CHAPTER

1 The Human Body

An Orientation

Chapter Summary

Chapter 1 introduces and establishes the framework upon which all the other chapters are built. This chapter provides the necessary terminology so that instructor and students are all "speaking the same language." Marieb begins by defining the key terms *anatomy* and *physiology*, and then continues to describe the ways in which these key terms are interrelated. It is important that students realize that structure determines function; moreover, the various body structures in their form are most efficient for the particular function that the structure performs. This concept will help them to master the more difficult material in future chapters. It is important to also emphasize to students that this course is similar to a language class in that new, unfamiliar terminology will be introduced; this course requires the students to learn a new medical language, so to speak. This language is a universal one shared by medical professionals across various specializations, and is one that the students will repeatedly "speak" in their future allied health careers.

Levels of hierarchical structural/anatomical organization in the body are presented next, beginning with the atomic building block level and progressing through to the highest level of organization, the human body. A brief overview of the various organ systems follows, with a focus on the ways in which all the organ systems are interconnected into a working whole. This concept is presented through the discussion of the eight necessary life functions, since it is important for students to understand that each of the organ systems has several functions, and that any given function (e.g., excretion) is actually carried out by several organ systems working together. The survival needs of the body to accomplish the necessary life functions are then discussed. Homeostasis, the ability of the organ systems to cohesively function to respond to the ever-changing environment is then introduced, as well as consequent disease states that occur when homeostasis cannot be achieved or resolved. Students appreciate the image of the dynamic body continually striving to maintain balance and equilibrium.

The final section of this chapter provides the basic terminology that will be used and expanded upon throughout the text. Instructors should emphasize anatomical position and the midline of the body as an axis point. To that end, directional terms referencing trunk attachment points, such as *proximal and distal*, or midline reference points, such as *medial and lateral*, are introduced. Regional terms are then discussed to address anterior and posterior body landmarks. Terminology for body sections and planes, as well as classification of body cavities and their respective components, round out the introduction of medical terminology.

Suggested Lecture Outline

I. An Overview of Anatomy and Physiology (pp. 1–2)

A. Anatomy (pp. 1-2)

B. Physiology (p. 2)

C. Relationship between Anatomy and Physiology (p. 2)

II. Levels of Structural Organization (pp. 2–7)

A. From Atoms to Organisms (pp. 2–3)

B. Organ System Overview (pp. 3–7)

1. Integumentary System

2. Skeletal System

3. Muscular System

4. Nervous System

5. Endocrine System

6. Cardiovascular System

7. Lymphatic System

8. Respiratory System

9. Digestive System

10. Urinary System

11. Reproductive System

III. Maintaining Life (pp. 7–12)

A. Necessary Life Functions (pp. 7–9)

1. Maintaining Boundaries

2. Movement

3. Responsiveness

4. Digestion

5. Metabolism

6. Excretion

7. Reproduction

8. Growth

B. Survival Needs (pp. 9, 12)

IV. Homeostasis (pp. 12–14)

A. Homeostatic Controls (pp. 12–13)

V. The Language of Anatomy (pp. 14–22)

A. Anatomical Position (p. 14)

B. Directional Terms (p. 14)

TEACHING TIP

Building a language of biology. Use commonly used words to help students decipher the meanings of anatomic terminology. For example, for hypergastric, break the word down to hyper (use a word like hyperactive to lead the students to understand hyper means "more than") and gastric (similarly use the term gastric bypass surgery, where the students will derive the word stomach). Have students make flash cards of commonly encountered A&P word roots, prefixes, and suffixes, then have students combine the word parts in different ways to create new terms. In discussing medical conditions, point out the use of these same word parts to form medical terms. Students are usually excited to see how quickly their vocabulary expands on their increasing knowledge of word parts.

MEDIA TIP

The Universe Within (PBS; 60 min., 1995). Using microphotography, NOVA presents the microworld of the human body.

C. Regional Terms (pp. 14, 16–17)
  1. Anterior Body Landmarks
  2. Posterior Body Landmarks

D. Body Planes and Sections (p. 17)

E. Body Cavities (pp. 18, 20–22)
  1. Dorsal Body Cavity
  2. Ventral Body Cavity
  3. Other Body Cavities

Key Terms

abdominal cavity
abdominopelvic cavity
anatomical position
anatomy
atoms
cardiovascular system
cells
control center
coronal section
cranial cavity
cross section
diaphragm
digestion
digestive system
dorsal body cavity
effector
endocrine system
excretion
frontal section
homeostasis
homeostatic imbalance
integumentary system
irritability
lymphatic system
median section
mediastinum
metabolism
midsagittal (median) section
movement
muscular system
negative feedback mechanisms
nervous system
organ
organ system
organism
pelvic cavity
physiology
plane
positive feedback mechanisms
receptor
reproduction
reproductive system
respiratory system
responsiveness (irritability)
sagittal section
skeletal system
spinal cavity
thoracic cavity
tissues
transverse section
urinary system
ventral body cavity

Directional Terms

Anterior (ventral)
Deep (internal)
Distal
Inferior (caudal)
Intermediate
Lateral
Medial
Posterior (dorsal)
Proximal
Superficial (external)
Superior (cranial or cephalad)

Anterior Body Landmarks

Abdominal
Acromial
Antebrachial
Antecubital
Axillary
Brachial
Buccal
Carpal
Cervical
Coxal
Crural
Deltoid
Digital
Femoral
Fibular
Frontal
Inguinal
Nasal
Oral
Orbital
Patellar
Pelvic
Pubic
Sternal
Tarsal
Thoracic
Umbilical

Posterior Body Landmarks

Calcaneal
Cephalic
Femoral
Gluteal
Lumbar
Occipital
Olecranal
Popliteal
Sacral
Scapular
Sural
Vertebral

Abdominopelvic Regions

Epigastric Region
Hypogastric (Pubic) Region
Left Hypochondriac Region
Left Iliac (Inguinal) Region
Left Lumbar Region
Right Hypochondriac Region
Right Iliac (Inguinal) Region
Right Lumbar Region
Umbilical Region

Other Body Cavities

Middle Ear Cavities
Nasal Cavity
Oral and Digestive Cavities
Orbital Cavities

Resources for Teaching Online

Discussion Board Topic: Homeostatic Imbalance – Physical Trauma

In the textbook on p. 20, the Homeostatic Imbalance section explains that organs within the abdominal cavity are most vulnerable to physical trauma. Engage your students by using the following discussion questions in lecture or by posting them to the discussion board on your course management system.

Discussion Questions

1. The textbook cites automobile accidents as a common cause of abdominopelvic injury. What are some other frequent causes of injury in the abdominopelvic area?
2. CT scans are used commonly in emergency rooms when a patient needs to be assessed for the level of trauma to the abdominopelvic area. Why do they do this? What other ways do emergency rooms assess the level of damage in the abdominopelvic area?
3. Which organs are injured most frequently? What is the impact to body functioning?

Investigate Online

Take learning a step further by searching for relevant research articles on the web. Visit science websites, such as those listed below, and begin by searching for key terms such as *accident and trauma*, *abdominal cavity*, and *abdominopelvic organs, solid organ injury* and see how what you're learning in the course applies to science and medicine today.

http://www.sciencedaily.com/
http://www.scientificamerican.com/
http://www.the-scientist.com/
http://www.pubmed.org/

Potential student responses to discussion questions:

1. Examples: stabbing, contact sports injuries (football, basketball, hockey, boxing, etc.), consequence of rib fractures, falls leading to pelvic fractures, bicycle riding injuries
2. CT scans are used to visualize the abdominopelvic region when the patient is clinically unstable, exhibits tenderness in the area, or has signs of trauma in the area. Other methods used are laparotomy, angiography, ultrasonography
3. Spleen and kidney. Hemorrhaging, contamination of abdominopelvic areas of injury with contents of the GI or urinary system tracts

Lecture Hints

1. To illustrate the basic concept of anatomy = structure and physiology = function, micrographs or models of organs or various cells of the body can be shown. An effective organ system to use as illustrations for structure for function is the respiratory system, where structures such as the nasal passages and trachea are specialized for conduction of air, and structural characteristics to aid respiratory function can continue to be described down to the level of the alveoli. An example at the microscopic level is the red blood cell, with emphasis on how the anatomy of the cell with its increased surface area is efficient in carrying oxygen. Other cells such as macrophages that look and function similar to amoebas, as well as neurons that have extensive processes to facilitate cellular communication can also be used as examples.

   Key point: Physiology or function, is dependent on anatomy. Use the analogy that the body is really a well-designed machine for optimal function of life processes. A slight change in anatomy, for example from a condition like sickle cell anemia, can have a significant effect on physiology.

2. Discuss the differences between microscopic and macroscopic (gross) anatomy, where microscopic is at the level of cells and tissues, while macroscopic is at the organ level. Reference the relevance to such specialties as pathology and microbiology.

   Key point: Point out to students that dissection is aimed at helping us to understand the functions of each of the various levels of organization, but that the body works as a whole and is consequently more complex than the simple sum of its component parts.

3. Starting with the concept of atoms joining to form molecules, have the students "build" a single organ system that then combines with other organs to form the living body.

   Key point: Every level of the system relies on the smooth workings of the level preceding it, and a malfunction at any level may have life-threatening consequences to the levels built upon it.

4. Discuss each of the fundamental life functions (e.g., digestion, metabolism) and have the students list all of the organ systems that contribute to this single function.

   Key point: It is important for students to understand that organ systems often have an obvious, primary function, but that all the systems are closely interrelated and impact one another in numerous ways, including ways not yet identified.

5. Ask the students to describe the physiological effects of being outside for an extended period of time on a hot, summer day (sweating, feeling thirsty), and compare that to being outside on a cold, winter day (shivering). Outline the ways in which the body compensates for such variations in temperature and identify these mechanisms as homeostasis at work.

   Key point: Point out to students that the body is still in a constant state of flux, balancing between a range of "normal" values that is rarely static.

6. A simple, clear method of demonstrating negative feedback is to discuss the thermostat in the classroom. Students can easily understand the negative feedback system of the HVAC system at work.

   Key point: Negative feedback loops are the chief regulators of homeostasis under normal healthy conditions. A rise in any given value (e.g., blood pH, heart rate, blood pressure) precipitates a reaction to lower it, until such time as it becomes too low, causing negative feedback to initiate responses to raise it again.

7. Positive feedback is more difficult to understand than negative feedback. An effective example is to set up a domino cascade, where one domino hits two dominoes that each in turn hit two more dominoes, etc.

   Key point: Negative feedback loops are more commonly used in homeostasis in the body rather than positive feedback loops. Nevertheless, positive feedback mechanisms are equally important for maintaining homeostasis. Some examples include childbirth, blood clotting, and hormone cascades (CRH to ACTH to cortisol secretion, for instance) , which involve an ever-increasing buildup of responses that trigger the next response until they bring about the culmination of a major event. Like a nuclear reaction, positive feedback involves a series of chain reactions of ever-increasing magnitude.

8. Directional terms are best presented as opposites, with appropriate demonstrations for each. For example, anterior is easily distinguished from posterior, superior from inferior, etc. The most difficult set to distinguish seems to be proximal and distal. Use a set of examples that demonstrate their relationship, such as elbow to wrist (the elbow is

proximal in this instance) compared with elbow to shoulder (the elbow is *distal* in this instance), to help clarify the concept.

Key point: It is important for students to understand that proximal and distal terminology is used *relative to the midline of the body*.

9. Point out to students how the terms ventral (anterior)/dorsal (posterior) and superior/inferior refer to different areas for bipeds and quadrupeds. In particular for ventral/dorsal, relate the dorsal fin of the shark. Show also the similarity of embryonic forms of various animals versus human to emphasize the derivation of this terminology. Also point out that words are often combined to more accurately identify the relative position of a single structure.

   Key point: Just as more than one adjective can be used to describe a single noun, so can more than one directional term be used to describe a single structure.

10. Emphasize that the language of anatomy is often redundant and that multiple terms exist for structures or events. These terms come from tradition (national origin, the discoverer, etc.) or were named in a more practical fashion, based on structure or function. Often both structural and functional names are given. Make sure students realize that it is difficult to master all of these terms quickly, and it can be frustrating as well, but that they can learn them more completely with experience.

    Key point: Science has its own language, as complex as English or any other language, and it takes time and concentrated effort to master.

11. Provide students with opportunities to verbalize material and use appropriate terminology that you have covered in your lecture. The unfamiliar terms students are introduced to will have more meaning if they pronounce them out loud. Encourage students to study verbally while practicing vocabulary and explaining concepts. Encourage students to explain processes or mechanisms in their own words whenever possible.

    Key point: As with any new language, practice is the key to development and long-term retention.

12. Have students use sticky notes with regional and directional terminology and put them on a classmate in class, or a friend or family member during their studies at home, and then use the book to double check placement of terms. Have them take photographs and turn in as an assignment.

    Key point: Devise fun and creative exercises that will make the terminology more relevant and less intimidating to tackle.

13. Most people correctly visualize a space when they hear the term cavity. Most body cavities, however, are potential spaces and are filled with viscera, tissues, and fluids. In addition to the dorsal body cavity and the ventral body cavity, mention other cavities such as the oral cavity, the nasal cavity, and the pericardial cavity.

    Key point: Explain that *potential space* is a space that exists, but that it may be filled, such as the abdominal cavity is filled with organs; an uninflated balloon also has a potential space that can be filled with air or fluid.

Classroom Demonstrations and Student Activities

Classroom Demonstrations

Classroom Demonstrations

1. Dissect a freshly killed rat or a small preserved animal (e.g., a fetal pig) to demonstrate the various organ systems of the body. Point out at least two organs from each organ system and discuss their function. If dissection is not an option, there are several films that can be substituted (see Media section). In addition, Carolina Biological Supply Company offers plastinated dissected specimens and preserved dissected specimens that are mounted in clear acrylic containers.
2. Use a dissectible human torso model to point out the dorsal and ventral body cavities and the organs in each cavity.
3. Use a skeleton and human torso to show directional terms. With a dissectible human torso model, first have students point out for example, an organ that is superior to the liver. Then once students are familiar with the gross anatomy, the various organs can be laid out on a table except for one, such as the liver, and students can be asked to pick up an organ (or even all organs) superior to the liver and replace within the model.
4. Demonstrate various pulse points, some of which the students will already be familiar with. Relating these pulse points to regional terminology will help the students understand their usage.
5. Arrange for the class to attend an autopsy or take a tour of the anatomy lab at the local medical school (preferably after the material of Chapter 1 has been covered).
6. Thin, plastinated sections of the human body can be purchased from Carolina Biological Supply Company and can be viewed with the naked eye. Using the 3-D overhead (ELMO) with figures from the text that can be drawn on is also effective.
7. Bring in a two-arm balance and demonstrate with weights how negative feedback works to maintain homeostasis or "balance." Positive feedback can also be demonstrated with the balance. If a two-arm balance is not readily available, create a simple balance using a stick, string, and weighing boats.
8. Create emergency room scenarios using terminology from Chapter 1. Have the students determine the location of the illness or injury. Also extend the exercise by relating to homeostatic feedback mechanisms.

Student Activities

1. Have students stand and assume the anatomical position. Ask the students to comment on how that position differs from the "usual" standing position and to explain why knowing this position is important to precisely identify anatomical terms and physiological processes.
2. Remove all the organs from the ventral and dorsal body cavities of a human torso model. Ask for volunteers or assign students to return them to their proper anatomical location. As each organ is properly repositioned, have other students call out its name and organ system relationship.
3. Place a human torso model at center stage. Ask for a volunteer to come up and show how the torso model would be cut along the sagittal, frontal, and transverse planes. Have

students come up with medical situations where visualizations along each respective plane would elucidate diagnosis or function of specific organs/areas.

4. To initiate a class discussion on the relative degree of protection of organs in the dorsal versus the ventral body cavity, ask the class a question such as, "Why do you think a dog instinctively curls over and protects its abdomen when that body region is approached (threatened by a blow, etc.) even playfully?" or "Two people have rapidly growing tumors. The tumor is in the dorsal cavity in one of these individuals and in the ventral cavity of the other. Which of these people will develop symptoms first, and why?"
5. Call out anatomical terms (buccal, femoral, etc.) and have the students (as a group) point out the named regions on their own bodies.
6. Have students find a series of landmarks on their own bodies, providing a list of landmarks for the students to locate. Use real-life examples to help the students better understand the terminology. For example, the list could include items such as "the location where a necktie is worn," "the location of a belly button piercing," and so on. Have the students do this in small groups so they can discuss the terms with each other and begin to develop camaraderie among the group.
7. Have students devise a crossword puzzle or a "Jeopardy" style game with the various landmarks and their descriptions.
8. Demonstrate the location of the radial, brachial, carotid, femoral, popliteal, and pedal pulses. Have students try to locate several pulse points on themselves and their fellow students.
9. Have students get into groups of four or five. List five root words on the board and have the student groups come up with as many terms as they can think of that incorporate those roots. The terms can be common English, biological, or medical in nature, as long as a root word is found in each. Allow them 15 minutes to compile their lists, then compare the terms of the various groups. Point out their increased vocabulary based on the knowledge of a relatively small number of roots.
10. To help the students understand negative feedback, ask them to explain how scratching an itch can be considered an example of negative feedback. Some students may be familiar with a TENS Unit which provides pain relief by continual electrical "scratching of an itch."
11. To encourage an understanding of organ system interrelationships, ask the students to comment on the functional relationships between muscles and bones, and between the respiratory and cardiovascular systems.
12. Use a simple battery-operated clock as an example to indicate the importance of relatively constant conditions on optimal functioning of any system. Ask the class to indicate what would happen if it was (a) immersed in water, (b) hit with a hammer, (c) heated until it was red-hot, and (d) had its battery removed. Then ask them what conditions would be best suited for the clock to operate properly, and ask them to provide a single term that describes those conditions (homeostasis).
13. Have students go up to the board and create a hierarchy chart: first listing the essential survival needs to sustain life, and then listing which necessary life functions are needed to carry out each survival need, and finally what organ systems are involved to carry out the necessary life functions.

14. Student assignment for class discussion: Bring in an article from a popular magazine or newspaper describing an environmental problem(s), such as toxic waste disposal, pollution of the ocean, etc., that threatens their homeostasis, even survival. Be prepared to describe the problem and how it represents a threat to the body.
15. Discuss the changes in medical technology that have occurred over the lifetime of the students in your class. Have them speculate on what new technologies could emerge in the next decade, or even in the next century.

MultiMedia

See page 156 for a listing of media distributors.

1. *Homeostasis* (FHS: 20 min., 1995, DVD, 3-year streaming webcast). From *The New Living Body* series, live-action video, advanced imaging technology, and 3-D computer graphics show homeostatic mechanisms in the human body at work during a marathon.
2. *Human Biology* (FHS: 58 min., 1995, VHS, DVD). Twenty-one live-action video sequences provide an overview of human biology.
3. *Human Body: The Ultimate Machine* (CBS: 27 min., 2005, DVD). The body's major systems are described through footage of surgical procedures, microphotography, and 3-D animation.
4. *Introduction to the Body: Landscapes and Interiors* (FHS: 28 min., 1984, VHS, DVD, 3-year streaming webcast). Introduction to the award-winning *The Living Body* series that shows the body's adaptability to diverse climates and other homeostatic triggers.

Software

1. *A.D.A.M.® Interactive Anatomy 4.0* (AIA: CD-ROM, DVD). Classic comprehensive database of the human body.
2. *Essentials of Interactive Physiology®* (BC: CD-ROM). Educational package with CD-ROM modules to help students learn the difficult concepts of physiology.

