important phagocytes within the immune system. Test your knowledge of the immune system by coloring the neutrophils pink, the inflamed cell green, and the chemical agent purple. Then, fill in the blanks to describe the action of neutrophils. Use the numbers in the figure as a guide.



1. _____ release a chemical that summons neutrophils, a process known as _____.
2. Once there, neutrophils _____.
3. They then _____. This process is called _____.
4. In addition, the neutrophils also secrete _____ to form a killing zone around themselves to kill even more pathogenic cells.
5. Pus, a thick yellowish fluid, consists of _____.
6. When pus accumulates in a tissue cavity, it is called an _____.

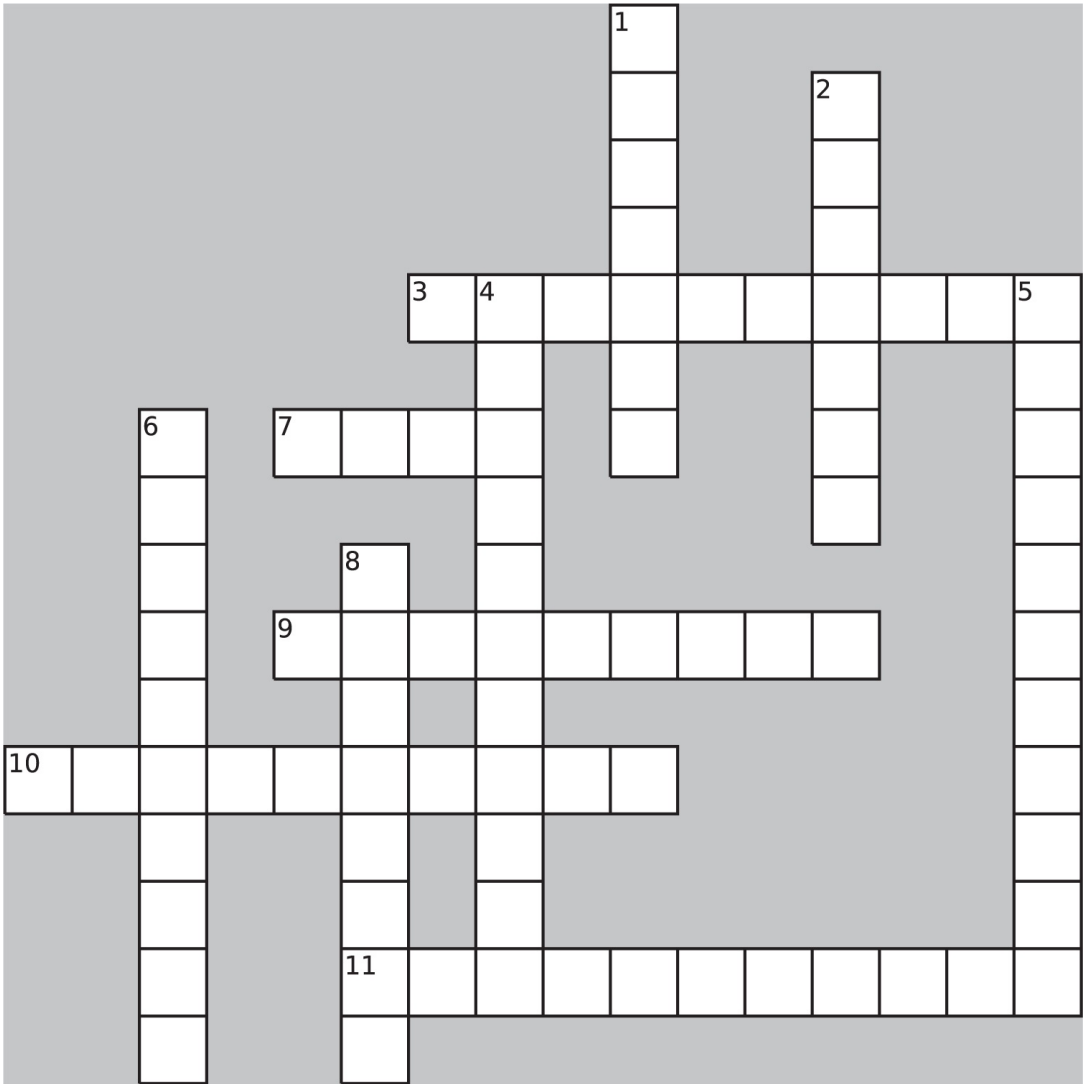
Illuminate the Truth Process of Inflammation

Tissue injury produces inflammation, which stimulates the immune system. Highlight the word or phrase that completes each sentence correctly.

1. Injured cells secrete chemicals, such as (histamine)(complement) that (constrict)(dilate) blood vessels in the area. Blood rushes in, bringing necessary (platelets)(leukocytes) and flushing out toxins and wastes.
2. The same chemicals cause the cells in the capillary walls to (constrict)(separate) slightly. Fluid, leukocytes, and plasma proteins—as well as antibodies, clotting factors, and complement—(flow into the capillary)(leak into the tissue).
3. (Neutrophils)(Platelets), which have been drawn to the area by chemicals released from damaged cells, (form a clot)(phagocytize the pathogens).
4. Neutrophils also secrete chemicals to summon other neutrophils and (platelets)(macrophages), which help destroy bacteria and engulf dead and damaged cells.

Puzzle It Out Immune System

Complete the following crossword puzzle to test your knowledge of the immune system.



ACROSS

3. Antimicrobial protein secreted by a virus-infected cell
7. First line of defense against microorganisms
9. Area of increased blood flow
10. Immunoglobulins
11. Phagocytic white blood cells that congregate in areas where invasion is likely to occur

DOWN

1. An accumulation of pus within a cavity
2. Fever
4. Type of immunity aimed at a broad range of attackers
5. Phagocytic white blood cells that roam the body, seeking bacteria
6. Process whereby neutrophils are attracted to sites of infection as a result of a chemical released from inflamed cells
8. Enzyme found in mucus, tears, and saliva that destroys bacteria

Drawing Conclusions Complement System

Proteins called complement circulate in the bloodstream in inactive form. Once activated, a complement reaction begins. Test your knowledge of this process by filling in the blanks of each sentence. Then, draw the process in the space below as described.

1. _____ or _____ activate complement, triggering a cascade of chemical reactions. The final group of proteins, called the _____, embed themselves into the bacterium's membrane in ring-like circles.
(On the left-hand side of the space below, draw a large oval to symbolize a bacterium. Draw small triangles outside the bacterium to symbolize complement. Draw the complement embedding in the wall of the bacterium in ring-like circles.)
2. _____ and _____ rush into the bacterium through the openings.
(Draw another bacterium with the ring-like circles of complement embedded in the wall. Draw arrows and symbols to represent the process being described in sentence 2.)
3. The bacterium _____ and _____.
(Draw what is being described in sentence 3.)

List for Learning

Acute Inflammation

Using the spaces below, list the four classic signs of acute inflammation.

1.
2.
3.
4.

Sequence of Events

Fever

Insert the numbers 1 through 7 in the spaces provided to identify the sequence of events that occur during a fever.

- A. The temperature rises until it reaches its new set point, where it remains as long as the pathogen is present.
- B. Neutrophils and macrophages secrete a fever-producing substance called a pyrogen.
- C. When the pathogen is no longer a threat, the phagocytes stop producing the pyrogen, and the body's set point for temperature returns to normal.
- D. The body loses excess heat through sweating and dilating the blood vessels in the skin, resulting in warm, flushed skin.
- E. PGE resets the body's set point for temperature.
- F. The body shivers and constricts the blood vessels in the skin, resulting in chills and cold, clammy skin.

_____ G. The pyrogen stimulates the anterior hypothalamus to secrete prostaglandin E (PGE).

Make a Connection Classes of Immunity

In the spaces below, list the four classes of immunity. The first letter of each word is provided to get you started. Then, draw a line to link each class of immunity with its characteristics. Note that items may link with more than one characteristic.

1. N _____

A _____

2. A _____

A _____

3. N _____

P _____

4. A _____

P _____

- a. Results following an injection of serum from a person or animal that has produced antibodies against a pathogen
- b. Occurs when the body produces antibodies or T cells after being exposed to a particular antigen
- c. Follows a tetanus shot
- d. Follows an infection with measles
- e. Occurs through breastfeeding
- f. Results when the body makes T cells and antibodies following a vaccination
- g. Follows an injection for rabies
- h. Results when a fetus acquires antibodies from the mother through the placenta

Illuminate the Truth Adaptive Immunity

Highlight the word or phrase that completes each sentence correctly.

- 1. Adaptive immunity is known as the (second)(third) line of defense.
- 2. This line of defense is (present at birth)(develops during life from exposure to pathogens).
- 3. Adaptive immunity (targets a specific pathogen)(repels a wide variety of pathogens).
- 4. One mechanism of this line of defense is to destroy foreign or host cells that have become infected with a pathogen; this mechanism is called (cellular)(humoral) immunity.

5. The other mechanism sends out antibodies to mark a pathogen for later destruction; this mechanism is (cellular)(humoral) immunity.
6. The chief weapons of the adaptive immune system are (neutrophils and macrophages)(T and B cells).
7. Once mature, T and B cells (reside in bone marrow until needed)(migrate to lymphatic organs and tissues). B cells mature in the (thymus)(bone marrow) while T cells mature in the (thymus)(bone marrow).
8. Also known as immunoglobulins, (antibodies)(antigens) are formed by B cells in response to a specific (antigen)(antibody).
9. An (antigen)(allergen) is any molecule that triggers an immune response.
10. A secondary immune response (takes longer)(happens more quickly) than the primary immune response.

Fill in the Gaps Cellular Immunity

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

ANTIBODY
ANTIGEN PRESENTATION
ANTIGEN-PRESENTING CELL (APC)
B
CELL
COMPLEMENT
CYTOTOXIC T
EFFECTOR CELLS
HELPER T
INTERLEUKIN
LEUKOCYTE
MEMORY T
OUTSIDE
PHAGOCYTE
T
T CELL
WITHIN

1. Cellular immunity destroys pathogens _____ existing a cell; it is also called _____-mediated immunity.
2. The immune process begins when a _____ ingests an antigen.
3. Called an _____, this cell displays fragments of the antigen on its surface—a process called _____, which alerts the immune system to the presence of a foreign antigen. When a _____ spots the foreign antigen, it binds to it.
4. This activates (or sensitizes) the _____, which begins dividing repeatedly to form clones. Some of these cells become _____ (such as _____ cells and _____ cells), which will carry out the attack, while others become _____ cells.
5. The _____ cell binds to the surface of the antigen and delivers a toxic dose of chemicals that will kill it.
6. _____ cells support the attack by secreting the chemical _____, which attracts neutrophils, natural killer cells, and macrophages. It also stimulates the production of _____ and _____ cells.

Fill in the Gaps Humoral Immunity

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words in the Word Bank below. Words may be used more than once; not all words may be used.

ANTIBODIES
ANTIBODY
ANTIGENS
B CELL
CELL
EFFECTOR B
HELPER T
INTERLEUKINS
MEMORY B
OUTSIDE
PLASMA
T CELL
WITHIN

1. Humoral immunity focuses on pathogens _____ a cell; it is also called _____ -mediated immunity.
2. The surface of a _____ contains thousands of receptors for a specific antigen. When the antigen specific to that receptor comes along, it binds to the _____.
3. The _____ then engulfs the antigen, digests it, and displays some of the antigen's fragments on its surface. A _____ cell binds to the presented antigen and secretes _____, which activates the _____.
4. The _____ begins to rapidly reproduce, creating a clone, or family, of identical cells that are programmed against the same antigen.
5. Some of these cloned cells become _____ cells or _____ cells; most, though, become _____ cells.
6. The _____ cells secrete large numbers of _____.

Illuminate the Truth Hypersensitivity

Highlight the word or phrase that completes each sentence correctly.

- 1.** When someone with a genetic disposition to an allergy is first exposed to the (allergen)(antigen), the body produces large amounts of the (antibody)(antigen) (IgE)(IgG).
- 2.** This reaction (does)(does not) produce an allergic reaction, and the body is now (sensitized) (immune) to the offending substance.
- 3.** When the person encounters the same substance or material at a later date, the (allergen)(antigen) binds to the (antibodies)(antigens) already in the body.
- 4.** (B cells)(Mast cells) release (interleukins)(histamine) and other inflammatory chemicals that produce the symptoms of an allergy, such as runny nose, watery eyes, congestion, and hives.

RESPIRATORY SYSTEM

The respiratory and cardiovascular systems work closely together to provide the body with essential oxygen and to remove carbon dioxide. What's more, the respiratory system also influences your ability to speak, smell, and taste. Use this chapter to review the structures and function of the respiratory system.

List for Learning Upper and Lower Respiratory Tract

Using the spaces below, list the structures of the upper and lower respiratory tracts.

Upper respiratory tract:

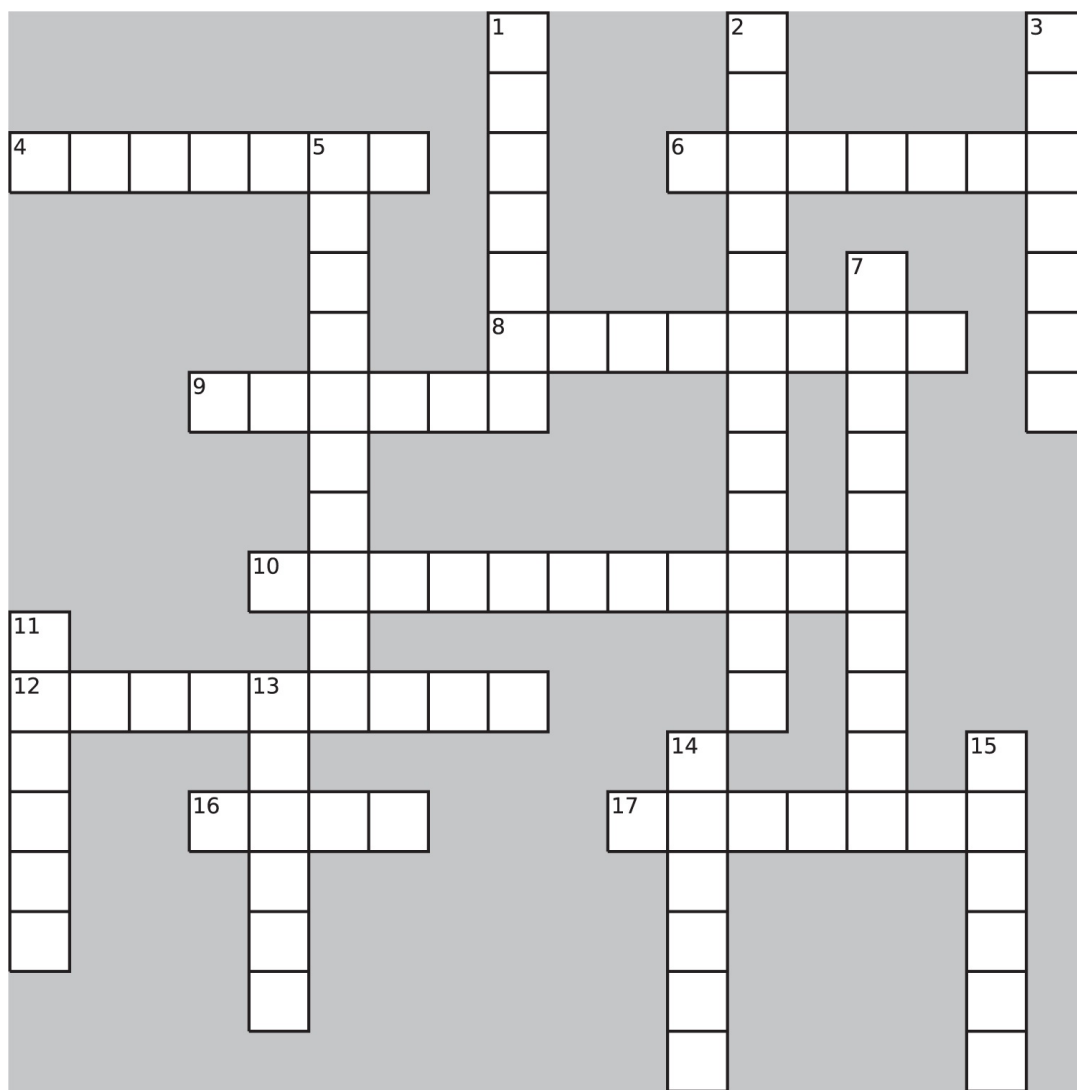
1. _____
2. _____
3. _____
4. _____
5. _____

Lower respiratory tract:

1. _____
2. _____
3. _____

Puzzle It Out Respiratory System Terms

Complete the following crossword puzzle to test your knowledge of the respiratory system.



ACROSS

4. Portion of the respiratory tract that carries air through the neck and upper chest
6. Area of the brain that contains the centers for controlling breathing
8. Primary structure for gas exchange
9. Bony structure that separates the mouth from the nasal cavity
10. Type of pressure that drives respiration
12. During times of forced breathing, these muscles join in to aid respiratory effort.
16. The top of the lung
17. The opening between the vocal cords

DOWN

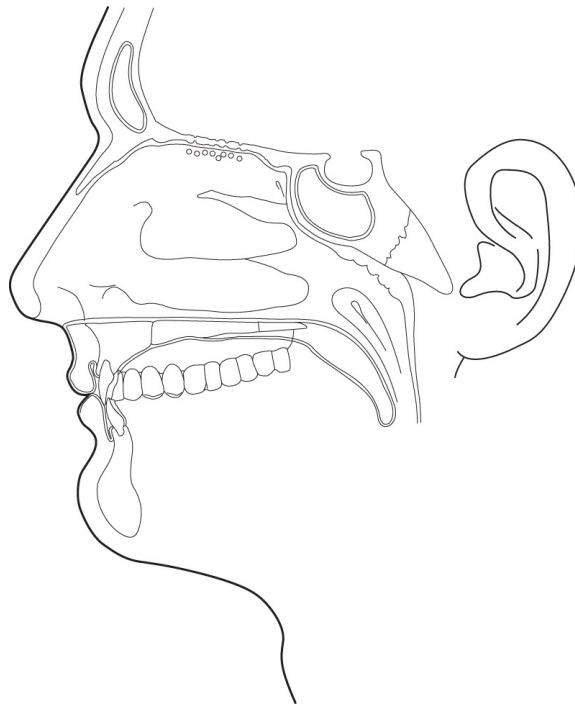
1. Three bones projecting from the lateral wall of the nasal cavity
2. A collapsed lung
3. Another name for throat
5. Closes over the top of the larynx during swallowing to direct food and liquids into the esophagus
7. Lipoprotein secreted by alveolar cells that decreases surface tension of the fluid lining the alveoli, permitting expansion
11. Respiratory structure where sound is produced
13. Vertical plate of bone and cartilage that separates the nasal cavity into two halves

- 14. Serous membrane covering the lungs and the thoracic cavity
- 15. Most common chronic illness in children

Conceptualize in Color Nasal Cavity

Identify the structures of the nasal cavity by coloring the figure below. Use the suggested colors or choose your own.

- Nasal conchae: Pink
- Hard palate: Red
- Soft palate: Yellow
- Frontal sinus: Orange
- Sphenoid sinus: Blue
- Olfactory receptors: Green



Make a Connection The Pharynx

In the spaces below, list the three regions of the pharynx. The first letter of each term is provided to get you started. Then, draw a line to link each region with its particular characteristics. Note that items may link with more than one characteristic.

1. N_____
2. O_____

3. L _____

- a. Space between the soft palate and the base of the tongue
- b. Contains openings for the right and left auditory (Eustachian) tubes
- c. Lies just behind the soft palate
- d. Ends at the inferior end of the larynx (the beginning of the esophagus)
- e. Contains the palatine and lingual tonsils

Illuminate the Truth The Larynx

Highlight the word or phrase that completes each sentence correctly.

- 1. The larynx prevents (food and liquids)(dust) from entering the trachea.
- 2. The larynx acts as a passageway for (food)(air) between the pharynx and trachea.
- 3. The (vestibular folds)(vocal cords) found in the larynx produce sound.
- 4. The larynx is formed by nine (bones)(pieces of cartilage) that keep it from collapsing.
- 5. The opening between the vocal cords is called the (glottis)(epiglottis).
- 6. The vestibular folds, or false vocal cords, function to (close the glottis during swallowing)(form high-pitched sounds).
- 7. The “Adam’s apple” is actually (the anterior portion of the trachea)(a large piece of cartilage called the thyroid cartilage).
- 8. The (cricoid)(thyroid) cartilage links the larynx to the trachea.

Fill in the Gaps Structures of the Respiratory Tract

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Not all words may be used.

ALVEOLAR DUCTS
ALVEOLAR SACS
BRONCHIOLES
CARINA
EPIGLOTTIS
LARYNX
LEFT
ONE
PRIMARY BRONCHI
RIGHT
SECONDARY BRONCHI
TERTIARY BRONCHI
THREE
TRACHEA
TWO

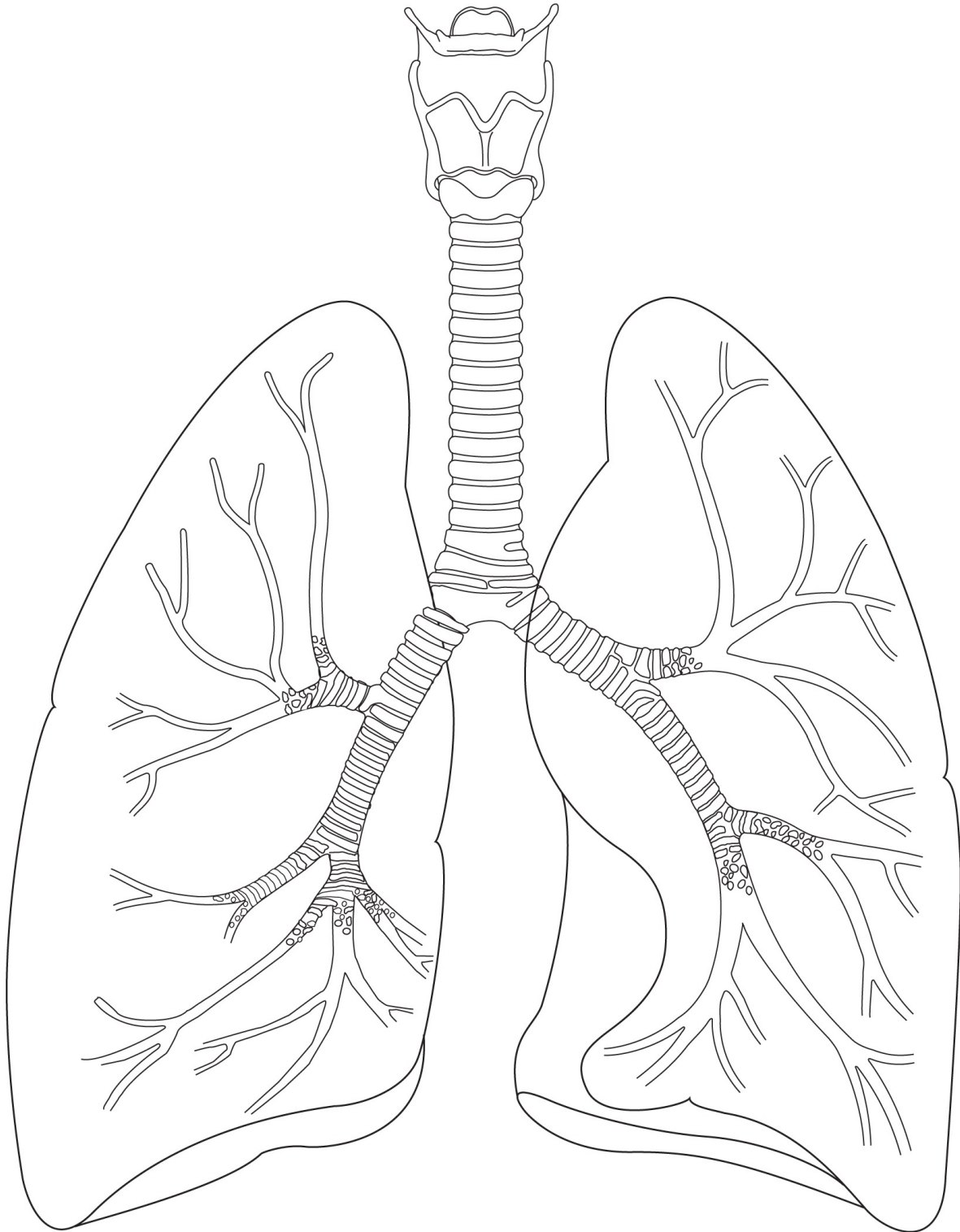
1. The _____ is a rigid tube that lies just in front of the esophagus.
2. The _____ is a chamber lying between the root of the tongue and the upper end of the trachea.
3. The trachea branches into two _____ at the _____.
4. The left lung has _____ (Hint: a number) secondary bronchi whereas the right lung has _____ (Hint: a number) secondary bronchi.
5. Tertiary bronchi branch into small airways called _____; these divide further into passageways called _____.
6. The primary structures for gas exchange are the _____.
7. The _____ primary bronchus is slightly wider and shorter than the other bronchus, making it the most likely location for inhaled objects to lodge.

Conceptualize in Color The Larynx and Bronchial Tree

Identify the structures of the larynx and bronchial tree by coloring the figure below. Use the suggested colors or choose your own.

- Larynx: Blue

- Trachea: Green
- Carina: Orange
- Primary bronchi: Yellow
- Secondary bronchus: Purple
- Tertiary bronchi: Pink
- Bronchioles: Tan



Fill in the Gaps Alveoli

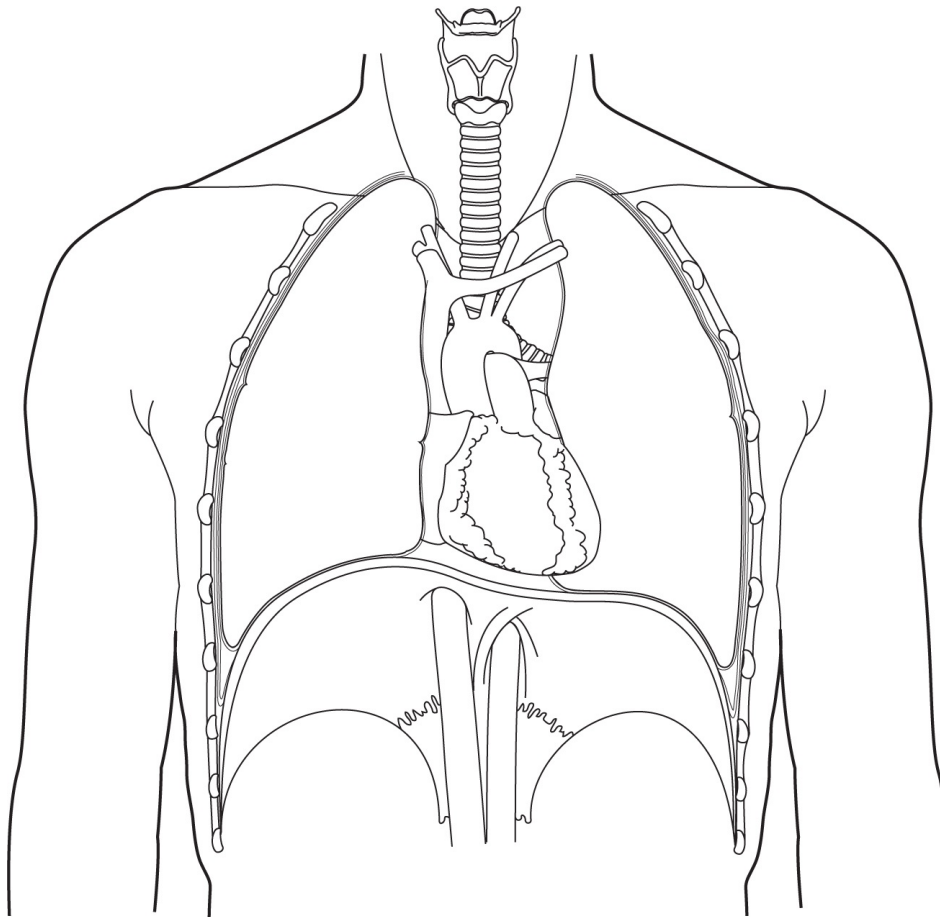
Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Not all words may be used.

**BLOOD CAPILLARIES ELASTIC FIBERS LIQUID MEMBRANE MUCUS SURFACTANT
VEINS**

1. The alveoli are wrapped in a fine mesh of _____.
2. Gas exchange occurs through the respiratory _____.
3. For gas to enter or leave a cell, it must be dissolved in _____.
4. The surrounding alveoli give alveoli the ability to expand during inhalation and spring back into shape during exhalation.

Drawing Conclusions The Lungs

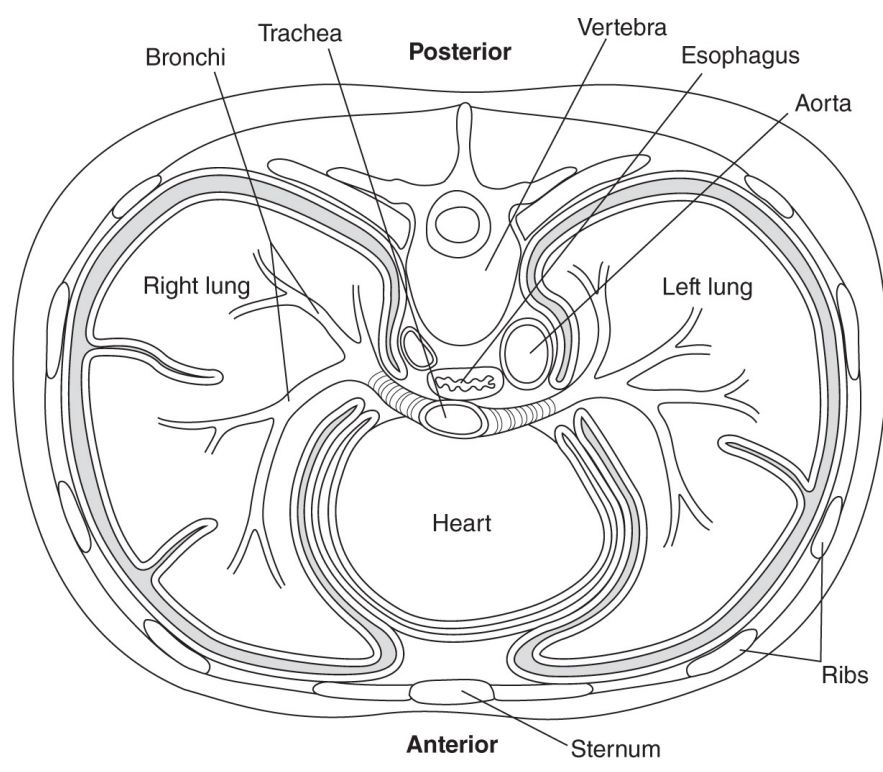
Test your knowledge of the fissures that divide the lungs into lobes by drawing lines to show the locations of the fissure. Then, label these lines with the name of each fissure. Finally, write the name of each lobe within the appropriate space inside the lungs.



Drawing Conclusions Pleura

Test your knowledge of pleura by coloring the figure below. Use the suggested colors or choose your own. Then, in the spaces provided, state the two purposes of pleural fluid.

- Visceral pleura: Green
- Parietal pleura: Orange
- Pleural space: Light blue



Pleural fluid serves two purposes:

1. _____

2. _____

Illuminate the Truth Lung Microbiota

Highlight the word or phrase that completes each sentence correctly.

1. The microbiota of the lungs is (less densely populated)(has similar density) when compared to that of the gut.
2. The microbial population of the lungs most closely resembles that of the (nasal cavity)(mouth).
3. Microbes tend to congregate in the (trachea)(carina).

4. Studies confirm a link between the microbiota of the lung and that of the (kidney)(gut).
5. Most patients with chronic lung disorders also tend to suffer from disorders of the (intestines) (nervous system).

Conceptualize in Color Respiratory Muscles

Identify the respiratory muscles by coloring the figure below. Use the suggested colors or choose your own.

Muscles used for inspiration and expiration:

- External intercostal muscles: Pink
- Internal intercostal muscles: Green
- Diaphragm: Yellow

Muscles used for deep inspiration:

- Sternocleidomastoids: Orange
- Scalenes: Purple
- Pectoralis minor: Light blue

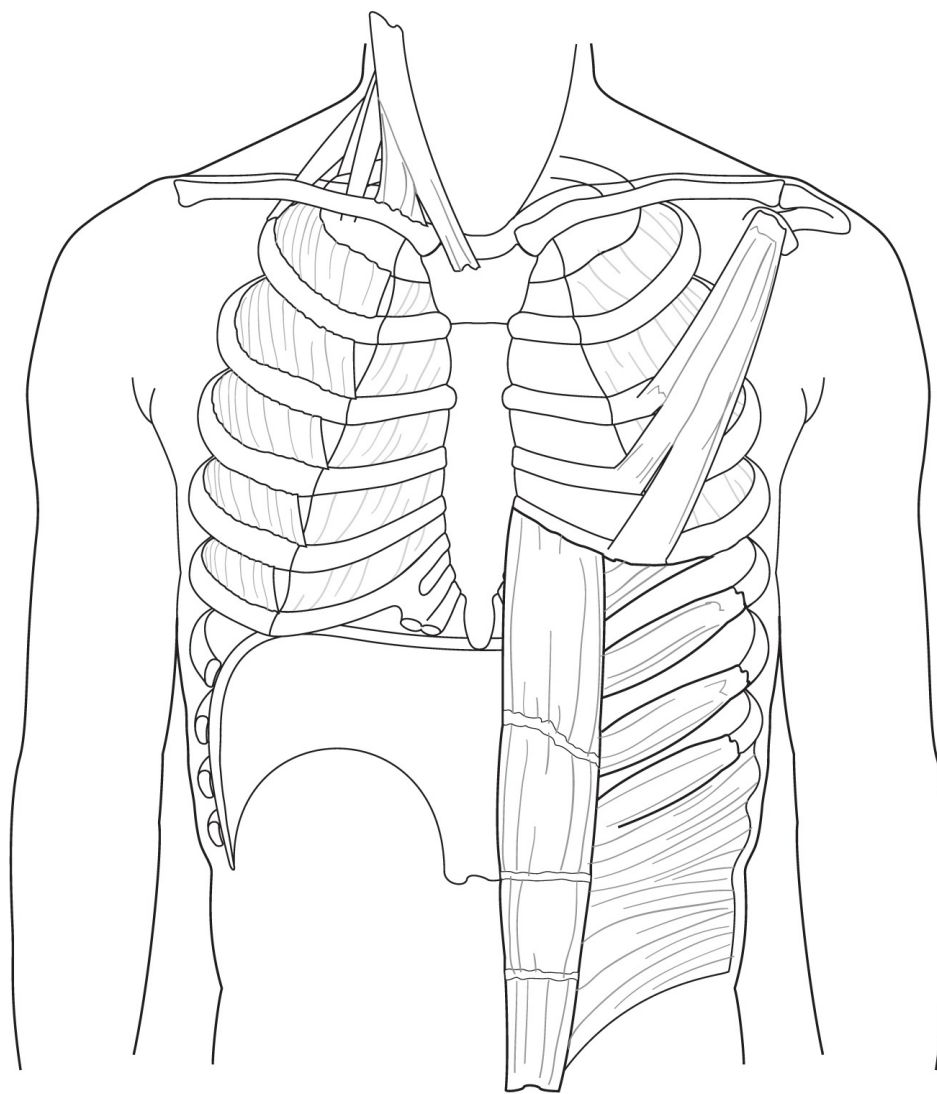
Muscles used during forced expiration:

- Rectus abdominis: Brown
- External abdominal obliques: Gray

Then, identify the action of the muscles during inspiration. Use a black pen to insert arrows on the right side of the chest (the left side of the figure), showing the direction of pull for each group of muscles used.

Next, identify the action of the muscles during expiration. Use a blue pen to insert arrows on the left side of the chest (the right side of the figure), showing the direction of pull for each group of muscles used.

Finally, identify the action of accessory muscles. Use a red pen to insert arrows, showing the direction of pull for the muscles used in deep inspiration and forced expiration.



Illuminate the Truth Neural Control of Breathing

Highlight the word or phrase that completes each sentence correctly.

1. The skeletal muscles used for breathing (contract spontaneously)(require neural input to contract).
2. The centers for controlling breathing in the medulla (are interconnected)(operate independently).
3. The inspiratory center sends impulses to the intercostal muscles via the (vagus)(intercostal) nerves and to the diaphragm via the (phrenic)(glossopharyngeal) nerve to cause muscle contraction.
4. Exhalation results when (the expiratory center sends impulses to cause muscle relaxation)(nerve output ceases and the inspiratory muscles relax).
5. In the pons, the (apneustic)(pneumotaxic) center stimulates the inspiratory center to increase the length and depth of inspiration.
6. Also in the pons, the (apneustic)(pneumotaxic) center helps prevent overinflation of the lungs.
7. The (medulla)(cerebral cortex) allows for voluntary control of breath for activities such as singing.
8. (Oxygen)(Carbon dioxide) levels are the primary regulator of respiration.

Describe the Process

Factors Influencing Breathing

The respiratory center can alter breathing patterns in response to a number of factors. (Five such factors are shown in a table in the textbook entitled “Factors Influencing Breathing.”) Using the spaces below, identify the sensory receptor for each factor. Then, describe the actions when each sensory receptor is activated. Some information has been provided to get you started.

FACTOR	SENSORY RECEPTOR	ACTION
Oxygen	chemoreceptors (located in the and bodies)	Low blood levels of oxygen cause: As a result:

FACTOR	SENSORY RECEPTOR	ACTION
Hydrogen ions (pH)	_____ chemoreceptors (located in the _____)	Declining pH levels indicate: When pH falls, these chemoreceptors signal the respiratory centers to:
Stretch	Receptors in the _____ and _____	Receptors detect stretching during inspiration and: This is called the:
Pain and emotion	_____ and _____ system	In response to pain and emotion:
Irritants (such as smoke, dust, pollen, noxious chemicals, and mucus)	_____ in the airway	These receptors respond to irritants by: This helps to:

Illuminate the Truth Pressure and Airflow

Highlight the word or phrase that completes each sentence correctly.

1. Air moves in and out of lungs because of a (pressure)(oxygen) gradient.
2. When the pressure within the lungs drops lower than atmospheric pressure, (inspiration)(expiration) occurs; when it rises above atmospheric pressure, (inspiration)(expiration) occurs.
3. The thin film of fluid between the visceral and parietal pleura (causes them to cling together)(keeps

them separated), aiding lung expansion.

4. The potential space between the two pleura maintains a pressure slightly (less)(greater) than atmospheric pressure; this is called (negative)(positive) pressure.
5. The pressure between the two pleura is called (intrapulmonic)(intrapleural) pressure.
6. Inspiration begins when the intercostal muscles and the diaphragm (contract)(relax) to (compress) (enlarge) the chest cavity.
7. When the lungs expand, the pressure within the bronchi and alveoli (drops)(rises).
8. Pressure within the bronchi and alveoli is called (intrapulmonic)(intrapleural) pressure.
9. During expiration, the diaphragm (contracts)(relaxes).
10. According to Boyle's Law, a given volume of gas at a constant temperature would exert (less)(more) pressure in a smaller versus a larger space.

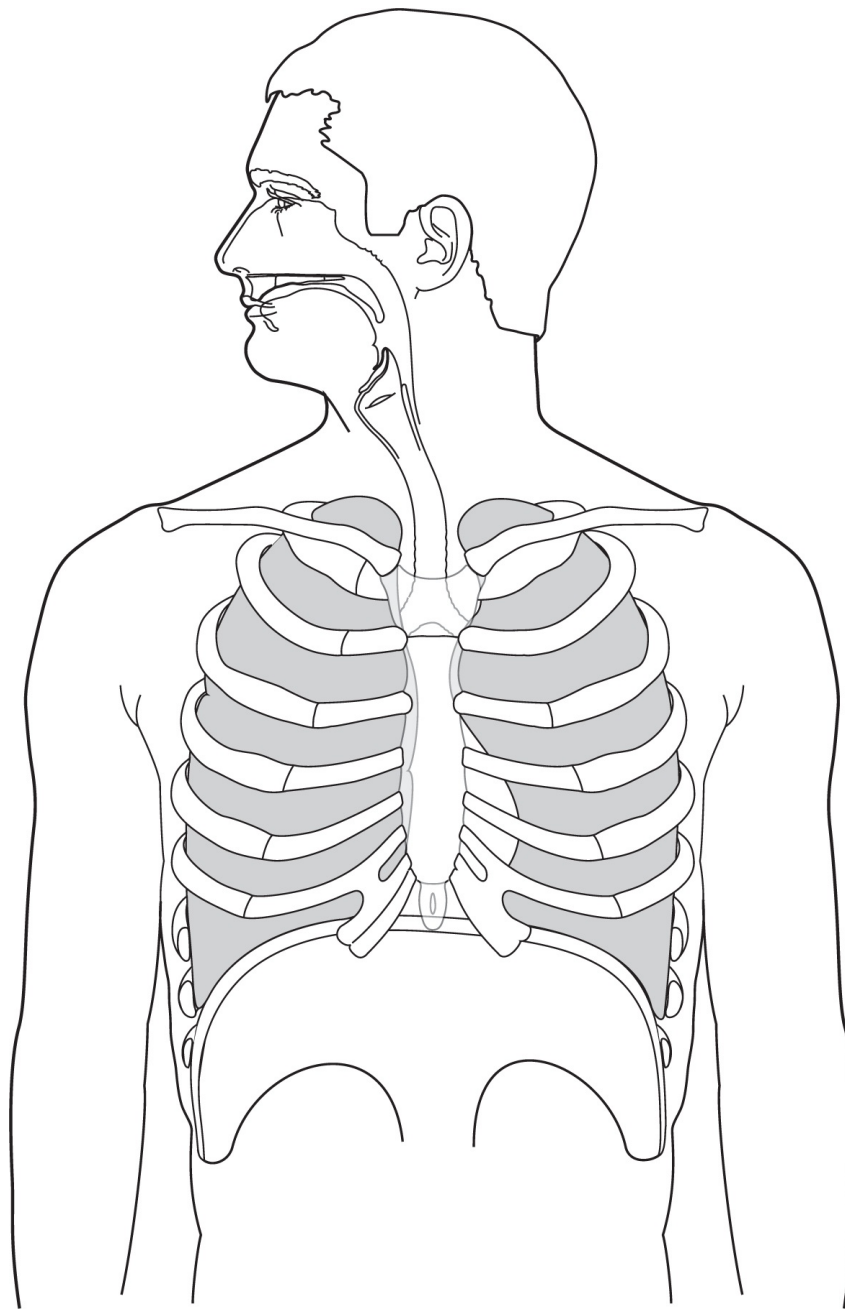
Just the Highlights Lung Disorders

Environmental conditions—including smoking, air pollutants, and trauma—contribute to the development of certain lung disorders. Three common lung disorders include asthma, emphysema, and pneumothorax. In the following list, to differentiate between these disorders, highlight characteristics of asthma in pink, emphysema in blue, and pneumothorax in green.

- a. This is the most common chronic disease in childhood.
- b. Treatment includes a pulmonary rehabilitation program consisting of breathing exercises and techniques.
- c. Treatment involves insertion of a needle or tube to remove air from the pleural space and re-establish negative pressure.
- d. This disorder typically occurs when long-term exposure to air pollution or cigarette smoke slowly destroys the walls of alveoli.
- e. This disorder involves inflamed airways that hyper-react to triggers such as dust, pet dander, pollen, cold air, and exercise.
- f. This disorder results when the thoracic wall is punctured, allowing air to fill the pleural cavity.
- g. Treatment involves dilating airways through administration of epinephrine and beta-adrenergic stimulants.
- h. Preventive measures include limiting exposure to irritants.
- i. Smoking cessation is crucial to stop progression of the disease.

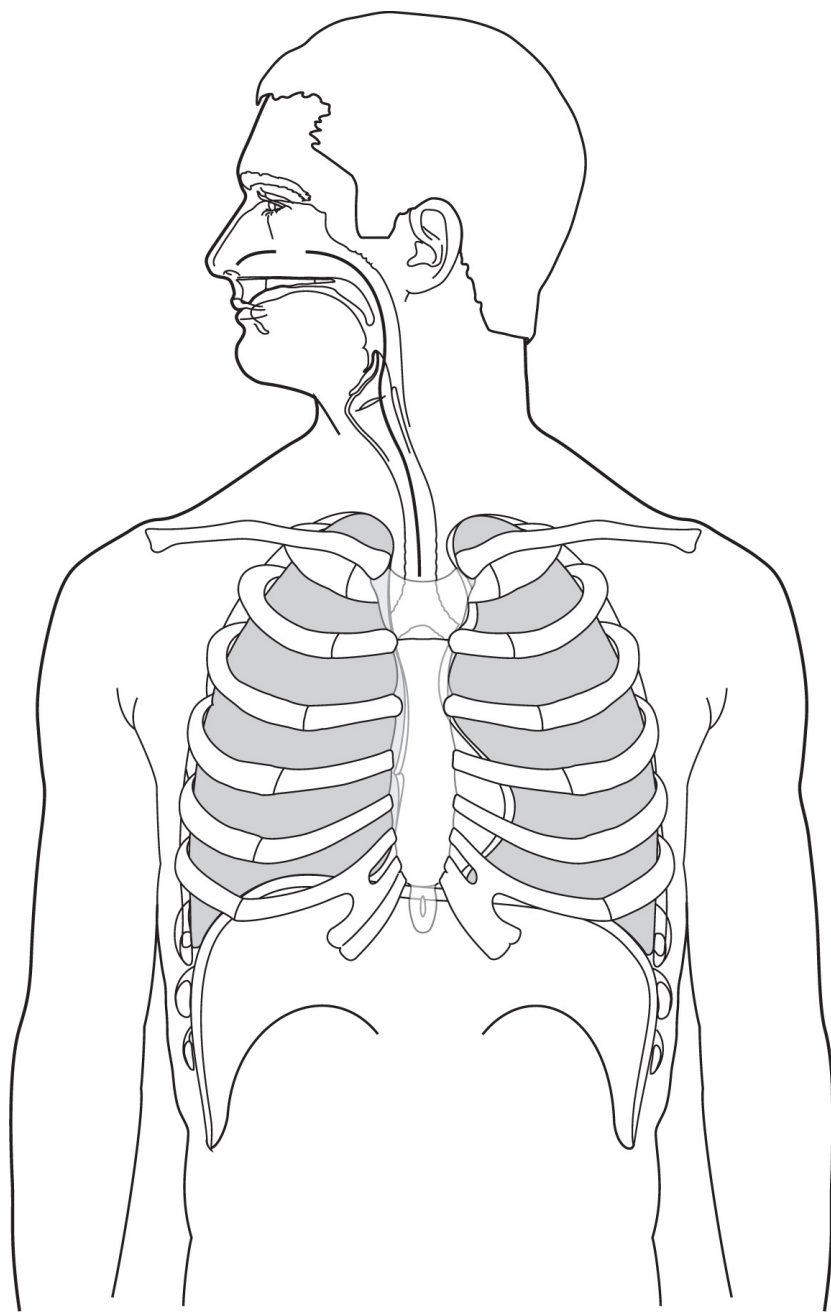
Drawing Conclusions The Respiratory Cycle

Test your knowledge of inspiration and expiration by filling in the blanks of each sentence. Then, label the figures below as described.



Inspiration:

1. The intercostal muscles _____, pulling the ribs up and out; the diaphragm contracts and moves _____. (Insert red arrows in the drawing above to illustrate this part of the process.)
2. The lungs _____ along with the chest. (Insert green arrows to illustrate what's happening.)
3. The pressure within the bronchi and alveoli _____. (Insert a black arrow inside the lung next to a letter *P* to indicate the change in pressure.)
4. When intrapulmonic pressure _____ than atmospheric pressure, air flows _____ the lungs. (Insert blue arrows to indicate the direction of air flow.)



Expiration:

1. The diaphragm and external intercostals _____ and the thoracic cage _____ to its original size. *(Insert red arrows in the drawing above to illustrate this part of the process.)*
2. The lungs _____ are by the thoracic cage. *(Insert green arrows to illustrate what is happening.)*
3. Intrapulmonary pressure _____. *(Insert a black arrow inside the lung next to a letter P to indicate the change in pressure.)*
4. Air flows _____ of the lungs. *(Insert blue arrows to indicate the direction of air flow.)*

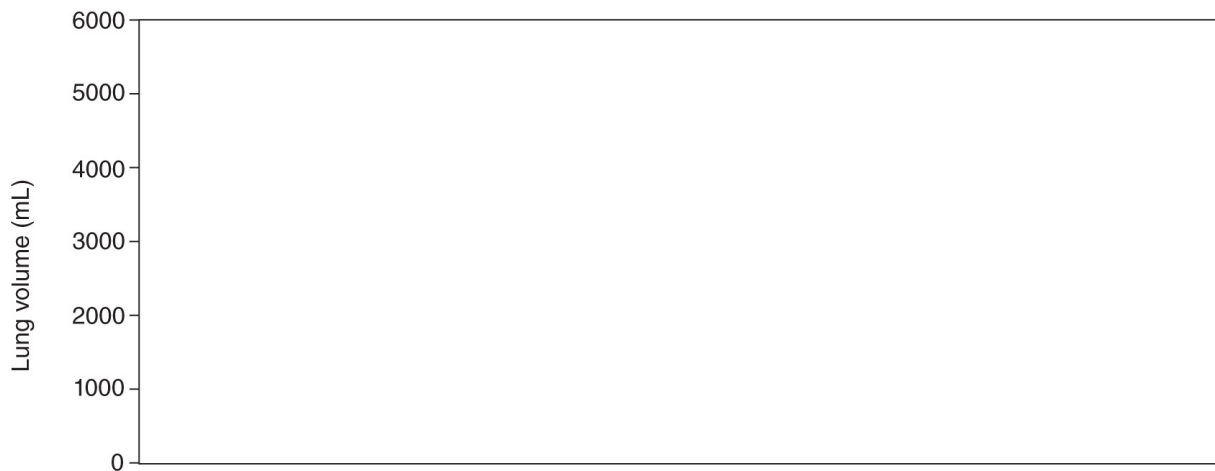
Besides being affected by pressure, airflow is also affected by resistance. Using the spaces below, list three factors that affect resistance and, therefore, airflow.

- 1. _____
- 2. _____
- 3. _____

Drawing Conclusions Measurements of Ventilation

Test your knowledge about measuring lung capacity by filling in the blanks of each sentence. Then, create a spirographic record as described in each step. Use a pencil to create the waveform so that you can alter it as needed to complete each step.

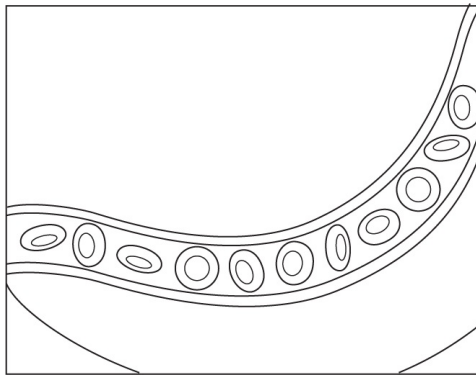
- 1. The amount of air inhaled and exhaled during quiet breathing is known as _____. In a healthy young adult, this measurement is typically _____ mL.
(Create a spirographic record in the rectangle below. Begin by inserting a waveform showing the measurement described in sentence 1. Use the numbers along the left of the rectangle as a guide. Color the area on the spirographic record indicative of this measurement blue. In other words, highlight the area behind the waveform blue. Write the name of the measurement in the blue area.)
- 2. The amount of air inhaled using maximum effort after a normal inspiration is called the _____ volume. This amount is typically _____ mL.
(Alter the waveform to include this reading. Color the area on the spirographic record indicative of this measurement green; write the name of the measurement in the green area.)
- 3. The amount of air that can be exhaled after a normal expiration using maximum effort is the _____ volume. This amount is typically _____ mL.
(Alter the waveform to include this reading. Color the area on the spirographic record indicative of this measurement orange and write the name of the measurement in the orange area.)
- 4. The amount of air remaining in the lungs after a forced expiration is called the _____. This amount is about _____ mL.
(Color the area on the spirographic record indicative of this measurement pink; write the name of the measurement in this pink area.)
- 5. The amount of air that can be inhaled and exhaled with the deepest possible breath is the _____. This number can be obtained by adding the tidal volume to the _____ and _____ volumes.
(Draw a bracket around the part or parts of the waveform that indicates this measurement. Label the bracket with the name of the measurement.)
- 6. The maximum amount of air that the lungs can contain is called the _____.
(Draw a second bracket around the part or parts of the waveform that indicate this measurement. Label the bracket with the name of the measurement.)



Drawing Conclusions Gas Exchange

Test your knowledge about gas exchange in the alveoli by filling in the blanks of each sentence. Then, label the figure below as described.

1. Gas diffuses from an area of _____ pressure to _____ pressure until the pressures are equalized.
2. Air flowing into the alveoli has a partial pressure of oxygen that is _____ than the partial pressure of oxygen in the pulmonary capillaries.
(In the following figure, insert the symbol for oxygen within the alveoli with an arrow showing whether the level of oxygen is high or low.)
3. The pulmonary capillaries surrounding the alveoli contain venous blood that contains a partial pressure of carbon dioxide that is _____ than the partial pressure of carbon dioxide in the alveoli.
(Near the capillary, insert the symbol for carbon dioxide with an arrow showing whether the level is high or low.)
4. These differences in partial pressures cause oxygen to flow _____ the alveoli and _____ the capillaries.
(Between the capillary and the alveoli, illustrate the direction of gas exchange by inserting red arrows to signify the movement of oxygen.)
5. Simultaneously, carbon dioxide flows _____ the alveoli and _____ the capillaries.
(Insert blue arrows to show the movement of carbon dioxide across the capillary membrane. Next, color the blood cells with low levels of oxygen blue, color those with high levels of oxygen red, and those undergoing gas exchange purple.)



Describe the Process Factors Affecting Gas Exchange

Optimal gas exchange depends on numerous factors. The table below lists six such factors, which are also shown in a table in the textbook entitled, “Factors Affecting Gas Exchange.” Using the spaces below, identify conditions that could disrupt that factor and interfere with gas exchange.

FACTOR	POTENTIAL DISRUPTION
Adequate airway	
Adequate respiratory rate	
Adequate alveolar surface area	
Pressure gradient between oxygen in alveolar air and oxygen in pulmonary blood	
Compliant lung tissue	
Adequate blood supply	

Fill in the Gaps Ventilation-Perfusion Coupling

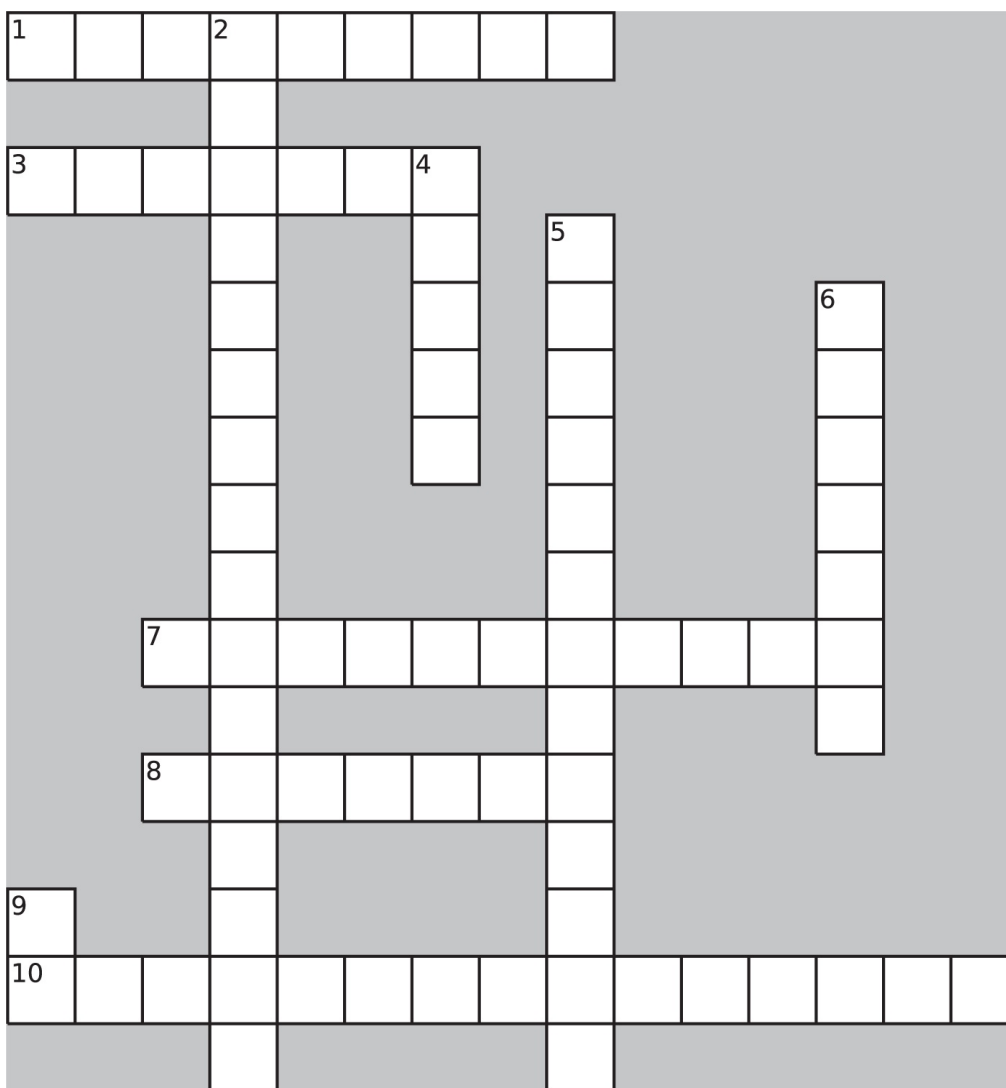
Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Not all words may be used.

BETTER PERFUSED
BETTER VENTILATED
CONSTRICT
DECREASES
DILATE
FALL
INCREASES
POORLY PERFUSED
POORLY VENTILATED
RISE

1. If a portion of the lung has poor airflow, oxygen levels in blood vessels serving that area _____.
2. In response, pulmonary vessels in that area _____.
3. This directs blood flow to _____ alveoli.
4. If a portion of the lung has good airflow, oxygen levels in those blood vessels _____.
5. This causes pulmonary vessels in that area to _____.
6. In turn, blood flow to that area _____.

Puzzle It Out Gas Transport

Complete the following crossword puzzle to test your knowledge of gas transport. Also, included are some terms used to describe variations in breathing.



ACROSS

1. Labored breathing that occurs when a person is lying flat but improves when standing or sitting up
3. Labored or difficult breathing
7. Most carbon dioxide is transported to the lungs in this form.
8. The contribution of a single gas in a mixture of gases is called _____ pressure.
10. Reduced rate and depth of respirations

DOWN

2. Increased rate of respirations
4. Temporary cessation of breathing
5. In the lungs, oxygen forms a weak bond with the iron portion of hemoglobin to form _____.
6. The process of carrying gases from the alveoli to the and back is known as gas transport.
9. Hemoglobin releases oxygen in response to differences in _____ between arterial and venous blood.

Drawing Conclusions Oxyhemoglobin Dissociation Curve

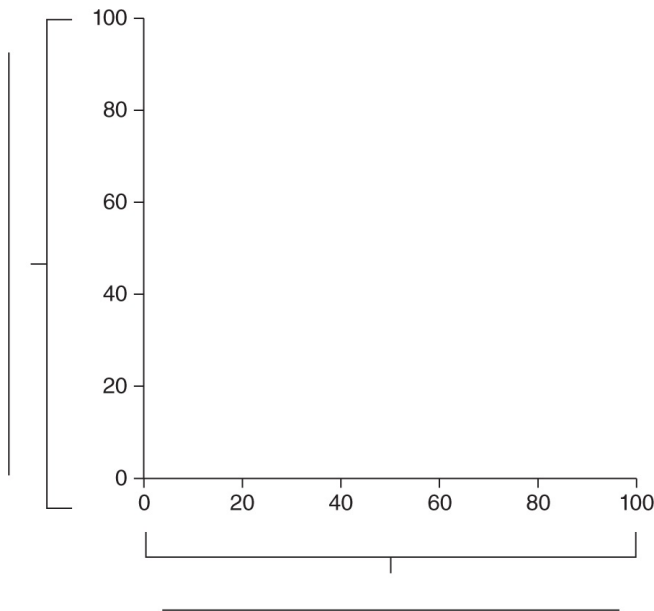
Test your knowledge of the oxygen-carrying capacity of hemoglobin by filling in the blanks of each

sentence. Then, create a graph showing the oxyhemoglobin dissociation curve to illustrate that capacity as described.

- 1. The term used to describe number of oxygen molecules hemoglobin is carrying at any one time is _____.
- 2. The number of oxygen molecules hemoglobin takes up varies depending on the _____.
- 3. When partial pressure is high, hemoglobin _____ oxygen; when partial pressure is low, hemoglobin _____ oxygen.
- 4. When hemoglobin is completely saturated, it contains _____ molecules of oxygen.
- 5. At rest, when PO₂ is 40 mm Hg, hemoglobin is _____% saturated.
- 6. The oxyhemoglobin dissociation curve displays the relationship between _____ and _____.

Fill in the graph below as directed:

- 7. Fill in the blanks along each axis to identify what that axis represents.
- 8. Use the coordinates to draw two lines and a circle representing where the two axes would intersect to reflect conditions when a person is at rest.
- 9. Use the coordinates to draw two lines and a circle to show conditions in the alveoli.
- 10. Draw a line representing the oxyhemoglobin dissociation curve.



chapter 19

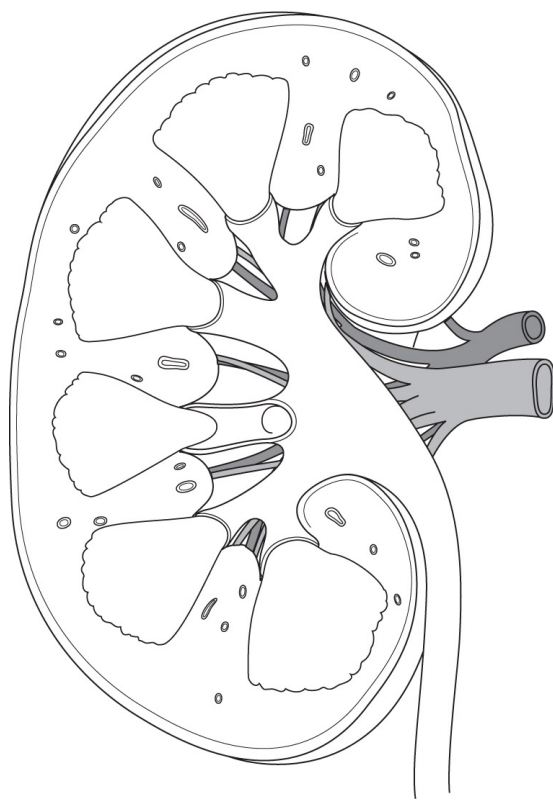
URINARY SYSTEM

Cells throughout the body continually perform a variety of metabolic processes, each of which results in waste products. The urinary system filters the blood to remove these products. But that's not all the kidneys do. They also regulate fluid volume, alter the levels of sodium and potassium, adjust the pH level, regulate blood pressure, and even contribute to the production of red blood cells. Complete the activities in this chapter to make sure you are well versed in all the functions of this body system.

Conceptualize in Color The Kidney

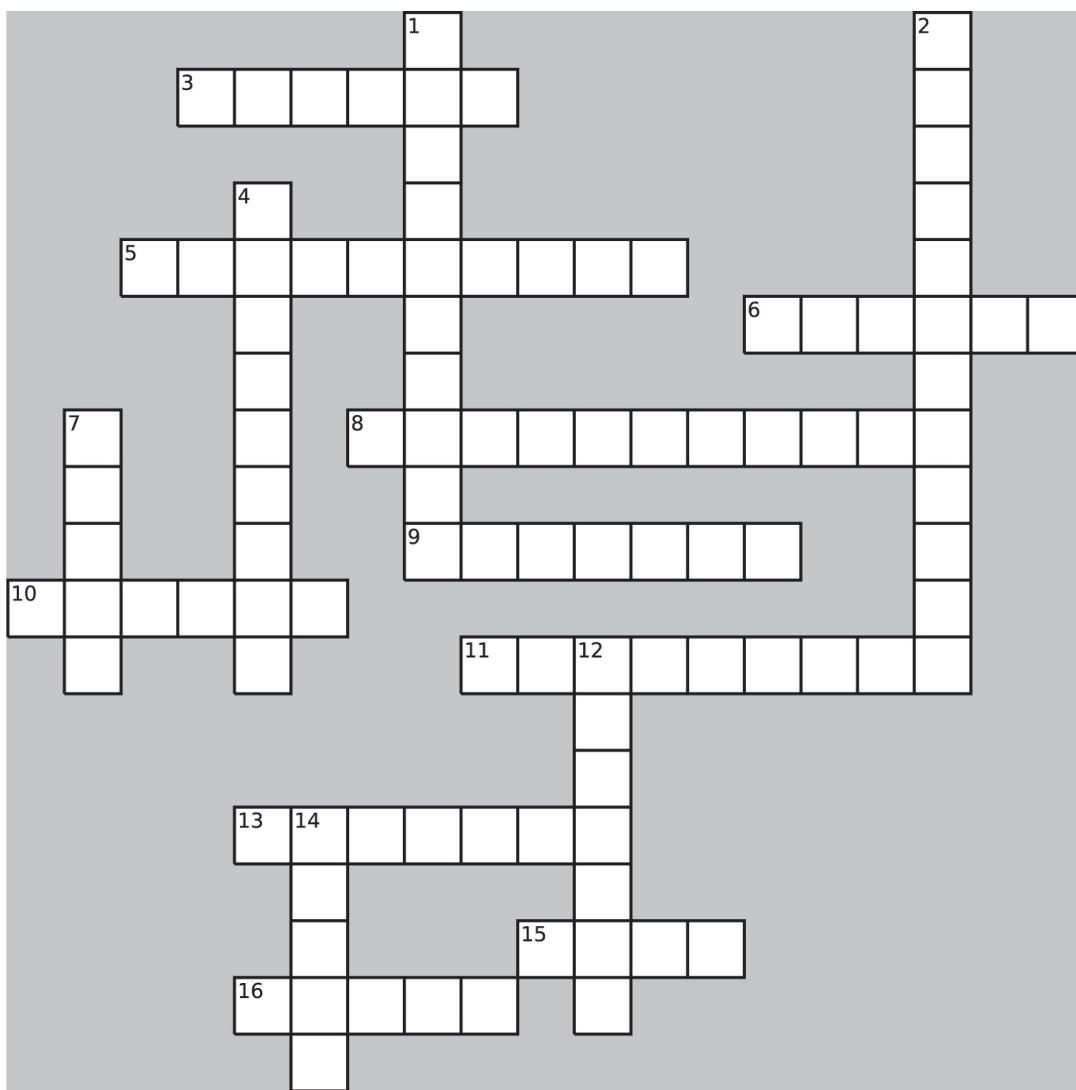
Identify the structures of the kidney by coloring the figure below. Use the suggested colors or choose your own.

- Renal cortex: Brown
- Renal columns: Pink
- Renal pyramids: Green
- Renal papilla: Orange
- Minor calyces: Yellow
- Major calyces: Gold
- Renal pelvis: Red
- Ureter: Blue



Puzzle It Out Urinary System

Complete the following crossword puzzle to test your knowledge of the urinary system.



ACROSS

3. The renal _____ funnels urine from the calyces to the ureter.
5. Cluster of capillaries inside the renal corpuscle
6. Location in the kidney where renal corpuscles reside
8. Term for urination
9. Functional unit of the kidney
10. The part of the nephron where urine formation begins is the renal _____.
11. The process of eliminating waste from the body
13. Branch of medicine concerned with the urinary tract
15. Blood leaves the kidney through the renal _____.
16. This kidney sits lower than its mate

DOWN

1. Process by which substances pass from the glomerulus into Bowman's capsule
2. Common cause of kidney damage
4. The part of the nephron that filters blood plasma is the renal _____.
7. Blood vessels, the ureters, and nerves enter and leave the kidney through a slit called the _____.
12. Cup-like structures that collect urine leaving the renal papilla

14. Secreted by the kidney in response to low blood pressure

Drawing Conclusions Nephron Blood Supply

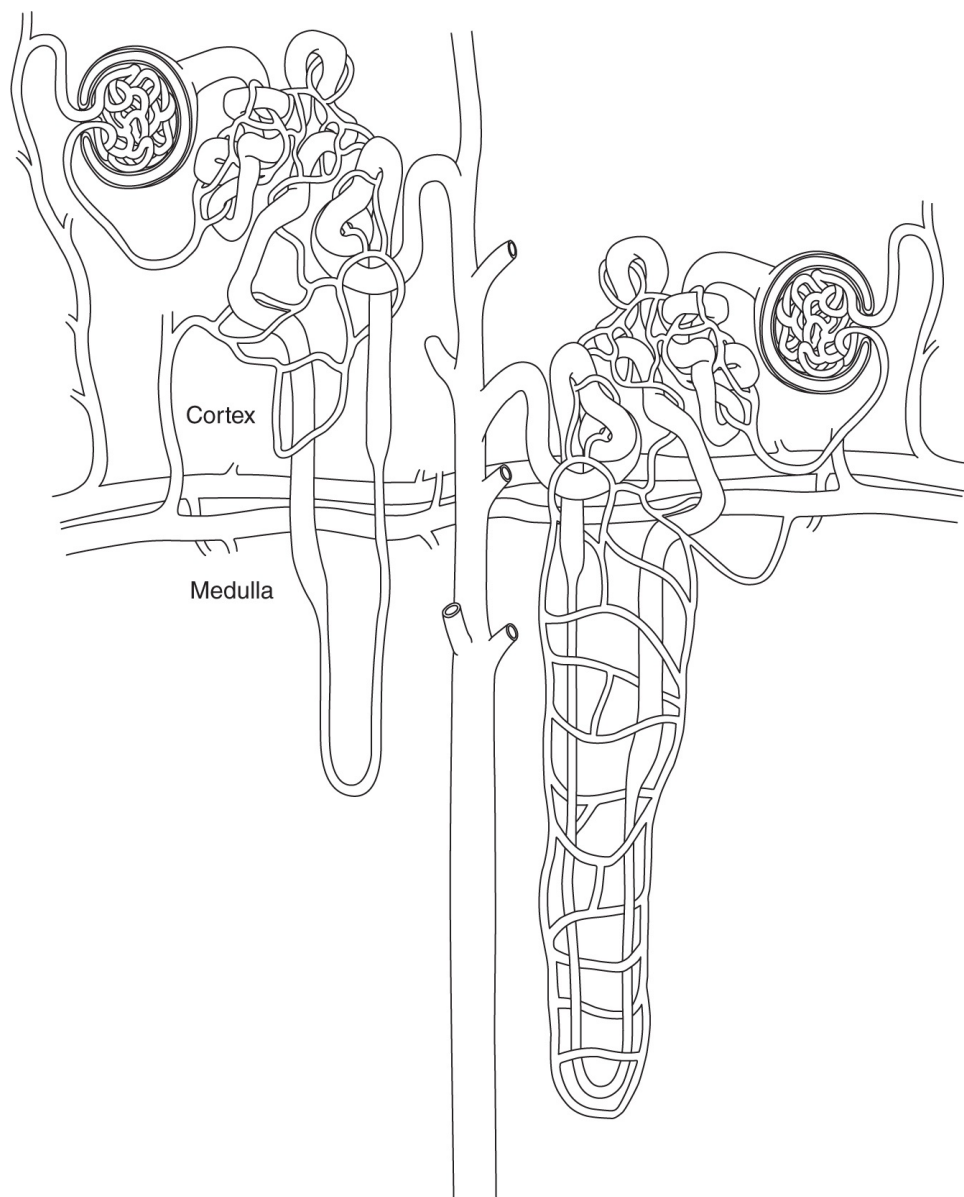
Test your knowledge of the blood supply to nephrons by coloring the structures in the figure below. Use the suggested colors or choose your own.

- Afferent arteriole: Pink
- Efferent arteriole: Light red
- Glomerulus capillaries: Orange
- Peritubular capillaries: Dark red
- Veins that feed into renal vein: Blue

Then, draw arrows to show the direction of blood flow. Next, label the following structures.

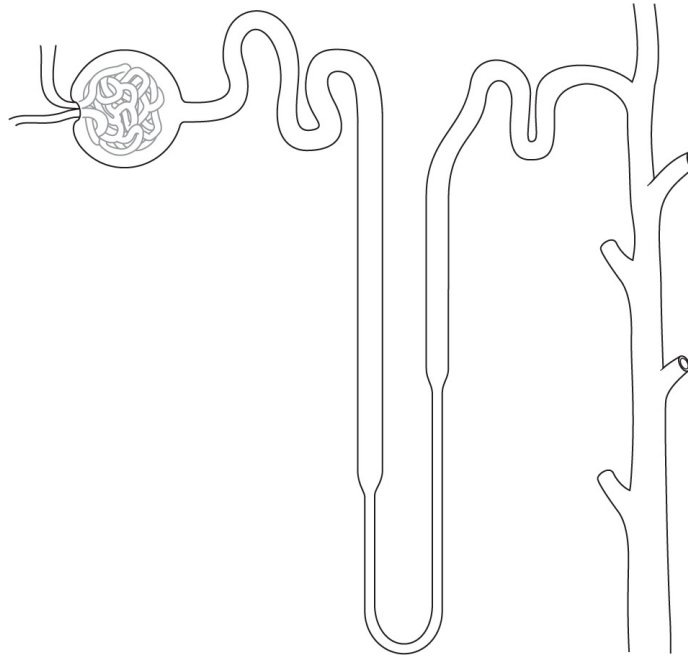
- Proximal convoluted tubule
- Distal convoluted tubule
- Loop of Henle
- Collecting duct

Finally, insert a bracket and label the cortical nephron and the juxtamedullary nephron.



Conceptualize in Color The Nephron

Identify the structures of the nephron by coloring the figure below. Use the suggested colors or choose your own. Then, insert arrows to show the direction of flow.



- Afferent arteriole: Dark red
- Efferent arteriole: Blue
- Proximal convoluted tubule: Pink
- Descending limb of loop of Henle: Green
- Ascending limb of loop of Henle: Purple
- Distal convoluted tubule: Orange
- Collecting duct: Yellow
- Outline Bowman's capsule in brown
- Glomerulus: Light red

List for Learning Urine Formation

Using the spaces below, list the three processes involved in urine formation.

1. _____
2. _____
3. _____

Fill in the Gaps Glomerular Filtration

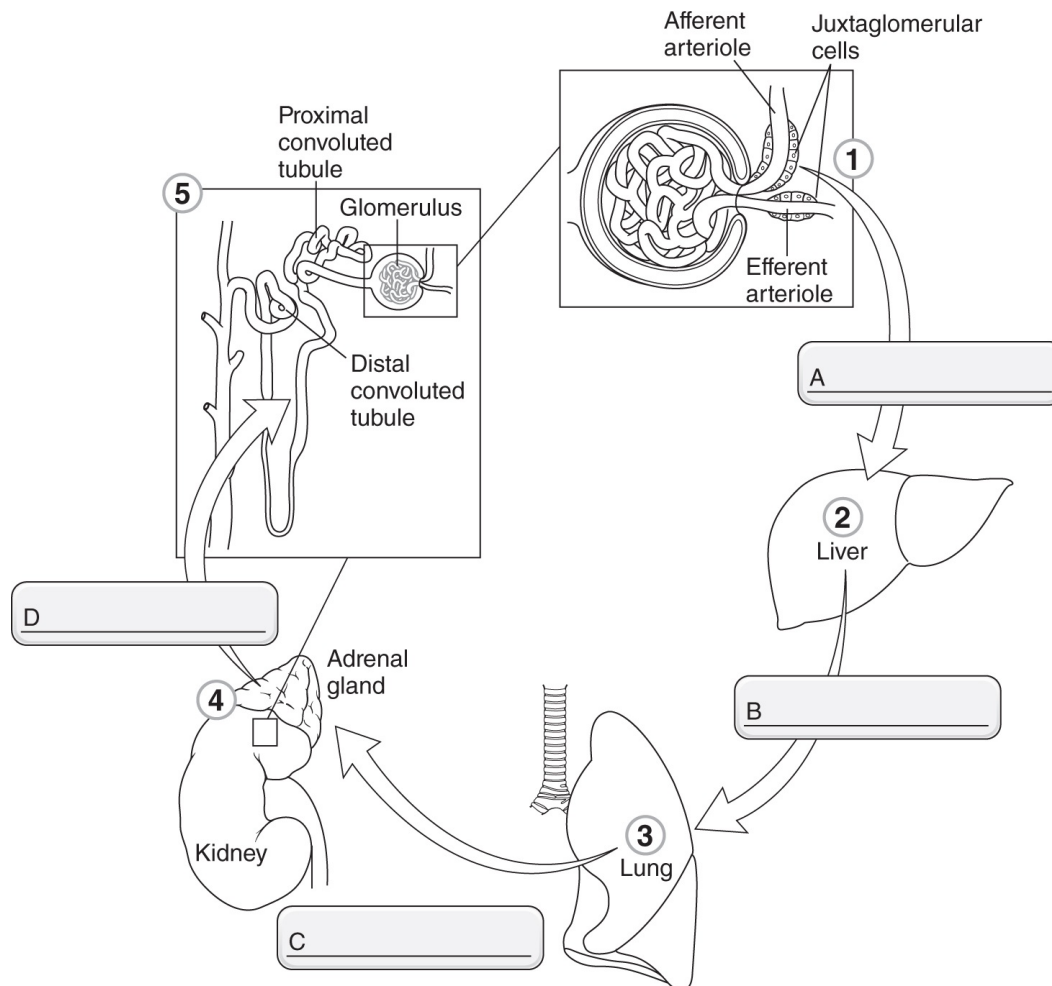
Fill in the blanks with the appropriate word or words to describe glomerular filtration. Choose from the words listed in the Word Bank below. Not all words may be used.

AFFERENT ARTERIOLE
BLOOD
DECLINES
EFFERENT ARTERIOLE
FILTRATION
GLOMERULAR FILTRATION RATE (GFR)
INCREASE
INCREASES
LOOP OF HENLE
OSMOSIS
PLASMA PROTEINS
PORES
RENAL TUBULES
SLOW
SMALL SOLUTES
WATER

1. Blood flows into the glomerulus through the _____.
2. The walls of the glomerular capillaries are dotted with _____, allowing _____ and _____ to pass into Bowman's capsule through the process of _____. Cells that are too large to pass through include _____ cells and _____.
3. Fluid in the Bowman's capsule flows into the _____. The amount of fluid filtered by the kidneys is called the _____.
4. In circulatory shock, blood flow to the kidneys _____, causing glomerular filtration rate to _____ significantly.

Describe the Process Renin-Angiotensin-Aldosterone System

A key mechanism for maintaining blood pressure and a steady glomerular filtration rate is the renin-angiotensin-aldosterone system. Using the spaces below, numbered 1 to 5, describe the events that occur in this system. Use the figure as a guide. Then, name the key hormone for each step in the figure below, labeled A to D.



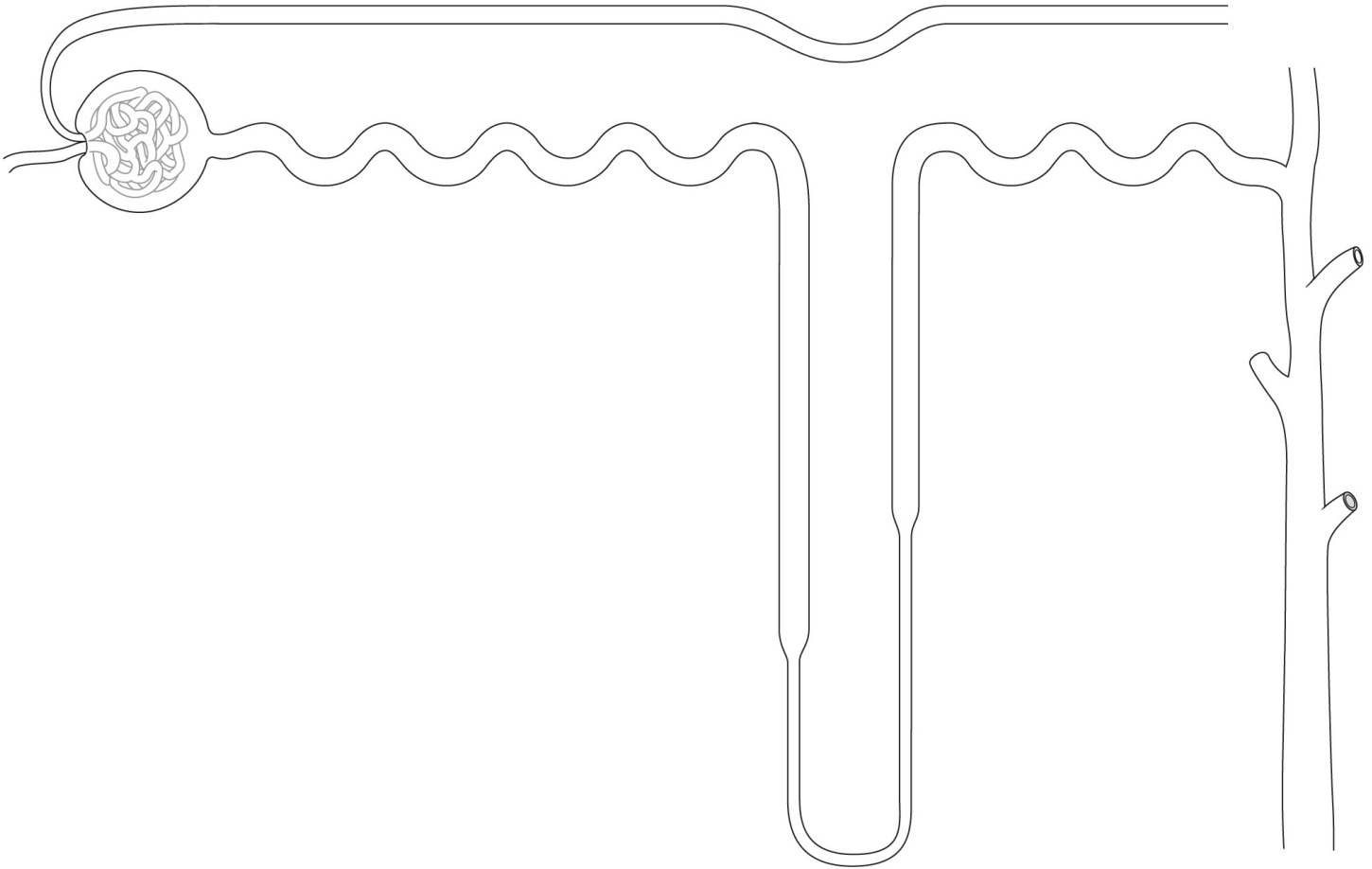
1. A drop in blood pressure leads to decreased flow to the kidneys. This causes _____
2. _____
3. _____
4. _____
5. _____

Drawing Conclusions Tubular Reabsorption and Secretion

Test your knowledge of tubular reabsorption and secretion by coloring the structures of the renal tubule in the figure below. Use the suggested colors or choose your own.

Then, identify key substances reabsorbed or secreted along the various sections of the tubule by writing the symbol for each substance along the pertinent section with an arrow pointing out of the tubule to signify reabsorption and arrows pointing into the tubule to signify secretion. (Hint: Substances include H_2O , $NaCl$, K^+ , H^+ , glucose, urea, uric acid, NH_3 , and drugs.) Insert arrows to depict the direction of flow within the tubule.

- Proximal convoluted tubule: Green
- Descending limb of the loop of Henle: Blue
- Ascending limb of the loop of Henle: Pink
- Distal convoluted tubule: Purple
- Collecting duct: Yellow



Make a Connection Hormones Affecting Urinary System

In the spaces below, list the names of hormones acting on the renal tubule. The first letters of each term is provided to get you started. Then, draw a line to link the name of each hormone to its characteristics. Note that items may link with more than one characteristic.

1. Al _____

2. A _____

N _____

P _____

3. A _____

H _____

4. P _____
H _____

- a. Inhibits the secretion of aldosterone and antidiuretic hormone
- b. Causes the cells of the distal and collecting tubules to become more permeable to water; water flows into the interstitial fluid and urine volume decreases
- c. Called the “salt-retaining hormone”
- d. Secreted by the adrenal cortex in response to falling blood levels of Na^+ or rising blood levels of K^+
- e. Secreted by the parathyroid glands in response to low blood calcium levels
- f. Prompts the distal convoluted tubule to absorb more Na^+ and secrete more K^+
- g. Secreted by atria of the heart in response to rising blood pressure
- h. Causes blood volume to increase and blood pressure to rise
- i. Secreted by the posterior pituitary gland (neurohypophysis)
- j. Causes distal convoluted tubule to excrete more NaCl and water
- k. Prompts the renal tubules to reabsorb more calcium and excrete more phosphate

Just the Highlights Components of Urine

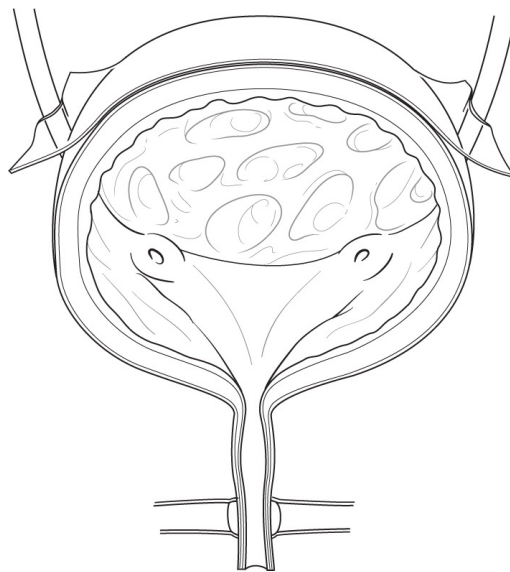
In the following lists, highlight the substances not normally found in urine. (The presence of these substances in urine indicates a disease process.)

Urea
Glucose
Blood
Uric acid
Ketones
Albumin
Ammonia
Hemoglobin
Creatinine

Conceptualize in Color Urinary Bladder

Identify the structures of the urinary bladder by coloring the figure below. Use the suggested colors or choose your own.

- Detrusor muscle: Pink
- Ureters: Brown
- Urethra: Green
- External urinary sphincter: Purple
- Internal urethral sphincter: Orange
- Trigone: Blue
- Rugae: Outline in black



Illuminate the Truth Renal Disorders

Highlight the word or phrase that completes each sentence correctly.

1. Kidney stones often become lodged in the (urethra)(ureter).
2. Women are prone to bladder infections because of their relatively short (urethra)(ureter).
3. Diabetes insipidus results from (hyposecretion)(hypersecretion) of ADH, resulting in (excessive) (scant) urine output.
4. In acute renal failure, the kidneys (often resume normal function)(rarely resume normal function) following treatment.
5. (Chronic renal insufficiency)(Acute renal failure) often results from diseases such as diabetes or hypertension.
6. In chronic renal insufficiency, nephron damage is (extensive and irreversible)(limited and reversible).

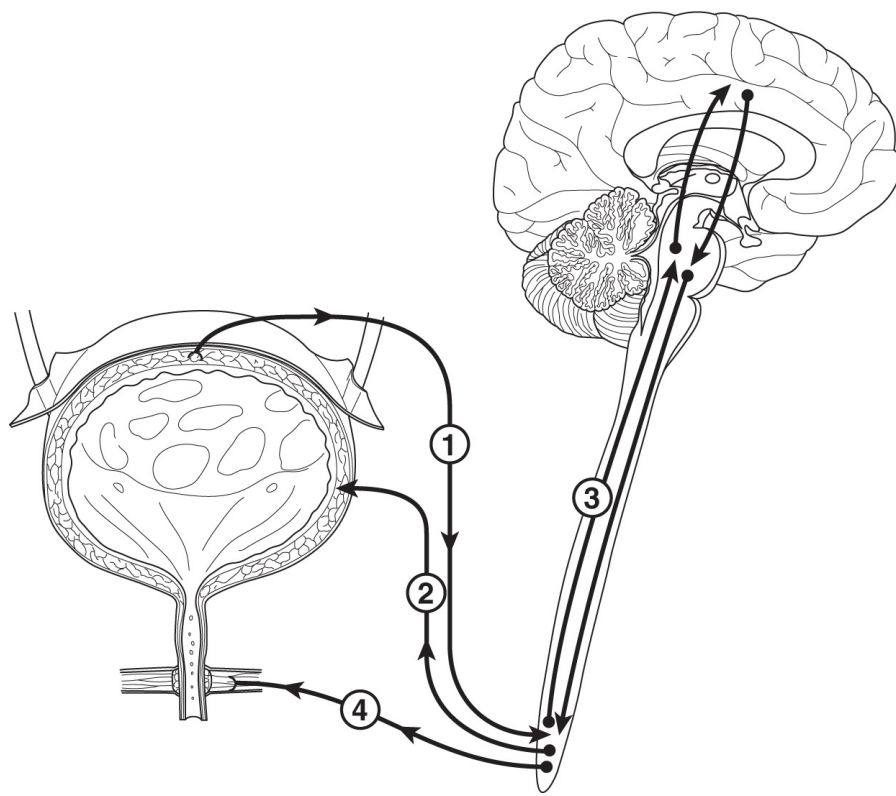
Illuminate the Truth Urinary Bladder Structure and Function

Highlight the word or phrase that completes each sentence correctly.

1. The wall of the bladder consists of (two)(three) layers of (skeletal)(smooth) muscle.
2. Inside the bladder, folds called (rugae)(tubules) form when the bladder is (empty)(full).
3. The bladder has a maximum capacity of (500)(800) ml of urine.
4. The floor of the bladder has (two)(three) openings.
5. The ureters enter the bladder from (above)(below).
6. Infections commonly occur in the area of the (external urinary sphincter)(trigone).
7. The point where the urethra leaves the bladder forms the (internal urethral sphincter)(external urinary sphincter).
8. The internal urethral sphincter is under (involuntary)(voluntary) control.
9. The external urinary sphincter is under (involuntary)(voluntary) control.
10. The small tube that conveys urine away from the bladder and out of the body is the (ureter)(urethra).
11. The opening that allows the body to expel urine is the (ureter)(external urinary meatus).
12. In females, the urethra is approximately (6 cm or 2.4 inches)(3 cm or 1.2 inches).
13. In males, the urethra is approximately (20 cm or 7.9 inches)(15 cm or 6 inches).

Describe the Process Urination

Using the spaces below, describe the processes that allow urination to occur. Use the figure as a guide.



1. When the bladder contains _____ ml or more of urine, stretch receptors in the _____ send impulses to the _____.
2. The _____ then sends motor impulses to the bladder wall to _____ and the _____ sphincter to _____. Voiding will occur unless _____.
3. The _____ can override the impulse to void because _____.
4. If the time to urinate is appropriate, the _____ sends signals to the _____ to contract and the _____ to relax, at which point voluntary urination occurs.

chapter 20

FLUID, ELECTROLYTE, & ACID-BASE BALANCE

About two-thirds of the body consists of water. Dissolved within the water are thousands of substances, such as electrolytes, that are used in the body's biochemical reactions. The maintenance of homeostasis, and even life itself, depends upon a precise balance of water, electrolytes, and pH. Complete the activities in this chapter to gain a better understanding of this complex topic.

Illuminate the Truth Fluid Compartments

Highlight the word or phrase that completes each sentence correctly. Words may be used more than once; not all words may be used.

1. Most of the body's water resides (outside)(inside) cells.
2. The fluid between cells inside tissue is called (transcellular)(interstitial) fluid.
3. The body's water that resides inside of cells is called (intracellular)(extracellular) fluid.
4. Blood, plasma, and lymph are examples of (extracellular)(intracellular) fluid.
5. Cerebrospinal fluid is an example of (interstitial)(transcellular) fluid.
6. Interstitial fluid is a type of (intracellular)(extracellular) fluid.
7. Intracellular and extracellular fluid (remain locked in their compartments)(continually mix).
8. If the concentration of electrolytes of tissue fluid rises, water moves (out of)(into) cells.
9. If osmolarity of tissue fluid falls, water moves (out of)(into) cells.

List for Learning Water Gain and Loss

Normally, the amount of water gained and lost by the body throughout a day is equal. Using the spaces below, describe how the body gains and loses water.

First, list three ways the body normally gains water during a day.

- 1. _____
- 2. _____
- 3. _____

Then, list four ways fluid leaves the body.

- 4. _____
- 5. _____
- 6. _____
- 7. _____

Finally, list two factors that can significantly affect the amount of water lost.

- 8. _____
- 9. _____

Describe the Process Regulation of Intake and Output

Using the spaces below, describe how the body uses mechanisms to regulate intake and output.

Various factors, including excessive sweating, cause the volume of total body water to decline.

1. Blood pressure _____, sodium concentration _____, and osmolarity _____.

- 2. Physical changes stimulate the thirst center in the _____.
- 3. _____ decreases, causing a dry mouth and a sensation of _____.
- 4. Consumption of _____ leads to a _____ in total water volume.

- 5. Physical changes stimulate the _____, which stimulates the posterior pituitary to secrete the hormone _____.
- 6. The hormone _____ prompts the kidneys to _____ more water and produce _____ urine.
- 7. The rate of fluid loss _____.

Fill in the Gaps Disorders of Water Balance

A water imbalance can result due to several different abnormalities. Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

ADULTS
DEHYDRATION
EDEMA
EXTRACELLULAR
HYPERVOLEMIA
HYPOVOLEMIA
INFANTS
INTAKE
INTERSTITIAL
OUTPUT
VOLUME DEPLETION
WATER INTOXICATION

1. A fluid deficiency occurs when _____ exceeds _____ over time.
2. Blood loss results in _____.
3. _____ results when the body eliminates more water than sodium.
4. _____ occurs when both sodium and water are lost, such as from diarrhea.
5. _____ are more prone to dehydration than are _____.
6. _____ fluid is a ready source of fluid to help maintain blood volume during the early stages of fluid loss.
7. _____ results from consuming an inadequate amount of water to cover the amount of water lost.
8. Volume depletion is also called _____.
9. If someone replaces heavy losses of water and sodium with just water, _____ can occur.
10. An accumulation of fluid within interstitial spaces is called _____.
11. A decreased concentration of plasma proteins or increased capillary pressure can trigger _____.

Sequence of Events Dehydration

Insert the numbers 1 through 6 in the spaces provided to identify the sequence of events that occur in dehydration.

- _____ A. Fluid shifts from tissues into the bloodstream.
- _____ B. Water is lost through sweat.
- _____ C. Fluid shifts from cells into tissues.
- _____ D. Fluid moves from the bloodstream to the sweat glands.
- _____ E. The osmolarity of the blood rises.
- _____ F. The osmolarity of tissue fluid rises.

Make a Connection Electrolytes

In the spaces below, list the chief electrolytes in blood plasma. The first two letters of each term have been provided to get you started. Then, draw a line to link each electrolyte to its characteristics. Note that items may link with more than one characteristic.

1. So _____
 2. Po _____
 3. Ca _____
 4. Ch _____
 5. Ph _____
- a. The main electrolyte in extracellular fluid
 - b. Is retained or excreted along with sodium, so that an imbalance in this ion occurs along with a sodium imbalance
 - c. The terms *hyperkalemia* and *hypokalemia* refer to abnormal plasma concentrations of this ion.
 - d. Levels are primarily regulated by aldosterone and ADH
 - e. Besides strengthening bones, this ion plays a key role in muscle contraction, nerve transmission, and blood clotting.
 - f. The terms *hypernatremia* and *hyponatremia* refer to abnormal plasma concentrations of this ion.
 - g. Aldosterone (which is released in response to rising plasma levels of this ion) causes the kidneys to increase excretion of this ion.
 - h. The body can tolerate broad variations in the concentration of this ion.
 - i. The chief cation of extracellular fluid
 - j. The terms *hypercalcemia* and *hypocalcemia* refer to abnormal plasma concentrations of this ion.

- k.** An increased plasma concentration of this ion usually represents a water deficit.
- l.** High plasma levels of this ion can lead to fatal cardiac arrhythmias.
- m.** Influences how body water is distributed between fluid compartments
- n.** The most abundant extracellular anion

Fill in the Gaps

Regulation of Sodium

Fill in the blanks with the appropriate word to describe the mechanisms the body uses to regulate sodium and normalize serum osmolarity in situations involving water excess as well as water deficit. Choose from the words listed in the Word Bank below. Words may be used more than once.

ADH

ALDOSTERONE

CHLORIDE

CONSUMPTION

DECREASE

FALL

INCREASE

INCREASED

REABSORB

RISE

SECRETE

SECRETION

SODIUM

THIRST

WATER

WATER EXCESS

A water excess causes serum sodium levels to (1) _____. This causes serum osmolarity to (2) _____. The hormone (3) _____ then prompts renal tubules to reabsorb (4) _____. (5) _____ and (6) _____ are also reabsorbed.

The release of the hormone (7) _____ is suppressed, which causes the kidney to (8) _____ more water. Reabsorption of (9) _____, combined with the (10) _____ of water, causes serum sodium levels to (11) _____.

WATER DEFICIT

A water deficit causes serum sodium levels to (1) _____. This causes serum osmolarity to (2) _____. The hormone (3) _____ stimulates the kidneys to (4) _____ water.

At the same time, the hormone (5) _____ stimulates (6) _____ to promote water (7) _____. (8) _____ renal absorption of water combined with (9) _____ water intake causes serum sodium levels to (10) _____.

Illuminate the Truth General Concepts of Fluids and Electrolytes

Highlight the word or phrase that completes each sentence correctly.

1. The average daily fluid intake for an adult is (2500 mL)(1800 mL).
2. Water usually follows the movement of (potassium)(sodium).
3. pH reflects the concentration of (hydrogen ions)(bicarbonate ions) in the blood.
4. The body's normal pH range is (7.45 to 7.55)(7.35 to 7.45).
5. An acid (releases)(accepts) H^+ ions.
6. As the concentration of H^+ ions increases, the pH (increases)(decreases), and the solution becomes more (acidic)(alkaline).
7. (Physiological buffers)(Chemical buffers) are the first to respond to an acid-base imbalance.
8. When the body's pH drops, chemical buffers work by (binding)(releasing) H^+ ions.
9. A rising CO_2 level causes the concentration of H^+ ions to (decrease)(increase).
10. The (respiratory system)(renal system) is the slowest system to respond to an acid-base imbalance.
11. The (respiratory system)(renal system) is the most powerful of all the buffer systems.

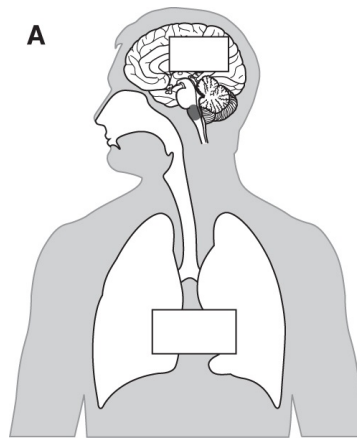
List for Learning Buffer Systems

Using the spaces below, list three ways the body combats the continual production of acid.

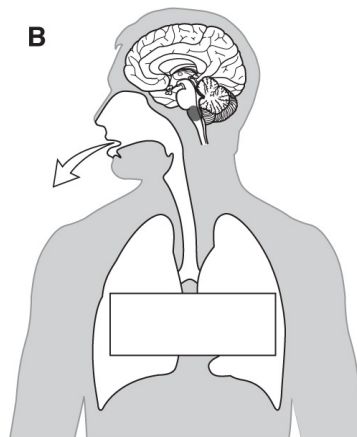
1. _____
2. _____
3. _____

Drawing Conclusions Respiratory Control of pH

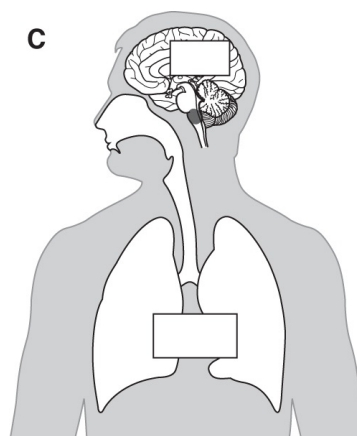
The respiratory system helps the body maintain an appropriate pH. Test your knowledge of this process by filling in the blanks of each sentence. Then, label the figures as described.



1. Central chemoreceptors in the _____ detect a fall in pH resulting from an accumulation of _____.
(Insert symbols inside the small boxes in the accompanying figure to illustrate what is being described.)



2. The central chemoreceptors signal the _____ centers to _____ the rate and depth of breathing. This results in the expulsion of _____.
(Insert symbols in the small boxes in the accompanying figure to illustrate what is being described. Also, insert other arrows and symbols as appropriate to complete the illustration.)



3. Since less _____ is available to combine with water to form _____, the concentration of falls and pH _____.
(Insert symbols in the small boxes in the accompanying figure to illustrate what is being described.)

Fill in the Gaps Renal Control of pH

The kidneys also help the body regulate pH. Fill in the blanks with the appropriate word or words to describe this important buffer system. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

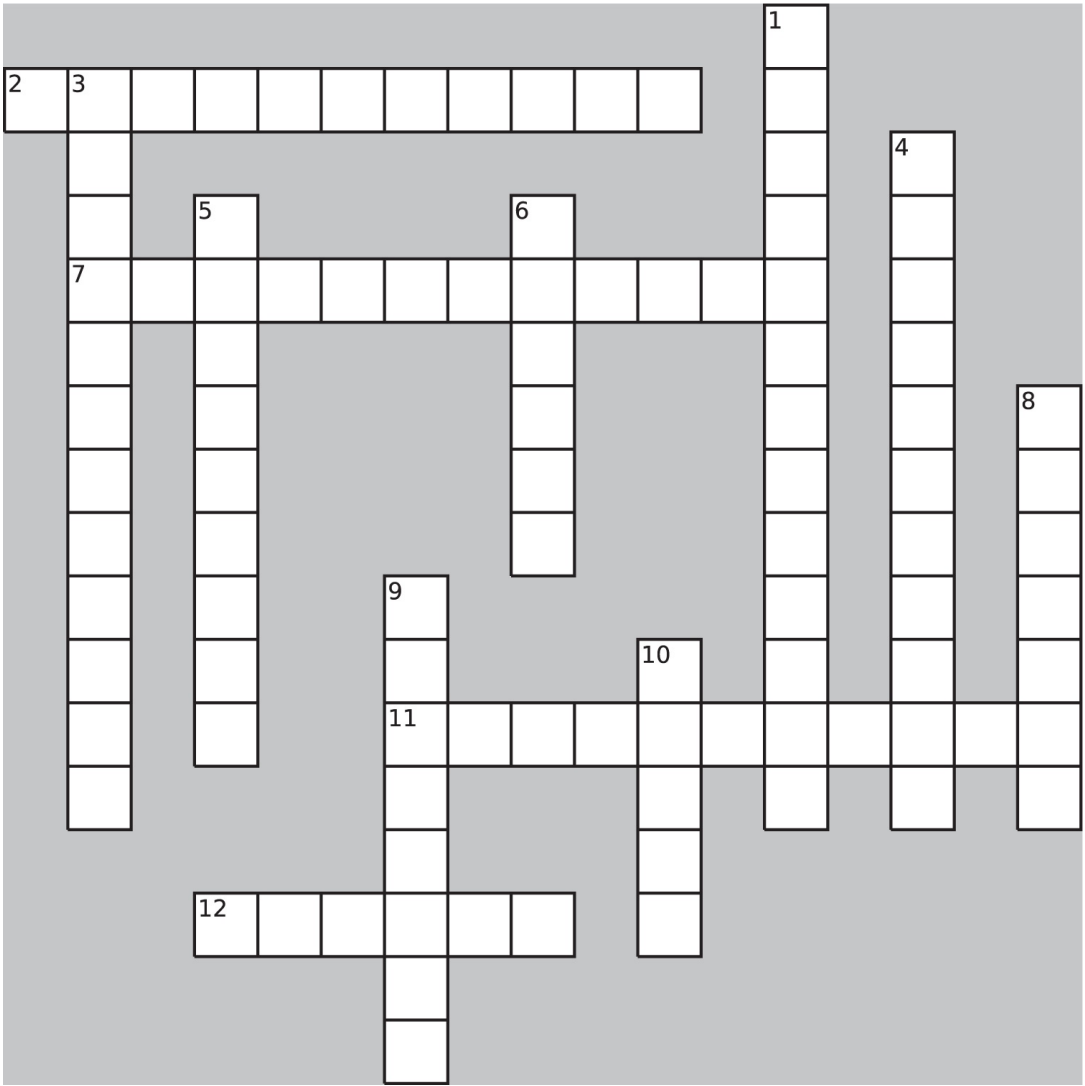
ABSORBED
BICARBONATE
BLOOD
CARBON DIOXIDE
CARBONIC ACID
DISTAL KIDNEY TUBULES
EXCRETED
HYDROGEN
LOWER
PROXIMAL KIDNEY TUBULES
RAISE
SODIUM
SODIUM BICARBONATE
TUBULAR CELL
TUBULAR FLUID
URINE

1. The kidneys are the only buffer system that expels _____ ions from the body while also reabsorbing _____.
2. _____ is the predominate buffer in extracellular fluid.
3. _____ leaves the blood and enters cells along the _____.
4. In these cells, _____ combines with water to form _____.
5. The _____ immediately dissociates to yield _____ ions and _____ ions.

- In turn, the _____ ions diffuse out of the cell and into _____, where they displace _____.
- The displaced _____ then diffuses into the _____, where it combines with _____ to form _____.
- Next, _____ is reabsorbed into the blood.
- The end result is that _____ ions are _____ into urine, while _____ is reabsorbed into the _____, which, in turn, helps _____ plasma pH.

Puzzle It Out Fluid and Electrolytes

Complete the following crossword puzzle to test your knowledge of fluid and electrolyte principals.



ACROSS

- When CO₂ levels are high, the kidneys reabsorb this to compensate.
- Substances that break up into electrically charged particles when dissolved in water
- Fluid deficiency that results when the body eliminates more water than sodium

12. Skin elasticity

DOWN

1. Cerebrospinal fluid and synovial fluid are categorized as _____ fluid.
3. Fluid between cells inside tissue
4. Volume depletion
5. Water produced as a byproduct of metabolic reactions is called _____ water.
6. This fluid makes up one component of extracellular fluid.
8. Persistence of pinched skin after release; a sign of dehydration
9. The kidneys are the only buffer system that expels this.
10. Occurs when fluid accumulates in interstitial spaces

Just the Highlights Acid-Base Imbalances

One of the most important factors influencing homeostasis is the body's balance between acids and bases. An imbalance between acids and bases may result in acidosis or alkalosis. In the following list, to differentiate between these two conditions, highlight the sentences pertaining to acidosis in pink and those pertaining to alkalosis in yellow.

1. May result from hypoventilation
2. May cause breathing to slow, so as to allow CO_2 to accumulate
3. May result from a loss of gastric juices, such as through vomiting or suctioning
4. Results from an excess concentration of H^+ ions in the plasma
5. Causes hypokalemia
6. Causes hyperkalemia
7. Produces symptoms of CNS depression, such as disorientation, confusion, and coma
8. Would result from a loss of CO_2
9. May trigger an increased rate of breathing so as to "blow off" CO_2
10. May result from diabetes mellitus
11. Caused by a loss of acid
12. Caused by a gain in acid

chapter 21

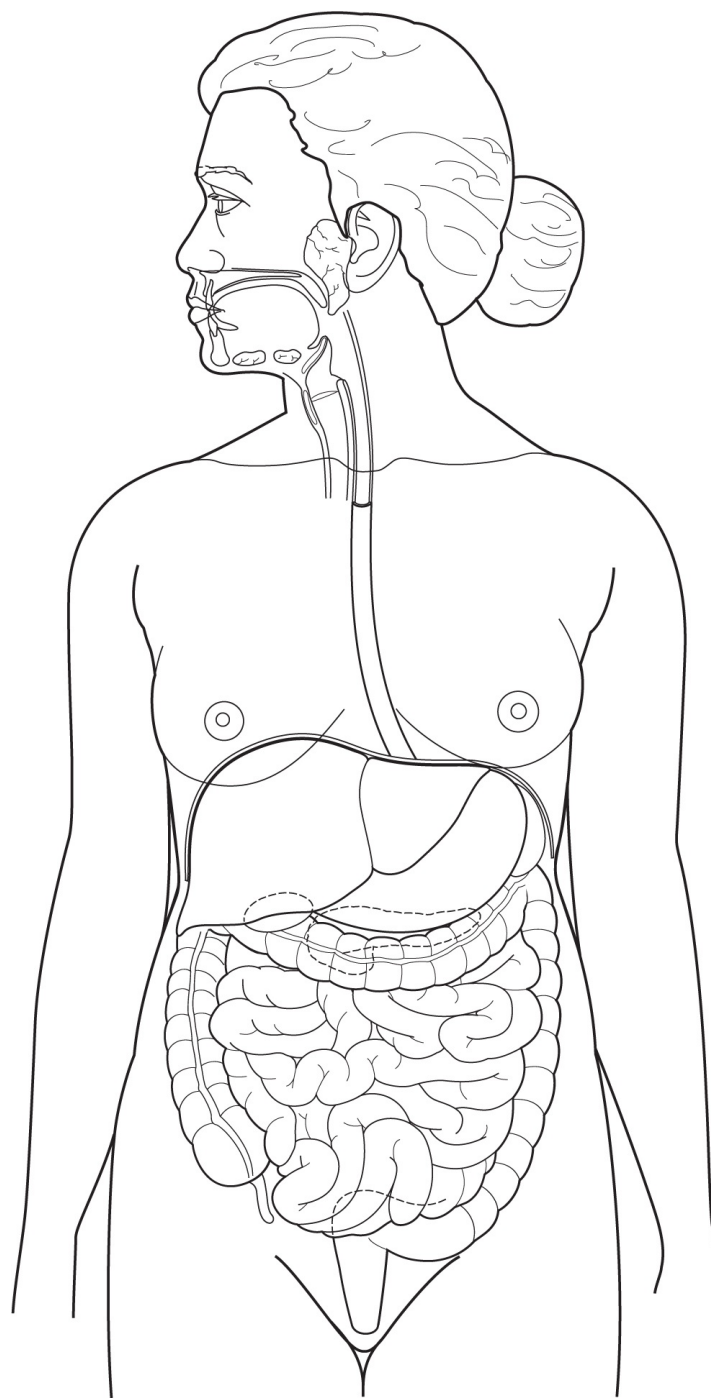
DIGESTIVE SYSTEM

Transforming food into fuel that the body can use is no simple task; it requires the use of a dozen organs, multiple enzymes, and thousands of chemical reactions. Use the activities in this chapter to help make sense of the digestive process.

Conceptualize in Color Organs of the Digestive System

Identify the organs of the digestive system by coloring the figure below. Use the suggested colors or choose your own.

- Esophagus: Pink
- Pharynx: Red
- Mouth: Tan
- Stomach: Yellow
- Liver: Brown
- Large intestine: Purple
- Small intestine: Orange
- Gallbladder: Green
- Salivary gland: Blue
- Pancreas: Outline in brown
- Rectum: Blue
- Anus: Pink



Just the Highlights Mechanical and Chemical Digestion

Digestion breaks down food both physically and chemically to transform it into substances cells can use. In the following list, highlight characteristics of mechanical digestion in blue and characteristics of chemical digestion in yellow.

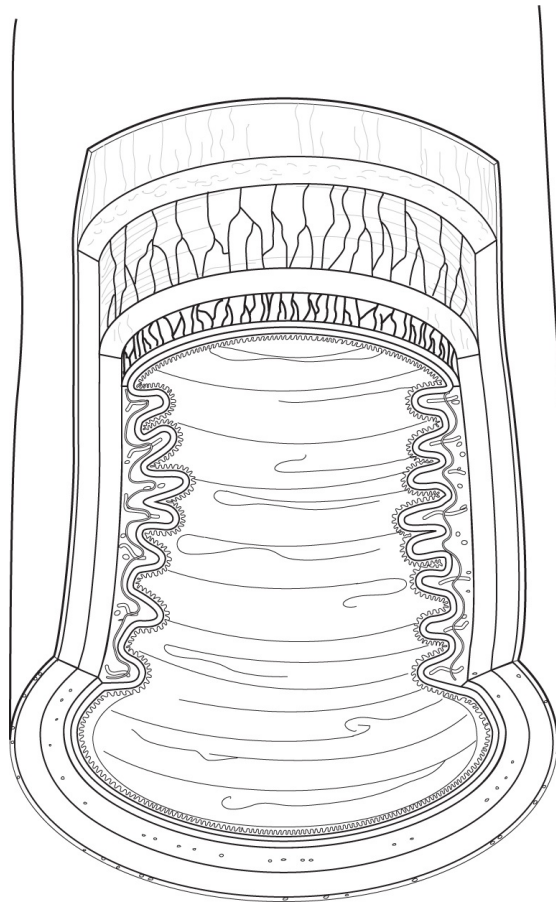
1. First phase of digestion
2. Uses digestive enzymes produced in salivary glands, stomach, pancreas, and small intestine
3. Involves physically breaking down food into smaller pieces
4. Begins with chewing in the mouth
5. Second phase of digestion

6. Contractions and churning in stomach and small intestine contribute to this type of digestion
7. Breaks down particles into nutrients cells can use

Drawing Conclusions Tissue Layers of the Digestive Tract

Test your knowledge of the structures of the digestive tract by coloring the figure below. Use the suggested colors or choose your own. Then, fill in the blanks of each sentence to describe the form and function of each of these layers.

- Mucosa: Red
- Submucosa: Pink
- Muscularis: Orange
- Serosa: Yellow
- Myenteric nerve plexus: Purple
- Submucosal nerve plexus: Green



1. The _____ is the innermost layer of the digestive tract; it consists of an inner layer of _____, a layer of _____ tissue, and a layer of _____.
2. The _____ is the outermost layer of the digestive tract; it covers the portion of the digestive tract within the peritoneal cavity.

3. The muscularis consists of two layers of _____.
4. The _____ consists of a thicker layer of connective tissue which contains glands, blood vessels, and nerves.
5. The layer that secretes mucus and digestive enzymes is the _____.
6. The layer that contracts and relaxes to propel food through the digestive tract is the _____.
7. The _____ is the layer that absorbs nutrients after digestion.

Illuminate the Truth Enteric Nervous System

Highlight the word or phrase that completes each sentence correctly.

1. The enteric nervous system (ENS) is part of the (central nervous system)(autonomic nervous system).
2. The ENS regulates (only digestive tract motility)(digestive tract motility, secretion, and blood flow).
3. If connection between the ENS and the central nervous system (CNS) is disrupted, the ENS will (cease to function)(continue to function).
4. The ENS uses more than 30 neurotransmitters that are (unique to the digestive system)(identical to those found in the CNS).
5. The ENS contains support cells similar to (astrocytes)(microglia).

Fill in the Gaps Peritoneum

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Not all words may be used.

FRICTION
GREATER CURVE OF THE STOMACH
INFECTION
INTRAPERITONEAL
LARGE INTESTINE
LESSER CURVE OF THE STOMACH
LIGAMENTS
LIVER
LOCALIZE
MESENTERIES
MESOCOLON
OUTSIDE
RETROPERITONEAL
SMALL INTESTINES
SPREAD
WITHIN

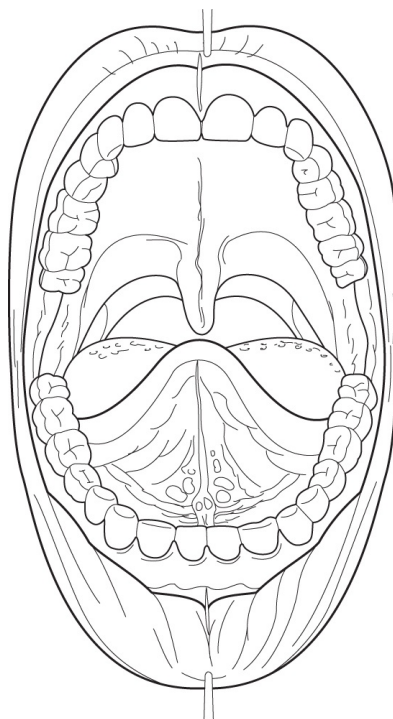
1. _____ suspend digestive organs within the abdominal cavity while anchoring them loosely to the abdominal wall.
2. The greater omentum extends from the _____ to hang down over the _____.
3. The greater omentum helps to prevent _____ from intestinal movement.
4. The _____ fixes the colon to the posterior abdominal wall.
5. If infection occurs, the greater omentum can _____ the infection.
6. The lesser omentum extends from the _____ to the _____.
7. The stomach and liver reside _____ the peritoneal cavity, which is called _____.
8. The duodenum and most of the pancreas reside _____ the peritoneal cavity and are called _____.

Drawing Conclusions The Mouth

Test your knowledge of the structures of the mouth, particularly as they relate to the digestive

process, by filling in the blanks of each sentence. Then, color the figure below as described. Use the suggested colors or choose your own.

1. A key role of the tongue in digestion is to _____.
(Color the tongue pink.)
2. A fold of mucous membrane called the _____ anchors the tongue to the floor of the mouth.
(Color this structure red.)
3. The _____ separates the mouth from the nasal cavity. It is formed by portions of the _____ and _____ bones.
(Color this structure tan.)
4. The _____ forms an arch between the mouth and the nasopharynx. It consists mostly of _____.
(Color this structure orange.)
5. The _____ hangs down from the soft palate.
(Color this structure yellow.)
6. Because the floor of the mouth contains numerous superficial blood vessels, it is an ideal site for _____ to be absorbed.

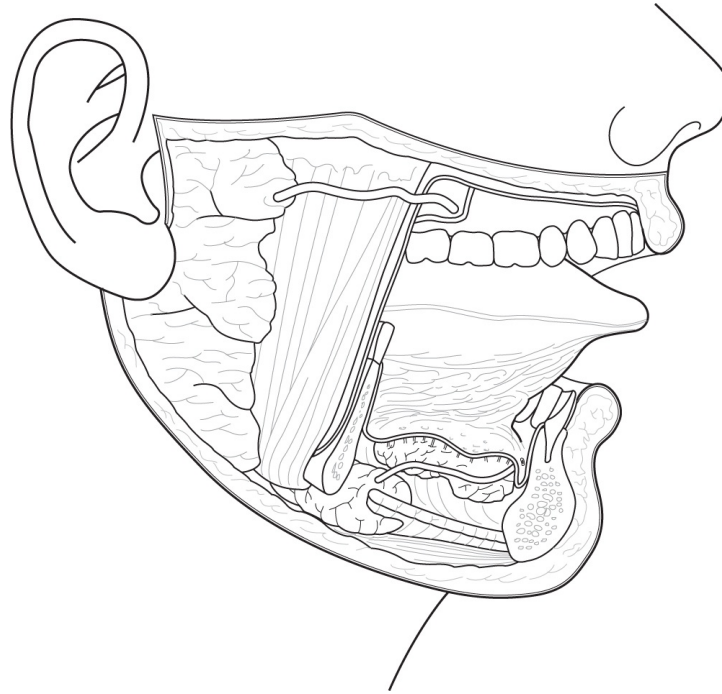


Drawing Conclusions Salivary Glands

Test your knowledge of where the main salivary glands drain by filling in the blanks of each sentence. Then, color the figure below as described. Use the suggested colors or choose your own.

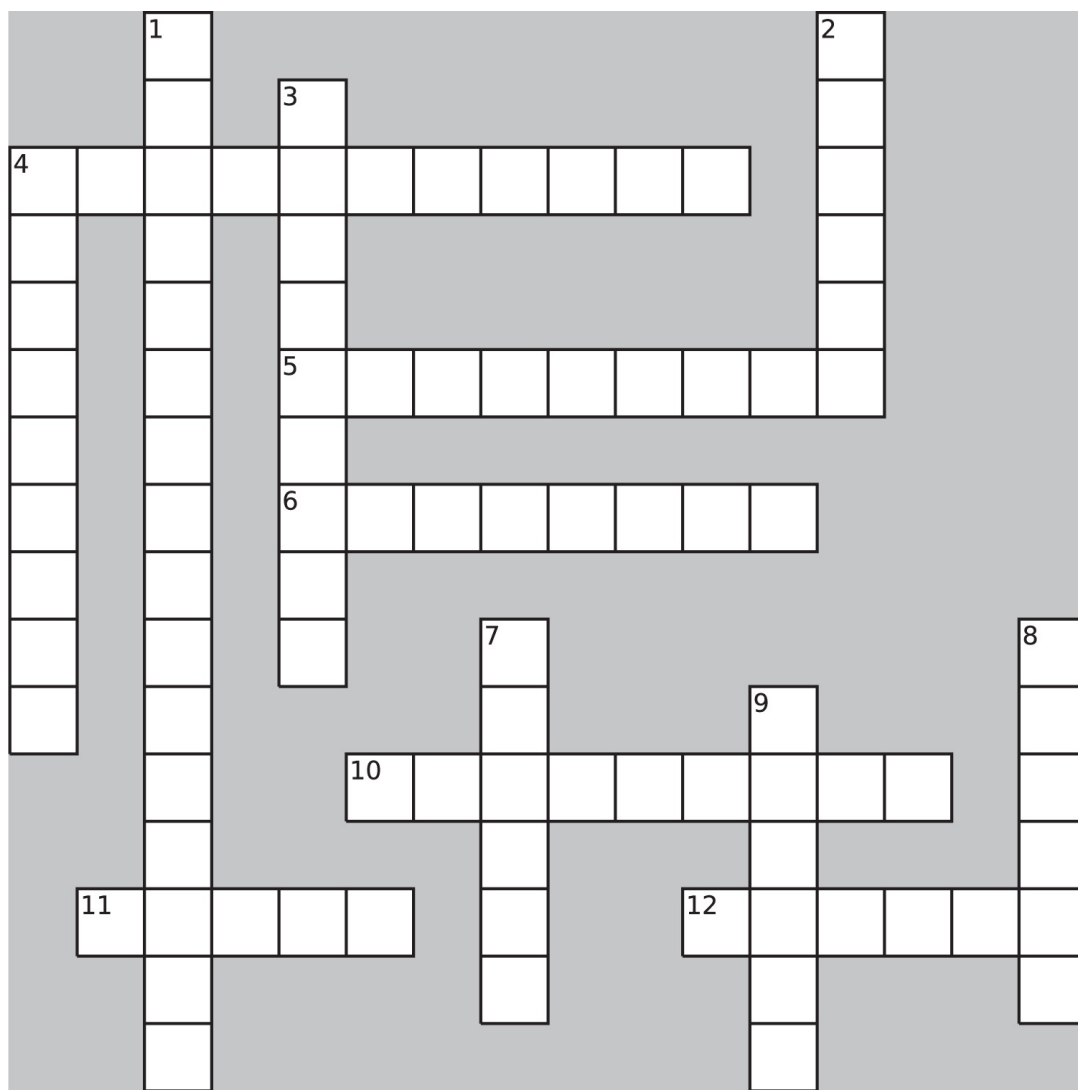
1. The gland drains saliva to an area near the second upper molar.
(Color this salivary gland purple.)

2. The gland empties into the mouth on either side of the lingual frenulum.
(Color this salivary gland orange.)
3. The gland drains through multiple ducts onto the floor of the mouth.
(Color this salivary gland green.)



Puzzle it Out Digestive System Basics

Complete the following crossword puzzle to test your knowledge of the digestive system.



ACROSS

4. Chewing
5. Tissue layer of the digestive tract that contains glands, blood vessels, lymphatic vessels, and nerves
6. Chisel-like front teeth with sharp edges for cutting food
10. Early teeth that fall out and are replaced by permanent teeth
11. Mass of moistened food that can be swallowed easily
12. Pointed teeth designed to tear food

DOWN

1. The area of medicine concerned with the study of the digestive tract and the diagnosis and treatment of its diseases
2. Clear fluid secreted by the mouth that contains digestive enzymes
3. Process of breaking down food into a form that cells can use
4. Holds the intestines loosely in place
7. The mouth is also called the _____ cavity.
8. Hardest substance in the body
9. Teeth with flat surfaces for crushing or grinding food

List for Learning Saliva

Using the spaces below, list four of the roles played by saliva.

1. _____
2. _____
3. _____
4. _____

List for Learning Organs of the Digestive Tract

Using the spaces below, list the six organs of the digestive tract.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

List for Learning Accessory Organs of the Digestive Tract

Using the spaces below, list the six accessory organs of the digestive tract.

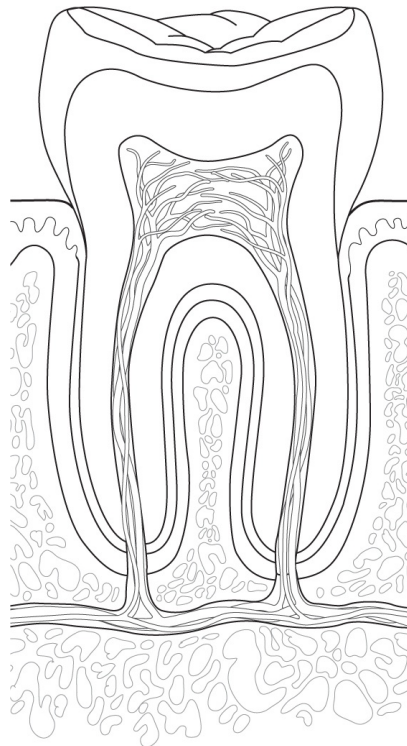
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Drawing Conclusions Teeth

Test your knowledge of the tooth by coloring in the figure below. Use the suggested colors or choose

your own. Then, fill in the blanks of each sentence to describe the form and function of teeth.

- Enamel: Light tan
- Dentin: Gold
- Pulp cavity: Red
- Cementum: Gray
- Periodontal ligament: Purple
- Gingiva: Pink
- Draw a red bracket around the crown
- Draw a green bracket around the root
- Draw an orange bracket around the neck
- Outline the root canal in black



1. The portion of the tooth above the gum (also called the _____) is the _____.
2. The _____ is embedded in a socket in the jawbone.
3. A hard tissue called _____ covers the crown.
4. A firm, yellowish tissue called _____ makes up the bulk of the tooth.
5. A mass of connective tissue, blood and lymphatic vessels, and nerves fills the _____.
6. The tooth is anchored in place by a _____.

7. If damaged, _____ and _____ can regenerate, whereas _____ cannot.

Fill in the Gaps Esophagus and Stomach

Fill in the blanks with the appropriate word or words to describe the esophagus and stomach. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

CHYME
DIAPHRAGM
DIGEST
LOWER ESOPHAGEAL SPHINCTER (LES)
LUNGS
MUCUS
OBLIQUE
PARIETAL
PHARYNX
POSTERIOR
PYLORIC
RUGAE
SALIVA
STOMACH
STORE
TRACHEA
UPPER ESOPHAGEAL SPHINCTER (UES)
VITAMIN B12
VITAMIN D

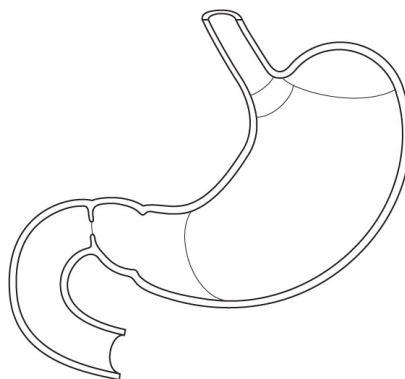
1. The esophagus extends from the _____ to the _____
2. A muscular sphincter called the _____ prevents the backflow of stomach acid into the esophagus.
3. The esophagus lies _____ to the trachea.
4. The esophagus penetrates the _____ and enters the stomach.

5. Glands within the small of the esophagus secrete _____ that helps lubricate food.
6. Just below the _____, the digestive tube expands to form the _____.
7. The primary function of the stomach is to _____ food.
8. The stomach contains folds in its lining called _____.
9. The muscularis of the stomach contains an additional layer of _____ muscle.
10. The stomach mixes particles of food with gastric juice to create a semifluid mixture called _____.
11. The _____ sphincter controls the opening between the stomach and duodenum.

Conceptualize in Color The Stomach

Identify the regions of the stomach and nearby structures by coloring the figure below. Use the suggested colors or choose your own.

- Cardia: Orange
- Fundus: Blue
- Body: Yellow
- Pylorus: Green
- Esophagus: Pink
- Duodenum: Tan
- Draw a red line along the lesser curvature
- Draw a purple line along the greater curvature
- Highlight pyloric sphincter in purple



Describe the Process Gastric Secretions

Using the spaces below, describe gastric secretions.

1. The gastric mucosa contains depressions called _____.
2. Opening into these depressions are _____, which secrete various components of _____.
3. _____ cells secrete mucus, which serves to _____.
4. _____ cells secrete hydrochloric acid, which helps _____. They also secrete _____, which is necessary for absorption of vitamin _____.
5. Chief cells secrete _____.
6. _____ cells secrete the hormone _____, which stimulates the hypothalamus to increase appetite; they also secrete _____, which influences digestive function.

Fill in the Gaps Gastric Digestion

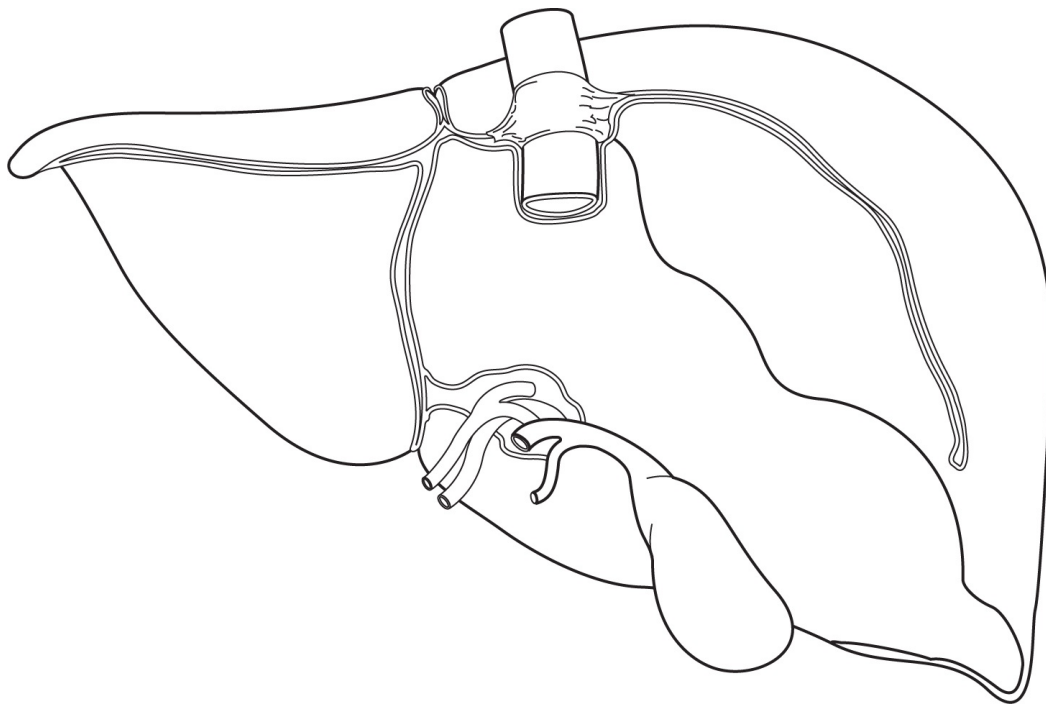
Fill in the blanks with the appropriate word or words to describe the role of the stomach in the digestive process. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

CEPHALIC
CHYME
DUODENUM
FOUR HOURS
FUNDUS
GASTRIC
GASTRIN
INCREASE
INHIBIT
INTESTINAL
NEURAL
PARASYMPATHETIC
PYLORIC
RELAX
STIFFEN
THIRTY MINUTES

1. The sight, smell, taste, or thought of food sends _____ impulses to the brain. The _____ nervous system then signals the stomach to secrete _____ juice as well as _____. This is called the _____ phase of gastric secretion.
2. Swallowing signals the stomach _____ to so food can enter.
3. When food enters the stomach, the _____ phase begins. The stretching of the stomach triggers nervous impulses that _____ the secretion of _____ juice and _____.
4. The stomach contracts, with contractions beginning in the _____ and continuing toward the _____ region, to break down food and mix it with gastric juices to form _____.
5. Under pressure of a contraction, about 30 ml of _____ squirts into the duodenum. This continues until the stomach empties, which takes about _____ (Hint: Amount of time) after a typical meal.
6. As chyme moves into the duodenum, the _____ phase begins. At this point, nervous impulses and hormones secreted by the duodenum _____ gastric secretion.

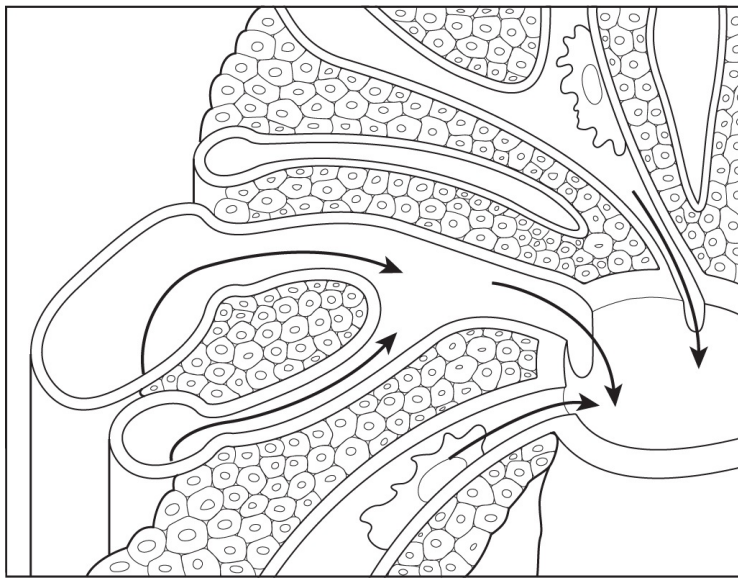
The figure below shows a posterior view of the liver. Identify the structures of the liver by coloring the figure below. Use the suggested colors or choose your own.

- Right lobe: Light brown
- Left lobe: Dark brown
- Caudate lobe: Tan
- Quadrate lobe: Gold
- Falciform ligament: Gray
- Portal vein: Blue
- Hepatic artery: Red
- Inferior vena cava: Purple
- Gallbladder: Dark green
- Common hepatic duct: Light green



Drawing Conclusions Hepatic Lobules

Test your knowledge of the structure and function of hepatic lobules by filling in the blanks of each sentence. Then, color the figure as described. Use the suggested colors or choose your own.



1. Tiny, six-sided cylinders called _____ are the functional units of the liver.
2. A _____ passes through the core of each lobule.
3. Sheets of hepatic cells called _____ fan out from the center of each lobule; these cells secrete _____, which is then carried through tiny canals called _____.
(Color the cells brown and the canal green.)
4. In between the sheets of hepatic cells are passageways filled with _____ called _____.
5. Nutrient-rich blood from the stomach and intestine enters the lobule through small branches of the _____.
(Color this structure dark blue.)
6. Oxygen-rich blood enters the lobule through small branches of the _____.
(Color this structure red.)
7. The blood filters through the _____, allowing the cells to remove nutrients, hormones, toxins, and drugs.
(Color these structures light blue. Insert arrow to show direction of flow.)
8. _____ cells called _____ remove bacteria, worn-out red blood cells, and debris from the bloodstream.
(Color these structures yellow.)
9. The _____ carries the processed blood out of the liver.
(Color this structure purple.)
10. _____ carry the bile secreted by hepatic cells and ultimately drain into the _____.

Drawing Conclusions The Gallbladder and Pancreas

Test your knowledge of the structure and function of the gallbladder by filling in the blanks of each

sentence. Then, color the figure as described. Use the suggested colors or choose your own.



1. Bile leaves the liver by way of the _____ ducts. (Color these structures orange.) _____
2. These ducts converge to form the _____ duct. (Color this structure blue.)
3. In turn, this duct becomes the _____ duct. (Color this structure purple.) Bile from the liver fills this duct before backing up through the _____ duct (color this structure green) and into the _____. (Color this structure pink.)
4. The _____ merges with the duct of the pancreas to form the hepatopancreatic ampulla, also called the _____. (Color this structure red.)
5. The ampulla enters the _____ (color this structure brown) at a raised area called the _____. (Draw a red circle around this area.)
6. The head of the _____ lies within the curve of the duodenum. (Color this structure tan.)
7. Ducts within this organ converge on the main _____ duct, (outline this duct in blue) which joins the bile duct at the _____ (color this structure orange), which controls the flow of bile and pancreatic juice into the _____.

Illuminate the Truth Bile and the Gallbladder

Highlight the word or phrase that completes each sentence correctly.

1. Each day the (gallbladder)(liver) secretes up to a liter of bile; bile is formed from (cholesterol)(bile salts).

2. The main bile pigment is (bile salts)(bilirubin).
3. The most important component of bile is (bile salts)(bilirubin).
4. Bile salts aid in the digestion and absorption of (carbohydrates)(fat) in the small intestine.
5. After secretion, (80%)(50%) of bile salts are reabsorbed in the (large intestine)(ileum).

Illuminate the Truth The Pancreas and Duodenum

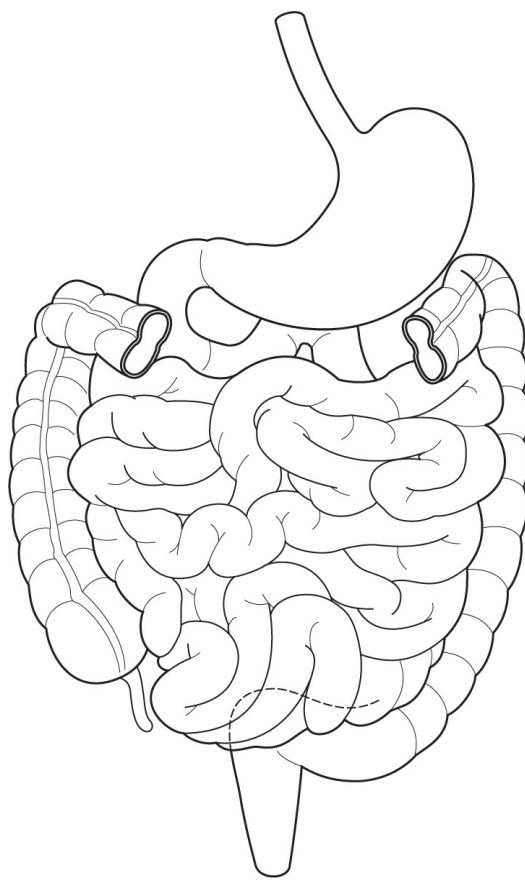
Highlight the word or phrase that completes each sentence correctly.

1. Most of the pancreas contains (endocrine)(exocrine) tissue.
2. (Acinar)(Duct) cells in the pancreas secrete digestive enzymes in an inactive form.
3. The enzymes are activated in the (stomach)(duodenum), after which they help break down lipids, proteins, and carbohydrates.
4. (Acinar)(Duct) cells in the pancreas secrete sodium bicarbonate, which buffers the acidic chyme entering the duodenum.
5. The arrival of chyme in the duodenum prompts the duodenum to secrete (cholecystokinin)(insulin), which (stimulates)(inhibits) the release of bile and pancreatic enzymes.
6. The hormone (gastrin)(secretin) also triggers gallbladder contraction and pancreatic enzyme secretion.
7. The hormone (gastrin)(secretin) causes the pancreatic ducts to release bicarbonate to neutralize the stomach acid.

Drawing Conclusions The Small Intestine

Test your knowledge of the small intestine by coloring the figure below. Use the suggested colors or choose your own. Then, use the same color to highlight the characteristics of each region. For example, after coloring the duodenum green, highlight the sentences describing characteristics of the duodenum in green.

- Duodenum: Green
- Ileum: Yellow
- Jejunum: Blue



1. Begins at the pyloric valve and ends where the intestine turns abruptly downward
2. Forms the last 12 feet of intestine
3. Receives chyme from the stomach as well as pancreatic juice and bile
4. Is where stomach acid is neutralized and pancreatic enzymes begin the task of chemical digestion
5. Provides an ideal location for nutrient absorption
6. Forms the first 10 inches of small intestine
7. Wall of this part of the intestine is thick and muscular with a rich blood supply
8. Contains clusters of lymphatic nodules called Peyer's patches
9. Is where more digestive processes occur than in any other part of the intestine

Just the Highlights Segmentation and Peristalsis

Two types of contractions in the small intestine aid in the digestion process. In the following list, to differentiate between these characteristics, highlight the characteristics of segmentation in blue and peristalsis in yellow.

1. Involves ring-like contractions that occur at intervals in the small intestine_____
2. Involves successive, wave-like ripples
3. When contracted areas relax, new contractions occur in other locations

4. Serves to break up food particles and knead contents of the intestines to mix it with digestive juices
5. Begins when most of the nutrients have been absorbed and undigested residue remains
6. Serves to move digested material along the gastrointestinal tract

Fill in the Gaps Intestinal Wall

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

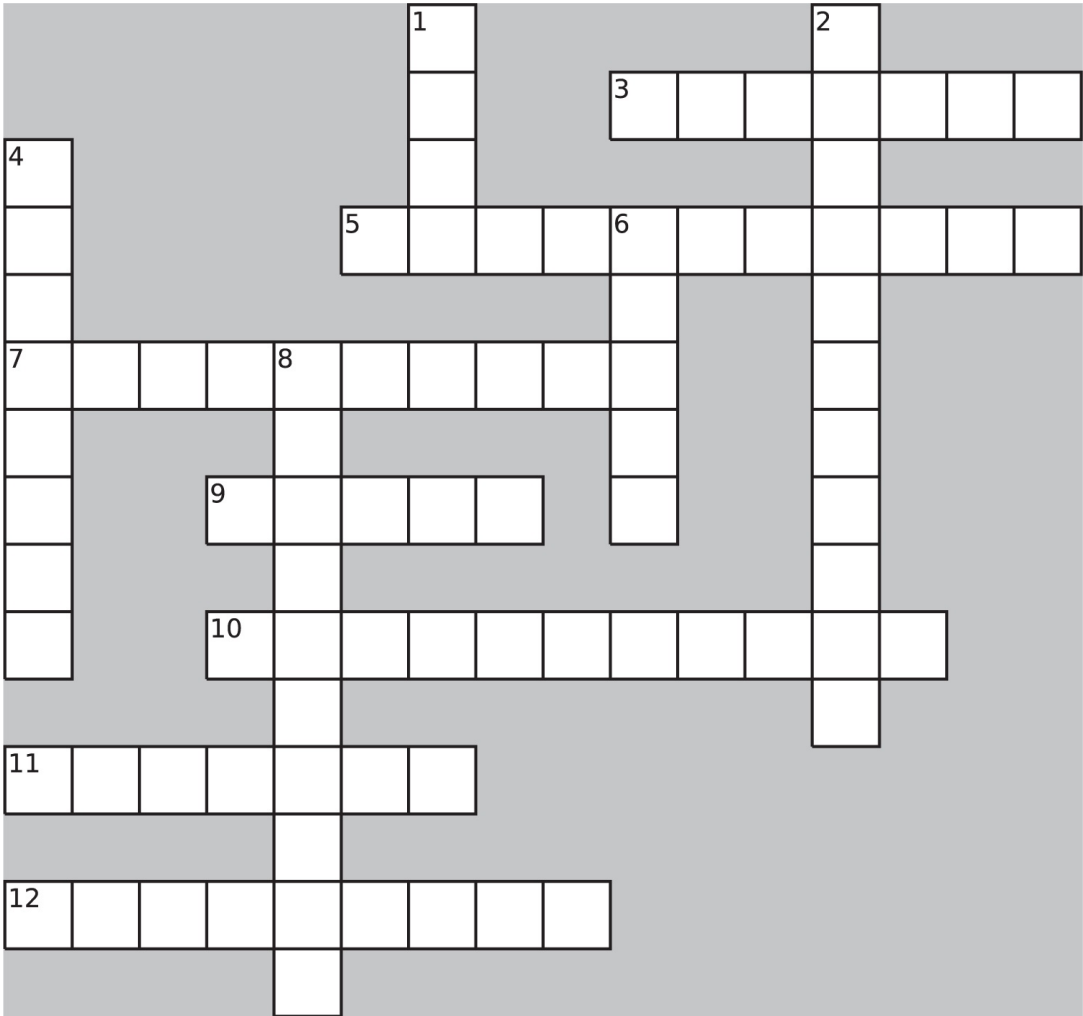
ACCELERATE
BILE
CHYME
DECREASE
DIGESTIVE ENZYMES
EPITHELIAL
GOBLET
HORMONES
INCREASE
INTESTINAL CRYPTS
LACTEAL
MICROVILLI
MUCUS
SLOW
VILLI

1. The intestinal lining contains circular folds that _____ the progress of _____ and _____ its contact with the mucosa.
2. On top of the circular folds are projections called _____.
3. These projections are covered by absorptive cells as well as mucus-secreting _____ cells.
4. An arteriole, a venule, and a lymph vessel called a _____ fill the core of each villus.
5. The villi have a brush border of ultrafine _____; these projections serve to _____ the absorptive area and produce _____.

6. Pores at the base of the villi, called _____ contain _____ cells that secrete mucus, which helps the passage of food.

Puzzle it Out Digestive System Basics

Complete the following crossword puzzle to test your knowledge of the digestive system.



ACROSS

- 3. Term referring to the liver
- 5. Wave-like contractions that propel food through the digestive tract
- 7. Type of digestion that breaks food into smaller particles
- 9. Secretes bile
- 10. Sheets of hepatic cells that fan out from the center of the hepatic lobule
- 11. The portion of the mesentery that hangs over the small intestine like an apron is called the greater _____.
- 12. Main bile pigment

DOWN

- 1. Yellow-green fluid that aids in the digestion and absorption of fat
- 2. Serves to store and concentrate bile

4. Type of digestion that uses digestive enzymes to break down food particles into nutrients
6. The most important component of bile is bile _____.
8. Another name for the digestive tract is the _____ canal.

Describe the Process Carbohydrate Digestion

Using the spaces below, describe the process of carbohydrate digestion.

1. Salivary glands in the mouth secrete the enzyme _____, which works to hydrolyze _____ to _____
2. The low pH of the stomach _____ the enzyme _____
3. In the intestine, chyme mixes with _____ and the process of digestion _____
4. The membranes of the cells covering the villi contain the enzymes _____, _____, and _____
5. As chyme slides along the brush border, _____. This is called _____ digestion.
6. The final step in the digestion process produces _____, which is immediately absorbed.

Illuminate the Truth Protein Digestion

Highlight the word or phrase that completes each sentence correctly.

1. Enzymes called (proteases)(sucrases) work in the (mouth)(stomach) and (esophagus)(small intestine) to break peptide bonds.
2. In the stomach, the enzyme (pepsin)(amylase) hydrolyzes the peptide bonds between certain amino acids.
3. In the duodenum, the pancreatic enzymes (lipase and amylase)(trypsin and chymotrypsin) assume the task of breaking peptide bonds.
4. Brush border enzymes called (pepsin)(peptidases) break the remaining chains into individual amino acids, which are then absorbed into the bloodstream.

Sequence of Events Fat Digestion

Insert the numbers 1 through 8 in the spaces provided to identify the sequence of events that occur in fat digestion. The first step has been provided to get you started.

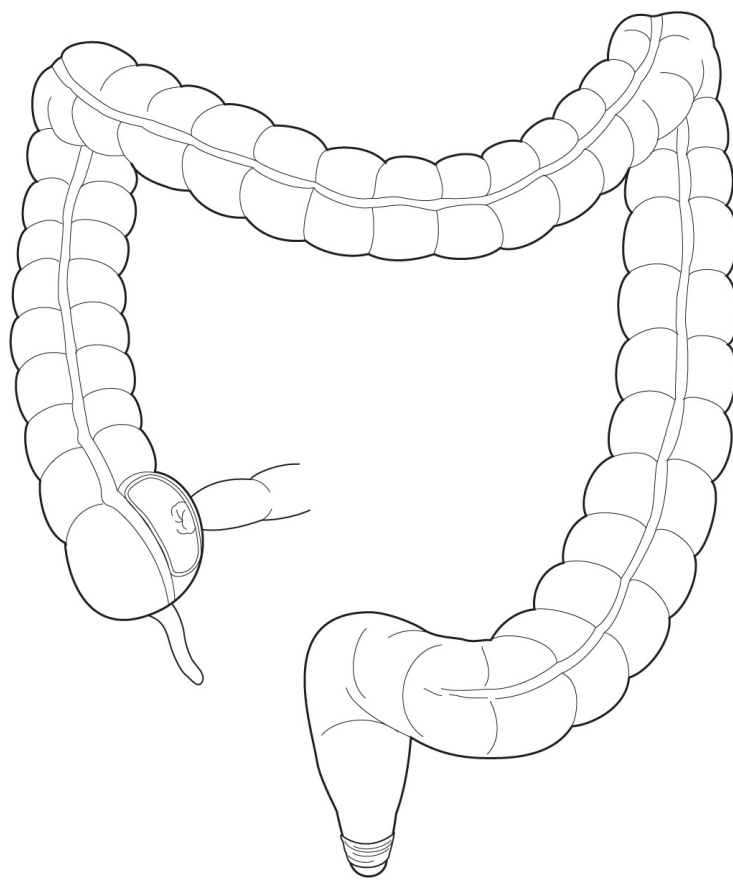
- 1 A. A fat globule enters the duodenum.

- _____ **B.** Pancreatic lipase begins to digest fat.
- _____ **C.** Triglycerides travel through the lymphatic system and enter the bloodstream at the left subclavian vein.
- _____ **D.** Glycerol and short-chain fatty acids are absorbed into the bloodstream of villi, and long-chain fatty acids are absorbed into the walls of the villi.
- _____ **E.** Two substances in bile (lecithin and bile salts) emulsify fat.
- _____ **F.** Fats are broken down into a mixture of glycerol, short-chain fatty acids, long-chain fatty acids, and monoglycerides.
- _____ **G.** The gallbladder secretes bile.
- _____ **H.** Triglycerides enter the lacteal of the villi.

Conceptualize in Color Large Intestine

Identify the regions of the large intestine by coloring the figure below. Use the suggested colors or choose your own.

- Cecum: Pink
- Appendix: Green
- Ileocecal valve: Brown
- Ascending colon: Blue
- Transverse colon: Red
- Descending colon: Orange
- Sigmoid colon: Yellow
- Rectum: Tan
- Anal canal: Light blue
- Label the right colic (hepatic) flexure and the left colic (splenic) flexure



Fill in the Gaps Large Intestine

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words in the Word Bank below. Not all words may be used.

APPENDIX
BACTERIAL FLORA
CHYME
FECES
FLATUS
GUT MICROBIOTA
HAUSTRA
NUTRIENTS
WATER

1. The large intestine acts to absorb a large amount _____ of from food residue.
2. Pouches called _____ exist all along the large intestine.
3. The _____ contains masses of lymphoid tissue and serves as a source for immune cells.

4. The large intestine houses millions of bacteria called _____ or _____.
5. One of the products of bacterial action is intestinal gas, called _____.
6. Waste material that exits the large intestine is called _____.

NUTRITION & METABOLISM

The body's source of energy is food. However, before the body can access that energy, food must be broken down into usable components. In turn, those components must undergo chemical reactions within cells before that energy is unleashed. To ensure that you have a working knowledge of nutrition and metabolism, complete the activities in this chapter.

Make a Connection Carbohydrates

In the spaces below, list the three forms of dietary carbohydrates. The first letter of each term is provided to get you started. Then, draw a line to link each form with its particular characteristics. Note that items may link with more than one characteristic.

1. M_____
 2. D_____
 3. P_____
- a. Known as complex carbohydrates
 - b. Known as simple sugars
 - c. Broken down into monosaccharides during the digestive process
 - d. Consist of the starches found in vegetables, grains, potatoes, rice, and legumes
 - e. Taste sweet
 - f. Examples include fruit sugar as well as glucose and galactose
 - g. Examples include table sugar as well as the sugar found in milk
 - h. Are absorbed through the small intestine without being broken down
 - i. Includes cellulose

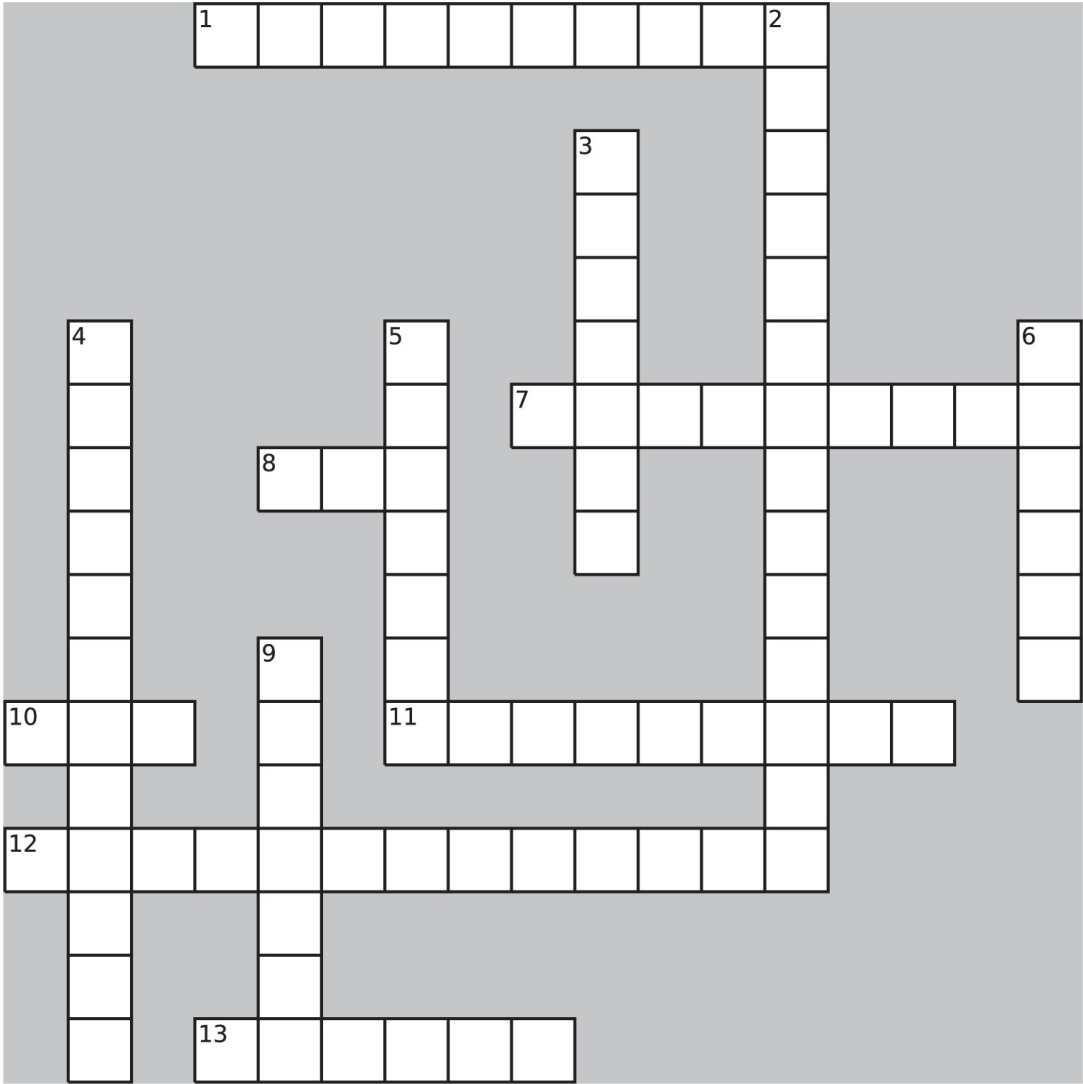
List for Learning Metabolic Rate

Using the spaces below, list three key factors affecting metabolic rate. Then, in the corresponding space, list how that factor affects metabolic rate. For example, does it raise it or slow it?

1. _____ : _____
2. _____ : _____
3. _____ : _____

Puzzle It Out Nutrition Concepts

Complete the following crossword puzzle to test your knowledge of nutrition.



ACROSS

1. Chemical reactions occurring within cells that transform nutrients into energy
7. An important contributor of fiber in the diet
8. The amount of energy the body needs at rest (abbreviation)
10. Energy-dense nutrient containing 9 calories/gram
11. The digestive system breaks food into usable components called _____.
12. The body's primary energy source
13. One factor affecting basal metabolic rate

DOWN

2. Group of vitamins and minerals needed by the body in small quantities
3. Nutrient used in every aspect of cellular metabolism
4. Location of the control centers for hunger and satiety
5. Hormone that stimulates appetite
6. Hormone secreted by adipose tissue that suppresses appetite
9. The amount of heat needed to raise the temperature of 1 g of water by 1°C

Illuminate the Truth Nutrition Basics

Highlight the word or phrase that completes each sentence correctly.

1. Energy expenditure is measured by the output of (heat)(urine) from the body.
2. A calorie is a measure of the amount of (sugar one needs to eat to gain a pound of body weight)(heat needed to raise the temperature of 1 gram of water 1°C).
3. (Protein)(Carbohydrates) should make up the greatest percentage of the diet.
4. Most of the carbohydrates consumed should be in the form of (simple sugars)(complex carbohydrates).
5. Excess carbohydrates are (stored in the body as fat)(converted into protein).
6. Carbohydrates, lipids, proteins, and water are called (macronutrients)(essential nutrients).
7. Dietary fiber is (fermented)(digested) by bacteria in the small intestine to produce (glucose)(short-chain fatty acids).
8. Saturated fats are derived mainly from (plants)(animals).
9. The most energy-dense nutrient is (protein)(fat).
10. (Unsaturated)(Saturated) fats tend to be solid at room temperature.
11. Hydrogenated oils, such as margarine, are (saturated)(unsaturated) fats.
12. All carbohydrates are eventually broken down into (glucose)(glycogen), which is then used as fuel for energy.
13. Fats that must be obtained through the diet—such as linoleic acid, which is a necessary part of the cell membrane—are called (essential fatty acids)(essential lipids).
14. (Short-chain fatty acids)(Trans fat) tend(s) to raise blood cholesterol levels and increase the risk for heart disease.
15. Consumption of indigestible fibers results in the production of (short-chain fatty acids)(body fat).

Fill in the Gaps Hunger and Satiety

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

ADIPOSE
AFTER
BEFORE
CONNECTIVE
CHOLECYSTOKININ (CCK)
HYPOTHALAMUS
LEPTIN
PEPTIDE YY (PYY)
PITUITARY GLAND
STIMULATES
STOMACH
SUPPRESSES

1. The _____ in the brain contains control centers for both hunger and satiety.
2. The hormone _____, which is stored in _____ tissue signals the brain that the body has enough energy stores and suppresses appetite.
3. _____, which is secreted by enteroendocrine cells in the ileum and colon, serves as a prompt to _____ eating.
4. The hormone ghrelin is secreted by cells in the _____ and _____ appetite.
5. The hormone inulin increases _____ eating and _____ appetite.
6. _____ is secreted by cells in the duodenum and jejunum; it stimulates the secretion of bile and pancreatic enzymes and also _____ appetite.

Just the Highlights

Short-Chain Fatty Acids

In the following list, highlight the statements pertaining to short-chain fatty acids.

1. Result from consumption of fat
2. Result from consumption of dietary fiber
3. Lead to heart disease

4. Promote the growth of beneficial gut bacteria
5. Calm intestinal inflammation
6. Trigger intestinal inflammation
7. Help prevent colon cancer
8. Nourishes the bowel epithelium
9. Feeds harmful bacteria
10. Lessen the risk for development of certain metabolic and immune disorders

Fill in the Gaps Proteins

Proteins fulfill a vast array of functions in the body. Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Not all words may be used.

AMINO ACIDS
ANIMAL
CAN
CANNOT
CELL MEMBRANES
COMPLETE PROTEINS
ESSENTIAL AMINO ACIDS
INCOMPLETE PROTEINS
MOLECULES
NONESSENTIAL AMINO ACIDS
PLANT

1. Proteins are a major component of all _____.
2. During the process of digestion, proteins are broken down into their individual _____.
3. Foods that supply all the essential amino acids are called _____; these foods mainly come from _____ sources.
4. Foods that lack one or more essential amino acids are called _____; these foods mainly come from _____ sources.
5. The body _____ store extra amino acids.

6. Amino acids that can be synthesized by the body and, therefore, do not need to be consumed in the diet are called _____.
7. Amino acids that cannot be synthesized by the body and, therefore, must be consumed in the diet are called _____.

List for Learning Lipids

Using the spaces below, list four key roles of fat in the body.

1. _____
2. _____
3. _____
4. _____

Illuminate the Truth Vitamins and Minerals

The body requires a number of vitamins and minerals to function properly. Highlight the word or phrase that completes each sentence correctly.

1. (Vitamin C)(Vitamin A) aids in wound healing.
2. (Vitamin K)(Vitamin E) is necessary for normal blood clotting.
3. A deficiency of (vitamin A)(vitamin D) results in night blindness.
4. A deficiency of (folic acid)(vitamin D) results in rickets.
5. Pernicious anemia results from a deficiency of (vitamin B₁₂)(vitamin B₆).
6. Besides being necessary for the formation of bones and teeth, calcium is also necessary for (carbohydrate digestion)(muscle contraction and relaxation).
7. (Iodine)(Iron) is necessary for hemoglobin production.
8. Folic acid is needed for (bone growth and development)(synthesis of DNA).
9. A potassium deficiency can lead to (softening of the bones)(abnormal cardiac rhythm).

List for Learning Fat-Soluble Vitamins

Fat-soluble vitamins are absorbed with dietary fat, after which they are stored in the liver and fat tissues of the body. Using the spaces below, list the four fat-soluble vitamins.

1. _____

- 2. _____
- 3. _____
- 4. _____

Make a Connection Metabolism

Nutrients are transformed through metabolism into energy the body can either use immediately or store for later use. In the spaces below, list the two types of metabolic processes. The first letter of each term is provided to get you started. Then, draw a line to link each process to its particular characteristics.

- 1. A_____
- 2. C_____
- a. Used in protein metabolism
- b. Breaks down complex substances into simpler ones or into energy
- c. Forms complex substances out of simpler ones
- d. Used in the metabolism of carbohydrates and lipids

Fill in the Gaps Carbohydrate Metabolism

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Not all words may be used.

AEROBIC

AEROBIC RESPIRATION

A FRACTION

ALL

ANAEROBIC

ANAEROBIC FERMENTATION

BURNED AS ENERGY

GLUCOSE

GLYCOGEN

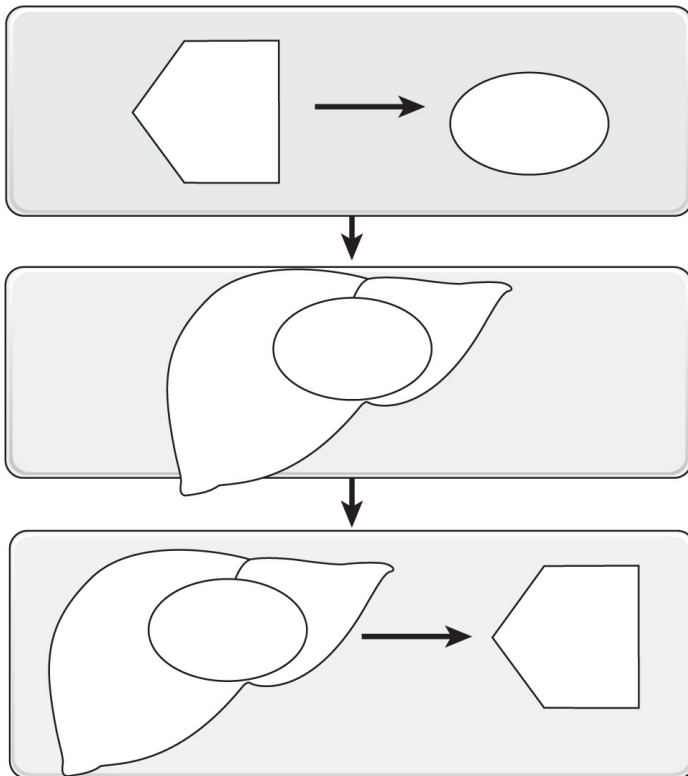
GLYCOLYSIS

STORED

1. All ingested carbohydrates are converted to _____, most of which is immediately _____.
2. The first phase of carbohydrate metabolism is called _____; because it does not use oxygen, this is called an _____ process.
3. This first phase releases _____ of the available energy.
4. During a period of strenuous exercise, the next phase of metabolism would be _____.
5. During a time of rest, the next phase of metabolism would be _____.

Drawing Conclusions Anaerobic Fermentation

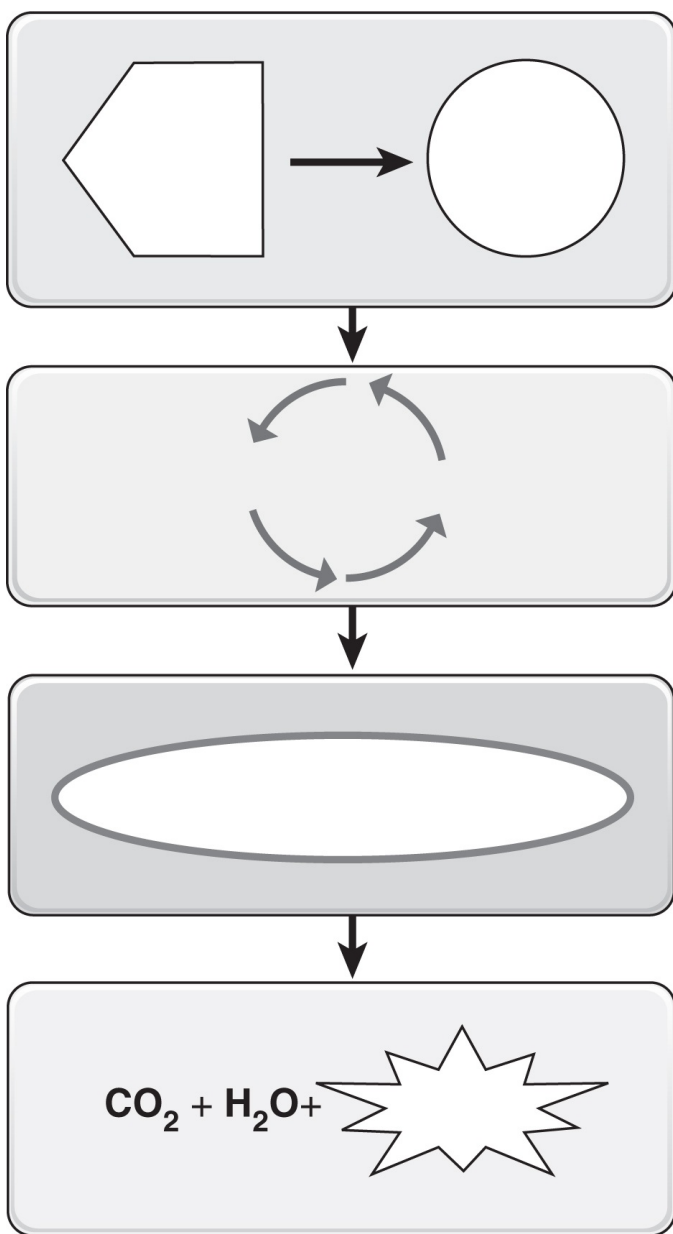
The process the body uses to metabolize carbohydrates varies according to the availability of oxygen. Test your knowledge of how the body metabolizes carbohydrates when oxygen is in short supply by filling in the blanks of each sentence. Then, label the figures below with the name of the substances produced along the way.



1. When oxygen is in short supply, _____
_____ is converted into _____.
2. The _____ then travels
through the bloodstream to the _____
_____, where it is stored.
3. Later, during a period of rest when oxygen
becomes available, _____
is converted into _____,
which may then enter the series of reactions in _____.

Drawing Conclusions Aerobic Respiration

Test your knowledge of how the body metabolizes carbohydrates when oxygen is available by filling in the blanks of each sentence. Then, label the figures below with the name of the substances produced along the way.



1. When oxygen is available, _____
_____ enters the
_____ and is
converted into _____.
2. This begins a series of reactions known as the
_____.
3. This is followed by still another series of reactions
called the _____
_____.
4. The end result is the complete breakdown of
_____ into carbon
dioxide, water, and, most importantly, large
amounts of _____.

Fill in the Gaps Lipid Metabolism

Fill in the blanks with the appropriate word or words to describe the process of lipid metabolism. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

ACETYL CoA
ADIPOSE TISSUE
CITRIC ACID
ELECTRON TRANSPORT
FATTY ACID(S)
GLUCOSE
GLYCOLYSIS
LARGE
SMALL
THE LIVER

1. When needed for energy, fat molecules stored within _____ are hydrolyzed into glycerol and three molecules of _____.
2. Glycerol enters the _____ pathway and yields a _____ amount of energy.
3. At the same time, _____ are broken down to form _____.
4. In turn, _____ proceeds through the _____ cycle and _____ chain to yield _____ amounts of energy.

Illuminate the Truth Protein Metabolism

While carbohydrates and fat are mainly used to supply energy, proteins have a different role. Highlight the word or phrase that completes each sentence correctly.

1. Proteins are mainly used to (supply energy)(build tissue); this is called protein (anabolism) (catabolism).
2. Protein (anabolism)(catabolism) is the process whereby proteins may be converted to glucose or fat or used directly as fuel.
3. During the digestion process, proteins are broken down into (glucose)(individual amino acids), which are then (stored as fat)(recombined to form new proteins).
4. Before proteins are used for energy, they are altered in the liver to produce (ammonia and keto acid) (urea and citric acid).
5. A nitrogenous waste product resulting from protein catabolism is (urea)(ketones).

Make a Connection Thermoregulation

In the spaces below, list three ways the body loses heat. The first letter of each term is provided to get you started. Then, draw a line to link each to its particular characteristics. Note that items may link to more than one characteristic.

1. R_____

2. C_____

3. E_____

- a. Involves the transfer of heat between two materials that touch each other
- b. Involves the transfer of heat through the air by electromagnetic heat waves
- c. Uses heat to change water into a gas
- d. How our bodies tend to lose heat
- e. An example is standing in bright sunlight
- f. An example is perspiration
- g. An example is a warm chair after we stand from sitting

Illuminate the Truth Regulation of Body Temperature

Several negative feedback mechanisms regulate body temperature. Highlight the word or phrase that completes each sentence correctly.

- 1. The (pituitary gland)(hypothalamus) acts as the body's thermostat: it monitors the temperature of the (blood)(skin) and sends signals to blood vessels and sweat glands.
- 2. When the body temperature rises too high, the (hypothalamus)(pituitary gland) signals cutaneous blood vessels to (constrict)(dilate). More warm blood flows (close to the body's surface)(deep into the body) and heat is (lost)(conserved) through the skin.
- 3. If the temperature remains high, sweat glands produce sweat; in turn, the (production)(evaporation) of sweat produces (cooling)(warming).
- 4. When the body temperature falls below normal, the (pituitary gland)(hypothalamus) signals cutaneous blood vessels to (constrict)(dilate). More warm blood (flows to the body's surface)(remains confined deep in the body). As a result, (less)(more) heat is lost through the skin.
- 5. If the temperature remains below normal, the body begins to (shiver)(grow rigid). As a result, muscles (retain)(release) heat and the body's temperature (falls)(rises).

REPRODUCTIVE SYSTEMS

In human reproduction, sex cells from the male and the female fuse to create a genetically unique individual. Structurally, the male and female reproductive systems differ significantly. Build upon your knowledge of these two systems by completing the activities in this chapter.

Just the Highlights Primary and Secondary Sex Organs

In the following list, highlight characteristics of primary sex organs in blue and secondary sex organs in yellow.

- a. Called gonads
- b. Include ovaries in females
- c. Include organs that provide an environment for nourishing a fertilized egg
- d. Produce sperm in males
- e. Include organs that allow for the uniting of an egg and a sperm
- f. Produce ova in females
- g. Include ducts, glands, and the penis in males
- h. Include testes in males
- i. Produce gametes

Make a Connection Accessory Glands

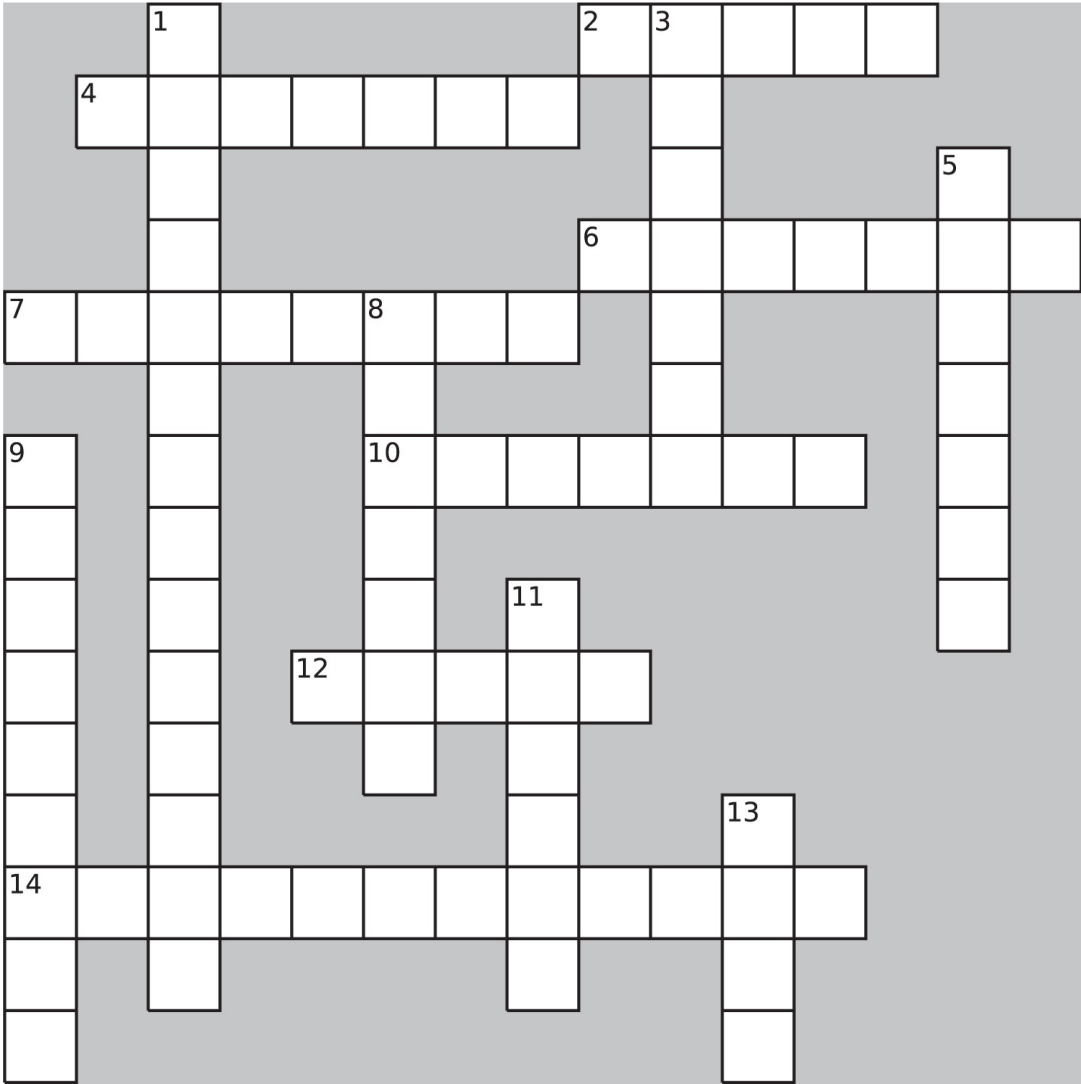
In the space below, list the names of the three accessory glands of the male reproductive system. The first letter of each term is provided to get you started. Then draw a line to link each gland to its particular characteristics. Note that items may link with more than one characteristic.

- 1. S_____
- 2. P_____
- 3. B_____

- a. Secretes a clear fluid into the penile portion of the urethra during sexual arousal
- b. Encircles urethra and ejaculatory duct
- c. Secretes a thick, yellowish fluid into the ejaculatory duct
- d. Fluid secreted comprises about 30% of the fluid portion of semen
- e. Fluid secreted comprises about 60% of semen
- f. Fluid secreted serves as a lubricant during intercourse and also neutralizes the acidity of residual urine in the urethra
- g. Secreted fluid contains fructose as well as other substances that nourish sperm and help ensure motility
- h. Secretes a thin, milky, alkaline fluid into the urethra

Puzzle It Out Reproductive Terms

Complete the following crossword puzzle to test your knowledge of the reproductive system.



ACROSS

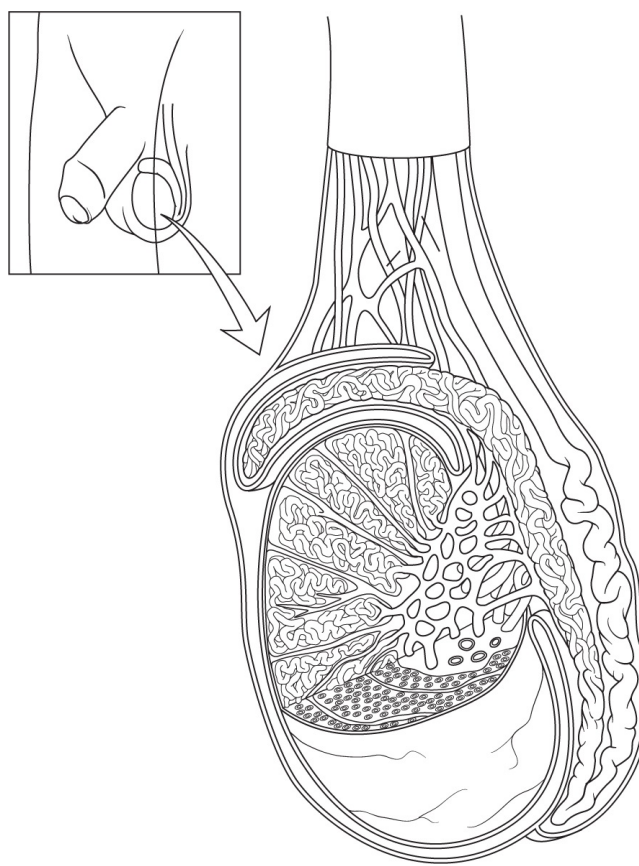
- 2. Term for the primary sex organ
- 4. Male structure that serves both the reproductive and urinary systems
- 6. Foreskin
- 7. Hormone necessary for the development of female secondary sex characteristics
- 10. Process by which gametes divide
- 12. Whitish fluid emitted during ejaculation that contains both sperm and the secretions of the accessory glands
- 14. Male hormone necessary for sperm production and the development of male secondary sex characteristics

DOWN

- 1. Undescended testes
- 3. Primary sex organs in females
- 5. Sac of tissue in which the testes lie
- 8. Sex cells
- 9. Muscle that contracts in cold weather to pull the testes closer to the body
- 11. Primary sex organs in males
- 13. Secretion of this hormone by the hypothalamus marks the onset of puberty

Drawing Conclusions The Testes

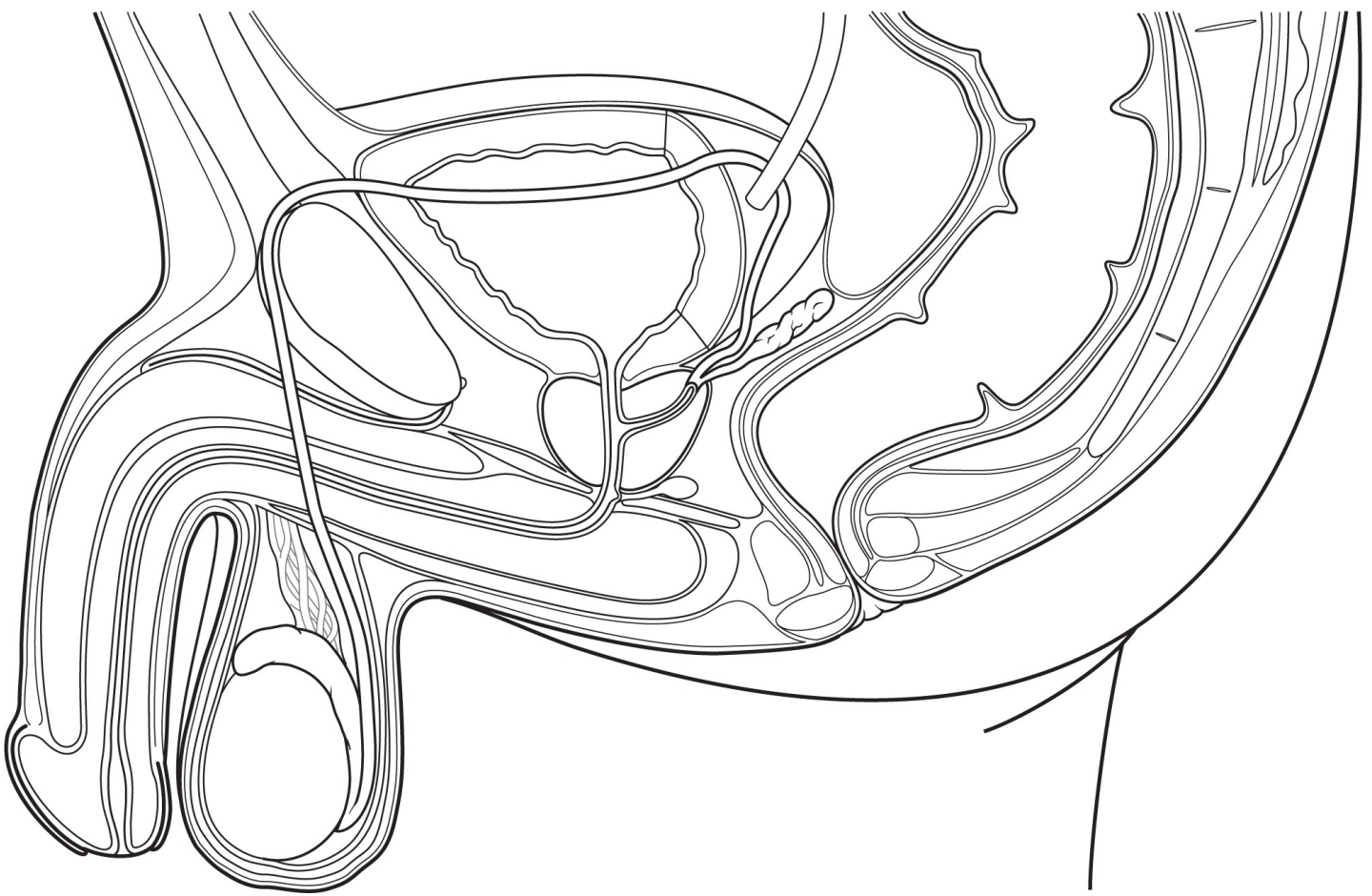
Test your knowledge of the structure and function of the testes by filling in the blanks of each sentence. Then, color the figure below to further test your knowledge. Use the suggested colors or choose your own.



1. A strand of connective tissue called the _____ extends from the abdomen to each testicle; housed inside are blood, lymphatic vessels, and nerves.
(Color this structure gray.)
2. Fibrous tissue separates each testis into more than 200 _____.
(Outline these areas in brown.)
3. Coiled inside each of these structures are one to three tightly coiled ducts called _____, which is where sperm are _____.
(Color these structures yellow.)
4. A network of vessels called the _____ lead away from this area and provide a location in which sperm partially mature.
(Color these vessels blue.)
5. _____ ductules conduct immature sperm away from the testes.
(Color these vessels green.)
6. Sperm pass into the _____, where they remain fertile for 40 to 60 days.
(Color this structure orange.)
7. Sperm leave the previous structure and pass into the _____.
(Color this structure purple.)

Conceptualize in Color Male Reproductive Organs

Identify the structures of the male reproductive system by coloring the figure below. Use the suggested colors or choose your own.



- Vas deferens: Dark blue
- Ejaculatory duct: Fuschia
- Bulbourethral gland: Brown
- Seminal vesicle: Yellow
- Prostate gland: Light green
- Urethra: Purple
- Testis: Gray
- Epididymis: Gold
- Scrotum: Tan
- Corpus spongiosum: Red
- Corpus cavernosum: Pink
- Glans penis: Orange
- Prepuce: Dark green
- Urinary bladder: Light blue

Thousands of sperm are produced each second. Insert the numbers 1 through 5 in the spaces provided to identify the sequence of events that occur in spermatogenesis.

- _____ A. Daughter cells of spermatogonia differentiate into slightly larger cells called primary spermatocytes, which move toward the lumen of the seminiferous tubule.
- _____ B. Spermatids differentiate to form heads and tails and eventually transform into mature spermatozoa (sperm), each with 23 chromosomes.
- _____ C. Each secondary spermatocyte divides to form two spermatids.
- _____ D. Spermatogonia in the walls of the seminiferous tubules divide by mitosis to produce two daughter cells, each with 46 chromosomes.
- _____ E. Through meiosis, the primary spermatocyte yields two genetically unique secondary spermatocytes, each with 23 chromosomes.

Fill in the Gaps Spermatozoa

Fill in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

ACIDITY
ACROSOME
ALKALINITY
GROWTH HORMONE
HEAD
MIDDLE PIECE
STICKINESS
TAIL
TESTOSTERONE
THINNESS

1. The _____ of the sperm contains the nucleus, which is packed with genetic material.
2. A cap called an _____ tops the head of the sperm.
3. The _____ contains enzymes that help the sperm penetrate the egg during fertilization.
4. The _____ contains numerous mitochondria that supply the sperm with energy needed for mobility.
5. The _____ helps propel the sperm forward.

6. The hormone _____ controls spermatogenesis as well as the male sex drive.
7. Two key qualities of semen are its _____ and _____.

Illuminate the Truth More Reproductive Facts

Highlight the word or phrase that completes each sentence correctly.

1. The most common cancer in American men is (prostate)(testicular) cancer.
2. The body of the penis is called the (shaft)(prepuce).
3. Through the process of meiosis, each daughter cell has (46)(23) chromosomes.
4. Each daughter cell of meiosis is (genetically identical to)(genetically unique from) the parent cell.
5. An important quality of semen is its (acidity)(alkalinity).
6. The portion of sperm that contains genetic information is the (acrosome)(head).
7. The portion of the sperm that contains an enzyme that helps it penetrate an egg is the (acrosome)(middle piece).
8. The testes are located outside the body to (protect them from infection)(keep them cooler).

List for Learning Sexual Response

Using the spaces below, list the four phases of both the male and female sexual response.

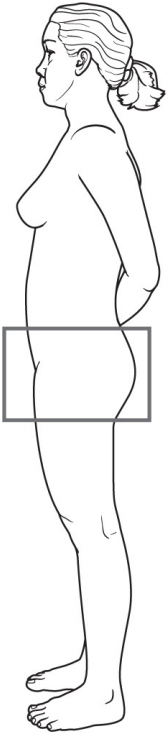
1. _____
2. _____
3. _____
4. _____

Conceptualize in Color Female Reproductive System

Identify the structures of the female reproductive system by coloring the figure below. Use the suggested colors or choose your own.

- Uterus: Red
- Fallopian tube: Pink
- Ovary: Gray

- Cervix: Orange
- Rectum: Brown
- Vagina: Purple
- Bladder: Blue
- Labium majus: Tan
- Labium minus: Gold
- Urethra: Light blue



Fill in the Gaps Development of Ovarian Follicles

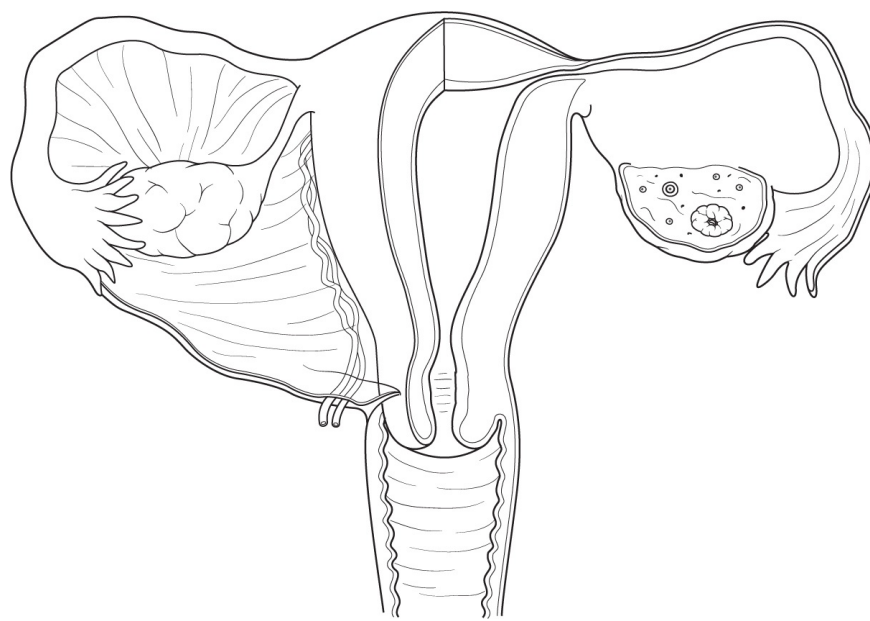
Fill in the blanks with the appropriate word or words to complete each sentence correctly to describe the development of ovarian follicles. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

CENTER
EGG
ESTROGEN
FETAL PERIOD
FOLLICULAR CELLS
FSH
GRAAFIAN FOLLICLE
MENOPAUSE
OOCYTE
OVULATION
PUBERTY
SURFACE

1. Each ovary contains thousands of ovarian follicles that consist of an _____ surrounded by _____.
2. Follicles evolve during the _____, but then halt development until _____.
3. During a menstrual cycle, the hormone _____ prompts several follicles to resume meiosis.
4. As follicles develop, they migrate toward the _____ (*Hint: location*) of the ovary; once there, the mature follicle forms a fluid-filled blister called a _____.
5. The follicle then bursts and releases the _____ from inside, a process called _____.

Drawing Conclusions Internal Genitalia

Unlike the male, the organs of the female reproductive system are housed within the abdominal cavity. Test your knowledge of these structures by filling in the blanks of each sentence. Then, color the figure to further test your knowledge. Use the suggested colors or choose your own.



1. The narrow portion of the fallopian tube closest to the uterus is called the _____; the middle portion is called the _____; while the funnel-shaped distal portion is called the _____. *(Color the fallopian tubes pink.)*
2. Finger-like projections called _____ fan over the ovary. *(Color these structures orange.)*
3. The uterus is held in place by the _____ ligament. *(Color this structure tan.)*
4. The curved, upper portion of the uterus is called the _____. *(Outline this portion in blue.)*
5. The inferior end of the uterus is called the _____. *(Color this structure brown.)*
6. The _____ serves as a receptacle for the penis and sperm and as a route for the discharge of menstrual blood. *(Color this structure purple.)*
7. The smooth muscle layer of the uterus is called the _____. *(Color this structure light red.)*
8. The innermost layer of the uterus, called the _____, is where an embryo attaches. *(Color this structure dark red.)*

Describe the Process Uterine Wall

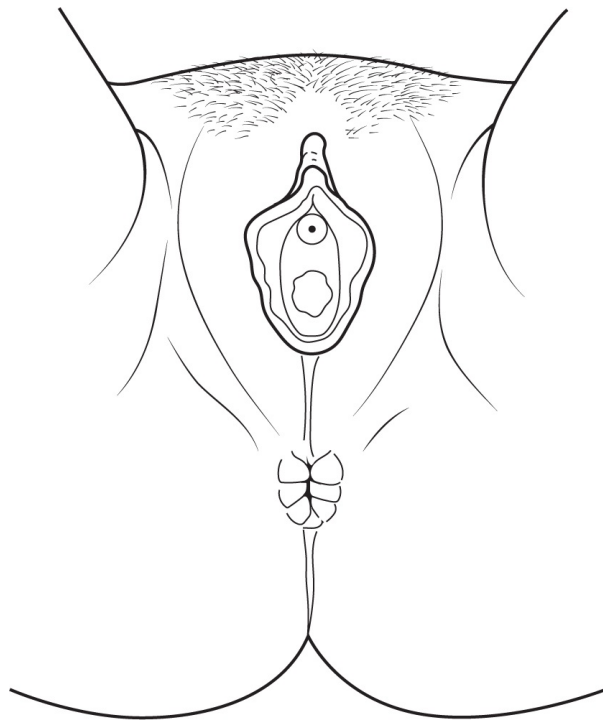
The wall of the uterus has two key roles: housing and nourishing a growing fetus and expelling the fetus from the body during delivery. Identify the layers of the uterus and describe how the layers aid in their tasks by filling in the blanks of each sentence.

1. The outer layer of the uterus is called the _____; it consists of a _____ membrane.

2. The middle layer is called the _____; it consists of _____ that functions to _____.
3. The innermost layer is called the _____; this is where _____.
4. The upper two-thirds of the endometrium is the _____; each month, this layer _____.
5. The layer underneath the layer described in the previous question is called the _____. This layer attaches the _____ to the _____.
6. The layer that sloughs off each month if a fertilized egg doesn't arrive is the _____.

Drawing Conclusions External Female Genitalia

Test your knowledge of the structure and function of external female reproductive organs and female accessory glands by filling in the blanks of each sentence. Then, color the figure below to further test your knowledge. Use the suggested colors or choose your own.



1. The _____ is a mound of hair-covered adipose tissue overlying the symphysis pubis. (Color this area brown.)
2. The _____ is one of two thick folds of skin and adipose tissue that helps surround the vaginal opening. They serve to _____. (Color this structure tan.)
3. The area inside the labia is called the _____. It contains the _____.

(Outline this area in blue.)

4. The _____ is a small mound of erectile tissue that resembles a penis. Its role is _____.

(Color this area pink.)

5. A pair of mucus glands, called _____, open into the vestibule near the urinary meatus. They serve to _____.

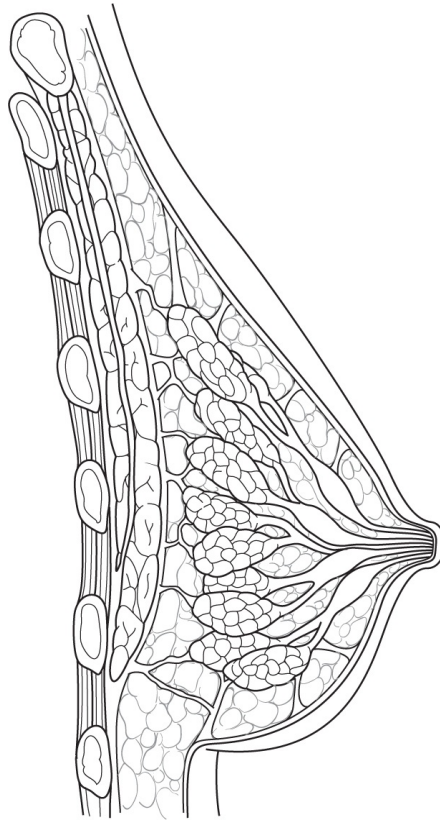
(Draw green dots to signify the location of these glands.)

6. Two pea-sized glands called _____ sit on either side of the vaginal opening. They serve to _____.

(Draw red dots to signify the location of these glands.)

Conceptualize in Color Breasts

Identify the structures of the breasts by coloring the figure below. Use the suggested colors or choose your own.



- Pectoralis muscle: Pink
- Acini: Red
- Lobules: Outline in purple
- Lactiferous ducts: Tan
- Lactiferous sinuses: Orange

- Areola: Brown
- Adipose tissue: Yellow
- Suspensory ligaments: Blue

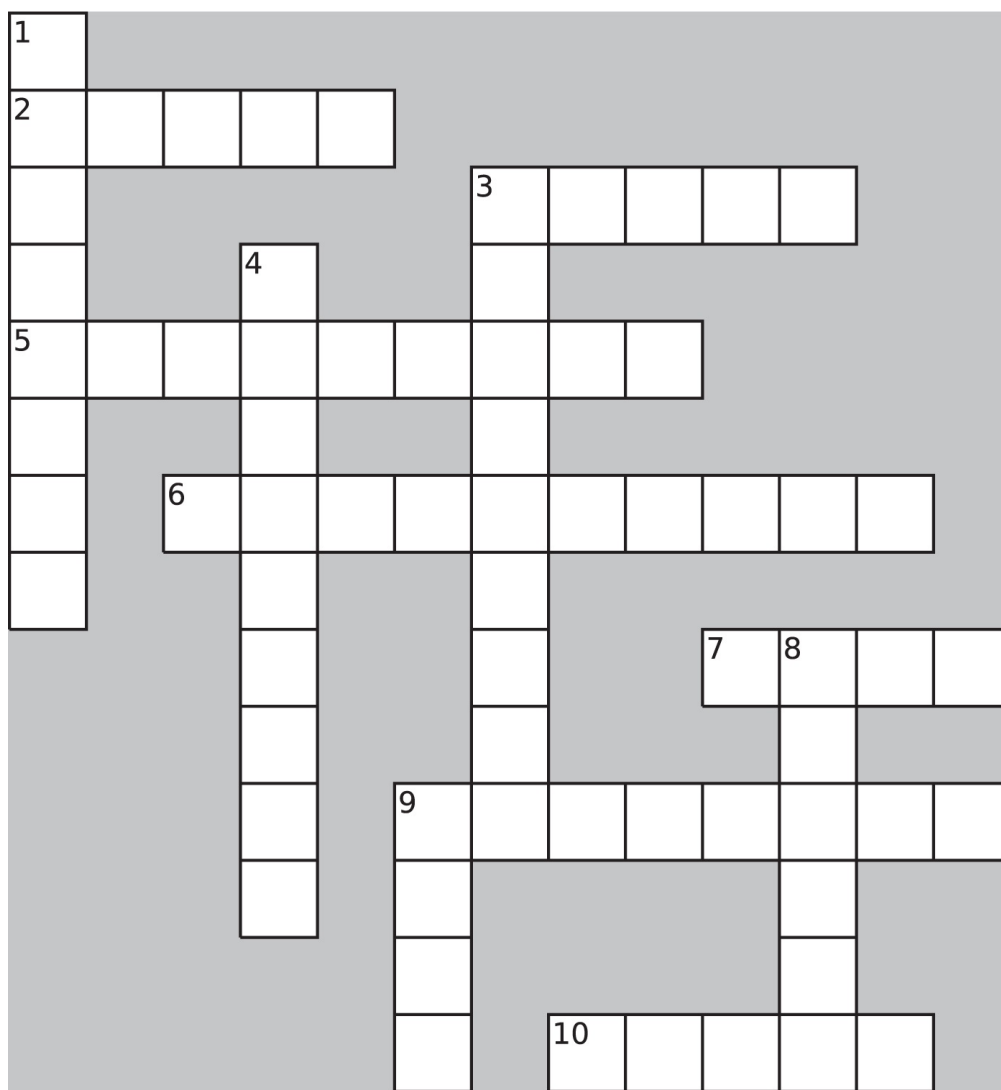
Illuminate the Truth Oogenesis

Highlight the word or phrase that completes each sentence correctly.

1. Oogenesis begins (at puberty)(before birth).
2. Oogonia differentiate into primary oocytes shortly before (ovulation)(birth).
3. After pausing, egg development resumes at (puberty)(menopause).
4. Upon ovulation, (mitosis)(meiosis I) occurs, resulting in two daughter cells.
5. The larger daughter cell is called a (polar body)(secondary oocyte) while the smaller daughter cell is called a (polar body)(primary oocyte).
6. Meiosis resumes (only if fertilization occurs)(regardless of fertilization).
7. If fertilization does not occur, the secondary oocyte (continues to divide)(degenerates).

Puzzle It Out Female Reproductive System

Complete the following crossword puzzle to test your knowledge of the female reproductive system.



ACROSS

2. Thick folds of skin and adipose tissue on either side of the vaginal opening are called the _____ majora.
3. Collective term for female external genitalia
5. Process through which a mature ovum is formed
6. Cells surrounding the egg
7. The central region of the uterus
9. First menstrual period
10. Fold of mucous membrane partially covering the entrance to the vagina

DOWN

1. Small mound of erectile tissue in females that resembles a penis
3. Area inside the labia
4. State of life when menstruation ceases permanently
8. Another name for egg
9. Mound of hair-covered adipose tissue overlying the symphysis pubis is called the _____ pubis.

Fill in the Gaps Ovarian Cycle

A woman's reproductive system undergoes cyclical changes each month as it prepares for the possibility of pregnancy. These changes, called the reproductive cycle, consist of two interrelated cycles: the ovarian cycle and the menstrual cycle. Test your knowledge of the sequence of events of the ovarian cycle by filling in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once.

ANTERIOR
CORPUS ALBICANS
CORPUS LUTEUM
ESTROGEN
FOLLICULAR
FSH
GONADOTROPIN-RELEASING HORMONE (GNRH)
LH
LUTEAL
POSTERIOR
PROGESTERONE

1. Low levels of _____ and _____ stimulate the hypothalamus to release _____.
2. The hormone _____ stimulates the _____ pituitary to release the hormones and _____.
3. The hormone _____ triggers several follicles in the ovary to resume development, beginning what is known as the _____ phase.
4. As the follicle develops, it secretes _____, which stimulates the thickening of the endometrium, as well as small amounts of _____.
5. At the mid-point of the cycle, _____ levels peak, triggering a spike in _____, which causes ovulation.
6. The remnants of the follicle remain on the ovary and form the _____, which marks the beginning of the _____ phase.
7. The _____ secretes large amounts of the hormone _____ and small amounts of _____.
8. If fertilization doesn't occur, the _____ degenerates into inactive scar tissue called the _____.

- _____.
9. Levels of _____ and _____ plummet, causing the endometrium to slough off, resulting in menstruation.

Make a Connection Menstrual Cycle

In the spaces below, list the four phases of the menstrual cycle. The first letter or two of each term has been provided to get you started. Then draw a line to link each phase to its particular characteristics. Note that items may link with more than one characteristic.

1. M_____
 2. Pro_____
 3. S_____
 4. Pre_____
- a. Involves the atrophy of the corpus luteum
 - b. Blood vessels grow as the base layer is repaired
 - c. Time when menstruation occurs
 - d. Involves ischemia and necrosis of the endometrium
 - e. Dominated by increased levels of progesterone
 - f. Involves the shedding of the endometrium's functional layer
 - g. Encompasses days 26 to 28 of the cycle
 - h. Encompasses days 6 to 14 of the cycle
 - i. Rising levels of estrogen dominate
 - j. Encompasses days 15 to 26 of the cycle
 - k. Encompasses days 1 to 5 of the cycle
 - l. Involves increased thickening of the endometrium as it becomes suitable for implantation of a fertilized egg
 - m. Instituted by plummeting levels of progesterone

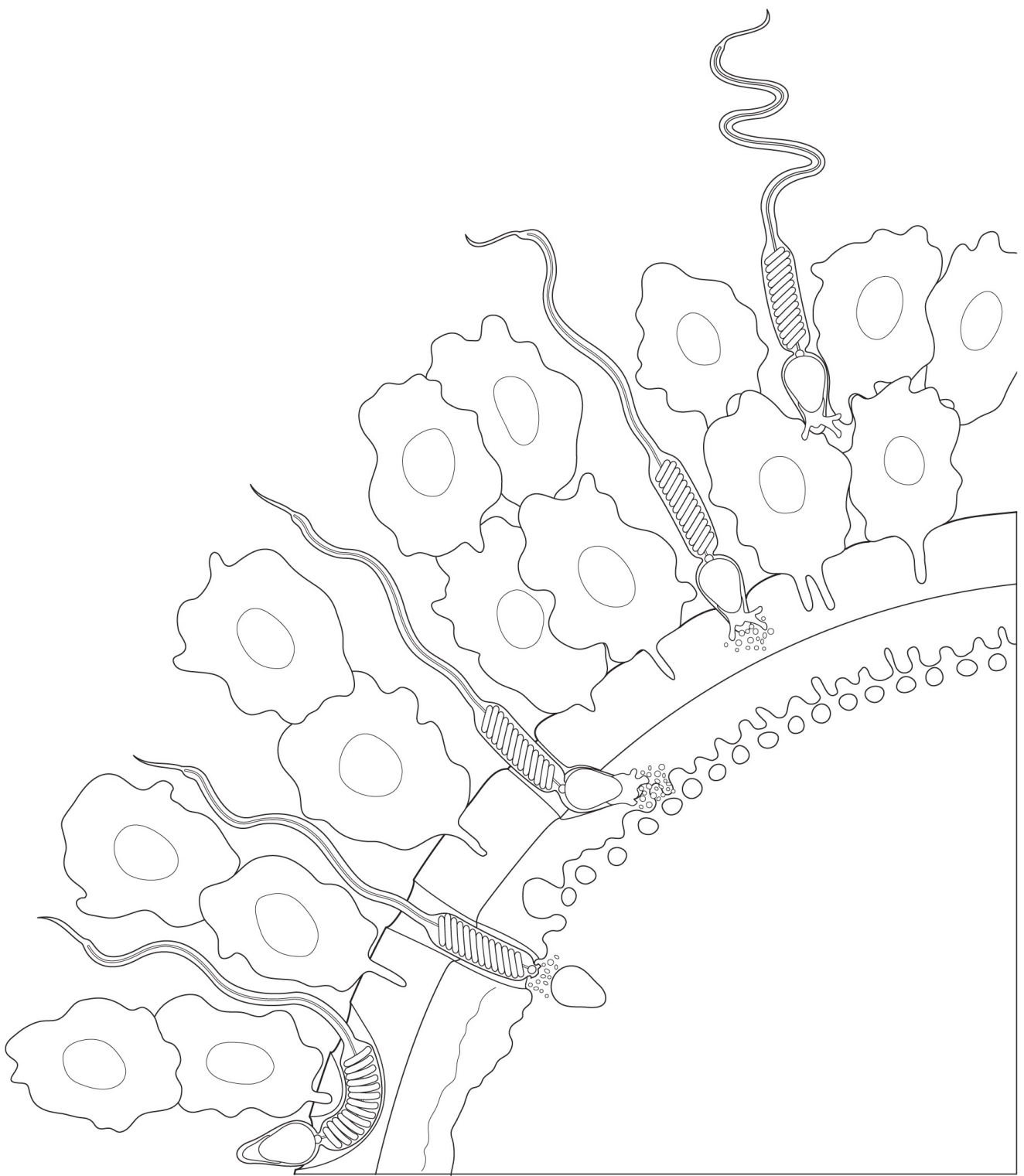
PREGNANCY & HUMAN DEVELOPMENT

The creation of a new life—beginning with the fusion of an egg and a sperm and culminating with the entrance of a neonate into the world—involves numerous body processes. Review some of these processes by completing the activities in this chapter.

Drawing Conclusions Fertilization

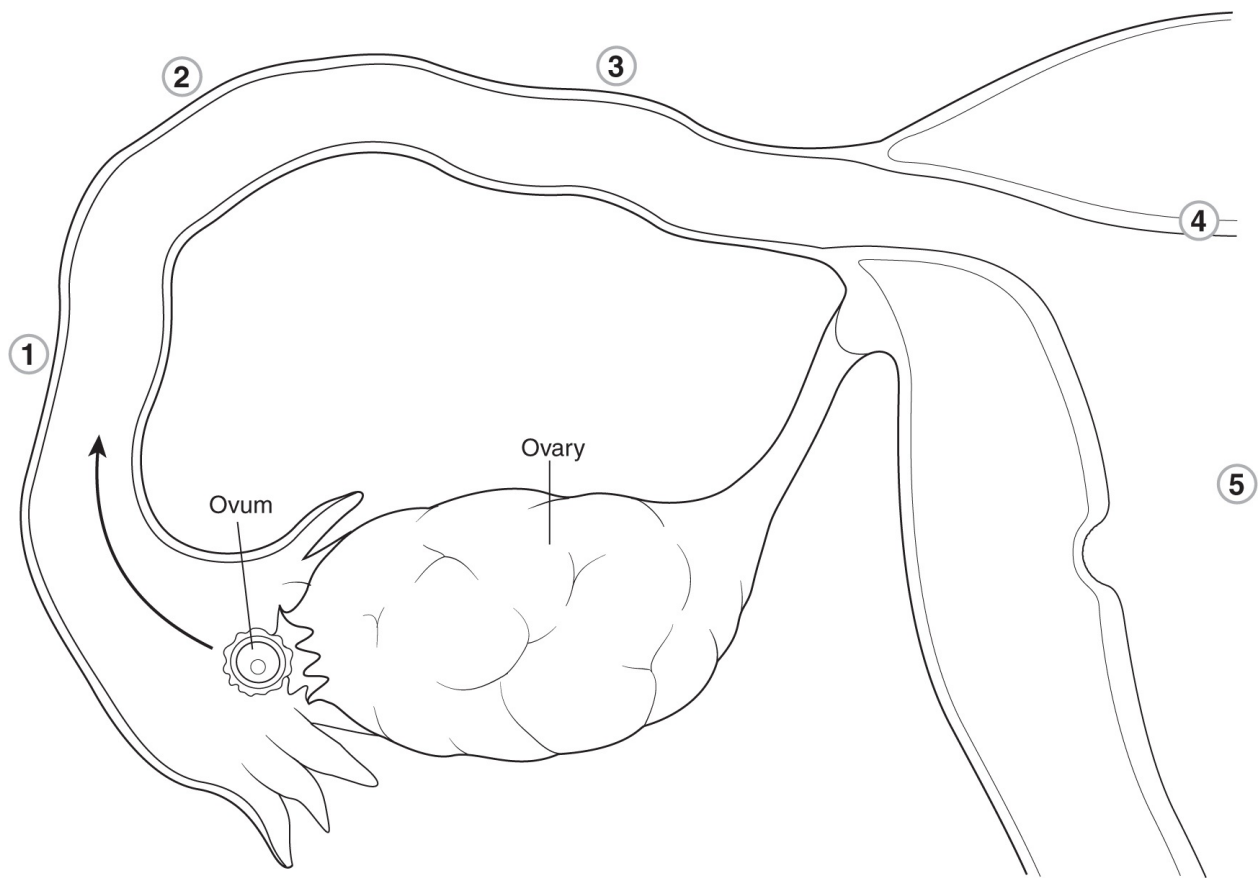
Conception occurs when an egg and a sperm fuse. Test your knowledge of the fertilization process by filling in the blanks of each sentence. Then, color and label the figure below. Use the suggested colors or choose your own.

1. As hundreds of sperm swarm the egg, the _____ on their heads release _____ that break down the cells and a gel-like layer called the _____ surrounding the egg.
(Color the body of the sperm gray; the heads of the sperm yellow; the covering over the heads of the sperm green; the granulosa cells tan; the gel-like coating of the egg blue; and the substance released from the heads of the sperm pink.)
2. A path is created that allows (Hint: a number) sperm to penetrate the egg.
(Label the sperm being blocked, the two sperm that are helping to clear a path into the egg, and the sperm that has penetrated the egg.)
3. As fertilization occurs, the _____ of the sperm is released into the ovum as its _____ degenerates and falls away.
(Label the sperm that is fertilizing the egg.)
4. The _____ of the sperm, which has _____ chromosomes, fuses with the _____ of the egg, which also has _____ chromosomes, creating a single cell with _____ chromosomes.
5. The fertilized egg is called a _____.
6. Sperm can remain viable within the female reproductive tract for as long as _____, whereas the egg is viable for _____.
7. Fertilization usually occurs in the _____.



Drawing Conclusions Fertilization to Implantation

Test your knowledge of what occurs between fertilization and implantation by filling in the blanks of each sentence. Then, draw and label the figure to show the product of conception in each stage of development as it proceeds through the fallopian tube.



1. The _____ stage begins when fertilization forms a zygote with 23 chromosomes.
(By the number 1 in the illustration, draw the egg being fertilized.)
2. Within 24 to 36 hours, the zygote divides by the process of _____ to form two daughter cells called _____.
(By the number 2 in the illustration, draw this process using two separate figures. Label these figures.)
3. The divisions continue, with the cells _____ with each division. Finally, a blackberry-like cluster of (Hint: a number) _____ cells called a _____ results.
(Draw this process by the number 3 in the illustration, using three separate figures. Label the final figure.)
4. Three to four days after fertilization, the morula enters the uterine cavity, where it _____ for 2 or 3 days. As the cell cluster continues to divide, a hollow cavity forms; the cell cluster is now called a _____. This differentiates into two layers: an outer layer of cells called the _____, which eventually forms the _____, and an inner cell mass that becomes the _____.
(Draw and label this structure by the number 4 in the illustration.)
5. About 6 days after ovulation, the _____ lands on and attaches to the endometrium—a process called _____.
(Draw what is being described, using the space by the number 5 in the illustration.)

As the blastocyst attaches to the endometrium, it undergoes rapid changes. Highlight the word or phrase that completes each sentence correctly.

1. Shortly after implantation, the outer wall of the blastocyst, called the (trophoblast)(blastomere), fuses with the underlying endometrium.
2. About that time, the inner cell mass separates to create a narrow space called the (yolk sac)(amniotic cavity).
3. The inner cell mass flattens to form the (ectoderm)(embryonic disc).
4. Next, the (embryonic disc)(trophoblast) gives rise to three (germ layers)(embryonic layers), which produce the body’s organs and tissues.

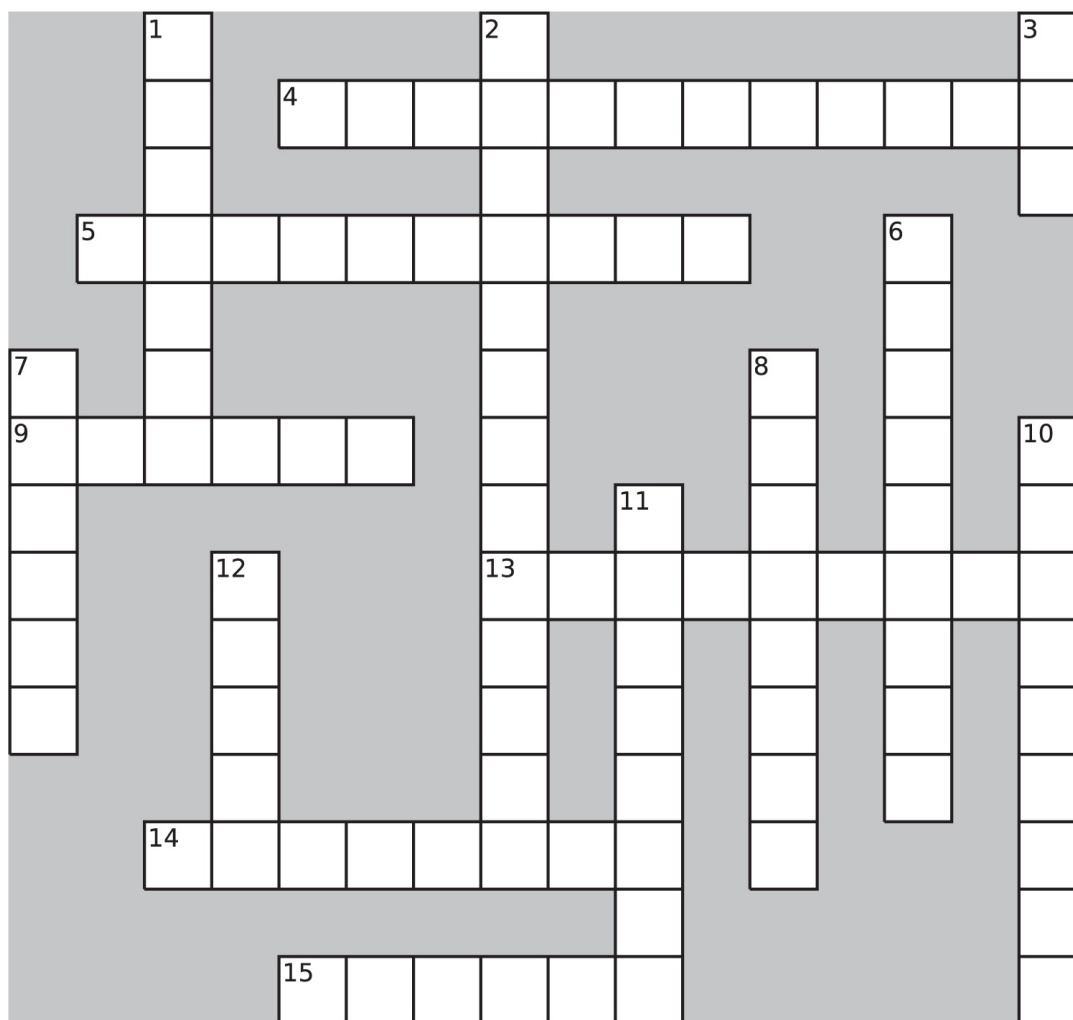
List for Learning Germ Layers

Using the spaces below, write the names of the three germ layers. Then, next to each name, list specific organs that that layer gives rise to.

- _____
- _____
- _____

Puzzle It Out Human Growth and Development Terms

Complete the following crossword puzzle to test your understanding of terms used in human growth and development.



ACROSS

4. Stage of development beginning at fertilization and lasting for 16 days
5. The 3-month periods dividing the term of pregnancy
9. Transparent sac filled with fluid that surrounds the embryo and fetus
13. Extraembryonic membrane that serves as the foundation for the umbilical cord
14. Supplies the fetus with oxygen and nutrients during pregnancy
15. Fertilized egg

DOWN

1. Outermost membrane that surrounds other extraembryonic membranes
2. The union of the nuclei of the egg and sperm
3. Hormone that prompts the corpus luteum to secrete estrogen and progesterone and also forms the basis for pregnancy tests (*Hint: use initials*)
6. Stage of development lasting from the third until the eighth week of pregnancy
7. Fine hair covering the fetus' body
8. The time of growth before birth is called the _____ period.
10. Length of time from conception until birth
11. Process by which the fertilized cell divides by mitosis
12. Stage of development beginning the eighth week and lasting until birth

Just the Highlights Stages of Prenatal Development

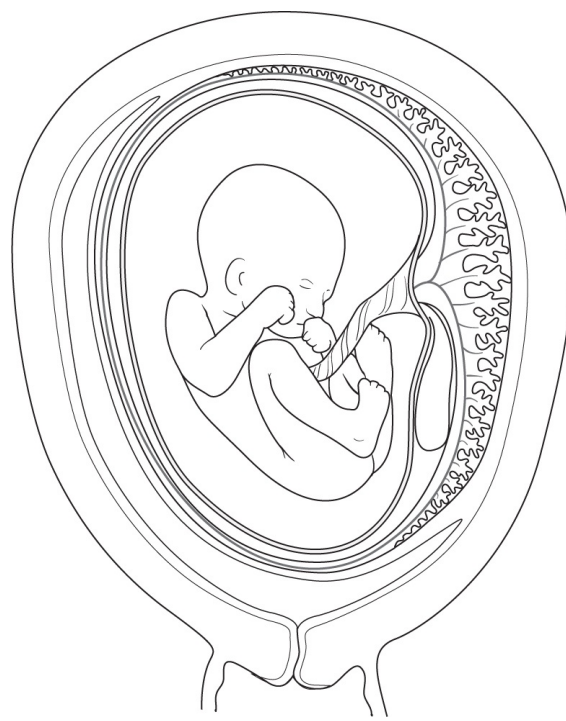
The approximately 9-month period between fertilization and birth transforms a single cell into a complete human being. In the following lists, highlight events of the preembryonic stage in pink, events of the embryonic stage in blue, and the events of the fetal stage in yellow.

1. Formation of the amnion, yolk sac, allantois, and chorion
2. Begins at fertilization
3. Involves rapid growth
4. Differentiation of germ layers into organs and organ systems
5. Fusion of the trophoblast with the endometrium
6. Movement that can be felt by the mother occurs
7. Formation of the amniotic cavity
8. Begins sixteen days after conception and lasts for 6 weeks
9. Formation of the embryonic disc
10. Begins the eighth week and lasts until birth
11. Development of the placenta and umbilical cord
12. Formation of the three germ layers
13. Encompasses the time of the zygote
14. The heart begins to beat

Conceptualize in Color Embryonic and Fetal Membranes

Identify the differences between the various membranes surrounding the embryo and fetus by coloring the figure below. Use the suggested colors or choose your own.

- Uterus: Pink
- Chorion: Green
- Amnion: Orange
- Amniotic fluid: Blue
- Umbilical cord: Gray
- Yolk sac: Yellow
- Chorionic villi: Red



Illuminate the Truth The Placenta

Highlight the word or phrase that completes each sentence correctly.

1. The placenta becomes the fetus' sole source of nutrition by the (sixth)(twelfth) week of pregnancy.
2. Maternal and fetal blood (does)(does not) mix.
3. Toxins in the mother's blood such as nicotine, alcohol, and most drugs (can)(cannot) enter the fetus' bloodstream.
4. Oxygen, nutrients, and some antibodies pass from maternal to fetal blood via the umbilical (arteries)(veins).
5. Maternal (arteries)(veins) carry away fetal waste products.
6. The (placenta)(chorion) is responsible for secreting hormones such as estrogen, progesterone, and HCG that help maintain a pregnancy.

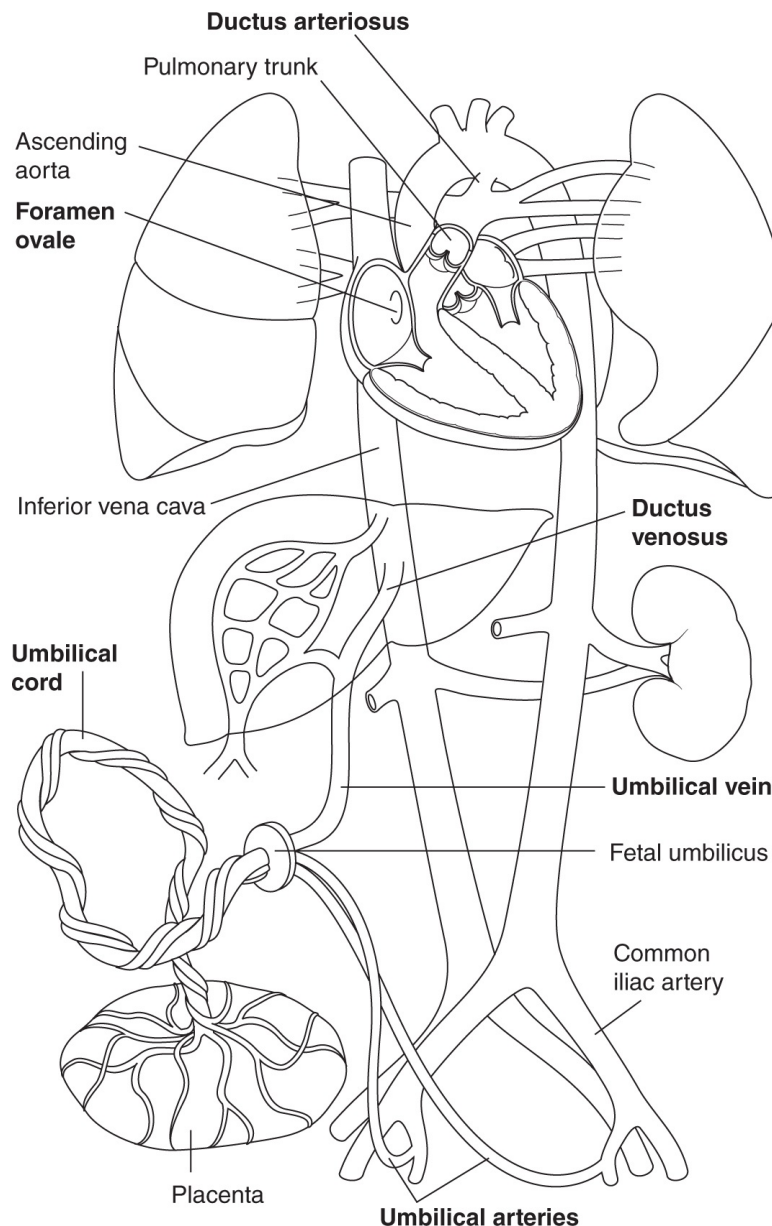
Conceptualize in Color Fetal Circulation

Because the fetus depends on the placenta for oxygen and nutrients as well as for the removal of waste products, the circulatory system of the fetus differs significantly from that of a newborn infant. Trace the pathway of fetal circulation by coloring the figure below. Use the suggested colors or choose your own.

1. Color the umbilical vein *red* to depict the oxygen-rich blood flowing in from the placenta.
2. Color the ductus venosus *red* as it bypasses the liver; change the color to *purple* as blood merges into the inferior vena cava. Draw a black arrow depicting the movement of blood from the umbilical vein,

through the ductus venosus, and into the inferior vena cava.

3. Color blood in the right atrium *purple*; continue coloring into the left atrium and through the foramen ovale. Insert a black arrow depicting the movement of blood through the foramen ovale.
4. Color the right ventricle *purple*; continue coloring into the pulmonary trunk. Insert black arrows showing the movement of blood into the right ventricle and into the pulmonary trunk. Then show the passage of blood into the ductus arteriosus and the descending aorta by coloring these areas *purple* and inserting arrows.
5. Continue the *purple* color into the iliac and umbilical arteries. Insert black arrows to depict the flow of blood into the umbilical arteries and back to the placenta.



Fill in the Gaps Childbirth

Fill in the blanks with the appropriate word to describe the events that occur during childbirth. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

AFTERBIRTH
BRAXTONHICKS
DILATION
EFFACEMENT
ESTROGEN
FIRST
OXYTOCIN
PROGESTERONE
PSEUDOCONTRACTIONS
SECOND
THIRD

1. The onset of labor is thought to result from a decline in the hormone _____ and an increase in the hormones _____ and _____.
2. The contractions sometimes known as “false labor” are called _____ contractions.
3. The _____ stage of labor is the longest.
4. The first stage of labor involves thinning of the cervical walls, called cervical _____, as well as progressive widening of the cervix, called cervical _____.
5. The baby is born during the _____ stage of labor.
6. The amniotic sac usually breaks during the _____ stage of labor.
7. The final stage of labor involves delivery of the _____.

Illuminate the Truth Mammary Glands

After childbirth, the mammary glands produce and secrete milk to nourish the neonate. Review this process by highlighting the word or words that completes each sentence correctly.

1. The process by which the mammary glands produce and secrete milk is called (parturition)(lactation).
2. The growth of ducts throughout the mammary glands is stimulated by the high levels of (progesterone) (estrogen) during pregnancy.
3. The development of acini at the ends of the ducts is stimulated by the high levels of (estrogen) (progesterone) during pregnancy.
4. The production of milk is initiated by the secretion of (prolactin)(progesterone).

5. The secretion of the hormone (estrogen)(oxytocin) causes milk to be released into the ducts.
6. Before milk is secreted, the mammary glands secrete a yellowish fluid called (vernix caseosa) (colostrum).

Fill in the Gaps Human Development Through the Life Span

Human development continues throughout the lifespan. Test your knowledge of the various stages of human development by filling in the blanks to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once; not all words may be used.

ADOLESCENCE

ADULTHOOD

CHILDHOOD

EMBRYONIC

NEONATAL

PUBERTY

SENESCENCE

SENILITY

1. The first four weeks of life is called the _____ period.
2. The second stage of life, which continues to the end of the first year, is called _____.
3. The beginning of the second year of life is the beginning of _____. This stage lasts until _____.
4. The next stage, which lasts until about age 19, is called _____.
5. Most body systems peak in development and efficiency during early _____.
6. The process of degeneration is called _____.

chapter 25

HEREDITY

The process of passing traits from biological parents to children is called heredity, while the study of heredity is called genetics. Test your knowledge of this fascinating topic by completing the activities in this chapter.

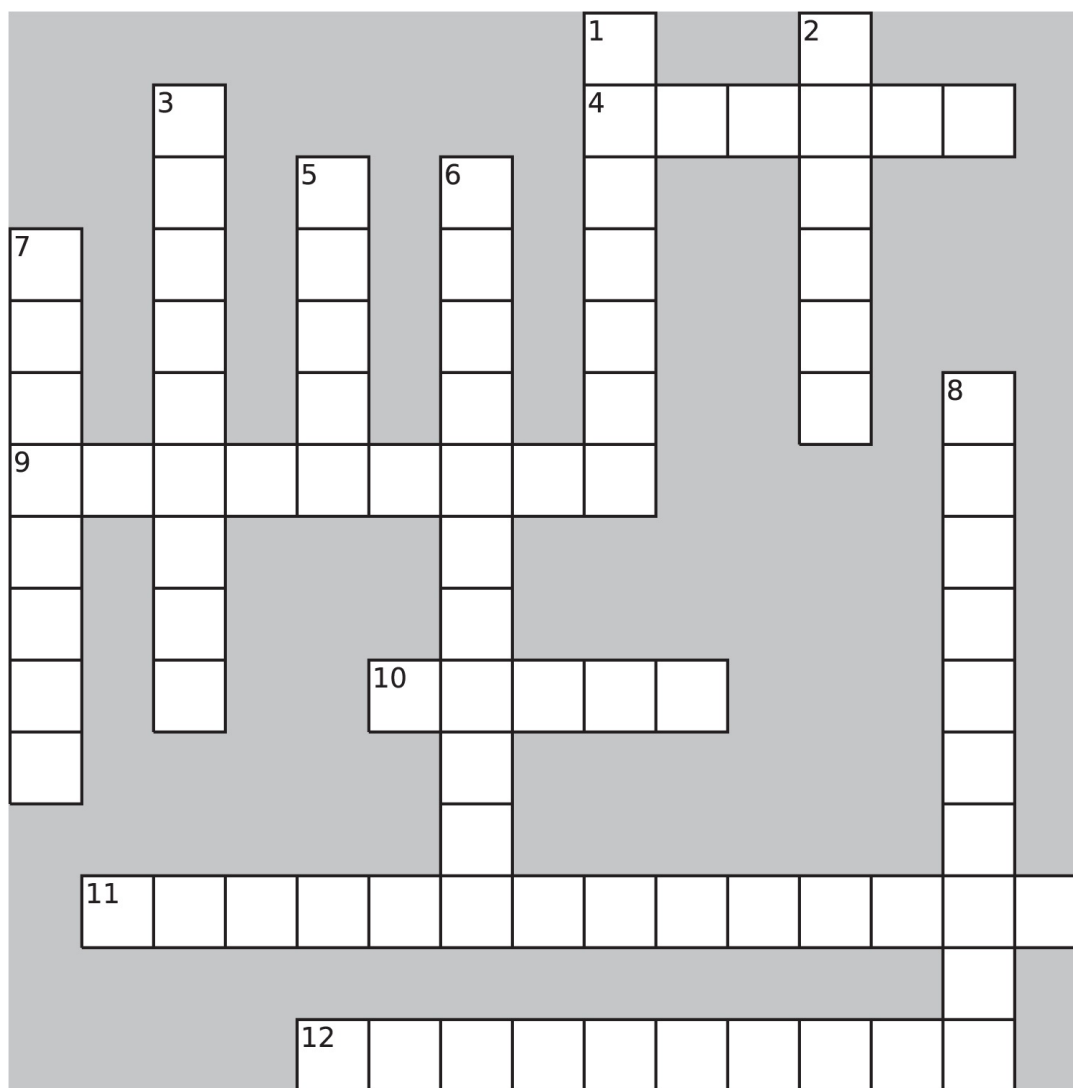
Illuminate the Truth Basic Heredity

Highlight the word or phrase that completes each sentence correctly.

1. Gametes contain (23)(46) chromosomes.
2. Chromosomes consist of long strands of tightly coiled (DNA)(genes).
3. Both males and females need (one normal Y chromosome)(one normal X chromosome).
4. X-linked recessive traits typically express themselves in (females)(males).
5. Trisomy 21 results from (nondisjunction)(mutation) of a chromosome.
6. The 23rd pair of chromosomes are (autosomes)(sex chromosomes).
7. Many common diseases result from an interaction between genetic mutations and (hormonal) (environmental) influences.
8. When homologous chromosomes have different alleles at a particular site, the person is said to be (homozygous)(heterozygous) for that trait.

Puzzle It Out Heredity Terms

Complete the following crossword puzzle to test your knowledge of the study of genetics and heredity.



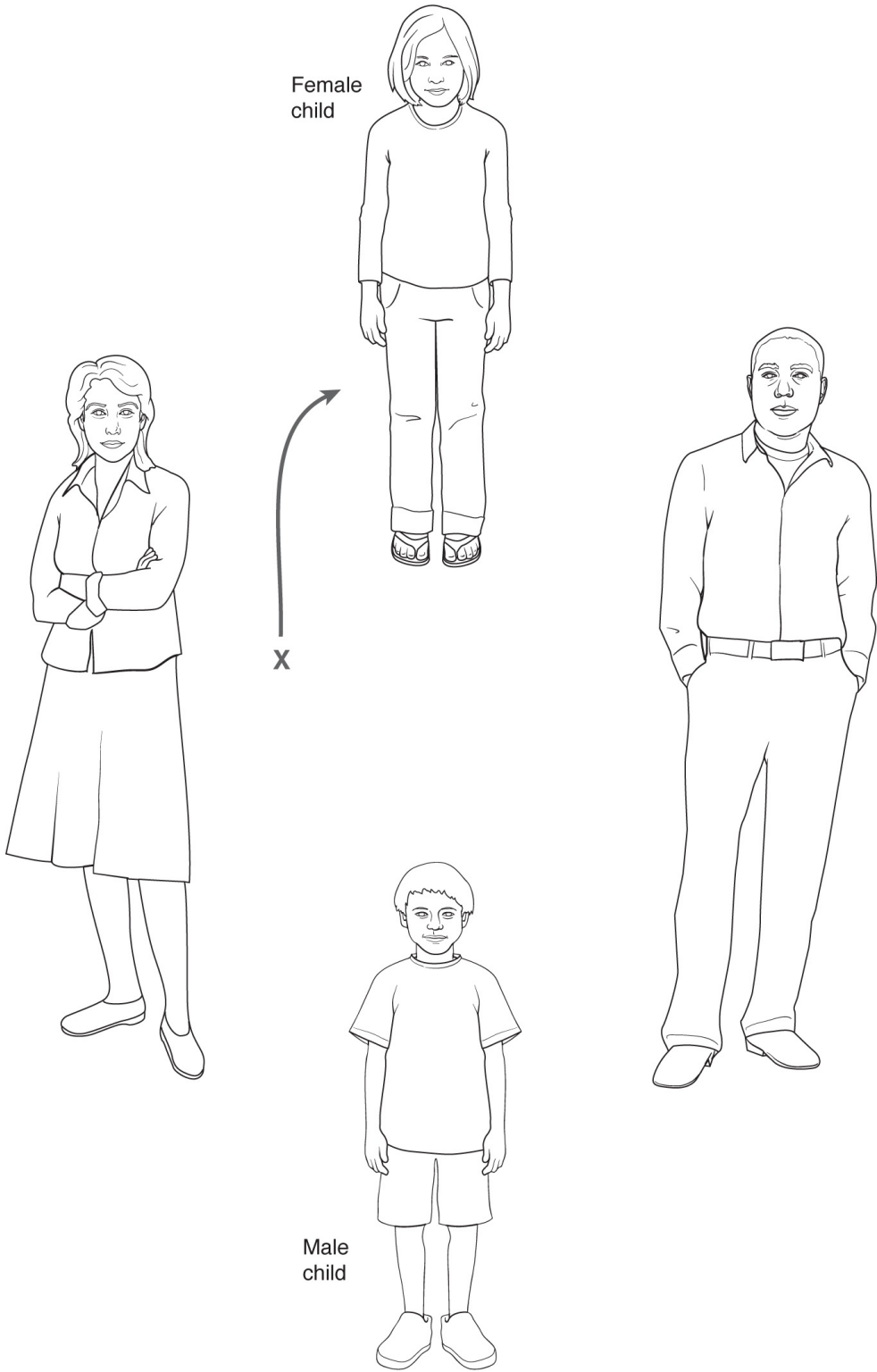
ACROSS

4. An alternative form of a gene
9. Non-sex chromosomes
10. The location of a gene on a specific chromosome
11. When homologous chromosomes fail to separate during meiosis
12. When an individual has two alleles that are the same, he is said to be _____ for the trait.

DOWN

1. These are the only cells that contain a single set of 23 chromosomes.
2. A complete set of genetic information for one person
3. Chart showing all the chromosomes arranged in order by size and structure
5. Contain the traits that each person inherits
6. DNA is spiraled into packages called _____.
7. A permanent change in genetic material
8. Name for similar-looking matched chromosomes

Insert the symbols for X and Y chromosomes by each of the male and female figures to symbolize their gender. Then draw arrows from each parent to each offspring to show how those chromosomes are transmitted. (One arrow and chromosome is inserted to get you started.)



Fill in the Gaps Dominant and Recessive Genes

Review the transmission of dominant and recessive traits by filling in the blanks with the appropriate word or words to complete each sentence correctly. Choose from the words listed in the Word Bank below. Words may be used more than once.

BLUE
BOTH
BROWN
CODOMINANT
DOMINANT
HETEROZYGOUS
HOMOZYGOUS
NEITHER
RECESSIVE
WILL
WILL NOT

1. A _____ allele overshadows the effect of a _____ allele.
2. If only one chromosome carries a dominant allele, the offspring _____ express the trait.
3. If only one chromosome carries a recessive allele, the offspring _____ express the trait.
4. When an allele for brown eyes is paired with an allele for blue eyes, the offspring (who is _____ for the trait) will have _____ eyes.
5. When an allele with brown eyes is paired with another allele for brown eyes, the offspring (who is _____ for that trait) will have _____ eyes.
6. When an allele with blue eyes is paired with another allele for blue eyes, the offspring (who is _____ for that trait) will have _____ eyes.
7. Alleles that are equally dominant are called _____; in this instance, _____ alleles are expressed.

Illuminate the Truth Sex-linked Inheritance

Highlight the word or phrase that completes each sentence correctly.

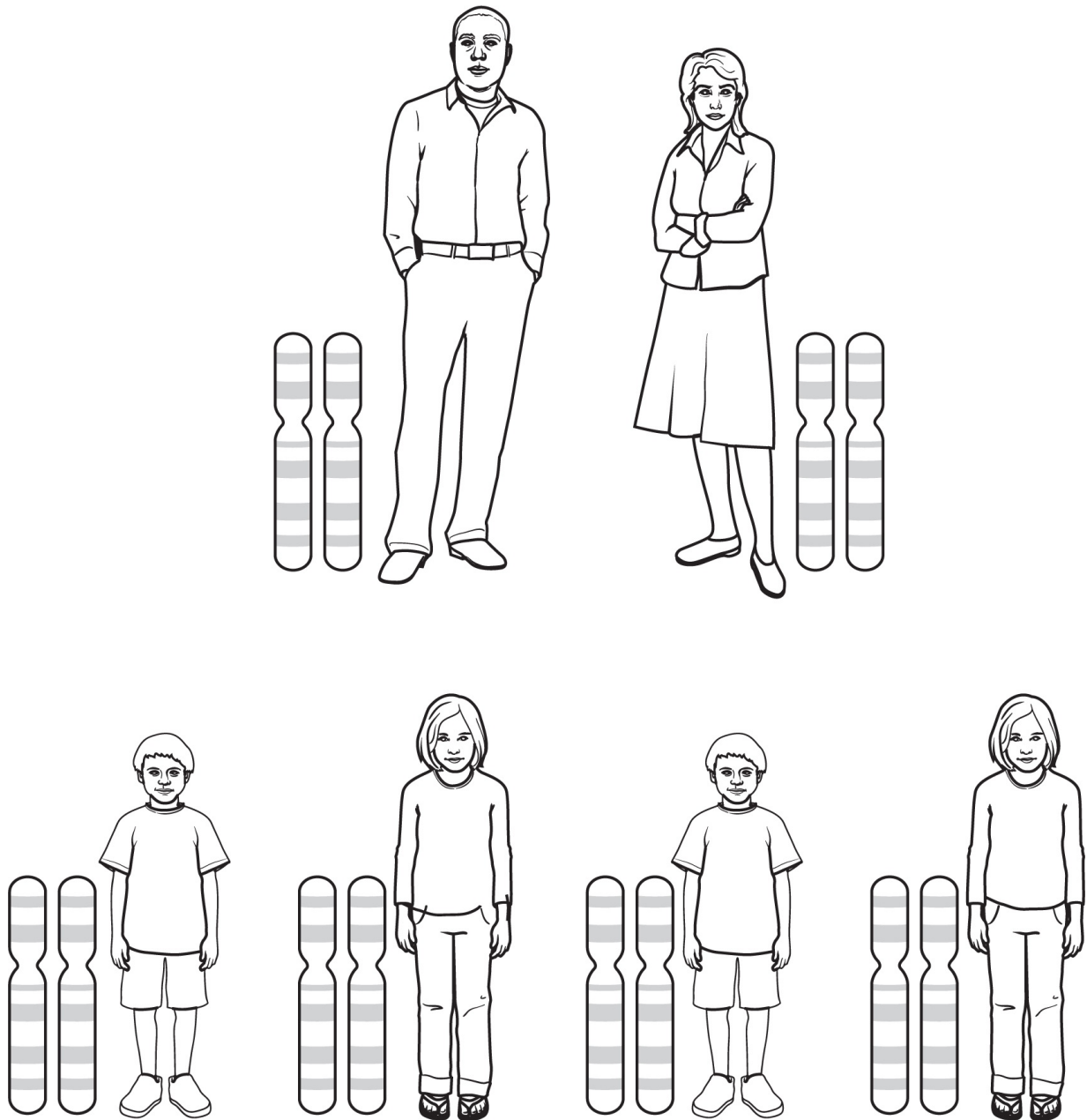
1. Almost all sex-linked traits are (dominant)(recessive).
2. Sex-linked traits are carried on the (X)(Y) chromosome.
3. A common sex-linked disorder is (Down syndrome)(red-green color blindness).
4. If a female inherits the allele for a sex-linked disorder, she will (develop the disorder)(be a carrier of the disorder).

5. If a male inherits the allele for a sex-linked disorder, he will (develop the disorder)(be a carrier of the disorder).

Conceptualize in Color Autosomal Dominant Inheritance

Identify the process of autosomal dominant inheritance by coloring the figures below. In this instance, the father is affected and the mother is unaffected. To illustrate transmission of the disorder from the father to his children, color the figures as described.

- Dominant, affected gene: Red
- Recessive gene: Blue
- Everyone affected by the disorder: Red
- Unaffected people: Blue
- Carriers of the disorder: Purple

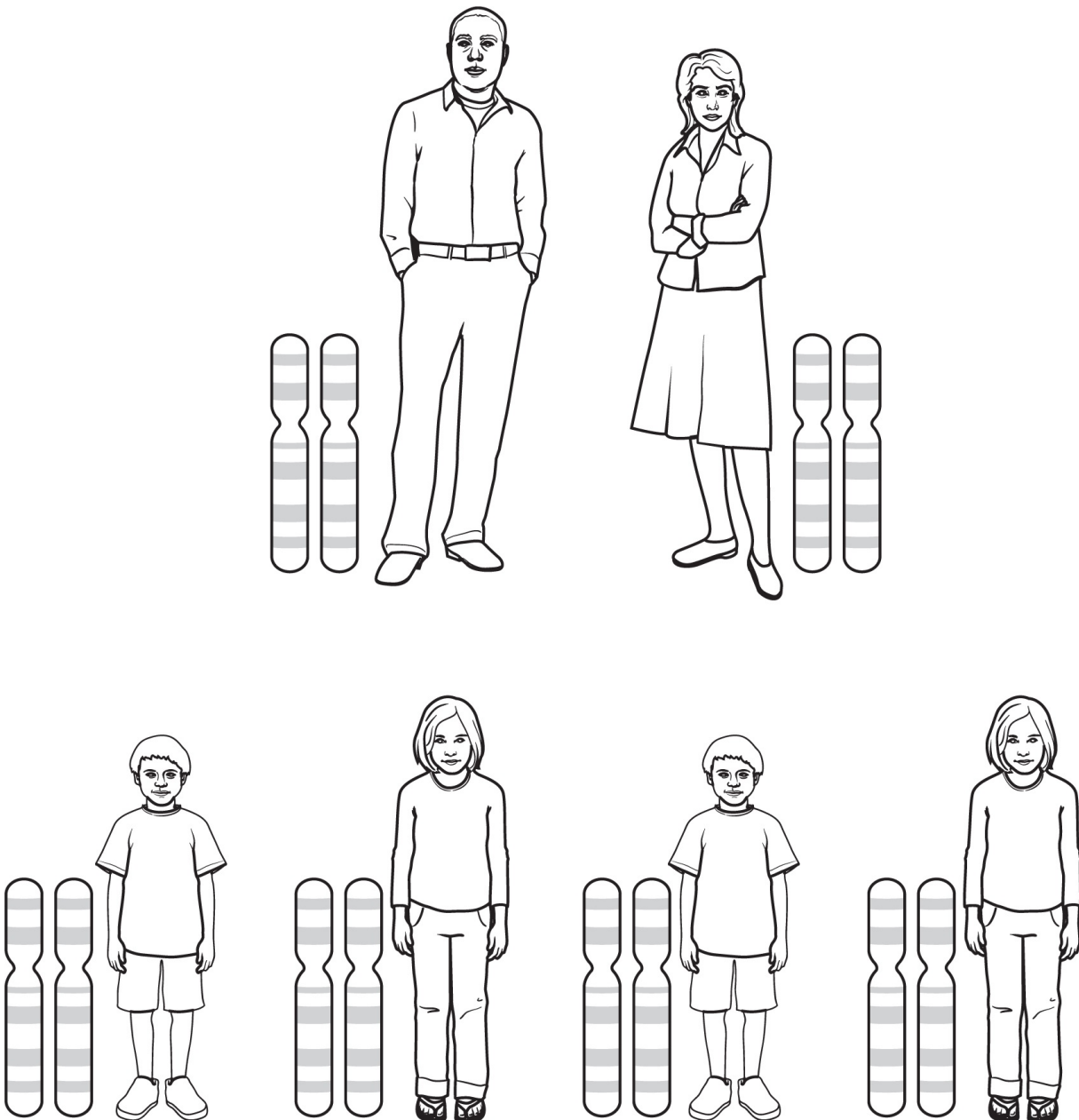


Conceptualize in Color Autosomal Recessive Inheritance

Identify the process of autosomal recessive inheritance by coloring the figures below. In this instance, both parents are carriers of a trait. To illustrate the transmission of the disorder from the parents to their children, color the figures as described.

- Dominant, affected gene: Red
- Recessive gene: Blue
- Everyone affected by the disorder: Red
- Unaffected people: Blue
- Carriers of the disorder: Purple

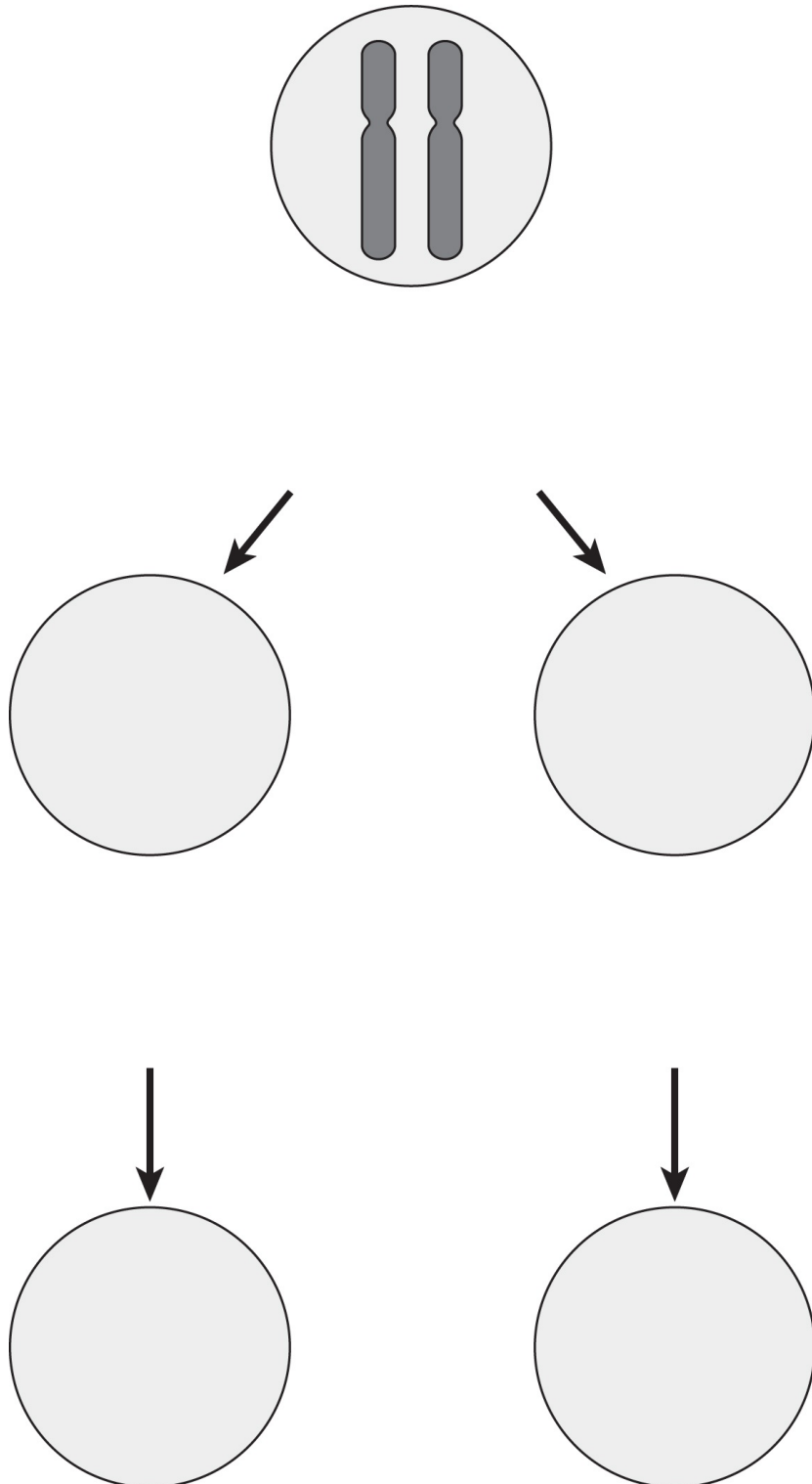
(Hint: Since both parents are carriers, each will have one red and one blue gene.)



Drawing Conclusions Nondisjunction

Nondisjunction, which can affect sex chromosomes as well as autosomal chromosomes, is a common cause of genetic disorders. Test your knowledge of the process of nondisjunction by drawing in the remaining cell stages, with the end result being that one cell exhibits monosomy while the other one exhibits trisomy. (Hint: A sperm will fertilize the “egg” and add its chromosome in the last step.)

Nondisjunction



Illuminate the Truth Genetic Disorders

Highlight the word or phrase that completes each sentence correctly.

1. Genetic mutations (may result)(never result) from exposure to radiation, certain chemicals, or viruses.
2. In autosomal recessive inheritance, the child must inherit (only one)(two) copies of a defective allele to manifest a disorder.
3. An example of an autosomal recessive disease is (Huntington's disease)(cystic fibrosis).
4. In autosomal dominant inheritance, a child has a (50%)(100%) chance of developing the disorder.
5. Down syndrome results from (inheriting a defective allele)(nondisjunction of a chromosome).
6. Down syndrome is often associated with (abnormalities of the heart)(excessive mucus production).
7. The hallmark of cystic fibrosis is the production of (excessive mucus)(deformed red blood cells).
8. Individuals with cystic fibrosis have problems with (breathing and digestion)(adequate urine output).
9. Cystic fibrosis often leads to (kidney failure)(malnutrition).
10. Multifactorial disorders likely result from the combination of lifestyle and environmental factors in combination with (a single gene)(multiple genes).