

Structure and Function of the Body

STRUCTURAL LEVELS OF ORGANIZATION

- A. Organization is an outstanding characteristic of the body structure.
- B. The body is a unit constructed of the following smaller units:
 - a. **Cells** – smallest living structural units; organizations of various chemicals
 - b. **Tissues** – organizations of similar cells
 - c. **Organs** – organizations of different kinds of tissues
 - d. **Systems** – organizations of many different kinds of organs

ANATOMICAL POSITION

- A. Standing erect with the feet slightly apart and arms at the sides with palms turned forward.

ANATOMICAL DIRECTIONS

- A. **Superior** – toward the head, upper, above
- B. **Inferior** – toward the feet, lower, below
- C. **Anterior** – front, in front of, (same as ventral in humans)
- D. **Posterior** – back, in back of (same as dorsal in humans)
- E. **Medial** – toward the midline of a structure
- F. **Lateral** – away from the midline or toward the side of a structure
- G. **Proximal** – toward or nearest the trunk, or nearest the point of origin of a structure
- H. **Distal** – away from or farthest from the trunk, or farthest from a structure's point of origin
- I. **Superficial** – nearer the body surface
- J. **Deep** – farther away from the body surface

PLANES OR BODY SECTIONS

- A. **Sagittal plane** – lengthwise plane that divides a structure into right and left sections
- B. **Midsagittal** – sagittal plane that divides the body into two equal halves
- C. **Frontal (coronal) plane** – lengthwise plane that divides a structure into anterior and posterior sections
- D. **Transverse plane** – horizontal plane that divides a structure into upper and lower sections

BODY CAVITIES

- A. **Ventral Cavity**
 - a. **Thoracic cavity**
 - i. **Mediastinum** – midpoint of the thoracic cavity, heart and trachea located in the mediastinum
 - ii. **Pleural cavities** – right lung located in right pleural cavity, left lung in left pleural cavity
 - b. **Abdominal cavity**
 - i. **Abdominal cavity** contains stomach, intestines, liver, gallbladder, pancreas, and spleen

- ii. **Pelvic cavity** contains reproductive organs, urinary bladder, and lowest part of the intestine
 - iii. **Abdominopelvic regions**
 - 1. Nine regions
 - 2. Four quadrants
- B. Dorsal cavity**
- a. Cranial cavity contains the brain
 - b. Spinal cavity contains the spinal cord

BODY REGIONS

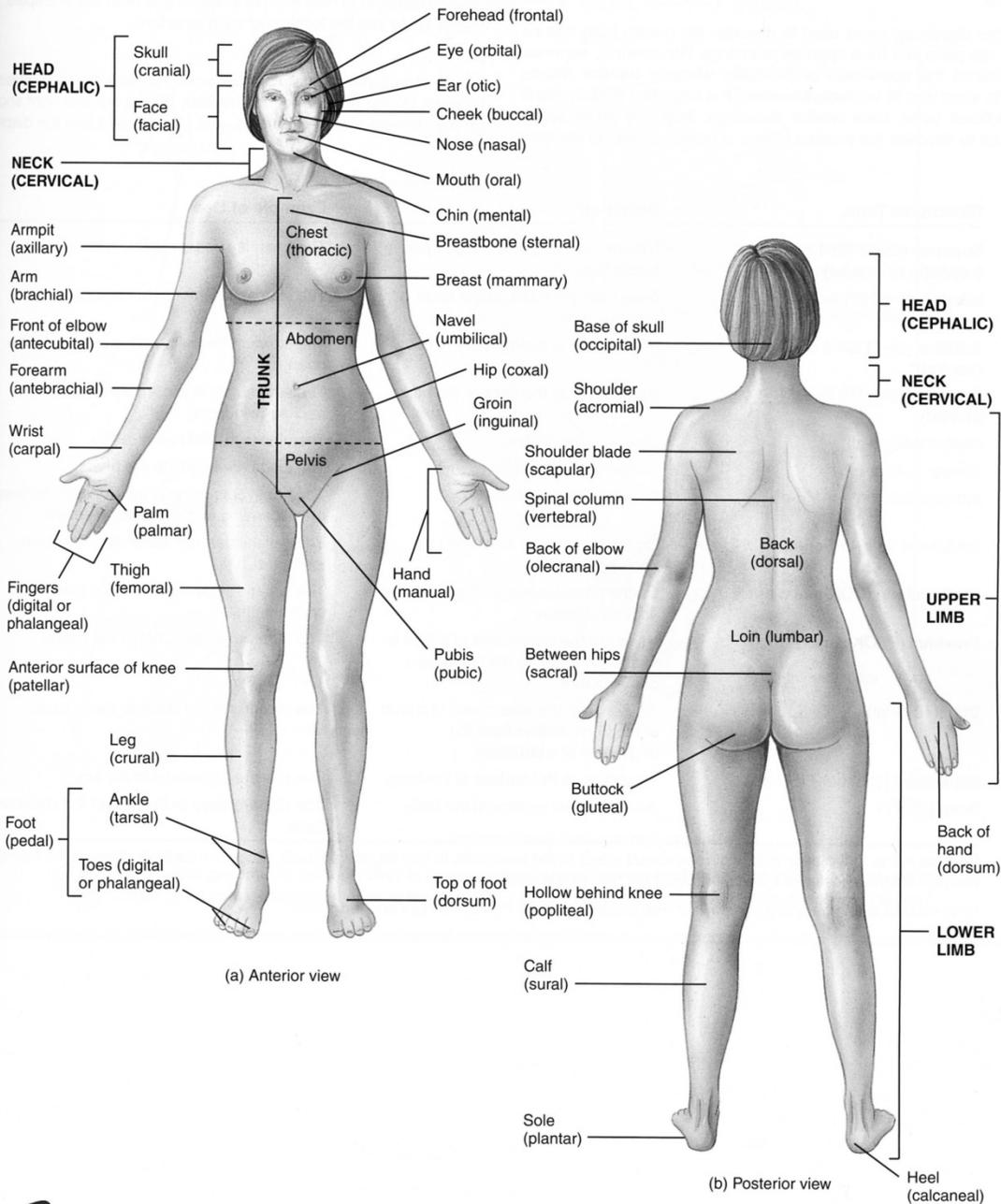
- A. **Axial region** – head, neck, and torso or trunk
- B. **Appendicular region** – upper and lower extremities

THE BALANCE OF BODY FUNCTIONS

- A. **Survival of the individual and of the genes** is the body's most important business
 - a. **Imperative 1: save yourself**
 - b. **Imperative**
- B. Survival depends on the maintenance or restoration of homeostasis (relative constancy of the internal environment) the body uses **negative feedback loops** and, less often, **positive feedback loops** to maintain or restore homeostasis.
- C. All organs function to maintain **homeostasis**
- D. Body functions are related to age; peak efficiency is during young adulthood, diminishing efficiency occurs after young adulthood

Figure 1.5 The anatomical position. The common names and corresponding anatomical terms (in parentheses) are indicated for specific body regions. For example, the head is the cephalic region.

In the anatomical position, the subject stands erect facing the observer with the head level and the eyes facing forward. The feet are flat on the floor and directed forward, and the arms are at the sides with the palms facing forward.



? What is the usefulness of defining one standard anatomical position?

An Introduction to the Structure and Function of the Body

section SYNOPSIS: In this section the student is introduced to the organizational composition of the body as it relates to the different levels of complexity. Although the body is considered a singular structure, it is made up of integrating atoms, molecules, cells, tissues, organs, and systems and remarkably, in most circumstances, is able to maintain a homeostatic balance necessary for survival.

LEARNING OBJECTIVES WITH RATIONALE

the student will be able to:

1. Define the terms anatomy and physiology.

Anatomy is the study of the structure of an organism and the relationship of its parts. Physiology is the study of the functions of living organisms and their parts.

2. List and discuss in order of increasing complexity the levels of organization of the body.

Levels of organization of the body include

- (1) chemical level (atoms and molecules),
- (2) cells (smallest “living” units),
- (3) tissues (groups of cells acting together),
- (4) organs (groups of tissues acting together),
- and (5) systems (groups of organs acting together).

3. Define the anatomical position.

In the anatomical position, the body is erect with arms at sides and palms forward. Head and feet are also pointing forward.

4. List and define the principal directional terms and sections (planes) used in describing the body and the relationship of body parts to one another.

- a. Directional terms

- (1) *Superior*—toward the head, upper, above
Inferior—toward the feet, lower, below
- (2) *Anterior*—front, in front of (same as ventral in humans)
Posterior—back, in back of (same as dorsal in humans)
- (3) *Medial*—toward the midline of a structure
Lateral—away from the midline or toward the side of a structure
- (4) *Proximal*—toward or nearest the trunk, or nearest the point of origin of a structure
Distal—away from or farthest from the trunk, or farthest from a structure’s point of origin
- (5) *Superficial*—nearer the body surface
Deep—farther away from the body surface

- b. Body planes

- (1) *Sagittal*—lengthwise plane running from front to back that divides the body into right and left sides
- (2) *Midsagittal*—sagittal plane that divides the body into two equal halves

- (3) *Frontal (coronal)*—lengthwise plane that divides a structure into anterior and posterior sections
- (4) *Transverse*—lengthwise plane running from side to side that divides the body into upper and lower portions

5. List the nine abdomino-pelvic regions and the four abdominopelvic quadrants.

a. The nine abdominopelvic regions include

- (1) right hypochondriac,
- (2) epigastric,
- (3) left hypochondriac,
- (4) right lumbar,
- (5) umbilical,
- (6) left lumbar,
- (7) right iliac,
- (8) hypogastric, and
- (9) left iliac regions.

b. The four abdominopelvic quadrants include

- (1) right upper or superior,
- (2) right lower or inferior,
- (3) left upper or superior,
- and (4) left lower or inferior.

6. List the major cavities of the body and the subdivisions found in each.

a. Ventral body cavity

- (1) Thoracic cavity
 - (a) Mediastinum
 - (b) Pleural cavities
- (2) Abdominopelvic cavity
 - (a) Abdominal cavity
 - (b) Pelvic cavity

b. Dorsal body cavity

- (1) Cranial cavity
- (2) Spinal cavity

7. Discuss and contrast the axial and the appendicular subdivisions of the body. Identify a number of specific anatomical regions in each area.

a. The axial portion of the body consists of the head, neck, and trunk. It is composed of thoracic, abdominal, and pelvic regions.

b. The appendicular portion of the body consists of the upper and lower extremities.

- (1) Upper extremities are composed of arm, forearm, wrist, and hand regions.
- (2) Lower extremities are composed of thigh, leg, ankle, and foot regions.

8. Explain the meaning of the term homeostasis and give an example of a typical homeostatic mechanism.

a. Homeostasis is relative consistency of the internal environment. It requires that chemical composition, volume, and other characteristics of blood and other body fluids remain constant within a narrow limit.

b. Example: Constant circulation of blood in the body allows for continuous removal of carbon dioxide produced by body cells.

LECTURE OUTLINE

I. STRUCTURAL LEVELS OF ORGANIZATION

- A. Organization is an outstanding characteristic of body structure
- B. The body is a unit constructed of the following smaller units:
 - 1. Cells—the smallest structural units; organizations of various chemicals
 - 2. Tissues—organizations of similar cells
 - 3. Organs—organizations of different kinds of tissues
 - 4. Systems—organizations of many different kinds of organs

II. ANATOMICAL POSITION —Standing erect with the arms at the sides and palms turned forward

III. ANATOMICAL DIRECTIONS - in pairs

- A. *Superior*—toward the head, upper, above
Inferior—toward the feet, lower, below
- B. *Anterior*—front, in front of (same as ventral in humans)
Posterior—back, in back of (same as dorsal in humans)
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IV. PLANES OR BODY SECTIONS (Figure 1-3)

- A. *Sagittal plane*—lengthwise plane that divides a structure into right and left sections
- B. *Midsagittal plane*—sagittal plane that divides the body into two equal halves
- C. *Frontal (coronal) plane*—lengthwise plane that divides a structure into anterior and posterior sections
- D. *Transverse plane*—horizontal plane that divides a structure into upper and lower sections

V. BODY CAVITIES

- A. Ventral cavity
 - 1. Thoracic cavity
 - a. Mediastinum—midportion of thoracic cavity; heart and trachea located in mediastinum
 - b. Pleural cavities—right lung located in right pleural cavity, left lung in left pleural cavity

2. Abdominopelvic cavity

a. Abdominal cavity contains stomach, intestines, liver, gallbladder, pancreas, and spleen

b. Pelvic cavity contains reproductive organs, urinary bladder, and lowest part of intestine

c. Abdominopelvic regions

(1) Nine regions

(2) Four quadrants

B. Dorsal cavity

1. Cranial cavity contains brain

2. Spinal cavity contains spinal cord

VI. BODY REGIONS (Figure 1-8)

A. Axial region—head, neck, and torso or trunk

B. Appendicular region—upper and lower extremities

VII. THE BALANCE OF BODY FUNCTIONS

A. Survival of the individual and of the genes is the body's most important business

B. Survival depends on the maintenance or restoration of homeostasis (relative constancy of the internal environment); the body uses negative feedback loops and, less often, positive feedback loops to maintain or restore homeostasis

C. All organs function to maintain homeostasis

D. Body functions are related to age; peak efficiency is during young adulthood, diminishing efficiency occurs after young adulthood

Review Questions

1. Define anatomy and physiology.

Answer: Anatomy is the study of the structure of an organism and the relationships of its parts. Physiology is the study of body function.

2. List and explain the levels of organization in a living thing.

Answer: (1) The chemical level of organization (see Appendix A) consists of atoms and molecules. The existence of life depends on the proper levels and proportions of many chemical substances in cells of the body and other living things.

(2) Cells are the smallest structural units.

(3) Tissues are an organization of many similar cells that act together to perform a common function.

(4) Organs are a group of several different kinds of tissues acting together to perform a special function.

(5) Systems are an organization of various kinds of organs arranged to perform complex functions of the body.

3. Describe the anatomical position.

Answer: Standing erect with the arms at the sides and palms turned forward.

4. Name and explain the three planes or sections of the body.

Answer: (1) Sagittal plane—a sagittal cut or section is a lengthwise plane running front to back. It divides the body or any of its parts into right and left sides. The sagittal plane divides the body into two equal halves. This unique type of sagittal plane is called a midsagittal plane. (2) Frontal plane (coronal)—divides a structure into anterior and posterior sections. (3) Transverse plane—a horizontal plane that divides a structure into upper and lower sections.

5. List two organs of the mediastinum, two organs of the abdominal cavity, and two organs of the pelvic cavity.

Answer: (1) Mediastinum—heart, trachea; (2) abdominal cavity—liver, stomach; (3) pelvic cavity—uterus, urinary bladder

6. From the upper left to the lower right, list the nine regions of the abdominopelvic cavity.

Answer: (1) left hypochondriac; (2) left lumbar; (3) left iliac; (4) epigastric; (5) umbilical; (6) hypogastric; (7) right hypochondriac; (8) right lumbar; (9) right iliac.

7. Name the two subdivisions of the dorsal cavity. What structures does each contain?

Answer: (1) The cranial cavity contains the brain. (2) The spinal cavity contains the spinal cord.

8. Explain the difference between the terms lower extremity, thigh, and leg.

Answer: Lower extremity refers to any of the lower limbs, including the hip, thigh, leg, ankle,

and foot. The thigh lies between the hip joint and the knee, and the leg is between the knee and the ankle.

9. List the four conditions in the cell that must be kept in homeostatic balance.

Answer: Temperature, salt content, acid level (pH), fluid volume and pressure, oxygen concentration, and other vital conditions must remain within acceptable limits.

10. List the three parts of a negative feedback loop and give the function of each.

Answer: The (a) sensor detects changes and feeds information to the (b) control center, which responds by initiating certain changes that are then sent to the (c) effector, which influences the controlled condition. Example: When you ride a bike, your eyes are the sensors, your brain is the control center, and your muscles are the effectors.

Critical Thinking Questions

11. Name a structure that is inferior to the heart, superior to the heart, anterior to the heart, posterior to the heart, and lateral to the heart.

Answer: Stomach, mandible, sternum, thoracic vertebrae, and arms.

12. The maintenance of body temperature and the birth of a baby are two functions that are regulated by feedback loops. Explain the different feedback loops that regulate each process.

Answer: A negative feedback loop operates to oppose, or negate, a change in a controlled condition. In maintaining body temperature, the nerve endings act as temperature sensors that feed information to a control center in the brain that compares actual body temperature to normal body temperature. In response to a chill, the brain sends nerve signals to the muscles, which then begin to shiver. Shivering produces heat that increases body temperature. Shivering stops when feedback tells the brain that the body temperature is normal. Positive feedback loops amplify or reinforce the change that is occurring until something stops the process. An example of a positive feedback loop is the events that cause rapid increases in uterine contractions before the birth of a baby.

13. If a person complained of pain in the epigastric region, what organs could be involved?

Answer: The liver and/or stomach.

CLASSROOM APPLICATION

The following questions can be used as individual assignments or for small-group discussion. Note: to copy the questions, cover the answers with a blank sheet of paper and print, thus leaving space for answers or note-taking.

1. You know that the respiratory system functions to move oxygen from the air into the bloodstream. Based on our discussion of homeostasis, you might also know that oxygen concentration in the blood is regulated homeostatically. For example, when muscle cells use more oxygen than normal during exercise, your rate of breathing increases in response. Can you explain this respiratory function using the terms sensor, control center, effector, controlled condition, and normal value?

Answer: Oxygen concentration in the blood is a controlled condition of the internal environment of the body. As cells use oxygen from the blood during exercise, the blood oxygen concentration decreases below the normal value. Sensors that detect this change must exist, and so must a control center that we assume at this point in our studies is in the brain. The control center causes us to breathe more rapidly, and thus the muscles that move the lungs act as effectors that return the controlled variable back to normal (raising the blood oxygen concentration back to its normal level).

2. In question 1, we saw that respiration rate increases when muscle cell activity increases. Yet this response is an example of negative feedback. Can you explain this response in terms of negative feedback? Hint: Review your answer to question 1. In negative feedback, something is reversed. What is it? The statement above regarding muscle cell activity is true, but misleading—can you see what is decreasing in this situation?

Answer: It is true that muscle cell activity is increasing, but it is more important to realize that the oxygen concentration in the blood, the real issue of importance here, is decreasing. Thus an increase in respiration reverses the direction of the decreasing blood oxygen concentration. This is a negative feedback situation because sensory feedback to the control center regarding changes in blood oxygen triggers a response by effectors that reverse the changes back toward the normal value.

3. What might happen if cell activity in the body slows to the point that the cells are using less than the normal amount of oxygen from the blood? Would there be a homeostatic response, or would breathing remain the same? Hint: Think in terms of the feedback loops. Don't worry about understanding the details of respiratory function—the answer lies in what you already know about homeostasis. Also, think about what happens to your respiration rate when you are resting.

Answer: It is reasonable to assume that using less oxygen would result in a decrease in blood oxygen concentration. Just as a decrease in blood oxygen level will trigger an increase in respiratory rate, an increase in blood oxygen will trigger a decrease in respiratory rate. You breathe more slowly than normal if you are very quiet and inactive, and breathe faster if you are more active than usual.

LAB ACTIVITIES

Using a human torso model or skeleton, locate major body cavities, planes, regions, and organs.

PRACTICAL/CREATIVE LEARNING ACTIVITIES

1. Place a mannequin (model of the human body) or clinical skeleton in correct anatomical position. Demonstrate correct anatomical position by standing erect.
2. Demonstrate and identify the different planes by cutting a piece of fruit into appropriate sections.
3. Discuss the importance of homeostasis as it relates to the body.
4. Make a drawing of the body and name the major organs found in each area.

5. Discuss the scientific method of approach to discovery. What is meant by a proposed hypothesis and explain the process of experimentation. Mention a few diseases that are being studied for possible cures.

AN INTRODUCTION TO THE STRUCTURE AND FUNCTION OF THE BODY

Define the following vocabulary words:

1. Anatomy _____

2. Physiology _____

3. Atrophy _____

4. Prone _____

5. Superior _____

6. Inferior _____

7. Anterior _____

8. Posterior _____

9. Ventral _____

10. Dorsal _____

11. Medial _____

12. Proximal _____

13. Distal _____

14. Effector loop _____

15. Experimentation _____

16. Hypothesis _____

17. Mediastinum _____

18. Negative feedback _____

19. Chemical _____

20. Positive feedback _____

21. List the nine abdominopelvic regions.

(1) _____

(2) _____

(3) _____

(4) _____

(5) _____

(6) _____

(7) _____

(8) _____

(9) _____

22. List the four abdomino-pelvic quadrants

(1) _____

(2) _____

(3) _____

(4) _____

Match the most appropriate term in Column B to each item in Column A. Write the letter in the blank provided. (Only one answer for each is correct.)

Column A Column B

___ 23. Ventral

A. Equal

___ 24. Skin

B. Cutaneous

___ 25. Transverse

C. Lung

___ 26. Anatomy

D. Extremities

___ 27. Superficial

E. Respiratory

___ 28. Pleural

F. Anterior

___ 29. Appendicular

G. Structure

- | | |
|---------------------|---------------|
| ___ 30. Posterior | H. Surface |
| ___ 31. Midsagittal | I. Back |
| ___ 32. System | J. Horizontal |

22. (Answers may be in any order.) (1) right upper or superior; (2) right lower or inferior; (3) left upper or superior; (4) left lower or inferior

Matching

23. E

24. B

25. J

26. G

27. H

28. C

29. D

30. I

31. A

32. E