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Introduction

Having a solid foundation in the knowledge of cells and tissues, you are now ready to study anatomy and physiology. As you have learned, anatomy is the study of body parts, and physiology is the study of how body parts function. This chapter will introduce you to the basic concepts that help students and healthcare professionals understand the human body. You will learn about body planes, cavities, and regions. You will also learn about terms related to anatomical location, the body’s structural organization, and homeostasis in the body.
Objectives

After completing this chapter, you will be able to
- describe anatomical position
- identify and understand the body planes
- list the major dorsal and ventral cavities of the body
- know the regions of the body, including regions of the head and neck, trunk, and appendages
- identify the abdominopelvic regions
- use anatomical terms related to location and position
- understand the five levels of organization in the body
- explain how homeostatic body temperature, blood glucose concentration, and blood pH are maintained in the body

Key Terms

The following terms and phrases will be introduced and explained in Chapter 9. Read through the list to become familiar with the words.

abdominal cavity  intermediate
abdominal region  lateral
abdominopelvic cavity  lower limb
abdominopelvic region  manus
anatomical position  medial
appendicular region  midsagittal plane
axial region  negative feedback
blood glucose concentration  organism
body cavity  pedal
body plane  pelvic cavity
body system  pelvic region
body temperature  proximal
cephalic region  pubic region
cervical region  sagittal plane
cranial cavity  spinal cavity
deep  superficial
distal  superior
dorsal  thoracic cavity
frontal plane  thoracic region
glucagon  transverse plane
inferior  upper limb
insulin  ventral
Section 9.1 Body Planes and Cavities

The study of anatomy and physiology is the study of body parts and their functions. In the fields of anatomy and physiology, healthcare professionals and students use body planes to describe locations and positions on the body. Body cavities also help divide the human body into sections that can be studied. In this section, you will learn about anatomical position and about body planes and cavities.

The terms below are some of those that will be introduced in Section 9.1. To become familiar with these terms, reproduce each word on the line beside it. Pronounce each term as you write it. You will learn the definitions of these words as you complete this section.

1. anatomical position ________________________________________________________________________________
2. body plane _________________________________________________________________________________________
3. midsagittal plane ___________________________________________________________________________________
4. sagittal plane _______________________________________________________________________________________ 
5. frontal plane _______________________________________________________________________________________
6. transverse plane ____________________________________________________________________________________
7. body cavity ________________________________________________________________________________________
8. cranial cavity ______________________________________________________________________________________
9. spinal cavity _______________________________________________________________________________________
10. thoracic cavity _____________________________________________________________________________________
11. abdominal cavity ___________________________________________________________________________________
12. pelvic cavity ______________________________________________________________________________________
13. abdominopelvic cavity _____________________________________________________________________________

Concept 1: Anatomical Position

Anatomy and physiology describe the locations and positions of body structures and body movements. Anatomy is the study of body parts, and physiology is the study of how body parts function. In anatomy and physiology, body locations are described in reference to anatomical position. Anatomical position is a body position in which a person stands upright with feet apart, arms at the sides, feet and palms facing forward, and thumbs pointing away from the body (Figure 9.1).
Recall Activity

1. In anatomy and physiology, body locations are described in reference to __________________________.
2. In anatomical position, the palms and feet face __________________________.
3. In anatomical position, the __________________________ point away from the body.

Concept 2: Body Planes

When describing locations, positions, and directions on the body, body planes serve as reference points. Body planes are imaginary, flat surfaces that divide the body into sections. They are also known as anatomical planes. Body planes divide the body in reference to anatomical position and divide the body into the same sections from any viewing angle (Figure 9.2).

Turned to the left

Straight on

Turned to the right

Figure 9.2  A plane divides this ball into left and right sections. The plane divides the ball into the same sections from all three viewing angles.
Four standard body planes are used in anatomy and physiology:
- midsagittal (median) plane
- sagittal plane
- frontal (coronal) plane
- transverse plane

By dividing the body into parts, you can get a better idea of how organs are positioned inside the body.

Recall Activity

1. List the four standard body planes used in anatomy and physiology. ________________________________
   ______________________________________________________________________________________

2. Body __________________________ are imaginary, flat surfaces that divide the body into sections.

3. Body planes divide the body in reference to __________________________.

Concept 3: Midsagittal and Sagittal Planes

The midsagittal and sagittal planes divide the body into left and right sections. Both planes start at the top of the head and continue down through the body. The midsagittal plane, also known as the median plane, divides the body down the middle into equal left and right halves. The sagittal plane also divides the body into left and right sections, but not down the middle (Figure 9.3).

Figure 9.3  The midsagittal plane divides the body into equal left and right halves. The sagittal plane divides the body into unequal left and right sections.
Recall Activity

1. Which body plane divides the body into equal left and right halves? ________________________________
2. Which body plane divides the body into unequal left and right sections? ____________________________

Concept 4: Frontal Plane

The frontal plane divides the body into front (ventral) and back (dorsal) sections. The frontal plane starts at the top of the head and continues down through the body (Figure 9.4). The sections on either side of the plane are not equal. The frontal plane is also called the coronal plane.

![Frontal plane diagram](https://example.com/frontal-plane.png)

**Figure 9.4** The frontal plane divides the body into front and back sections.

Recall Activity

1. The __________________________ plane divides the body into front and back sections.
2. True or False. The sections on either side of the frontal plane are not equal. _________________________

Concept 5: Transverse Plane

The transverse plane divides the body into top and bottom sections. The transverse plane passes through the middle of the body, starting at one arm and continuing through the body to the opposite arm (Figure 9.5). Sections of the body divided by the transverse plane are called cross-sections.

![Transverse plane diagram](https://example.com/transverse-plane.png)

**Figure 9.5** The transverse plane divides the body into top and bottom sections.
Recall Activity

1. The transverse plane divides the body into __________________________ and __________________________ sections.
2. The transverse plane passes through the __________________________ of the body.
3. Sections of the body divided by the transverse plane are called __________________________.

Concept 6: Body Cavities

A body cavity is a space within the body that contains organs. If you took the organs out of the body, the remaining body cavities would be empty. Some body cavities are surrounded by bone, and others are surrounded by muscle, connective tissue, or epithelial tissue. The body contains dorsal and ventral cavities.

Recall Activity

1. A body cavity is a space within the body that contains __________________________.
2. Some body cavities are surrounded by __________________________, and others are surrounded by muscle, __________________________ tissue, or __________________________ tissue.

Concept 7: Dorsal Cavities

The frontal plane divides the body into back (dorsal) and front (ventral) sections. The dorsal surface of the body is the back. There are two body cavities in the dorsal
section: the cranial cavity and the spinal cavity. The skull forms the cranial cavity, which contains the brain. The hollow spaces inside vertebrae (bone segments of the spine) form the spinal cavity, which protects the spinal cord (Figure 9.6).

Recall Activity

1. Name the two body cavities in the dorsal section. __________________________________________________
2. Which body cavity protects the brain? _____________________________________________________________

Concept 8: Ventral Cavities

The ventral surface of the body is the front. There are three cavities in the ventral section: the thoracic cavity, the abdominal cavity, and the pelvic cavity.
The thoracic cavity is formed by the rib cage and protects the heart and lungs. A portion of the rib cage forms the upper abdominal cavity; the rest of the abdominal cavity is surrounded with soft tissue. The major organs of the abdominal cavity are the stomach, liver, spleen, and intestines. The pelvic cavity is surrounded by the bones of the pelvis and contains the urinary bladder and some reproductive organs. Sometimes the abdominal and pelvic cavities are referred to collectively as the abdominopelvic cavity (Figure 9.7).

Recall Activity

1. The __________________________ cavity protects the heart and lungs.

2. The abdominal and pelvic cavities are referred to collectively as the __________________________ cavity.

3. The urinary bladder and some reproductive organs are housed in the __________________________ cavity.

Figure 9.7  The ventral cavities are the thoracic, abdominal, and pelvic cavities.
Section 9.1 Reinforcement

Answer the following questions using what you learned in this section.

1. In anatomical position, the __________________________ and __________________________ face forward.

2. Which of the following body planes divides the body into equal left and right halves?
   A. sagittal plane
   B. midsagittal plane
   C. frontal plane
   D. transverse plane

3. A(n) __________________________ is a space within the body that contains organs.

4. True or False. The frontal plane is also called the coronal plane. __________________________

5. Unscramble the letters: nertlav. Define the word that is formed. ____________________________________

6. Which of the following words are misspelled?
   A. dorsal
   B. ventrile
   C. saggital
   D. median

7. Which of the following is not a ventral cavity?
   A. thoracic cavity
   B. spinal cavity
   C. pelvic cavity
   D. abdominal cavity

8. The two body cavities of the dorsal section are the __________________________ cavity and the __________________________ cavity.

9. True or False. The stomach, liver, and intestines are housed in the pelvic cavity. __________________________

10. Describe the difference between the midsagittal plane and the sagittal plane. __________________________

11. Which of the following are ventral body cavities?
    A. thoracic cavity
    B. spinal cavity
    C. pelvic cavity
    D. abdominal cavity

12. The __________________________ plane divides the body into front and back sections.

13. Sections of the body divided by the __________________________ plane are called cross-sections.

14. True or False. All body cavities are surrounded by bone. __________________________

15. Which body cavity contains the heart and lungs? __________________________

16. True or False. The term ventral refers to the back section of the body. __________________________

17. The skull forms the __________________________ cavity.

18. In anatomical position, which direction do the thumbs point? __________________________

19. Unscramble the letters: haccroti. Define the word that is formed. ____________________________________

_____________________________________________________________________________________________________________________________________
_____________________________________________________________________________________________________________________________________
20. Which of the following are dorsal body cavities?
   A. thoracic cavity       C. pelvic cavity
   B. spinal cavity         D. cranial cavity

21. Which body plane divides the body into top and bottom sections? ______________________________

Match the following terms with their definitions.

______ 22. A body plane that divides the body into unequal left and right sections
   A. anatomical position
   B. body plane
   C. midsagittal plane
   D. sagittal plane
   E. frontal plane
   F. transverse plane

______ 23. A body plane that divides the body into equal left and right halves
______ 24. A body plane that divides the body into front and back sections
______ 25. A body plane that divides the body into top and bottom sections
______ 26. An imaginary, flat surface that divides the body into sections
______ 27. A body position in which a person stands upright with feet apart, arms at the sides, feet and palms facing forward, and thumbs pointing away from the body

Comprehensive Review (Chapters 1–9)

Answer the following questions using what you have learned so far in this book.

28. Which body plane divides the body into equal left and right halves? ______________________________

29. The “then” portion of a hypothesis is the __________________ variable.

30. Why are hydrogen bonds the weakest type of atomic bond? ________________________________

31. Science’s body of knowledge is the __________________ that scientists have accumulated about the natural world.

32. True or False. Cytoplasm is all the material found inside a cell except for the nucleus. __________

33. Which of the following word parts means “layer”?
   A. alb/o       C. rect/o       E. strat/o
   B. sten/o      D. lat/o       F. rubr/o

34. When atoms move from areas of high concentration to areas of low concentration, this is called a(n) __________________ reaction.

35. The volume measurement of 1000 mL is the same as ________ L.

36. Which type of muscle tissue is voluntary? ________________________________
Section 9.2 Regions of the Body

In anatomy and physiology, healthcare professionals and students use an array of terms to refer to specific regions of the body. In this section, you will learn about abdominopelvic regions and about anatomical terms related to the head and neck, trunk, and limbs.

The terms below are some of those that will be introduced in Section 9.2. To become familiar with these terms, reproduce each word on the line beside it. Pronounce each term as you write it. You will learn the definitions of these words as you complete this section.

1. axial region ______________________________________________________________________________________
2. appendicular region ________________________________________________________________________________
3. cephalic region _____________________________________________________________________________________
4. cervical region _____________________________________________________________________________________
5. thoracic region _____________________________________________________________________________________
6. abdominal region __________________________________________________________________________________
7. pelvic region _______________________________________________________________________________________
8. pubic region _______________________________________________________________________________________
9. abdominopelvic region ______________________________________________________________________________
10. upper limb _________________________________________________________________________________________
11. manus _____________________________________________________________________________________________
12. lower limb _________________________________________________________________________________________
13. pedal ______________________________________________________________________________________________

Concept 1: Axial Versus Appendicular Regions

The body can be divided into axial and appendicular regions. The **axial region** of the body is the body’s core: the head, neck, and trunk. The **appendicular region** includes the appendages, or limbs (arms and legs). The appendicular region is attached to the axial region, and regional terms identify specific surfaces of axial and appendicular parts (Figure 9.8).
Recall Activity

1. The limbs are part of the __________________________ region of the body.

2. True or False. The axial region and the appendicular region are attached. __________________________

3. The __________________________ region of the body includes the head, neck, and trunk.

Figure 9.8  The axial region includes the head, neck, and trunk. The appendicular region includes the limbs.
**Concept 2: Head and Neck**

At the top of the body, the head and neck are part of the axial region. The head area is called the **cephalic region**. Some surface parts of the cephalic region include the forehead, scalp, eyes, nose, mouth, cheeks, lips, and ears. The neck area is called the **cervical region** and includes the cervical vertebrae (bone segments of the spine that make up the neck).

**Recall Activity**

1. The head area is called the __________________________ region.
2. The cervical region makes up the __________________________ area and includes the cervical vertebrae.
3. List three surface parts of the cephalic region. ______________________________________________________

**Concept 3: Trunk**

The **trunk** of the body encompasses the chest, thorax, and hips. The body’s trunk can be divided into four regions: the thoracic region, the abdominal region, the pelvic region, and the pubic region. The **thoracic region** includes the chest or breast. The **abdominal region** encompasses the belly and navel (belly button). The **pelvic region** includes the hips, and the **pubic region** refers to the groin and genitals.

**Recall Activity**

1. Which region refers to the groin and genitals? ______________________________________________________
2. The __________________________ region includes the chest or breast.
3. The abdominal region encompasses the __________________________ and __________________________.

**Concept 4: Abdominopelvic Regions**

The abdominal and pelvic regions encompass the **abdominal cavity** and the **pelvic cavity**, known collectively as the **abdominopelvic cavity**. The abdominopelvic cavity can be divided into nine regions, much like a tic-tac-toe box. When referring to the **abdominopelvic regions**, envision the body in anatomical position. In anatomy, **left** always refers to the body’s left (not your left), and **right** always refers to the body’s right (not your right). The abdominopelvic regions are organized into three rows and three columns (Figure 9.9).
Recall Activity

1. The abdominopelvic regions are organized into three __________________________ and three __________________________.

2. In anatomy, left always refers to __________________________ left, and right always refers to __________________________ right.

3. The abdominopelvic cavity is divided into __________________________ region(s).

Concept 5: First Row

In the first row of abdominopelvic regions are the right hypochondriac region, the epigastric region, and the left hypochondriac region. The prefix hypo-means “below,” and the root word chondr (meaning “cartilage”) refers to the cartilage of the rib cage. Thus, the right hypochondriac region and the left hypochondriac region refer to the abdominopelvic areas just below the rib cage. The prefix epi- means “upon,” and the root word gastr refers to the stomach. Thus, the epigastric region encompasses the area above the stomach.
Recall Activity

1. List the three abdominopelvic regions in the first row. ____________________________________________________________
   ____________________________________________________________

2. Disassemble and define the word *epigastric.* ______________________________________________________________

3. Which of the following word parts means “below”?
   A. hypo-                      C. chondr
   B. epi-                      D. gastr

Concept 6: Second Row

The second row of abdominopelvic regions contains the right lumbar region, the umbilical region, and the left lumbar region. The word *lumbar* is formed from the root word *lumb* (meaning “lower back”) and the suffix -*ar* (meaning “pertaining to”). Thus, the right lumbar region and the left lumbar region refer to abdominopelvic areas of the lower back. The *umbilical region* identifies the area where the navel (the remnant of the *umbilical cord*) is located.

Recall Activity

1. The navel is the remnant of the __________________________ cord.

2. The second row of abdominopelvic regions contains the right __________________________ region, the __________________________ region, and the left __________________________ region.

3. The right lumbar region and the left lumbar region refer to abdominopelvic areas of the __________________________.

Concept 7: Third Row

In the third row of abdominopelvic regions are the right iliac region, the hypo-gastric region, and the left iliac region. The word *iliac* is formed from the root word *ili* (meaning “ilium”) and the suffix -*ac* (meaning “pertaining to”) and refers to the portion of the pelvis called the *ilium* (*Figure 9.10*). The right iliac region and the left iliac region encompass the area around the ilium. The prefix *hypo-* means “below,” and the root word *gastr* refers to the stomach; therefore, the hypogastric region is the area below the stomach.
Recall Activity

1. The hypogastric region is the area below the __________________________.
2. The word iliac refers to a portion of the pelvis called the __________________________.
3. List the three abdominopelvic regions in the third row. _____________________________________________
   ______________________________________________________________________________________

Concept 8: Limbs

The limbs, or appendages, make up the appendicular region of the body and include the arms, hands, legs, and feet. The arms are called the upper limbs, and the surfaces of the upper limbs include the shoulder, upper arm, elbow (front and back), forearm, and wrist. The hands are referred to as manus and include the surfaces of your thumbs, palms, and digits (fingers). The lower limbs are the legs. The surfaces of the lower limbs are the hip, thigh, knee (front and back), calf, shin, and ankle. The feet are called pedal and include the surfaces of the sole, heel, and digits (toes). An easy way to distinguish between manus and pedal is that manicures are for your hands, and pedicures are for your feet.

Recall Activity

1. The hands are referred to as __________________________.
2. The __________________________ are called pedal.
3. Explain the difference between the upper and lower limbs. __________________________
   ______________________________________________________________________________________
Section 9.2 Reinforcement

Answer the following questions using what you learned in this section.

1. The __________________________ area is called the cephalic region.

2. True or False. The navel is also known as the belly button. __________________________________________

3. The pubic region refers to the __________________________ and genitals.

4. Name the abdominopelvic regions in the second row. _______________________________________________

5. In which region is the chest found?
   A. pelvic region       C. abdominal region
   B. thoracic region     D. pubic region

6. Which body cavity is divided into nine regions? ____________________________________________________

7. True or False. The pelvic region encompasses the belly and navel. ___________________________________

8. Which of the following words are misspelled?
   A. epigastric       C. lumbar
   B. hypochondric     D. umbilical

9. Name the abdominopelvic regions in the third row. ________________________________________________

10. True or False. The term pedal refers to the hand. __________________________________________________

11. Which region of the body encompasses the head, neck, and trunk? _________________________________

12. The __________________________ region of the body includes the limbs (arms and legs).

13. Which of the following is not an abdominopelvic region of the first row?
   A. epigastric region       C. umbilical region
   B. left hypochondriac region     D. right hypochondriac region

14. Unscramble the letters: schryogipta. Define the word that is formed. ______________________________

15. The __________________________ area is called the cervical region.

16. True or False. The surfaces of the upper limbs include the shoulder, upper arm, elbow (front and back), forearm, and wrist. ____________________________________________________

17. List the four regions of the trunk. ________________________________________________________________

18. Unscramble the letters: enaclapdipru. Define the word that is formed. ______________________________

19. True or False. The prefix hypo- means “below.” ________________________________________________
20. Which of the following word parts means “stomach”?
   A. chondr  
   B. gastr  
   C. hypo-  
   D. epi-

21. The feet are called ________________________ and include the surfaces of the sole, heel, and digits (toes).

Match the following terms with their definitions.

   ______ 22. The hands  
   ______ 23. The neck area  
   ______ 24. The feet  
   ______ 25. The area containing the chest  
   ______ 26. The area containing the groin  
   ______ 27. The arms  
   ______ 28. The legs  
   ______ 29. The head, neck, and trunk  
   ______ 30. The head area  
   ______ 31. The abdominal and pelvic cavities  
   ______ 32. The area containing the hips  
   ______ 33. The area containing the belly  
   ______ 34. The limbs (arms and legs)

   A. abdominopelvic cavity  
   B. axial region  
   C. appendicular region  
   D. cephalic region  
   E. cervical region  
   F. thoracic region  
   G. abdominal region  
   H. pelvic region  
   I. pubic region  
   J. upper limbs  
   K. manus  
   L. lower limbs  
   M. pedal

Comprehensive Review (Chapters 1–9)

Answer the following questions using what you have learned so far in this book.

35. The prefix meso- means “________________________.”

36. An explanation is supernatural if it cannot be ________________________.

37. Arrange the following phases of mitosis from first to last: anaphase, prophase, telophase, and metaphase.

38. A scientific law is a general statement of ________________________.

39. Describe anatomical position. ______________________________________________________________________

40. What is the complementary base of guanine? _______________________________________________________

41. Water freezes at ______°C.

42. True or False. A cell’s plasma membrane is selectively permeable. ________________________

43. Which of the following body parts are made of elastic cartilage?
   A. nose  
   B. mouth  
   C. ear  
   D. epiglottis
Section 9.3 Terms of Location

Anatomy and physiology includes many terms related to the locations of body parts. All of these terms apply only when the body is in anatomical position. Some of the terms you will learn about in this section include superior, inferior, ventral, dorsal, medial, lateral, intermediate, proximal, distal, superficial, and deep. By the end of this section, you will know how to use all of these terms correctly.

The terms below are some of those that will be introduced in Section 9.3. To become familiar with these terms, reproduce each word on the line beside it. Pronounce each term as you write it. You will learn the definitions of these words as you complete this section.

1. superior ________________________________
2. inferior ________________________________
3. ventral _________________________________
4. dorsal _________________________________
5. medial _________________________________
6. lateral _________________________________
7. intermediate ____________________________
8. proximal ______________________________
9. distal _________________________________
10. superficial ______________________________
11. deep _________________________________

Concept 1: Describing Location

In anatomy and physiology, healthcare professionals and students often describe the locations of body parts in comparison to other body parts. Comparing the locations of body parts in relation to each other makes it easier to envision positions on the body. Note that the terms of location introduced in this section only apply to body parts when the body is in anatomical position.

Recall Activity

1. Healthcare professionals and students often describe the locations of body parts in comparison to ________________________.
2. Terms of location only apply to body parts when the body is in ________________________.
3. True or False. Terms of location apply to body parts when the body is in any position. __________

Concept 2: Superior and Inferior

The terms superior and inferior indicate whether a body part is closer to the head or closer to the feet. If a body part is superior, it is closer to the head. If a body part is inferior, it is closer to the feet. For example, your head is superior to your neck, and your neck is inferior to your head. Your neck is superior to your shoulder, and your shoulder is inferior to your neck (Figure 9.11).
Recall Activity

1. Which of the following body parts is most superior?
   A. hip  
   B. chest
   C. ankle
   D. knee

2. Your navel is __________________________ to your neck.

3. Which of the following body parts is most inferior?
   A. eye  
   B. nose
   C. neck
   D. shoulder

4. Your elbow is __________________________ to your knee.

**Concept 3: Ventral and Dorsal**

*Ventral* and *dorsal* describe locations in relation to the front and back of the body. If a body part is *ventral*, it is closer to the front of the body. Another word for ventral is *anterior*. If a body part is *dorsal*, it is closer to the back of the body. Another word for dorsal is *posterior*. Your heart is ventral (anterior) to your spine, and your spine is dorsal (posterior) to your heart. Your sternum is ventral (anterior) to your heart, and your heart is dorsal (posterior) to your sternum (*Figure 9.12*).
Recall Activity

1. Ventral is to __________________________ as dorsal is to posterior.
2. Which body part is more ventral: the toes or the heel? ______________________________________________
3. If a body part is dorsal, it is closer to the __________________________ of the body.
4. Which body part is more dorsal: the fingernails or the palms? ______________________________________
5. If a body part is ventral, it is closer to the __________________________ of the body.
6. Which body part is more anterior: the tip of the nose or the eyes? ___________________________________

Concept 4: Medial, Lateral, and Intermediate

The terms medial, lateral, and intermediate describe locations in reference to the middle (midsagittal plane) of the body. If a body part is medial, it is closer to the middle (midsagittal plane). If a body part is lateral, it is farther from the middle. A body part that is between one medial and one lateral body part is called intermediate. For example, the radial nerve of your arm is lateral to your sternum. Your sternum is medial to your arm’s ulnar nerve. The ulnar nerve is intermediate to the radial nerve and the sternum (Figure 9.13).
Recall Activity

1. Which of the following body parts is most lateral?
   A. nose  
   B. eye  
   C. ear  
   D. neck

2. Medial, lateral, and intermediate describe locations in reference to the ____________________ plane.

3. Compared to the nose and ears, the eyes are ____________________.

4. Which of the following body parts is most medial?
   A. thumb  
   B. index finger  
   C. middle finger  
   D. little finger

5. Compared to the ears and nose, the arms are ____________________.

Figure 9.13  A body part is lateral if it is farther from the middle of the body. It is medial if it is closer to the middle of the body.
**Concept 5: Proximal and Distal**

The terms *proximal* and *distal* only apply to limbs. If a body part is *proximal*, it is closer to the place where a limb is attached to the body’s trunk. If a body part is *distal*, it is farther from the place where a limb is attached to the body’s trunk. For example, the muscles of the forearm are distal to the muscles of the upper arm, and the muscles of the upper arm are proximal to the muscles of the forearm. The calf muscles are distal to the muscles of the thigh, and the muscles of the thigh are proximal to the calf muscles (Figure 9.14).

![Diagram of human body showing proximal and distal relationships between different muscle groups.](image)

**Figure 9.14** The terms *proximal* and *distal* apply to the arms and legs.

**Recall Activity**

1. If a body part is __________________________, it is closer to the place where a limb is attached to the body’s trunk.
2. The hand is __________________________ to the elbow.
3. If a body part is __________________________, it is farther from the place where a limb is attached to the body’s trunk.
4. The terms *proximal* and *distal* only apply to __________________________.
5. The ankle is __________________________ to the knee.
Concept 6: Superficial and Deep

The terms *superficial* and *deep* describe locations in relation to the surface of the body. If a body part is *superficial*, it is closer to the surface of the body. If a body part is *deep*, it is farther from the surface of the body. For example, the muscles of the face are superficial to the brain. The brain is deep to the muscles of the face. The skull is deep to the muscles of the face, but superficial to the brain (Figure 9.15).

![Figure 9.15](AridOcean/Shutterstock.com)  
*Figure 9.15* The terms *superficial* and *deep* describe how close a body part is to the surface.

Recall Activity

1. Which body part is deeper: the heart or the ribs?
2. If a body part is superficial, it is _________________ to the surface of the body.
3. The terms *superficial* and *deep* describe location in relation to the _________________ of the body.
4. Which body part is more superficial: the stomach or the skin?
5. If a body part is deep, it is _________________ from the surface of the body.
Section 9.3 Reinforcement

Answer the following questions using what you learned in this section.

1. Compared to the nose and ears, the eyes are __________________________.

2. Which of the following terms indicates that a body part is closer to the surface?
   A. deep   C. superficial
   B. medial   D. dorsal

3. If a body part is __________________________, it is closer to the head; if a body part is
   __________________________, it is closer to the feet.

4. Which of the following body parts is most lateral?
   A. hip   C. nose
   B. finger   D. left eye

5. True or False. The term medial describes location in reference to the frontal plane. ______________

6. Superficial and deep describe locations in relation to the __________________________ of the body.

7. If a body part is ventral, it is closer to the __________________________ of the body; if a body part is
dorsal, it is closer to the __________________________ of the body.

8. Which of the following body parts is most medial?
   A. right hand   C. left cheek
   B. navel   D. left knee

9. Compared to the skin, is the brain superficial or deep? __________________________

10. True or False. The terms proximal and distal apply only to the trunk of the body. ______________

11. Which of the following body parts is most superior?
   A. knee   C. foot
   B. hip   D. ankle

12. Medial, lateral, and intermediate describe locations in reference to the __________________________
    plane.

13. Which of the following body parts is most proximal?
   A. knee   C. foot
   B. hip   D. ankle

14. The terms ventral and __________________________ mean that a body part is closer to the front of
    the body.

15. True or False. The term lateral describes location in reference to the sagittal plane. ______________

16. If a body part is superior, it is closer to the __________________________.

17. Which of the following body parts is intermediate to the others?
   A. right thumb   C. right collarbone
   B. right forearm
18. True or False. The brain is deep to the skin. ________________________________________________________________________

19. Terms of location only apply to body parts when the body is in __________________________.

20. Which body part is deeper: the stomach or the skin? _______________________________________________________________________

21. If a body part is __________________________, it is farther from the middle of the body.

22. The terms dorsal and __________________________ mean that a body part is closer to the back of the body.

Match the following terms with their definitions.

______ 23. Closer to the front of the body  A. superior
______ 24. Closer to the back of the body  B. inferior
______ 25. Between medial and lateral body parts  C. ventral
______ 26. Closer to the point of limb attachment  D. dorsal
______ 27. Farther from the point of limb attachment  E. medial
______ 28. Closer to the middle of the body  F. lateral
______ 29. Farther from the middle of the body  G. intermediate
______ 30. Closer to the head  H. proximal
______ 31. Closer to the feet  I. distal
______ 32. Closer to the surface of the body  J. superficial
______ 33. Farther from the surface of the body  K. deep

Comprehensive Review (Chapters 1–9)

Answer the following questions using what you have learned so far in this book.

34. Which connective tissue structure connects bone to bone? ______________________________________________________________________

35. A hemisphere is __________________________ of a sphere.

36. Convert 2376 g into kg. ______________________________________________________________________

37. A macromolecule made of repeating subunits is called a(n) __________________________.

38. True or False. There is always some degree of uncertainty in science. ______________________________________________________________________

39. Which of the following structures make up a cell’s plasma membrane?
   A. ribosomes
   B. phospholipids
   C. proteins
   D. lysosomes

40. Facts are __________________________ of people and opinions.

41. Describe the difference between diffusion and facilitated diffusion. ______________________________________________________________________

42. Which region of the body encompasses the head, neck, and trunk? ______________________________________________________________________
Section 9.4 Body Organization

In anatomy and physiology, the body is organized into five different levels. These levels differ in complexity, from the most basic cell level to the organism level that considers cells, tissues, organs, and body systems. In this section, you will learn about body organization and about the characteristics of each organizational level.

The terms below are some of those that will be introduced in Section 9.4. To become familiar with these terms, reproduce each word on the line beside it. Pronounce each term as you write it. You will learn the definitions of these words as you complete this section.

1. body system ____________________________________________________________
2. organism ______________________________________________________________

Concept 1: Five Levels of Organization

The human body is organized into five levels that progress from simple to more complex. The five levels of organization are

- cells
- tissues
- organs
- body systems
- organisms

For example, cells make up tissue. Different types of tissue compose the organs involved in digestion, including the organs of the alimentary canal (mouth, pharynx, esophagus, stomach, small intestine, colon, rectum, and anus). The organs involved in digestion make up the body system known as the digestive system. Together, all of the body systems make up the human organism (Figure 9.16).
Recall Activity

1. List the five levels of organization in order of complexity from complex to simple. __________________
   ___________________________________________________________________________________

2. Together, all of the __________________________ make up the human organism.

Concept 2: Cell Level

As you have learned, the cell is the basic unit of life. Human body cells are specialized to perform specific functions in the body. If you were to look at the body’s alimentary canal on a cellular level, you would study many types of cells and their functions. For example, in the stomach, parietal cells release hydrochloric acid to make the environment acidic. Chief cells in the stomach secrete pepsinogen, which aids in digestion, and mucous neck cells produce mucus to protect the cells lining the stomach. Smooth muscle cells move food through the alimentary canal, and simple columnar epithelial cells with micro-villi absorb digested macromolecules.
Recall Activity

1. Simple columnar epithelial cells with __________________________ absorb digested macromolecules.
2. Which cells in the stomach release hydrochloric acid? ______________________________________________
3. Mucous neck cells produce __________________________ to protect the cells lining the stomach.

Concept 3: Tissue Level

A tissue is a group of cells that work together to do a job. On a tissue level, you study groups of cells that work with one another. In the alimentary canal, for example, muscle tissue contracts to move food through the canal. Through most of the alimentary canal, muscle tissue is composed of two sheets of muscle cells. The first sheet of smooth muscle cells is arranged in a circle around the tubelike canal. When these muscle cells contract in unison, the tube becomes smaller in diameter. The second sheet of muscle cells is perpendicular to the circular muscle cells. In the second sheet, muscle cells are arranged lengthwise around the tube. When these muscle cells contract, the tube becomes shorter in length.

Recall Activity

1. Through most of the alimentary canal, muscle tissue is composed of __________________________
   sheet(s) of muscle cells.
2. In the alimentary canal, muscle tissue __________________________ to move food through the canal.
3. A(n) __________________________ is a group of cells working together to do a job.

Concept 4: Organ Level

An organ is a group of tissues that work together to do a job. An organ is composed of different types of tissue. For example, the job of the small intestine is to move food, break down food into macromolecules, and absorb macromolecules into the blood. To achieve this, the small intestine contains several types of tissue. Lining the inside of the small intestine is a layer of epithelial tissue called mucosa. The cells of this tissue layer have microvilli and absorb macromolecules from digested food. The mucosa is supported by a layer of connective tissue called the lamina propria. Two layers of muscle tissue are next. Cells in these tissue layers contract to move food through the small intestine. Finally, another layer of epithelial tissue covers the outside of the small intestine. This layer of epithelial tissue is called serosa (Figure 9.17).
Recall Activity

1. The two layers of epithelium in the small intestine are the __________________________ and the __________________________.
2. The layer of connective tissue in the small intestine is called the __________________________.
3. Which tissue layer lines the inside of the alimentary canal? __________________________

Concept 5: Body System Level

Organs that work together to perform a group of functions make up a **body system** (also known as an *organ system*). For example, the organs of the alimentary canal, as well as some other organs (such as the salivary glands, liver, pancreas, and gallbladder), make up the **digestive system**. Together, all of these organs perform the functions of moving food, *digesting* food (chewing food into small pieces and breaking pieces into macromolecules), and absorbing macromolecules for use throughout the body.

The human body has 11 systems (Figure 9.18):

- integumentary system
- skeletal system
- muscular system
- nervous system
- endocrine system
- respiratory system
- cardiovascular system
- lymphatic system
- digestive system
- urinary system
- reproductive systems (male and female)

You will learn about the basic organs and functions of these body systems in Chapter 10.
Figure 9.18  Eleven body systems make up the human body.
Figure 9.18  Continued.
Recall Activity

1. A body system is a group of __________________________ working together to perform several functions.

2. __________________________ is chewing food into small pieces and breaking pieces into macromolecules.

3. How many systems does the human body have? ____________________________________________________

4. List the human body systems. ______________________________________________________________________
   ___________________________________________________________________________________
   ___________________________________________________________________________________

Concept 6: Organism Level

The most complex level of body organization is the organism level. An organism is a complex life form made of many interdependent parts. The human organism is a cooperative community of the 11 body systems. All of the body systems work together to maintain life.

Recall Activity

1. The human organism is a cooperative __________________________ of body systems.

2. An organism is a complex life form made of many __________________________ parts.

Section 9.4 Reinforcement

Answer the following questions using what you learned in this section.

1. Which of the following organs is not part of the alimentary canal?
   A. liver  C. esophagus  
   B. stomach  D. mouth

2. True or False. An organ is a group of tissues working together to do a job. __________________________

3. The epithelial tissue layer lining the inside of the alimentary canal is called the __________________________.

4. List the five levels of body organization in order of complexity from simple to complex. ____________
   ___________________________________________________________________________________

5. Which of the following cells makes pepsinogen?
   A. chief cell  
   B. goblet cell  C. smooth muscle cell  
   D. parietal cell
6. The basic unit of life is the __________________________.

7. Organs that work together to perform a group of functions make up a(n) __________________________.

8. **True or False.** The colon is not part of the alimentary canal.____________________________________

9. Unscramble the letters: stusie. Define the word that is formed.____________________________________
   _______________________________________________________________________________________

10. **True or False.** The digestive system is composed only of organs that make up the alimentary canal. _______________________________________________________________________

11. The cells of the mucosa have __________________________ that help them absorb macromolecules from digested food.

12. A group of cells working together to do a job is a(n) __________________________.

13. List the five levels of body organization in alphabetical order. ______________________________________
   _______________________________________________________________________________________

14. How many body systems does the human body have? _____________________________________________

15. **True or False.** The lamina propria is the muscle layer of the small intestine. _______________________

16. List the human body systems in alphabetical order. ________________________________________________
   _______________________________________________________________________________________
   _______________________________________________________________________________________

17. In the stomach, __________________________ cells release hydrochloric acid to make the environment acidic.

18. The human organism is a cooperative community of 11 __________________________.

19. Which of the following words are misspelled?
   A. organ  
   B. alimentary  
   C. salivary  
   D. esophgous

20. A(n) __________________________ is a complex life form made of many interdependent parts.

21. Which level of body organization is concerned with several organs that work together to perform a group of functions? __________________________________________________________________________

**Match the following terms with their definitions.**

22. Organs working together to perform a group of functions
   A. cell
   B. tissue
   C. organ
   D. body system
   E. organism

23. A group of cells working together to do a job

24. A group of tissues working together to do a job

25. The basic unit of life

26. A complex life form made of many interdependent parts
Comprehensive Review (Chapters 1–9)

Answer the following questions using what you have learned so far in this book.

27. What does the prefix *inter-* mean? __________________________________________________________________

28. An explanation is natural if it is __________________________ and __________________________.

29. The first step in the diagnostic scientific method is __________________________.

30. What is the value of pi? ________________________________________________________________________________

31. In a covalent bond, are electrons accepted, donated, or shared? ________________________________

32. Which of the following body parts is most distal?
   A. knee          C. foot
   B. hip          D. ankle

33. True or False. Tight junctions prevent heart muscle cells from separating. __________________________

34. Which type of tissue is composed mostly of extracellular fibers with few cells? _______________________

35. True or False. Energy is required to move from low concentration to high concentration. ____________

Section 9.5 Homeostasis in the Body

*Homeostasis* is a state of relative stability. In Section 7.7, you learned about how the cell maintains homeostasis for its continued survival. Homeostasis is also maintained in the body at large. In this section, you will learn about the body’s functions for maintaining homeostasis. Understanding these functions will prepare you for anatomy and physiology.

The terms below are some of those that will be introduced in Section 9.5. To become familiar with these terms, reproduce each word on the line beside it. Pronounce each term as you write it. You will learn the definitions of these words as you complete this section.

1. negative feedback __________________________________________________________________________________

2. body temperature __________________________________________________________________________________

3. blood glucose concentration __________________________________________________________________________

4. insulin _____________________________________________________________________________________________

5. glucagon ___________________________________________________________________________________________

Concept 1: Reviewing Homeostasis

As you have learned, life can only exist within a narrow range of circumstances. For life to continue, the body and its cells must maintain *homeostasis* (a state of relative stability). The environment outside your body can constantly change. You can walk out of a warm house into the cold street outside. In the midst of
this external temperature change, your body makes adjustments to maintain a stable internal body temperature. The environment inside your body can also change. For example, if you do not eat for several hours, your body will maintain a constant blood glucose concentration to supply your cells. In both of these examples, your body is maintaining homeostasis. In Section 7.7, you learned about homeostasis inside the cell. Now you will learn about homeostasis inside the body as a whole.

**Recall Activity**

1. For life to continue, the body and its cells must maintain __________________________.
2. If you do not eat for several hours, your body will maintain a constant blood _________________ concentration to supply your cells.

**Concept 2: Negative Feedback**

Your body is constantly monitoring the concentrations of hundreds of molecules and other factors necessary for life. When a concentration or factor falls below or climbs above a set value, your body will take action to correct the concentration or factor back to the set value. Once the set value is reached, the body will stop this action. This cycle of taking action to correct concentrations and factors inside the body is called **negative feedback**. To maintain a set value, your body signals cells to make products and perform certain actions and then signals them to stop when the set value is reached.

**Recall Activity**

1. In __________________________, the body takes action to correct a concentration or factor back to its set value.
2. Once the set value of a concentration or factor is reached, the body will __________________________ its action.

**Concept 3: Body Temperature**

The process of negative feedback enables your body to maintain homeostasis when the environment outside the body changes. An example of this is **body temperature**. In homeostasis, the body’s internal temperature is 37°C (98.6°F). If you are in a cold environment, your body will lose heat to the environment. In response to this change, your hypothalamus directs your body to adjust reactions inside cells to increase the amount of heat produced and make up for heat lost. If you are in a hot environment, your body will gain heat from the environment. In response, your hypothalamus directs your body to sweat,
losing heat to the environment as sweat evaporates (Figure 9.19). As you might imagine, sweating upsets the homeostasis of water inside your body. This is why you need to drink water to replace water lost as sweat.

**Recall Activity**

1. Sweating upsets the __________________________ of water inside your body.
2. Your body adjusts to cold by __________________________ the amount of heat produced by cellular reactions.
3. In homeostasis, the body’s internal temperature is _______°C (________°F).

**Concept 4: Blood Glucose Concentration**

Negative feedback also enables your body to maintain homeostasis when the environment inside the body changes. One factor that must remain stable inside the body is blood glucose concentration. In homeostasis, your blood maintains a glucose concentration of 90 mg/100 mL. However, the concentration of glucose in your blood is always changing. Your cells constantly take
glucose out of the blood for use in cell respiration. When you eat carbohydrates, your digestive system puts glucose into the blood. In response to these changes, your body takes several actions to maintain homeostasis.

Recall Activity

1. In homeostasis, your blood maintains a glucose concentration of __________________________.
2. Your cells constantly take glucose out of the blood for use in cell __________________________.
3. When you eat carbohydrates, your digestive system puts __________________________ into the blood.

Concept 5: High Blood Glucose Concentration

When you digest carbohydrates, your digestive system breaks down the carbohydrates into glucose and puts glucose into your blood. This causes your blood glucose concentration to rise, climbing above 90 mg/100 mL. In response, your body takes action to lower blood glucose concentration, causing the beta cells in your pancreas to produce the hormone **insulin**. Insulin signals your cells to take glucose out of the blood and signals your liver to draw glucose out of the blood and store it as **glycogen**. These actions lower the concentration of glucose in your blood back to 90 mg/100 mL (Figure 9.20).

Recall Activity

1. When you digest carbohydrates, does your blood glucose concentration rise or fall? ________________
2. Beta cells in your pancreas produce the hormone __________________________.
3. Insulin signals your __________________________ to take glucose out of the blood and signals your __________________________ to draw glucose out of the blood and store it as glycogen.

Concept 6: Low Blood Glucose Concentration

Because of cell respiration, your cells are constantly taking glucose out of the blood. This causes your blood glucose concentration to decrease, falling below 90 mg/100 mL. Digesting carbohydrates increases blood glucose concentration, but you are not constantly eating. Because of this, your liver stores a polysaccharide known as **glycogen** that can be broken into glucose and put into the blood if glucose concentration is low. When blood glucose concentration is too low, alpha cells in the pancreas produce the hormone **glucagon**. Glucagon signals the liver to break down stored glycogen into glucose and release glucose into the blood. These actions raise the concentration of glucose in your blood back to 90 mg/100 mL (Figure 9.20).
Insulin stimulates glucose uptake by cells.

Glucagon stimulates glycogen formation.

Blood glucose falls to normal.

Blood glucose rises to normal.

Pancreas

Glucose

Glycogen

Liver

Stimulates glucose uptake by cells

Stimulates glycogen formation

Stimulates glycogen breakdown by liver

Imbalance

Imbalance

Homeostasis: Normal blood glucose level (90mg/100 mL)

Figure 9.20  The hormones insulin and glucagon maintain homeostatic blood glucose concentration in the body.

Recall Activity

1. Alpha cells in the pancreas produce the hormone __________________________.
2. Glucagon signals the liver to break down stored __________________________ into glucose.
3. Does the action of glucagon cause blood glucose concentration to increase or decrease?

________________________________________________________________________
Concept 7: Blood pH

pH is another factor that must be kept in homeostasis. In Section 7.7, you learned about how cells regulate internal pH. pH must also be regulated in the blood. As you have learned, pH is the measurement of acid or base in a liquid and depends on the numbers of hydrogen ions (H⁺) and hydroxide ions (OH⁻). In homeostasis, the pH of blood is slightly basic, between 7.35 and 7.45.

The kidneys maintain the homeostasis of blood pH. Blood is constantly entering and leaving the kidneys. In fact, every four minutes, all the blood in your body will travel through a kidney. The kidneys sort through what to keep in the blood and what to remove from the blood, and molecules and ions that are removed from the blood become urine. The body’s metabolism is constantly producing hydrogen ions (H⁺). If blood pH is too low, the kidneys will remove hydrogen ions (H⁺) from the blood, raising blood pH. If blood pH is too high, the kidneys will retain hydrogen ions (H⁺), and as the body continues to produce hydrogen ions (H⁺), blood pH will fall.

Recall Activity

1. Removing hydrogen ions (H⁺) from the blood __________________________ blood pH.
2. In homeostasis, the pH of blood is between __________________________ and ________________.
3. If the kidneys retain hydrogen ions (H⁺) in the blood, blood pH will __________________________.

Section 9.5 Reinforcement

Answer the following questions using what you learned in this section.

1. Which hormone is produced by the alpha cells of the pancreas? _____________________________________
2. Glucagon signals the __________________________ to break down stored glycogen into glucose.
3. When the kidneys retain hydrogen ions (H⁺) in the blood, does blood pH rise or fall? ______________
4. True or False. The body’s homeostatic internal temperature is 39°C. __________________________
5. Which organ maintains homeostatic blood pH by choosing what to keep in the blood and what to remove from the blood? __________________________________________________________________________
6. The hormone __________________________ signals your cells to take glucose out of the blood.
7. True or False. Molecules and ions that are removed from the blood become urine. ______________
8. Which hormone is produced by the beta cells of the pancreas? ______________________________________
9. Unscramble the letters: anoggclu. Define the word that is formed. ___________________________________________
10. The hormone insulin signals the liver to take glucose out of the blood and store it as ______________________.

11. Does removing hydrogen ions (H⁺) from the blood raise or lower blood pH? _______________________

12. The hormone ______________________ raises blood glucose concentration.

13. What happens in negative feedback? ____________________________________________________________

14. True or False. The kidneys keep the pH of blood between 7.25 and 7.55. _______________________

15. To maintain a set value, your body signals cells to make ______________________ and perform certain ______________________ and then signals them to ______________________ when the set value is reached.

16. Which hormone causes the breakdown of glycogen in the liver? _________________________________

17. In response to a hot environment, your body sweats, losing heat to the environment as sweat ______________________.

18. What is the body’s homeostatic internal temperature? _________________________________

19. Unscramble the letters: smashsootie. Define the word that is formed. ________________________________

20. True or False. In homeostasis, blood glucose concentration is 90 mg/100 mL. ______________________

21. In homeostasis, the pH of blood is slightly ______________________, between ______________________ and ______________________.

Comprehensive Review (Chapters 1–9)

Answer the following questions using what you have learned so far in this book.

22. pH values range from ______________________ to ______________________.

23. Name the three types of extracellular fibers. ___________________________________________________________________

24. True or False. If additional evidence leads to a better explanation, science will change. _____________

25. What is the second step of the experimental scientific method? _________________________________

26. If the diameter of a circle is 100 cm, the radius is ______________________ mm.

27. List the three building blocks of the cytoskeleton. __________________________________________________________________

28. The prefix ______________________ means “false.”

29. Which will diffuse faster: a molecule containing few atoms or a molecule containing many atoms? __________________________________________________________________

30. Organs that work together to perform a group of functions make up a(n) ______________________.
Chapter 9 Review

Answer the following questions using what you learned in this chapter.

1. List the four body planes used in anatomy and physiology. _________________________________________
   ___________________________________________________________________________________
   ___________________________________________________________________________________

2. In anatomical position, the thumbs point __________________________ the body.

3. True or False. The word manus refers to the hand. __________________________

4. Which of the following is not a region of the trunk?
   A. thoracic region  C. abdominal region
   B. pubic region  D. cervical region

5. Is your knee proximal or distal to your hip? __________________________

6. True or False. The nose is intermediate to the eyes and ears. __________________________

7. Which of the following body parts is most superficial?
   A. liver  C. skin
   B. kidney  D. heart

8. Is your ankle superior or inferior to your shin? __________________________

9. The __________________________ plane divides the body into front and back sections.

10. True or False. Both the midsagittal plane and the sagittal plane divide the body down the middle. _______

11. List the human body systems. ______________________________________________________________________
   ___________________________________________________________________________________
   ___________________________________________________________________________________

12. Which of the following body parts is most medial?
   A. hip  C. nose
   B. finger  D. left eye

13. When you digest carbohydrates, does your blood glucose concentration rise or fall? __________

14. True or False. The heart is deep to the rib cage. __________________________

15. A(n) __________________________ is a group of organs working together to perform a group of functions.

16. The cranial and __________________________ cavities are found in the dorsal section of the body.

17. When blood glucose concentration is too high, beta cells in the pancreas produce the hormone __________

18. Is the sternum dorsal or ventral to the spine? __________________________

19. True or False. If a body part is inferior, it is closer to the head. __________________________

20. In homeostasis, what is the body’s blood glucose concentration? __________________________

21. List the five levels of body organization in order of complexity from simple to complex. ________
   ___________________________________________________________________________________
22. List the three abdominopelvic regions in the first row. ______________________________________________
_____________________________________________________________________________________________________________________________________

23. True or False. The head area is called the cephalic region. ___________________________________________

24. Which of the following body planes divides the body into top and bottom sections?
   A. sagittal plane  
   B. midsagittal plane  
   C. frontal plane  
   D. transverse plane

25. What is the body’s homeostatic internal temperature? ______________________________________________

26. The __________________________ region of the body includes the limbs (arms and legs).

27. In homeostasis, the pH of blood is between __________________________ and __________________________.

Comprehensive Review (Chapters 1–9)

Using what you have learned so far in this book, match the following terms with their definitions.

   ______  28. An area of biology that studies tissues
   ______  29. A combining form that means “belly side (of the body)”
   ______  30. Facts that relate to a possible cause
   ______  31. The movement of atoms from areas of low concentration to areas of high concentration using solute pumps
   ______  32. A type of connective tissue made of cells and calcium salts reinforced with collagen fibers
   ______  33. The speed of enzymatic reactions
   ______  34. An avascular connective tissue with an extracellular matrix made of extracellular fibers, carbohydrates, and water
   ______  35. A body plane that divides the body into front and back sections
   ______  36. A combining form that means “back (of the body)”
   ______  37. Finger-like projections of the plasma membrane that increase the surface area of the cell to allow for more absorption
   ______  38. A liquid that contains more H⁺ ions than OH⁻ ions
   ______  39. The total area of the outer surface of an object
   ______  40. A body plane that divides the body into top and bottom sections
   ______  41. The spreading out of atoms from areas of high concentration into areas of low concentration

A. evidence  
B. ventr/o  
C. surface area  
D. turnover rate  
E. microvilli  
F. histology  
G. diffusion  
H. bone  
I. frontal plane  
J. dors/o  
K. acid  
L. cartilage  
M. active transport  
N. transverse plane