Human Anatomy and Physiology 10th Edition Marieb Solutions Manual
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CHAPTER

1 The Human Body: An Orientation

1.1 What are anatomy and physiology, and how are they related?

Form (anatomy) determines function (physiology)

- Define anatomy and physiology and describe their subdivisions.
- Explain the principle of complementarity.

1.2 How is the body organized structurally?

The body's organization ranges from atoms to the entire organism

- Name the different levels of structural organization that make up the human body, and explain their relationships.
- List the 11 organ systems of the body, identify their components, and briefly explain the major function(s) of each system.

1.3 What are the requirements for life?

What are the requirements for life?

- List the functional characteristics necessary to maintain life in humans.
- List the survival needs of the body.

1.4 How does the body keep its internal environment in balance?

Homeostasis is maintained by negative feedback

- Define homeostasis and explain its significance.
- Describe how negative and positive feedback maintain body homeostasis.
- Describe the relationship between homeostatic imbalance and disease.

1.5 What terms do we need to describe anatomy?

Anatomical terms describe body directions, regions, and planes

- Describe the anatomical position.
- Use correct anatomical terms to describe body directions, regions, and body planes or sections.

1.6 Body cavities and membranes

Many internal organs lie in membrane-lined body cavities

- Locate and name the major body cavities and their subdivisions and associated membranes, and list the major organs contained within them.
- Name the four quadrants or nine regions of the abdominopelvic cavity and list the organs they contain.

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Suggested Lecture Outline

1.1 Form (anatomy) determines function (physiology) (pp. 21–23; Fig. 1.3)

A. Anatomy is the study of the structure of body parts and their relationships to each other, and physiology is the study of the function of body parts. (p. 21)

B. Topics of Anatomy (p. 22)

1. Gross (macroscopic) anatomy is the study of structures large enough to be seen with the naked eye.

a. Regional anatomy is the study of all body structures in a given body region.

b. Systemic anatomy is the study of all structures in a body system.

c. Surface anatomy is the study of internal body structures as they relate to the overlying skin.

2. Microscopic anatomy is the study of structures that are too small to be seen with the naked eye.

a. Cytology is the study of individual cells.

b. Histology is the study of tissues.

3. Developmental anatomy is the study of the change in body structures over the course of a lifetime; embryology focuses on development that occurs before birth.

4. Specialized Branches of Anatomy

a. Pathological anatomy is the study of structural changes associated with disease.

b. Radiographic anatomy is the study of internal structures using specialized visualization techniques.

c. Molecular biology is the study of biological molecules.

C. Topics of Physiology (pp. 22–23)

1. There are several subdivisions of physiology, most of which consider the function of specific organ systems, and often focus on cellular and molecular events.

D. Complementarity of Structure and Function (p. 23)

1. The principle of complementarity of structure and function is based on the fact that what a structure can do is related to its form.

1.2 The body's organization ranges from atoms to the entire organism (pp. 23–24; Fig. 1.1)

A. The chemical level is the simplest level of organization. (p. 23; Fig. 1.1)

1. Atoms, tiny building blocks of matter, combine to form molecules.

2. Molecules combine in specific ways to form organelles, which are the basic unit of living cells.

B. The cellular level is the smallest unit of life, and varies widely in size and shape according to the cells' function. (p. 23; Fig. 1.1)

C. The tissue level is groups of cells having a common function. (p. 23; Fig. 1.1)

D. The organ level is made up of discrete structures that are composed of at least two groups of tissues that work together to perform a specific function in the body. (p. 24; Fig. 1.1)

E. The organ system level is a group of organs that work closely together to accomplish a specific purpose (p. 24; Fig. 1.1).

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F. The organismal level is the total of all structures working together to promote life (p. 24; Fig. 1.1).

1.3 What are the requirements for life? (pp. 24–28; Figs. 1.2–3)

A. Necessary Life Functions (p. 25; Fig. 1.2)

1. Maintaining boundaries allows an organism to maintain separate internal and external environments or separate internal chemical environments.

2. Movement allows the organism to travel through the environment, and allows transport of molecules within the organism.

3. Responsiveness, or irritability, is the ability to detect changes in the internal or external environment and respond to them.

4. Digestion is the process of breaking down food into molecules that are usable by the body.

5. Metabolism includes all chemical reactions that occur in the body.

6. Excretion is the process of removing wastes.

7. Reproduction is the process of producing more cells or organisms.

8. Growth is an increase in size in body parts or the whole organism.

B. Survival Needs (p. 28)

1. Nutrients are consumed chemical substances that are used for energy and cell building.

2. Oxygen is required by the chemical reactions that release energy from foods.

3. Water, the most abundant chemical substance in the body, provides an environment for chemical reactions and a fluid medium for secretions and excretions.

4. Normal body temperature is required for the chemical reactions of the body to occur at the proper rate.

5. Atmospheric pressure must be within an appropriate range so that proper gas exchange occurs in the lungs.

1.4 Homeostasis is maintained by negative feedback (pp. 28–31; Figs. 1.4–1.6)

A. Homeostasis is the ability of the body to maintain a relatively constant internal environment, regardless of environmental changes (pp. 28–29).

B. Homeostatic Control (pp. 29–31; Figs. 1.4–1.6)

1. Homeostasis is controlled through communication systems involving various components:

a. The regulated factor or event is called the variable.

b. Receptors monitor changes in the environment and send some kind of signal to a control center.

c. The control center is a structure that determines the set point for a variable, analyzes input, and coordinates an appropriate response by signaling an effector.

d. An effector is a structure that carries out the response directed by the control center.

e. The response from the effector feeds back to either reduce or amplify the effect of the stimulus.

2. Negative Feedback Mechanisms

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a. Most homeostatic control mechanisms are negative feedback mechanisms that reduce or stop the effect of the stimulus, preventing severe changes within the body.

3. Positive Feedback Mechanisms

a. Positive feedback mechanisms enhance the effect of the stimulus, resulting in an amplifying effect of the stimulus, creating cascades that are used to control events that do not require continuous adjustment.

4. Homeostatic imbalances often result in disease.

1.5 Anatomical terms describe body directions, regions, and planes (pp. 31–37; Figs. 1.7–1.8; Table 1.1)

A. Anatomical Position and Directional Terms (pp. 32; Table 1.1)

1. Anatomical position is a position in which the body is erect, palms face forward, and thumbs point away from the body.

a. Anatomical position is always assumed, regardless of the actual body position and, in anatomical position, right and left refer to the right and left sides of the person viewed.

2. Directional terms are used to explain exactly where one body part is in relation to another.

B. Regional Terms (pp. 32–33,36; Fig. 1.7)

1. There are two fundamental divisions of the body: the axial region, consisting of the head, neck, and trunk, and the appendicular region, consisting of the appendages—the upper and lower limbs.

2. Regional terms designate specific areas within the axial and appendicular divisions.

C. Body Planes and Sections (p. 36; Fig. 1.8)

1. Body planes are flat surfaces that lie at right angles to each other.

a. Sagittal planes are vertical planes that separate the body into right and left parts.

i. A sagittal plane lying directly on the midline of the body is midsagittal, while any sagittal plane off the midline is parasagittal.

b. Frontal planes are vertical planes that separate the body into anterior and posterior parts.

c. Transverse, or horizontal, planes are planes that run horizontally from right to left, and divide the body into superior and inferior parts.

2. Sections are cuts made along or between specific planes, and are used to show different aspects of anatomy.

1.6 Many internal organs lie in membrane-lined body cavities (pp. 37–40; Figs. 1.9–1.12)

A. Body cavities are spaces within the body that are closed to the outside and protect the internal organs.

B. The dorsal body cavity is the space that houses the central nervous system, and has two subdivisions: the cranial cavity, which houses the brain, and the vertebral cavity, which houses the spinal cord.

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C. The ventral body cavity is anterior to and larger than the dorsal cavity and has two main subdivisions: the thoracic cavity and the abdominopelvic cavity. (pp. 38–39; Figs. 1.9–12)

1. The thoracic cavity is a superior division of the ventral cavity that is subdivided into the pleural cavities that surround each lung, and the medial mediastinum, which includes the pericardial cavity surrounding the heart, and other midline thoracic structures.

2. The abdominopelvic cavity is separated from the thoracic cavity by the diaphragm and consists of two regions: the superior abdominal region contains digestive structures, spleen, and other organs; and the inferior pelvic cavity contains urinary and reproductive structures, and the rectum.

3. Serous membranes within the ventral body cavity are double-layered membranes that cover the inner walls of the ventral cavity and the outer surfaces of organs.

a. Serous membranes within the ventral body cavity are double-layered membranes that cover the inner walls of the ventral cavity and the outer surfaces of organs.

b. The parietal serosa lines the body cavity walls and folds in on itself to form the visceral serosa, which covers the outer surfaces of organs.

c. Serous membranes secrete and are separated by a thin layer of lubrication fluid called serous fluid, which allows organs to slide without friction along cavity walls and between each other.

d. Serous membranes are named for the specific cavity or organs with which they are associated.

4. The abdominopelvic region is divided into either four quadrants or nine abdominopelvic regions (see p. 39 for a complete list of quadrants and regions).

a. The abdominopelvic region is divided into either four quadrants or nine abdominopelvic regions (see p. 39 for a complete list of quadrants and regions).

D. Other Body Cavities (p. 40)

1. There are several smaller body cavities, mostly in the head, and most open to the body exterior (see complete list on p. 40).

Cross References

Additional information on topics covered in Chapter 1 can be found in the chapters listed below.

1. Chapter 2: Basic chemical and physical principles

2. Chapter 3: Cellular level of structural organization

3. Chapter 4: Tissue level of structural organization

4. Chapter 16: Hormonal control as an example of feedback regulation

5. Chapter 22: Organs of the mediastinum

6. Chapter 23: Serous membranes of the abdominal cavity

7. Chapter 27: Example of positive feedback during the ovarian cycle

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Lecture Hints

1. The Internet provides a wealth of information on human anatomy and physiology. Throughout the semester, encourage students to spend some time looking at college websites and YouTube™ videos to help explain difficult concepts. Be sure to remind students to focus on reputable sites, such as those sponsored by colleges and universities or government agencies. Also keep in mind that some students may not be familiar with using online resources and may need assistance.
2. In order to illustrate the principle of complementarity of structure and function, ask the students to consider the relatively similar structure of the human arm and a bird wing. Then ask them to consider the functional constraints placed on the limbs by their form, as well as the adaptive value of each form. Manual dexterity versus flight is an excellent compare-and-contrast example.
3. Many students have a very poor concept of the dynamics of the human body and how it functions in the environment. Try to stress throughout this chapter the adaptive nature of the body and the interrelationship between environmental variables and system response.
4. The body organ systems are actually an artificial grouping of structures that work toward a common goal. Stress the interrelationship between organs and systems that make the body "work" as an entire unit.
5. At times, students might substitute the term *circulatory system* for *cardiovascular system*. Explain the difference and the relationship to the lymphatic system.
6. The role of negative and positive feedback systems in maintaining or disrupting homeostasis is basic to understanding many of the physiological processes covered throughout the text. Stress the importance of feedback systems throughout the course.
7. Students often equate the term *negative* in feedback systems to something disruptive. This misunderstanding is compounded by the term *positive* also used in feedback systems. Stress the differences and give an example; for example, describe how a thermostat controls house temperature.
8. To illustrate the different degrees of protection in the dorsal and ventral cavities, ask the questions:
   a. Why do you suppose that a dog instinctively curls up to protect its abdomen?
   b. Two people have rapidly growing tumors: one in the dorsal cavity, the other in the ventral. Which one would develop symptoms first?
9. To encourage understanding of structure/function relationships, ask students to comment on the relationship between muscle and bone, and between the respiratory and circulatory systems.

Activities/Demonstrations

1. Audiovisual materials are listed in the Multimedia in the Classroom and Lab section of this *Instructor Guide.* (p. 468)
2. Assume the anatomical position and ask why this particular position is important to the study of anatomy. Then relate that any position would be acceptable as long as it was the standard for anatomical description.

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3. Place a chair center stage. Ask a student to indicate how the chair would be cut in the different planes of section. The answer should include why the other options were not selected.
4. Have students identify body regions on themselves or a lab partner. Stress the usage of directional terms in describing their positions relative to each other.
5. Arrange for the class to attend an autopsy (after the material in Chapter 1 has been covered).
6. Use a balloon to illustrate the two layers of a serous membrane.
7. Use a torso model and/or dissected animal model to exhibit body cavities, organs, and system relationships.
8. Use the thermostat found in the classroom (or one found in a home) to illustrate how a negative feedback system works.

Critical Thinking/Discussion Topics

1. Discuss how our intercellular environment can be described as the "sea within us."
2. List several embryonic features that form early in the developmental stages but are "lost" or converted to entirely new structures, such as our "tail" (coccyx).
3. If an object were found on another planet that appeared to move and react to external stimuli, what other characteristics would be necessary to classify it as "alive" and why?
4. Contrast the type of imagery obtained with X-ray machines, CT scans, DSR scans, and ultrasonics.
5. What differences are there between a free-living, single-celled organism such as a paramecium and a single human cell such as a ciliated cell of the respiratory tract?

Library Research Topics

1. Research the historical development of anatomy and physiology.
2. Review the current definitions of death and life.
3. Develop a rationale for the chemical basis of stress and how it can affect homeostasis.
4. Explore the current research on aging and describe the effect of aging on the genetic material of the cell.

List of Figures and Tables

All of the figures in the main text are available in JPEG format, PPT, and labeled and unlabeled format on the Instructor Resource DVD. All of the figures and tables will also be available in Transparency Acetate format. For more information, go to www.pearsonhighered.com/educator.

Figure 1.1	Levels of structural organization.
Figure 1.2	Examples of interrelationships among body organ systems.
Figure 1.3	The body's organ systems and their major functions.

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Figure 1.4	Interactions among the elements of a homeostatic control system maintain stable internal conditions.
Figure 1.5	Body temperature is regulated by a negative feedback mechanism.
Figure 1.6	A positive feedback mechanism regulates formation of a platelet plug.
Figure 1.7	Regional terms used to designate specific body areas.
Figure 1.8	Planes of the body with corresponding magnetic resonance imaging (MRI) scans.
Figure 1.9	Dorsal and ventral body cavities and their subdivisions.
Figure 1.10	Serous membrane relationships.
Figure 1.11	The four abdominopelvic quadrants.
Figure 1.12	The nine abdominopelvic regions.
Table 1.1	Orientation and Directional Terms
A Closer Look	Medical Imaging: Illuminating the Body

Answers to End-of-Chapter Questions

Multiple-Choice and Matching Question answers appear in Appendix H of the main text.

Short Answer Essay Questions

11. Function (physiology) reflects structure (anatomy), structure will determine and/or influence function. (p. 22)

12. See Figure 1.3, which provides a summary of all the organ systems of the body.

13. Nutrients—the chemical substances used for energy and cell building; oxygen—used in the reactions that produce cellular energy; water—the liquid environment necessary for all chemical reactions; body temperature—to maintain the proper temperature for chemical reactions to proceed; and atmospheric pressure—to allow gas exchange to occur. (p. 28)

14. The body is erect, arms hanging at the sides, palms forward, and thumbs pointed away from the midline. (pp. 29–30)

15. Negative feedback mechanisms operate in the opposite direction to decrease the original stimulus and/or reduce its effects, thus returning the system back to normal. Examples include regulation of body temperature and blood sugar levels. (pp. 29–30)

Positive feedback mechanisms operate in the same direction to enhance the original stimulus such that the activity is accelerated. Examples include regulations of blood clotting and enhancement of labor contractions. (pp. 30–31)

16. At high altitudes, the atmospheric pressure is less than at lower levels resulting in a decrease in oxygen levels. The lower oxygen levels may be inadequate to support cellular metabolism. (p. 32)

17. Anatomical terms are precise words that have limited usage, which prevents confusion when describing the location of body parts. (p. 184)

18. **a.** arm—brachial
b. thigh—femoral
c. chest—thoracic

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d. fingers/toes—digits
e. anterior aspect of knee—patellar (p. 32)

19. The elbow's olecranal region is proximal (superior) and posterior (dorsal) to the palm. (pp. 32–33)

20. See Figures 1.11 and 1.12. The figures illustrate the regions and quadrants and list several organs for each.

Critical Thinking and Clinical Application Questions

1. The pleural space contains a small amount of fluid that acts as a lubricant, allowing the pleurae to slide smoothly over each other as the lungs expand and contract. Pleurisy is an inflammation of the pleura around the lungs. When inflammation occurs in the pleural space, the pleurae do not slide smoothly and this causes severe pain that is more directly transmitted by the parietal than the visceral pleura. (p. 38)

2. **a.** Blood was drawn from Harry's anterior elbow.
b. Harry took off his shirt to receive his injection.
c. Harry's bruise was on his buttock. (p. 33)

3. Childbirth is based on the increasing levels of oxytocin that cause the uterine contractions. Under positive feedback, oxytocin levels increase which results in increasingly strong contractions by the upper uterus that will ultimately result in the birth of the child. But this positive feedback needs numerous contraction cycles to overcome the muscular resistance to stretching in the lower uterus in order for the head to pass. (pp. 35–36)

4. This is an example of a negative feedback mechanism. The initial stimulus is the drop in blood calcium. This drop in blood calcium causes the release of PTH, which triggers bone to be broken down, thus releasing calcium into the blood and raising the blood calcium levels. The original downward trend of the calcium was stopped and reversed. (pp. 29–30)

5. Mr. Harvey will apply the splint to his wrist. (p. 32)

Suggested Readings

Bagaria, V., et al. "Use of Rapid Prototyping and Three-Dimensional Reconstruction Modeling in the Management of Complex Fractures." *European Journal of Radiology,* 80 (3) (Dec. 2011): 814–820.

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Gong, H., Peng, R., and Liu, Z. (2013). "Carbon nanotubes for biomedical imaging: the recent advances." *Advanced Drug Delivery Reviews, 65*(15), 1951–1963

Hazen, Robert. "What Is Life?" *New Scientist,* 192 (Nov. 2006): 46–51.

Rieke, Viola, and Kim Butts Pauly. "MR Thermometry." *Journal of Magnetic Resonance Imaging,* 27 (2) (Feb. 2008): 376–390.

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