Instructor's Guide for Essentials of Anatomy and Physiology

Eighth Edition

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INTRODUCTION

Dear Colleagues,

Tina joins me in thanking you for adopting our eighth edition of *Essentials of Anatomy and Physiology*, and we hope it will meet your expectations. To those of you who are using our book for the first time, welcome, and we certainly hope to please you with our text, and with the Workbook for your students. As always, this Instructor's Guide is intended primarily for new teachers. If you are just beginning your teaching career, my hope is that this guide will help you to make the best possible use of our textbook and enable you to use your time in the most productive way, to the benefit of both you and your students.

There is no "one way" to teach an introductory anatomy and physiology course; the ways are as varied as the teachers, schools, and programs. Some of you will have two semesters for your course, some only one semester, while others may have to integrate the material in another course. *Essentials of Anatomy and Physiology* is an introductory book, comprehensive yet not overwhelming in its presentation of the scientific information necessary for a first course. For students hoping to enter the health professions, this scientific material will be the basis for future courses of a more clinical nature. The book is very flexible, and its chapters and sections of chapters may be used in a variety of ways to meet the needs of your course.

Each chapter in this Instructor's Guide is organized as follows:

New to This Edition—This section may be helpful to those of you who have used *Essentials* before; it lists new or modified illustrations and factual material that has been added or changed significantly or that has been moved from its place in the previous edition. In the 8th edition, for example, Boxes have been added for brief presentations of specific human microbiomes and the gene-editing tool CRISPR/Cas9 (with an illustration), a clarification of meiosis as it relates to oogenesis has been added to chapter 20, and there are several more illustrated For Further Thought questions.

Chapter Organization and Content—The content of the chapter is described in detail (and follows the sequence of headings in the Chapter Outline in the textbook), with references to the appropriate figures and tables and to the boxes that describe pathophysiology or other clinically related material.

Although a textbook must include all of the aspects that are pertinent to a particular subject, such as an organ system, individual teachers may choose not to include certain of these topics. This section also describes how to use the flexibility of the textbook to bypass the more detailed aspects of a topic, such as chemistry, without losing the flow of the chapter as a whole. For some topics, such as the sliding filament mechanism of muscle contraction in Chapter 7, a way to summarize the section simply is given. For Chapter 2, a six-part summary is given for those who do not have the time for chemistry as a separate topic.

Topics for Research or Class Discussion—This section contains some suggestions for topics that may be of interest to students. Some of them may require a bit of input on the part of the teacher; others may require some research on the part of the students. A project for a good student in need of a challenge might be to create a 5-minute oral presentation on the ABCDs of melanoma or on selected food additives.

These are not meant to be "extra credit" opportunities for students who are struggling (in my classes there is no such thing as extra credit, except for bonus questions at the end of an exam, which everyone may try). Students who are doing poorly must concentrate on the basics and may need a reminder of that.

As you will see, the For Further Thought questions are also intended for class discussion.

Answers to Review Questions in the Textbook—Each question is answered thoroughly in this section. These questions are comprehensive of material in the chapter and are intended to be used for homework or as a guide to studying. (We hope you will consider having your students use the Student Workbook that accompanies the text, because it is even more comprehensive and provides a variety of question formats and different ways to study the chapter material.) These review questions are also the basis for the organization of the three computerized test banks (to be described later).

Answers to For Further Thought Questions in the Textbook—Our textbook is an introductory science book and is most often used during the students' first term or semester. Because the students are just beginning, they do not yet have the foundation to answer complex "critical thinking" questions, such as those found in textbooks for more advanced courses. Despite that, and though memorization is important for some things, we do want our students to think. As you will see as you go through the chapters, the questions in this section require various kinds of thinking: thought-gathering thinking, recall-from-previous-chapters thinking, making-mental-pictures thinking, and even common sense and "I knew that when I was eight" thinking. Some questions, especially those in the first chapters, are quite simple, while others are more demanding.

These questions usually do not involve hospital or clinical situations (as do some of the simple Clinical Applications questions in the Student Workbook), because students have little or no clinical experience at this time. Nor are all students who use this book nursing students. These questions have as their focus basic physiology and anatomy.

My own feeling is that any thinking my students do can be good thinking, and that successful thinking of any kind engenders an increased willingness to try to think again. Success begets confidence, and so many of our students need confidence. Too often I see students who do not trust themselves to think, who are terribly afraid of being wrong. That will not do. So yes, there is much to memorize, but any chance I have to make my students think, and think successfully, I try to take.

I do not assign these questions as written work (though some may be adapted for use on exams); rather, I use them in the last 5 minutes of a class for a group answer. This method has several advantages: Anyone and everyone may contribute. Students are able to hear themselves think and to hear their peers think. If there are steps in the thinking, they will hear the steps and not simply leap around hoping to land on the right answer with a guess.

Another advantage is that wrong answers do not matter in that they do not affect a student's grade (an unfortunately constant concern for some). A wrong answer? Not a problem, and sometimes wrong answers lead to right ones. Students are able to hear this—that we may take a wrong answer (no points off, no penalty for anyone), figure out just why it is wrong, and keep on going to the right answer. This is how science works, how research works, how diagnoses are made; this is how we live and solve problems, whether at home or at work.

Of great importance to me is the collaborative effort. We are not in a hurry and have time to listen to anyone who wishes to contribute. There is an undeniable aspect of teamwork to answering the question, which reflects "the real world" that students do not believe exists in school. But it does, and here it is: We work together to answer the question, just as we would work together in a hospital, clinic, doctor's office, or public health setting.

I have tried to make my answers as thorough as possible. These are questions I have used, some of them for many years, and I have tried to be complete while giving them to you. For some of the questions in the later chapters, students may need a bit of help to get started, and I have provided the questions I use to get them heading in the right direction. You know your students and will find your own questions as well; you will know when they need a little help. I hope that you will not think these later questions (such as on acid–base balance) too difficult. I try not to overestimate my students' abilities, but I especially try never to underestimate them.

In some cases I suggest ways to take the question further. It has been my experience that when students are successful, they are pleased with themselves and open to trying a little more. These questions are intended to be answered successfully by the class, and some students may even be eager to be asked to think a little more, eager to show us what they are capable of doing. Of course, some students will not like these questions, but as teachers we are certainly well aware that we cannot please everyone. My hope is that you will find at least a few of the questions in each chapter useful to provoke thinking in your classes and perhaps with some of them even have a little fun. You may find yourself, as I have, a bystander while students talk among themselves and get to the answer. And then the best part—when they do not need me to tell them that they are right.

Every chapter has at least one illustrated question. These are often meant to be part of the material of the chapter, and you may refer the students to them whenever you complete the relevant material in the chapter. Chapter 10, for example, has a graph depicting blood hormone levels in positive and negative feedback mechanisms. It's a very simple picture, but it provides what I like to call "a visual for the verbal" in that it reinforces a discussion in the text by asking for a little effort from the students. Chapter 17 has a diagram that depicts the regulation of body temperature. For those of you who do not cover body temperature as a separate topic, this question can be used along with Chapter 5 (the Integumentary System, and there is a reminder to that effect in this Guide for Chapter 5).

Ancillaries—In addition to this Instructor's Guide, other ancillaries are available to adopters for use with this eighth edition of our textbook. They may be accessed on the F.A. Davis website; your Davis sales representative can be of assistance.

Computer Test Banks—Many of you make up your own exams, with questions in many formats, and have no need of test banks, but three are provided for those who wish to make use of them. Each chapter test bank has questions in three formats: Multiple choice, fill in the blank, and multiple-selection. Each group of questions is based on the end-of-chapter Review Questions in the textbook, which in turn are based on the student objectives. There is a subset of questions for each Review Question *and related material*, whenever such material is not covered by another question. Every question in each of the three formats is followed by the number of the Review Question on which it is based.

Multiple-Choice Tests—The questions vary from simple ones with short choices for answers, to more demanding ones with longer choices for answers, and finally to summary questions on a particular topic that require the students to read carefully and evaluate quite a bit of information in the four statements given as choices. My intent was to provide a variety of questions that could be used for quizzes, chapter tests, or final exams. For example, for Chapter 8 there are 18 questions concerning parts of the brain, Review Question 9. Most ask about one part at a time and would be suitable for a quiz or chapter test. The last three of these questions are summary questions in that each asks about four parts of the brain; such questions may be more useful in a final exam that may cover several organ systems.

Often there are variations of the same question—different ways of asking for the same information. For example, also for Chapter 8, there are two ways of finding out if the students know what sensory neurons are and what motor neurons are. For Chapter 3, there are questions that have the cell organelle as the answer followed by questions that have the function of the cell organelle as the answer. The same facts are covered but asked about in a different way. These questions may be useful if you have several class sections, to vary the exams yet keep them on the same level of difficulty and content covered, or to vary your tests from year to year. Whenever possible, I have tried to provide such variations.

Fill-in-the-Blank Tests—The questions are just that: fill-in statements. Any such question may be "turned around" to provide a variation; that is, the answer may be put into the statement and another word in the statement left out to become the answer. Some questions will have one blank, others will have two or even three blanks, and still others will combine two or three of the one-blank questions. The simpler ones may be used for quizzes perhaps; the more complex ones may be suitable for major exams. I have done quite a few of these, but you will know the variations that best meet your needs.

Multiple-Selection Tests—These are also called multiple-response or group multiple-choice tests. Each "question" is the same: Which of the following statements are true of _____? The student is to select all of the correct answers. I like this format and first began to use it in my Microbiology classes because a great deal of information can be included in one question. In Chapter 16, for example, the functions of the liver are covered in one question with 8 statements. (The test-bank software would permit a maximum of only 8, but feel free to add more. All of the questions have an even number of statements, intended to make it easier to have the total be an even number for grading purposes, but of course any total may be used.) If your students are wary of an unfamiliar format, tell them, as I do mine, that each group of statements is simply a large true-or-false question.

These are not prepackaged tests to be printed out and used as is; I would not presume to think I could construct a test for another teacher's class. But I can make up questions, and have done so. The multiple-choice test bank has more than 2,500 questions, with a minimum of 80 per chapter. The fill-in test bank has more than 2,100 questions, with a minimum of 70 per chapter. The multiple-selection test bank has fewer questions but with up to eight statements to be deemed true or false for each question, it covers just as much information. Please keep in mind that the questions are grouped by format and organized based on the textbook's Review Questions; they are not in a random sequence. You will have to spend some time reading at first and then choose the assortment that best meets your needs.

To new teachers: Please make these questions your own. If you think of a variation I have missed, use it and save it. If you think that some of my wrong choices in the multiple-choice questions are too easy, or too difficult, or too silly, change them. If you want to add or subtract statements from the multiple-selection questions, do so. Make the questions yours. No test bank can take the place of the questions you devise for your classes. No one can know what you have emphasized, what you have made sure that your students know is important, and how you plan to make sure they have heeded you. No one else can construct the test you have in mind for your class. So be creative. Add a little humor—your humor, or something that has come up in class. Your students will recognize it and enjoy it. Save your inspirations (you will find that they multiply like mice), take what is here and make it your own, and you will never need my or anyone else's test bank again. There is much to be said for such independence, and both you and your students will be the beneficiaries.

My own students like to be prepared for tests, so I tell them what is especially important. The good students quickly learn to ask if they are unsure and to be specific. If some of your students are like some of mine, they are, sadly, looking for "tricks" on a test. No, there will be no "trick questions" (being asked to read carefully is not a "trick," despite what these students insist, and yes, merely one word may make a statement entirely wrong), and there will certainly be no secrets about what they should be sure to know. Most of us can probably remember a teacher who blithely said, "Know everything," as if all of the material had equal significance, when we as students knew very well it did not. I believe part of a teacher's job is to give students guidance, especially at the start of the semester. Of course, later on we can expect them to begin to discern significance on their own.

The Takeaways sections in each chapter are also meant to help students by giving them examples of what is important.

I tend to use a few short explanation questions (requiring logical use of nouns and verbs and especially prepositions) in each chapter test, because I like to see my students' thinking in their writing for material such as the differences between DNA and RNA, the important characteristics of water, or the purpose of hepatic portal circulation. Most students quickly come to expect this, and they are ready, have learned the difference between "results in" and "results from," have learned the vague phrases to avoid, and love even once being able to say after a test: "We knew you were going to ask that."

Again to new teachers, may I say that you have this to look forward to: The time when your students realize that a teacher is neither an ogre nor an opponent, but rather a collaborator (though undeniably in charge) who will be as pleased by their success as they are.

Lecture Outlines in PowerPoint Format—These are truly outlines, not scripts. The slides are an outline that may be useful for a variety of classroom presentations. Please see the introduction that accompanies the slides for more information. Two versions of the same lecture outline are available; the difference is the type of question that is interspersed in the chapter material. The first version has open-ended questions, which are meant to be answered orally by students. The second version has multiple-choice questions that may also be answered orally or be used with clicker technology. In both versions, a chapter ends with a Wrap-up Question that is meant to be enjoyable as well as instructive.

Knowledge Evaluations —Several of our adopters have asked for a means to assess students' knowledge either before or after a chapter is covered, or in some cases, at both times. In

response, we have created these evaluations. They are as comprehensive of chapter material as merely 20 questions can be, and focus on important aspects of physiology and anatomy. However, they are not intended to take the place of a teacher's own chapter exam.

Each chapter has an evaluation, or an assessment, of 20 questions; all questions are in multiple-choice format. Some questions are relatively simple (The "'sunshine vitamin' is ___?"); others are more complex and require students to read carefully. Questions in later chapters often ask about material that has been presented in earlier chapters and is again of significance. (The function of cartilage in the trachea, for example, was first mentioned in Chapter 4; it returns in Chapter 15.) Please see the introduction for a fuller explanation and a suggestion on how to use each evaluation as a pre-test, a post-test, or both.

This 8th edition of *Essentials* is my last one, but as long as I keep my wits about me, I remain pleased to respond to any comments you may have. If you find something that you feel should be modified or corrected (in the test banks, in this Instructor's Guide, or in the textbook), please do let me know. It is always a pleasure to hear from colleagues.

I wish you every success in our common goal of education.

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Chapter 1 ORGANIZATION AND GENERAL PLAN OF THE BODY

New to This Edition

"The Rest of 'Us'" section (in Levels of Organization) has been expanded somewhat. Included is a more detailed explanation of where the word "microbiome" comes from and what it means: that it can mean both a place (such as the skin) and the microbial population of that place.

Researchers have greatly reduced their estimation of our microbiomes (meaning populations). No longer are human cells supposedly outnumbered 10 to one by microbes, but rather by about 2 to one.

In the section on cautions about our microbiomes, the concept of "opportunists" is introduced.

Again, I have not included anything about probiotics, the many formulations of pills, yogurts, and fermented plants that are offered for sale with the claim that they will establish more "good" bacteria in the human intestine. Some of the ads boast that besides bacteria, their products also contain antibodies. They do not say antibodies to what, and seem to have no idea that antibodies are very specific, that each will fit only one antigen (and are proteins and if taken by mouth will be at least partially digested). A basic textbook such as ours does not have the space to devote to debunking fraudulent claims, but it does seem a good topic for a few minutes of class discussion.

Also in this chapter, for Table 1–1, is the first guideline note suggesting to students how they might make the best use of a table.

Chapter Organization and Content

This chapter is organized in a very traditional way to present introductory material for the study of anatomy and physiology.

Anatomy and Physiology—These terms are defined, and the relationship between them is emphasized. Mention is also made of pathophysiology, and its relationship to physiology is explained by using iron-deficiency anemia as an example.

Levels of Organization—These levels are presented simply and are illustrated in **Fig. 1–1.** This illustration depicts some of the tissues of the urinary system. Students will not know what they are just yet in terms of functions, but they will begin to grasp the great variety of cells and tissues found in the body. Mention is made of the later chapters in which each level of organization will be described in detail. For the organ system level, all the systems are illustrated in **Fig. 1–2,** and concise descriptions are given in **Table 1–1,** with examples of representative organs. Some students may be able to add organs that are not in this table. If students try to identify the organs they see in **Fig. 1–2,** they may be pleasantly surprised by how much they already know. A brief introduction to our microbiomes in general is given, and mention is made that more specific ones will be covered in later chapters. **Box 1–1** presents material that will certainly be familiar to some students; it concerns the replacement of organs and tissues.

Metabolism and Homeostasis—These concepts are defined. Then, because of the importance of homeostasis, several examples are given to make this rather abstract concept more concrete and real to the students. Students may get the idea that homeostasis is a process, but of course it is

not; it is a state of being, of being healthy. To correct that misconception, it may be helpful to say that all the body processes, working as they should, contribute to and maintain homeostasis, thus creating a healthy human being.

How a negative feedback mechanism works is explained, and examples are given. This type of regulatory mechanism will come up again in many chapters. A positive feedback mechanism is also described, with childbirth used as the example. The important difference between these two mechanisms is illustrated in **Fig. 1–3** and emphasized with the figure question—that a negative feedback mechanism contains its own brake, whereas a positive feedback mechanism requires an external brake of some sort. Students will need a place to start with part A, so tell them to start at the lower left, with metabolic rate decreasing. Point out that the upper right corner has the opposite—metabolic rate increasing. Let them find the other opposites, and they will see that the secretion (or not) of thyroxine is a self-contained cycle. Part B is easier, with the cycle of higher temperature and higher metabolic rate leading to a higher fever away from the stimulus and needing a brake outside the cycle, the white blood cells destroying the bacteria that started the fever. Other positive feedback mechanisms, such as blood clotting and inflammation, both of which can also become vicious cycles and lead to serious damage or death, will be discussed in the appropriate chapters later in the book.

Terminology and General Plan of the Body—The terminology of anatomy is presented using text, illustrations, and tables. Body parts and areas are defined in **Table 1–2** and illustrated in **Fig. 1–4.** Terms of location and position are defined in **Table 1–3,** and an example is included for each one. If time permits, you may wish to ask for other examples. Body cavities are described in the text and are illustrated in **Fig. 1–5.** Included here is an introduction to the meninges and to the serous membranes of the thoracic and abdominal cavities. Planes and sections are described in the text and are depicted in **Fig. 1–6.** The text discussion guides the students through the transverse section to "see" that we are looking down on this slice through the body. **Figure 1–7** shows the two ways to subdivide the abdomen; the four quadrants and nine areas are described in the text.

Our students often wonder why they must memorize this kind of terminology, so it may be helpful here to point out how useful these terms will be. The names of the areas of the head, for example, are the same as the names of the large bones of the skull and the lobes of the cerebrum (you may wish to mention other bones in this context, such as the femur and ilium). Muscles, nerves, arteries, and veins are also often named for the part of the body in which they are located.

Box 1–2 discusses three technologies for viewing the interior of the body without the need for surgery: CT scans, MRI, and PET scans. An illustration of each has been included.

Box 1–3 explains functional MRI, with an example of driving and talking on a phone, with activity in the brain depicted.

Topics for Research or Class Discussion

1. How the anatomy of the head is related to the organs contained within it, that is, the brain and all the organs of special sense.
2. Examples of impaired homeostasis: A broken bone in the leg or the accumulation of fluid in the lungs in pneumonia. (There are many others.) How will each affect the body? Can

homeostasis be restored? Can the body do it by itself, or is medical help required? If so, what kind of help?

Answers to Review Questions in the Textbook

1. A bone is hard and strong (anatomy) and, therefore, is able to support parts of the body or protect certain organs from trauma (physiology). Some bones are thick (the femur) for support. Other bones form hollow structures (the skull, the rib cage) for protection of the organs within.

   The hand includes five fingers, each with three joints (anatomy). The number and types of joints permit the hand to grip objects, and the thumb is especially movable (physiology) for this purpose.

2. Anatomic position: The body is erect and facing forward, with the arms at the sides and palms forward, the feet parallel. This knowledge is important so that the meaning of directional terms will always be consistent and the same for everyone who uses them.

3. a. muscular system
   b. endocrine system
   c. integumentary system
   d. lymphatic system
   e. respiratory system

4. The closed body cavities are the cranial, spinal (vertebral), thoracic, abdominal, and pelvic cavities.

   The peritoneum lines the abdominal cavity.
   The meninges line the cranial and spinal cavities.
   The parietal pleura lines the thoracic cavity.

5. Left upper quadrant—stomach or spleen
   Left lower quadrant—small intestine or colon (these organs are in all four quadrants)
   Right upper quadrant—liver or gallbladder
   Right lower quadrant—appendix or colon

6. Equal right and left halves—midsagittal section
   Anterior and posterior parts—coronal (or frontal) section
   Superior and inferior parts—transverse section

7. Students review body areas.

8. A cell is the smallest living unit of structure and function of the body, and it is made of inorganic and organic chemicals.

   A group of similar cells is called a tissue.

9. An organ is a group of tissues arranged in a precise way to accomplish specific functions.

   Several organs that contribute to a common function are called an organ system.

10. Metabolism is the total of all of the physical changes and chemical reactions that take place in the body. Metabolic rate is the total energy production by the body, which we measure as the body's heat production. Homeostasis is a state that reflects the ability of the body to maintain a stable internal environment despite constant changes; it is a state of good health.

    a. An external change might be a drop in environmental temperature, and the body would respond by shivering to produce more heat.
    b. An example of an internal change might be a sensation of hunger after not eating for a while, and the response would be to eat something. (There are many other examples.)
    c. In a negative feedback mechanism, a stimulus triggers a response by the body. The response eventually decreases the stimulus. In turn, the response decreases until the stimulus recurs. In this way, some aspect of the body, such as blood glucose level, is maintained within normal limits.

Answers to For Further Thought Questions in the Textbook

1. Fingers and toes contain the same number of bones and joints (students may not believe this at first), but finger bones are longer. This enables the hand to grasp. Toes can also grasp, but most of us do not develop that ability.

The base of the thumb has a joint (saddle joint) that allows the thumb to touch the other fingers, which is also important for gripping. The big toe has no such joint (some students will no doubt remember that the big toes of gorillas and monkeys do have such joints and that their big toes are as movable as their thumbs).

The seven ankle bones are an important part of the foot and are large and strong for supporting the weight of the body. The eight wrist bones are all very small and do not have a supportive function.

2. The appendix is in the lower right abdominal quadrant. Peritonitis is very serious, because the peritoneum is a continuous membrane that lines the entire abdominal cavity and bacteria may spread along it very rapidly. From the peritoneum, all abdominal organs may become infected. Taking the question a step further, I ask if the same rapid spread of bacteria would be possible in the thoracic cavity. Yes, because the parietal pleura lines the entire cavity.

3. The meninges surround the brain and spinal cord. These are continuous membranes, and a small bacterial infection may spread very quickly. Swelling is often found in bacterial infections, and swelling of the meninges and the pressure that it causes may do great harm to the brain. The skull does not "give" outward to the increased pressure (as the wall of the abdomen would), and the pressure is directed inward, perhaps destroying brain tissue.

4. We may not often ask students to create mental pictures and describe them, and students are sometimes very resistant. But perhaps we should ask, because doing so involves several kinds of thinking, and mental pictures are so useful and at times essential. This question concerns sections, and students should not feel threatened by it.

The tree trunk cut top to bottom is a longitudinal section and may be described as a rectangle, with the "grain" of the wood seen as a series of parallel lines running the long way. A tree trunk cut side to side is of course a cross-section, and the growth rings of the tree may be described as a series of concentric circles. Often I see hands waving, and yes, they are waving in the

appropriate directions or shapes, but I demand words. The response, "I know what I mean but can't say it" will not do, and the time for students to learn that is in the first week of class. Whatever their chosen profession, they will have to find the words for what they mean. If they do not yet know the word "concentric," they may learn it and someday tell it to their children.

The grapefruit cut top to bottom (I have had students insist that a grapefruit does not have a top, but it does, just as an apple does, the stem point, and the bottom is the flower point) is a longitudinal section and may be described as sections looking like semicircles on either side of a central line. The slice through the equator of the grapefruit is a cross-section, and the sections may be described as a series of side-by-side triangles with their bases forming a circle and their points all meeting in the center. I usually draw this on the chalkboard at their direction, because I love drawing on the board. And the eraser is close to hand for any false starts. This is what I mean about being wrong with these questions. Wrong? A mutant grapefruit? Not a problem. The mutant is gone with a few swipes; I get to draw another large circle with a dramatic sweep, and we try again.

You may wish to take this question a step further and ask for another correct name for the cross-section of the tree or grapefruit. This would be a transverse section, though the students must keep in mind that the two are not always equivalent in the human body, which must be assumed to be in anatomic position.

I usually go yet another step further to bring us all back to human anatomy and ask the students to create a mental picture of a midsagittal section of the head. Then I ask which of the following we would see in that section (and why or why not)—brain, eyes, nose, ears, tongue, teeth. Of those parts, the eyes and ears are not on the midline; they are lateral to the midline, so we would not see them. The other parts do cross the midline, so we would see them. Students can compare their mental pictures with **Fig. 15–1** in the chapter on the respiratory system.

The same can be done with a midsagittal section of the trunk (or you might save this for a test question). In such a section, above the diaphragm, would we see the heart? The trachea? The sternum? Yes, because they are on the midline. Would we see the lungs? Or any of the ribs? No, because these are not on the midline. Below the diaphragm, would we see the small intestine? Large intestine? Liver? Yes, because they cross the midline. Would we see the spleen or kidneys or gallbladder? No, because they are not on the midline.

5. Most students should have little trouble with this picture. In this transverse section of the upper arm, A is the brachial artery; it is red in color. B is the biceps brachii; it has two parts. C is the triceps brachii; it has three parts. These muscles are included as examples of the use of the term *brachial* in the Body Parts and Areas section.

6. Students should be able to find a few words to describe each arrow and should be able to see the centrality and importance of the circulatory system.

Environmental interactions: A—Food is taken in.
B—Feces are excreted.
C—Oxygen is taken in.
D—Carbon dioxide is exhaled.
E—Metabolic wastes are excreted in urine.

Internal interactions: 1—CO_2 moves from blood to alveoli.

2—O_2 moves from alveoli to the blood.
3—O_2 and nutrients move from blood to tissues, and CO_2 and waste products move from tissues to blood.
4—Hormones move from endocrine glands to the blood.
5—Nutrients absorbed by the digestive system enter the blood.