

1: The Human Body: An Orientation

Objectives

An Overview of Anatomy and Physiology

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

Levels of Structural Organization

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

Maintaining Life

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

Homeostasis

7. Define homeostasis and explain its importance.
8. Describe how negative and positive feedback maintain body homeostasis.
9. Describe the relationship between homeostatic imbalance and disease.

The Language of Anatomy

10. Describe the anatomical position.
11. Use correct anatomical terminology to describe body directions, body regions, and body planes or sections.
12. Locate and name the major body cavities and their subdivisions and associated membranes, and list the major organs contained within them.
13. Name the four quadrants or nine regions of the abdominopelvic cavity and list the organs they contain.

Suggested Lecture Outline

I. An Overview of Anatomy and Physiology (pp. 2-3)

- 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. 2).
- B. Topics of Anatomy (p. 2)
 - 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.
 - 5. Essential tools for studying anatomy are the mastery of medical terminology and the development of keen observational skills.
- C. Topics of Physiology (pp. 2-3)
 - 1. Physiology has several topics, most of which consider the function of specific organ systems.
 - 2. Physiology often focuses on cellular and molecular events.
- D. Complementarity of Structure and Function (p. 3)
 - 1. The principle of complementarity of structure and function states that function is dependent on structure, and that the form of a structure relates to its function.

II. Levels of Structural Organization (p. 3; Figs. 1.1, 1.3)

- A. The chemical level is the simplest level of organization (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.
- C. The tissue level is groups of cells having a common function.
- 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.
- E. The organ system level is a group of organs that work closely together to accomplish a specific purpose (Fig. 1.3).
- F. The organismal level is the total of all structures working together to promote life.

III. Maintaining Life (pp. 4–8; Fig. 1.2)

- A. Necessary Life Functions (pp. 4–8; 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. 8)
 - 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.

IV. Homeostasis (pp. 8–11; Figs. 1.4–1.6)

- A. Homeostasis is the ability of the body to maintain a relatively constant internal environment, regardless of environmental changes (p. 8).
- B. Homeostatic Control Mechanisms (pp. 9–11; Figs. 1.4–1.6)
 - 1. Components
 - a. Variable: the regulated factor or event.
 - b. Receptor: structure that monitors changes in the environment and sends information to the control center.
 - c. Control center: structure that determines the set point for a variable, analyzes input, and coordinates an appropriate response.
 - d. Effector: structure that carries out the response directed by the control center.
 - 2. Negative Feedback Mechanisms
 - a. Most homeostatic control mechanisms are negative feedback mechanisms.
 - b. A negative feedback mechanism causes the variable to change in a way that opposes the initial change.
 - c. Both the nervous system and the endocrine system are important to the maintenance of homeostasis.

- d. The goal of negative feedback mechanisms is to prevent sudden, severe changes in the body.
3. Positive Feedback Mechanisms
 - a. A positive feedback mechanism causes the variable to change in the same direction as the original change, resulting in a greater deviation from the set point.
 - b. Positive feedback mechanisms typically activate events that are self-perpetuating.
 - c. Most positive feedback mechanisms are not related to the maintenance of homeostasis.
4. Homeostatic imbalance often results in disease.

V. *The Language of Anatomy (pp. 11-20; Figs. 1.7-1.12; Table 1.1)*

- A. Anatomical Position and Directional Terms (pp. 11-13; Fig. 1.7; 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. In anatomical position, right and left refer to the right and left sides of the person viewed.
 - b. In anatomy, anatomical position is always assumed, regardless of the actual position of the body.
 2. Directional terms are used to explain exactly where one body part is in relation to another.
- B. Regional Terms (p. 14; Fig. 1.7)
 1. There are two fundamental divisions of the body.
 - a. The axial region includes the head, neck, and trunk.
 - b. The appendicular region consists of the upper and lower limbs.
 2. Regional terms designate specific areas within the axial and appendicular divisions.
- C. Body Planes and Sections (p. 14; Fig. 1.8)
 1. Body planes are flat surfaces that lie at right angles to each other.
 - a. Sagittal plane: a vertical plane that separates the body into right and left parts.
 - i. Median, or midsagittal plane: lies exactly along the body's midline.
 - ii. Parasagittal plane: lies offset from the midline.
 - b. Frontal plane: a vertical plane that separates the body into anterior and posterior parts.
 - c. Transverse, or horizontal, plane: a plane that runs horizontally from right to left, and divides the body into superior and inferior parts.
 2. Sections are cuts made along specific planes.
 - a. Transverse section, or cross section, is a cut made along the transverse plane.
 - b. Oblique sections are cuts made at angles between the horizontal and vertical planes.
- D. Body Cavities and Membranes (pp. 14-20; Figs. 1.9-1.12)
 1. Body cavities are spaces within the body that are closed to the outside and contain the internal organs.
 2. The dorsal body cavity is the space that houses the central nervous system, and has two subdivisions: the cranial cavity and the vertebral cavity.

- a. The cranial cavity is within the skull, and houses the brain.
- b. The vertebral, or spinal, cavity is within the vertebral column, and houses the spinal cord.
3. 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.
 - a. The thoracic cavity is a superior division of the ventral cavity that is further subdivided into the lateral pleural cavities that surround the lungs.
 - b. The thoracic cavity also contains the medial mediastinum, which includes the pericardial cavity surrounding the heart and the space surrounding the other thoracic structures.
4. The ventral body cavity houses the body organs, or viscera.
5. Membranes in the Ventral Body Cavity
 - a. Serous membranes, or serosae, cover the inner walls of the ventral cavity and the outer surfaces of organs.
 - b. The parietal serosa lines the body cavity walls, and is named for the specific cavities it is associated with.
 - c. The visceral serosa covers the outer surfaces of organs, and is named for the specific organs it is associated with.
 - d. 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.
6. Abdominopelvic Regions and Quadrants
 - a. There are nine abdominopelvic regions used primarily by anatomists.
 - b. There are four quadrants used primarily by medical personnel.
7. Other Body Cavities
 - a. Oral and digestive cavities are continuous cavities that extend from the mouth through the digestive system to the anus.
 - b. The nasal cavity is within and posterior to the nose.
 - c. The orbital cavities house the eyes.
 - d. The middle ear cavities are within the skull just medial to the eardrums, and house the bones that transmit sound vibrations to the internal ears.
 - e. Synovial cavities are joint cavities lined with a lubricating fluid-secreting membrane associated with all movable joints.

Cross References

Additional information on the 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

Laboratory Correlations

1. Marieb, E. N., and S. J. Mitchell. *Human Anatomy & Physiology Laboratory Manual: Cat and Fetal Pig Versions*. Ninth Edition Updates. Benjamin Cummings, 2009.
Exercise 1: The Language of Anatomy
Exercise 2: Organ Systems Overview
2. Marieb, E. N., and S. J. Mitchell. *Human Anatomy & Physiology Laboratory Manual: Main Version*. Eighth Edition Update. Benjamin Cummings, 2009.
Exercise 1: The Language of Anatomy
Exercise 2: Organ Systems Overview

Lecture Hints

1. *The Incredible Human Machine* is an excellent videotape that offers an exciting overview of many physiological functions. With the help of sophisticated photographic techniques, the wonders of the body's internal world are revealed. The videotape is inexpensive and available from numerous vendors, including Carolina Biological Supply Company. Listed below are alternate methods for using the tape.
 - a. Show the entire video during lecture or lab (60 min.).
 - b. Show selected sections of video during an introductory lecture or lab.
 - c. Show selected sections as an introduction to each body system.
 - d. Place the videotape on reserve in the library or video center and have students view it on their own. This could be required or optional (if optional, encourage viewing by adding bonus points).
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 listed under Multimedia in the Classroom and Lab.
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.
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 Mars that appeared to move and react to external stimuli, what other characteristics would be necessary to classify it as “live” 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.

Multimedia in the Classroom and Lab

Online Resources for Students

*myA&P*TM

www.myaandp.com

The following shows the organization of the Chapter Guide page in myA&PTM. The Chapter Guide organizes all the chapter-specific online media resources for Chapter 1 in one convenient location, with e-book links to each section of the textbook. Students can also access A&P Flix animations, MP3 Tutor Sessions, Interactive Physiology® 10-System Suite, Practice Anatomy LabTM 2.0, PhysioExTM 8.0, and much more.

Objectives

Section 1.1 An Overview of Anatomy and Physiology (pp. 2-3)

Section 1.2 Levels of Structural Organization (pp. 3-4)

Section 1.3 Maintaining Life (pp. 4-8)

Memory Game: Major Systems of the Body

Section 1.4 Homeostasis (pp. 8-11)

MP3 Tutor Session: Homeostasis

Art Labeling: Interaction Among the Elements of a Homeostatic Control System (Fig. 1.4, p. 9)

Section 1.5 The Language of Anatomy (pp. 11-20)

Art Labeling: Regional Terms Used to Designate Specific Body Areas (Fig. 1.7a, p. 13)

Art Labeling: Regional Terms Used to Designate Specific Body Areas (Fig. 1.7b, p. 13)

Art Labeling: Dorsal and Ventral Body Cavities and Their Subdivisions (Fig. 1.9, p. 16)

Memory Game: Major Cavities of the Body

Chapter Summary

Crossword Puzzle 1.1

Crossword Puzzle 1.2

Web Links

Chapter Quizzes

Art Labeling Quiz

Matching Quiz

Multiple-Choice Quiz

True-False Quiz

Chapter Practice Test

Study Tools

Histology Atlas
myeBook
Flashcards
Glossary

CourseCompass™

Resources in the myA&P™ Chapter Guide are also available in the Chapter Contents section of the CourseCompass™. Students can also access A&P Flix animations, MP3 Tutor Sessions, Interactive Physiology® 10-System Suite, Practice Anatomy Lab™ 2.0, PhysioEx™ 8.0, and much more.

Media

See Guide to Audiovisual Resources in Appendix A for key to AV distributors.

Video

1. *Systems Working Together* (WNS; 15 min., 1993). Animation, X rays, motion pictures, and micrographs help explain the workings of the human body. Students learn that some organs belong to more than one system, and that all of the systems must work together to support all of their activities.
2. *The Incredible Human Machine* (CBS; 60 min., 1992). Sophisticated photographic techniques show the wonders of the body's internal world.
3. *The Universe Within* (PBS; 60 min., 1995). NOVA takes viewers on an incredible voyage into the microworld of the human body. Featuring 3-D computer animations and footage of microscopic events, this program follows the functions of the human muscular, immune, digestive, and reproductive systems. Interviews and footage showing four famous athletes in action demonstrate the links between internal functions and external physical performance and health.

Software

1. *A.D.A.M.® Interactive Anatomy® 4.0* (ADAM, BC; Win/Mac). Comprehensive, precise, and anatomically correct database of the human body gives the student an opportunity to explore human systems and structures within the context of the whole body.
2. *A.D.A.M.® MediaPro* (ADAM, BC; Win/Mac). Provides clinical illustrations for classroom curriculum and presentations. Contains more than 2000 images in JPEG format.
3. *Practice Anatomy Lab™ 2.0* (PAL) (BC; Win/Mac). An interactive, one-stop study and lab assessment tool that gives students 24/7 access to a rich array of anatomy lab specimens including human cadavers, anatomical models, histology slides, cat dissections, and fetal pig dissections. Each module includes a self-review with built-in audio pronunciation of key terms, as well as gradable practice quizzes and lab practical exams. The *PAL 2.0 Instructor Resource DVD* includes hundreds of editable images in PowerPoint® and JPEG format, and a customizable Test Bank of more than 1,800 questions.
4. *The Ultimate Human Body, Version 2.2* (AS; Win/Mac). A blend of illustrations, animation, and microphotographs make the complex systems of the human body accessible to students. A "Body Scanner" gives students an interactive, hands-on approach to learning as they examine a skeleton, view organs from multiple angles, and overlay any of the 10 body systems.
5. *WARD's Radiographic Anatomy: A Gallery of Images CD-ROM* (WNS; Windows). This CD contains an extensive collection of images ideal for college-level study. Includes X rays,

angiograms, CT scans, MRIs, and urograms. Each image is accompanied by descriptive text and identifying labels. The CD also includes a variety of testing methods.

Lecture Enhancement Material

To view thumbnails of all of the illustrations for Chapter 1, see Appendix B.

Transparencies Index/Instructor Resource DVD

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.
Figure 1.4	Interaction among the elements of a homeostatic control system.
Figure 1.5	Regulation of body temperature by a negative feedback mechanism.
Figure 1.6	Summary of the positive feedback mechanism regulating 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	A CT scan through the superior abdomen; a DSA image of the arteries that supply the heart; regions of beta-amyloid accumulation in a PET scan.

Answers to End-of-Chapter Questions

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

Short Answer Essay Questions

11. Because function (physiology) reflects structure, structure will determine and/or influence function. (p. 3)
12. See Fig. 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. 8)
14. It is the ability to maintain relatively stable internal conditions even in the face of continuous change in the outside world. (p. 8)
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. 9–10)

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. 10–11)

16. The anatomical position requires the body being erect, the arms hanging at the sides, the palms forward, the thumbs pointing away from the body, and the feet flat to the ground. It is necessary to use this standard position because most directional terms refer to the body in this position, regardless of its actual position. The use of anatomical terms saves a great deal of description and is less ambiguous. (p. 13)
17. A plane refers to an imaginary line, and a section refers to a cut along that imaginary line. (p. 14)
18.
 - a. arm—brachial
 - b. thigh—femoral
 - c. chest—thoracic
 - d. fingers/toes—digits
 - e. anterior aspect of knee—patellar (p. 13)
19. The elbow's olecranal region is proximal (superior) and posterior (dorsal) to the palm. (pp. 12–13)
20. See Figs. 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.
 - a. Parietal and/or visceral pleural membranes.
 - b. The membranes allow the organs to slide easily across the cavity walls and one another without friction.
 - c. The organs and membranes stick together and grate against one another, creating friction, heat, and pain. (pp. 16–17)
2.
 - a. anterior aspect of elbow
 - b. took off his shirt
 - c. buttock (p. 13)
3. Of the procedures listed, MRI would be the best choice because dense structures (e.g., the skull) do not impair the view with this technique, and it is best at producing a high-resolution view of soft tissues, particularly neural tissue. Furthermore, MRI can provide information about chemical conditions in a tissue. Thus, once the suspected tumor is localized, MRI can perform a “metabolic biopsy” to determine if it is cancerous . . . all of this without surgery. (pp. 18–19)
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 releasing calcium into the blood raising the blood calcium levels. The original downward trend of the calcium was stopped and reversed.
5. The carpal region is found at the wrist. (p. 13)

Suggested Readings

Hazen, Robert. “What Is life?” *New Scientist* 192 (Nov. 2006): 46–51.

- Lester, David S. and Olds, James L. "Biomedical Imaging: 2001 and Beyond." *The Anatomical Record* 265 (2001): 35-36.
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- Vella, Matt. "Using Nature as a Design Guide." *Business Week Online* (Feb. 2008):
http://www.businessweek.com/innovate/content/feb2008/id20080211_074559.htm.
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