

Laboratory Textbook

Sixth Edition

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Intermediate Cat Version

ANATOMY & PHYSIOLOGY

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ANATOMY & PHYSIOLOGY Laboratory Textbook, Intermediate Cat Version,
SIXTH EDITION

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Some of the laboratory experiments included in this text may be hazardous if materials are handled improperly or if procedures are conducted incorrectly. Safety precautions are necessary when you are working with chemicals, glass test tubes, hot water baths, sharp instruments, and the like, or for any procedures that generally require caution. Your school may have set regulations regarding safety procedures that your instructor will explain to you. Should you have any problems with materials or procedures, please ask your instructor for help.

These laboratory exercises have been developed to provide you with a basic understanding of anatomical and physiological principles that underlie medicine, nursing, dentistry, and other related health professions. Laboratory procedures that reflect actual clinical practices are included wherever feasible. In each exercise you will find essential terminology that will become part of your working vocabulary. Mastery of all concepts, vocabulary, and techniques will provide you with a core of knowledge crucial to success in your chosen profession.

What's New

In this sixth edition of the *Anatomy and Physiology Laboratory Textbook Intermediate Cat Version* we have

- Revised over 350 images, adding color and photo to important concepts
- Improved labeling activities
- Updated laboratory exercises in Part 8, Hematology
- Updated the design

Features

Illustration Labeling These exercises are essential in determining your understanding of the written text, and may be used for reference and review.

Dissections Since the cat anatomy is similar to human anatomy, the cat has been selected as the primary dissection specimen in this manual. The rat will also be used. Occasionally, sheep and beef organs will be studied. Frogs will frequently be used in physiological experiments.

Physiological Experiments Instructions for using Spirocomp™ and Intellitool experiments are included in the laboratory exercises.

Microscopic Studies Cytological and histological studies will be made to lend meaning to text descriptions. The **Histology Atlas** includes photomicrographs of most of the tissues discussed in the text. This atlas contains forty pages featuring 140 images

Histology Self-Quizzes At many institutions, students are subjected to laboratory practical examinations in which microscopes are set up with various types of tissues displayed for identification by the student. This type of exam can be quite traumatic to the student the first time it is experienced. To give the student an opportunity to see how he or she might do on such an exam, we continue to offer four "Self-Quizzes."

In laboratories where practical exams are used, these self-quizzes can do much to show the student ahead of time what type of questions might be asked. Even if no laboratory practical is used, the self-quizzes are helpful review tests.

The four Self-Quizzes are located at the end of Exercise 68.

You will find:

- 80 microscope setups
- Over 250 questions
- Answers located on pages 202 and 294
- Prompts throughout the manual directing the student to the quiz

Laboratory Reports

The laboratory reports at the end of the text will provide a comprehensive review of the topics covered.

Teaching and Learning Supplements Instructor's Handbook

The Instructor's Handbook is located online at **Lab Central** www.mhhe.com/labcentral.

Virtual Anatomy Dissection Review CD-ROM

0-07-285621-1, by John Waters, Pennsylvania State University. This multimedia program contains vivid, high quality labeled cat dissection photographs. The program helps students easily identify and review the corresponding structures and functions between the cat and the human body.

MediaPhys 2.0 CD-ROM

0-07-283401-3

This interactive tool offers detailed explanations, high quality illustrations and animations to provide students with a thorough introduction to the world of physiology—giving them a virtual tour of physiological processes. MediaPhys is filled with interactive activities and quizzes to help reinforce physiology concepts that are often difficult to understand.

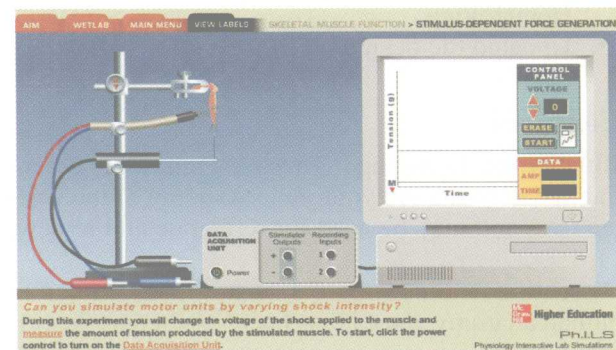
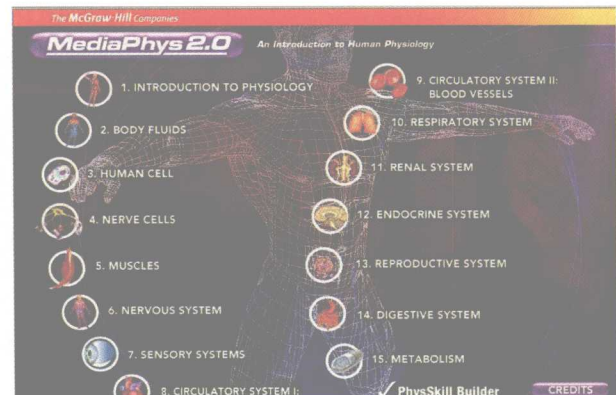
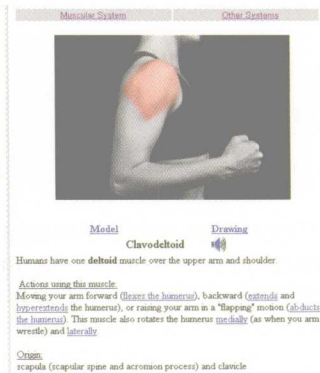
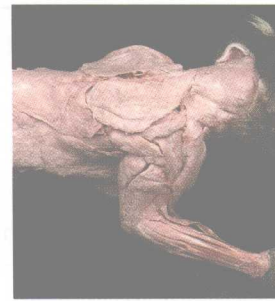
Physiology Interactive Lab Simulations (Ph.I.L.S.)

0-07-287167-9

The Ph.I.L.S CD-ROM contains eleven laboratory simulations that allow students to perform experiments without using expensive lab equipment or live animals. This easy-to-use software offers students the flexibility to change the parameters of every lab experiment, with not limit to the amount of times a student can repeat experiments or modify variables. This power to manipulate each experiment reinforces key physiology concepts by helping students to view outcomes, make predictions, and draw conclusions.

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For the Student

During the first week of this course your instructor will provide you with a schedule of laboratory exercises in the order of their performance. There is an implied expectation that you will have familiarized yourself with the content of each experiment before that week's session, thus ensuring that you will be properly prepared so as to minimize disorganization and mistakes.

The *Laboratory Reports* coinciding with each exercise are located at the back of the book. They are perforated for easy removal; be sure to remove each sheet as necessary. Removing them will facilitate data collection, completion of answers, and grading. Your instructor may give further procedural details on the handling of these reports.

The exercises in this laboratory guide consist of four kinds of activities:

- Illustration labeling
- Anatomical dissections
- Physiological experiments
- Microscopic studies

Labeling

- Determines your understanding of the text
- May be used as reference in dissections or examinations of anatomical specimens
- Useful for review
- Should be completed before you come to the laboratory

Dissections

- Cat
- Rat
- Sheep and beef organs
- Frog

When using live animals in experimental procedures, it is imperative that they be handled with great care. Consideration must be exercised to minimize pain in all experiments on vertebrate animals. Inconsiderate or haphazard treatment of any animal will not be tolerated.

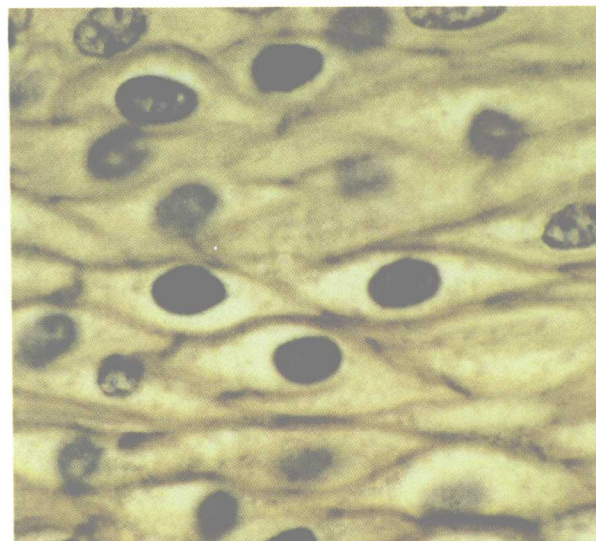
Physiological Experiments

- Read the experiment before entering the laboratory

- Handle instruments carefully
- Understand how the equipment is expected to function
- Record data immediately
- Insightful data interpretation will also be expected

Microscopic Studies

- Familiarize yourself with the Histology Atlas located in the center of the text
- If drawings are required, execute them with care
- Label those structures that are significant



Histology Self-Quizzes

- Test your comprehension of histological studies by taking the Histology Self-Quizzes, located on pages 401, 406, 409, and 413.
- Answers to the self-quizzes are found on pages 202 and 294.

Laboratory Reports

- Found at the end of your text page 417
- Work independently

Laboratory Efficiency

Success in any science laboratory requires a few additional disciplines:

1. Always follow the instructor's verbal comments at the beginning of each laboratory session. It is at this time that difficulties will be pointed out, group assignments will be made, and procedural changes will be announced. Take careful notes on substitutions or changes in methods or materials.
2. In view of the above statement, it is obvious that the beginning of each laboratory period is a critical time. It is for this reason that tardiness is intolerable. If you are late to class don't expect your instructor to be very helpful.
3. Keep your work area tidy at all times. Books, bags, purses, and extraneous supplies should be located away from the work area. Tidiness should also extend to assembly of all apparatus.
4. Abstain from eating, drinking, or smoking within the confines of the laboratory.
5. Report immediately to the instructor any injuries that may occur.
6. Be serious-minded and methodical. Horseplay, silliness, and flippancy will not be tolerated during experimental procedures.
7. Work independently, but cooperatively, when performing team experiments. Attend to your assigned responsibility, but be willing to lend a hand to others when necessary. Participation and development of laboratory techniques are integral parts of the course.

Some of the laboratory experiments included in this book may be hazardous if materials are handled improperly or if procedures are conducted incorrectly. Safety precautions are necessary when you are working with chemicals, glass test tubes, hot water baths, sharp instruments, and the like, or for any procedures that generally require caution. Your school may have set regulations regarding safety procedures that your instructor will explain to you. Should you have any problems with materials or procedures, please ask your instructor for help.

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Anatomical Terminology

1

Anatomical description would be extremely difficult without specific terminology. A consensus prevails among many students that anatomists synthesize multisyllabic words in a determined conspiracy to harass the beginner's already overburdened mind. Naturally, nothing could be further from the truth.

Scientific terminology is created out of necessity. It functions as a precise tool that allows us to say a great deal with a minimum of words. Conciseness in scientific discussion not only saves time, but it promotes clarity of understanding as well.

Most of the exercises in this laboratory manual employ the terms defined in this exercise. They are used liberally to help you locate structures that are to be identified on the illustrations. If you do not know the exact meanings of these words, obviously you will be unable to complete the required assignments. Before you attempt to label any of the illustrations in this exercise, read the text material first.

Relative Positions

Descriptive positioning of one structure with respect to another is accomplished with the following pairs of words. Their Latin or Greek derivations are provided to help you understand their meanings.

Superior and Inferior These two words are used to denote vertical levels of position. The Latin word *super* means *above*; thus, a structure that is located above another one is said to be superior. Example: The nose is *superior* to the mouth.

The Latin word *inferus* means *below* or *low*; thus, an inferior structure is one that is below or under some other structure. Example: The mouth is *inferior* to the nose.

Anterior and Posterior Fore and aft positioning of structures are described with these two terms. The word *anterior* is derived from the Latin, *ante*, meaning *before*. A structure that is anterior to another one is in front of it. Example: Bicuspid is *anterior* to molars.

Anterior surfaces are the most forward surfaces of the body. The front portions of the face, chest, and abdomen are anterior surfaces.

Posterior is derived from the Latin *posterus*, which means *following*. The term is the opposite of anterior. Example: The molars are *posterior* to the bicuspid.

When these two terms are applied to the surfaces of the hand and arm, it is assumed that the body is in the *anatomical position*, which is as shown in figures 1.1 and 1.2. In the anatomical position the palms of the hands face forward.

Cranial and Caudal When describing the location of structures of four-legged animals, these terms are often used in place of anterior and posterior. Since the word *cranial* pertains to the skull (Greek: *kranion*, skull), it may be used in place of anterior. The word *caudal* (Latin: *cauda*, tail) may be used in place of posterior.

Dorsal and Ventral These terms, as used in comparative anatomy of animals, assume all animals, including humans, to be walking on all fours. The dorsal surfaces are thought of as *upper* surfaces, and the ventral surfaces as *underneath* surfaces.

The word *dorsal* (Latin: *dorsum*, back) not only applies to the back of the trunk of the body but may also be used in describing the back of the head and the back of the hand.

Standing in a normal posture, a human's dorsal surfaces become posterior. A four-legged animal's back, on the other hand, occupies a superior position.

The word *ventral* (Latin: *venter*, belly) generally pertains to the abdominal and chest surfaces. However, the underneath surfaces of the head and feet of four-legged animals are also often referred to as ventral surfaces. Likewise, the palm of the hand may also be referred to as being ventral.

Proximal and Distal These terms are used to describe parts of a structure with respect to its point of attachment to some other structure. In the case of the arm or leg, the point of reference is where the

limb is attached to the trunk of the body. In the case of a finger, the point of reference is where it is attached to the palm of the hand.

Proximal (Latin: *proximus*, nearest) refers to that part of the limb nearest to the point of attachment. Example: The upper arm is the *proximal* portion of the arm.

Distal (Latin: *distare*, to stand apart) means just the opposite of proximal. Anatomically, the distal portion of a limb or other part of the body is that portion that is most remote from the point of reference (attachment). Example: The hand is *distal* to the arm.

Medial and Lateral These two terms are used to describe surface relationships with respect to the median line of the body. The *median line* is an imaginary line on a plane that divides the body into right and left halves.

The term *medial* (Latin: *medius*, middle) is applied to surfaces of structures that are closest to the median line. The medial surface of the arm, for example, is the surface next to the body because it is closest to the median line.

As applied to the appendages, the term *lateral* is the opposite of medial. The Latin derivation of this word is *lateralis*, which pertains to *side*. The lateral surface of the arm is the outer surface, or that surface farthest away from the median line. The sides of the head are said to be lateral surfaces.

Body Sections

To observe the structure and relative positions of internal organs it is necessary to view them in sections that have been cut through the body. Considering the body as a whole, there are only three planes to identify.

Sagittal Sections A section parallel to the long axis of the body (longitudinal section) that divides the body into right and left sides is a *sagittal section*. If such a section divides the body into equal halves, it is said to be a *midsagittal section*.

Frontal Section A longitudinal section that divides the body into front and back portions is a *frontal* or *coronal* section.

Transverse Sections Any section that cuts through the body in a direction that is perpendicular to the long axis is a *transverse* or *cross section*.

Although these sections have been described here only in relationship to the body as a whole, they can be used on individual organs such as the arm, finger, or tooth.

Assignment:

To test your understanding of the descriptive terminology, identify the labels in figure 1.1 by placing the correct numbers in front of the terms to the right

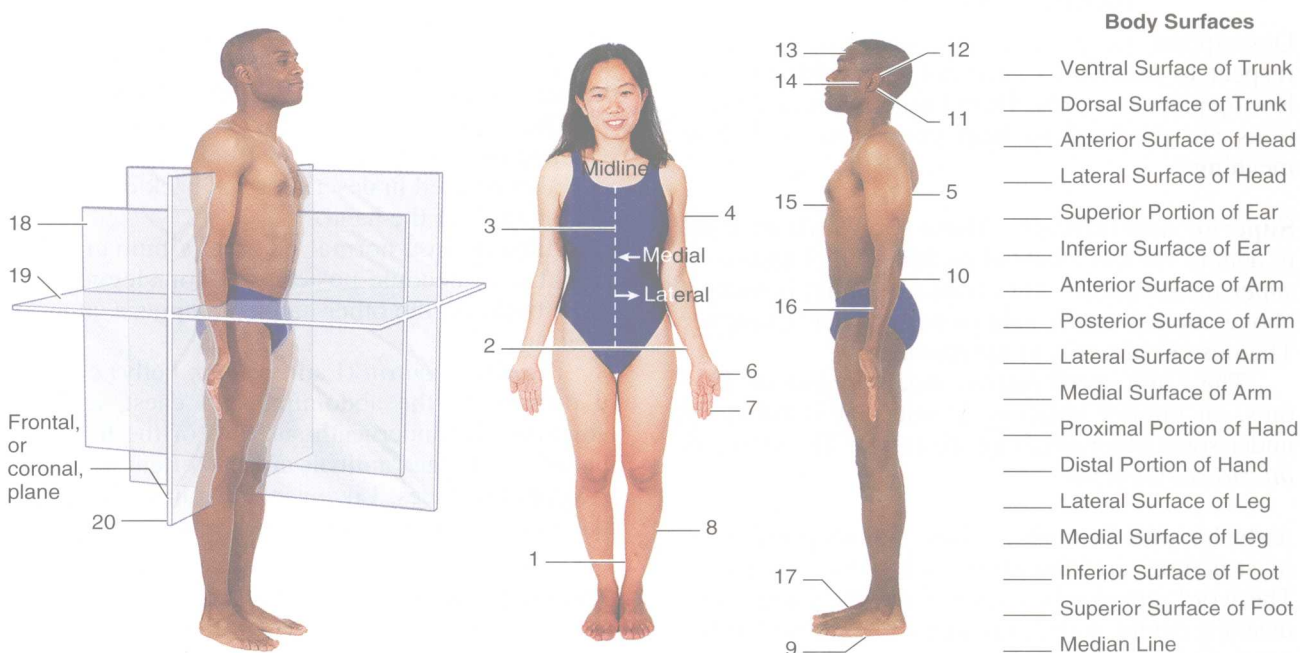


Figure 1.1 Body sections and surfaces.

Photos: © The McGraw-Hill Companies/Eric Wise, photographer

of the illustrations. Also, record these numbers on the Laboratory Report.

Regional Terminology

Various terms such as *flank*, *groin*, *brachium*, and *hypochondriac* have been applied to specific regions of the body to facilitate localization. Figures 1.2 and 1.3 pertain to some of the more predominantly used terminology.

Trunk

The anterior surface of the trunk may be subdivided into two pectoral, two groin, and the abdominal regions. The upper chest region may be designated as **pectoral** or **mammary** regions. The anterior trunk region not covered by the ribs is the **abdominal** region. The depressed area where the thigh of the leg meets the abdomen is the **groin**.

The posterior surface, or **dorsum**, of the trunk can be differentiated into the costal, lumbar, and buttocks regions. The **costal** (Latin: *costa*, rib) portion is the part of the dorsum that lies over the rib cage. The lower back region between the ribs and hips is the **lumbar** or **loin** region. The **buttocks** are

the rounded eminences of the rump formed by the gluteal muscles; this is also called the **gluteal** region.

The side of the trunk that adjoins the lumbar region is called the **flank**. The armpit region that is between the trunk and the arm is the **axilla**.

Upper Extremities

To differentiate the parts of the upper extremities, the term **brachium** is used for the upper arm and **antebrachium** for the forearm (between the elbow and wrist). The elbow area on the posterior surface of the arm is the **cubital** area. That area on the opposite side of the elbow is the **antecubital** area. It is also correct to refer to the entire anterior surface of the antebrachium as being antecubital.

Lower Extremities

The upper portion of the leg is designated as the **thigh**, and the lower fleshy posterior portion is called the **calf**. Between the thigh and calf on the posterior surface, opposite to the knee, is a depression called the **ham** or **popliteal** region. The sole of the foot is the **plantar** surface.

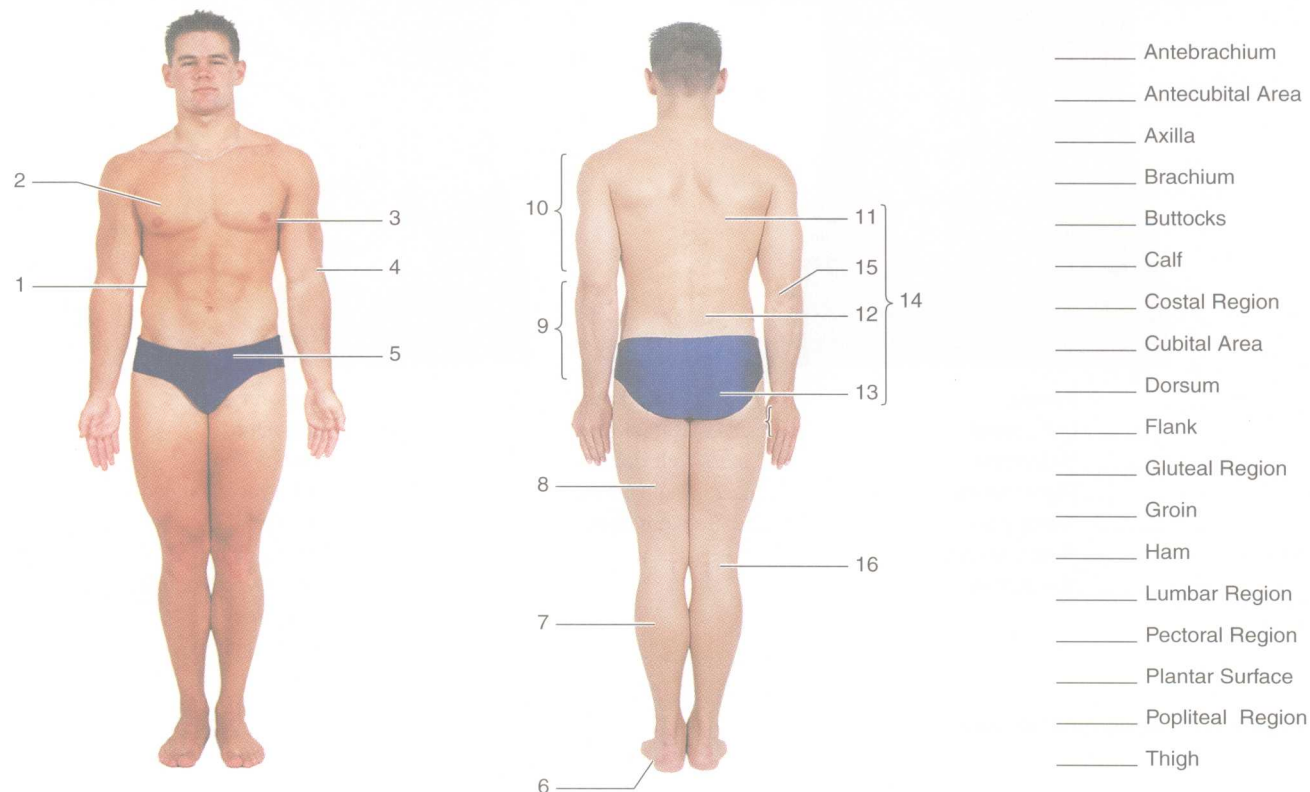


Figure 1.2 Regional terminology.

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Abdominal Divisions

The abdominal surface may be divided into quadrants or into nine distinct areas. To divide the abdomen into nine regions one must establish four imaginary planes: two that are horizontal and two that are vertical. The **transpyloric plane** is the upper horizontal plane, which would pass through the lower portion of the stomach (pyloric portion). The **transtuberular plane** is the other horizontal plane, which touches the top surfaces of the hip-bones (iliac crests). The two vertical planes, or **right** and **left lateral planes**, are approximately halfway between the midsagittal plane and the crests of the hips.

The planes describe the umbilical, epigastric, hypogastric, hypochondriac, and lumbar regions. The **umbilical** area lies in the center, includes the navel, and is bordered by the two horizontal and two vertical planes. Immediately above the umbili-

cal area is the **epigastric**, which covers much of the stomach. Below the umbilical zone is the **hypogastric**, or **pubic area**. On each side of the epigastric are the right and left **hypochondriac** areas, and beneath the hypochondriac areas are the right and left **lumbar** areas. (Note that although we tend to think of only the lower back as being the lumbar region, we see here that it extends around to the anterior surface as well.)

Assignment:

Label figures 1.2 and 1.3 and transfer these numbers to the Laboratory Report.

Laboratory Report

After transferring all the labels from figures 1.1 through 1.3 to the proper columns on Laboratory Report 1, 2 answer the questions that pertain to this exercise, p. 417.

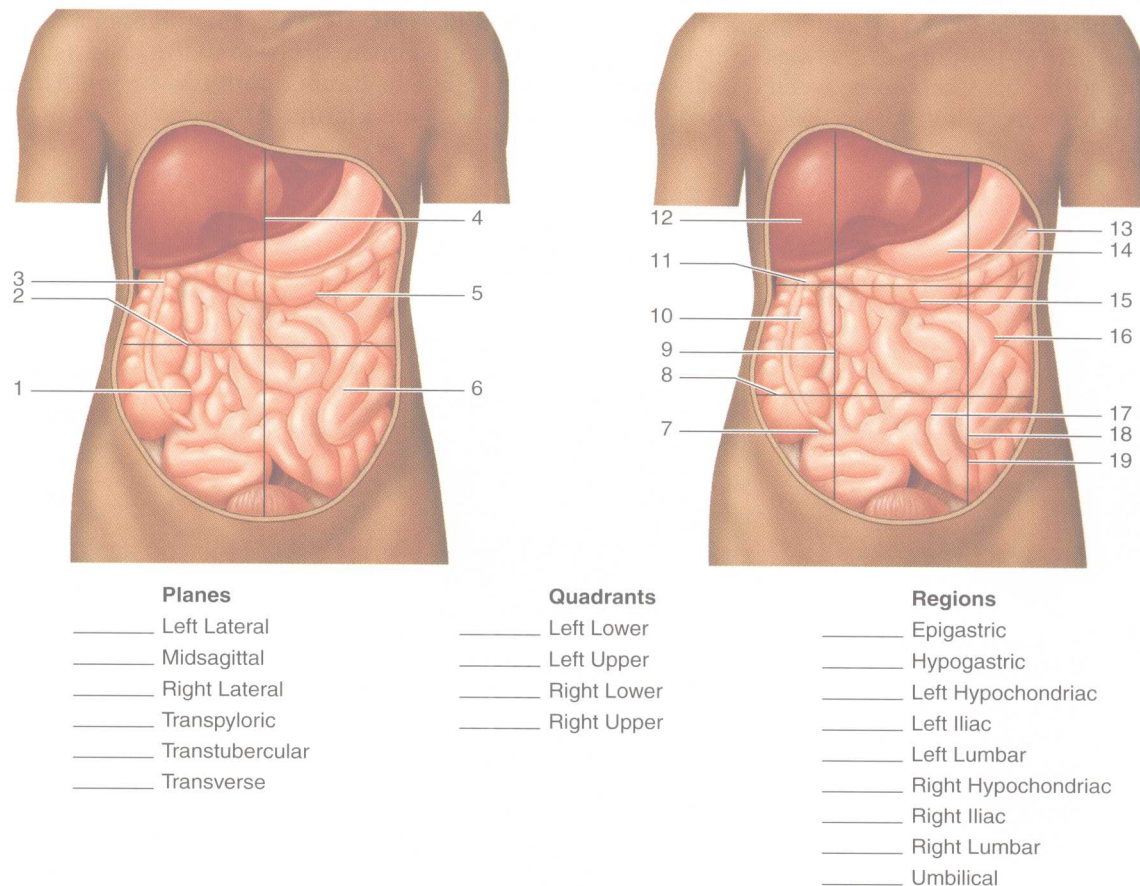


Figure 1.3 Abdominal regions.

Body Cavities and Membranes

2

All the internal organs (*viscera*) are contained in body cavities, which are completely or partially lined with smooth membranes. The relationships of these cavities to each other, the organs they contain, and the membranes that line them will be studied in this exercise.

Body Cavities

Figure 2.1 illustrates the principal cavities of the body. The two major cavities are the dorsal and ventral cavities. The **dorsal cavity**, which is nearest to the dorsal surface, includes the cranial and spinal cavities. The **cranial cavity** is the hollow portion of the skull that contains the brain. The **spinal cavity** is a long tubular canal within the vertebrae that contains the spinal cord. The **ventral cavity** is the largest cavity and encompasses the chest and abdominal regions.

The superior and inferior portions of the ventral cavity are separated by a dome-shaped thin muscle, the **diaphragm**. The **thoracic cavity**, which is that part of the ventral cavity superior to the diaphragm, is separated into right and left compartments by a membranous partition or septum called the **mediastinum**. The lungs are contained in these right and left compartments. The heart, trachea, esophagus, and thymus gland are enclosed within the mediastinum.

Figure 2.2 reveals the relationship of the lungs to the structures within the mediastinum. Note that within the thoracic cavity there exists a pair of right and left **pleural cavities** that contain the lungs and a **pericardial cavity** that contains the heart.

The **abdominopelvic cavity** is the portion of the ventral cavity that is inferior to the diaphragm. It consists of two portions: the abdominal and pelvic

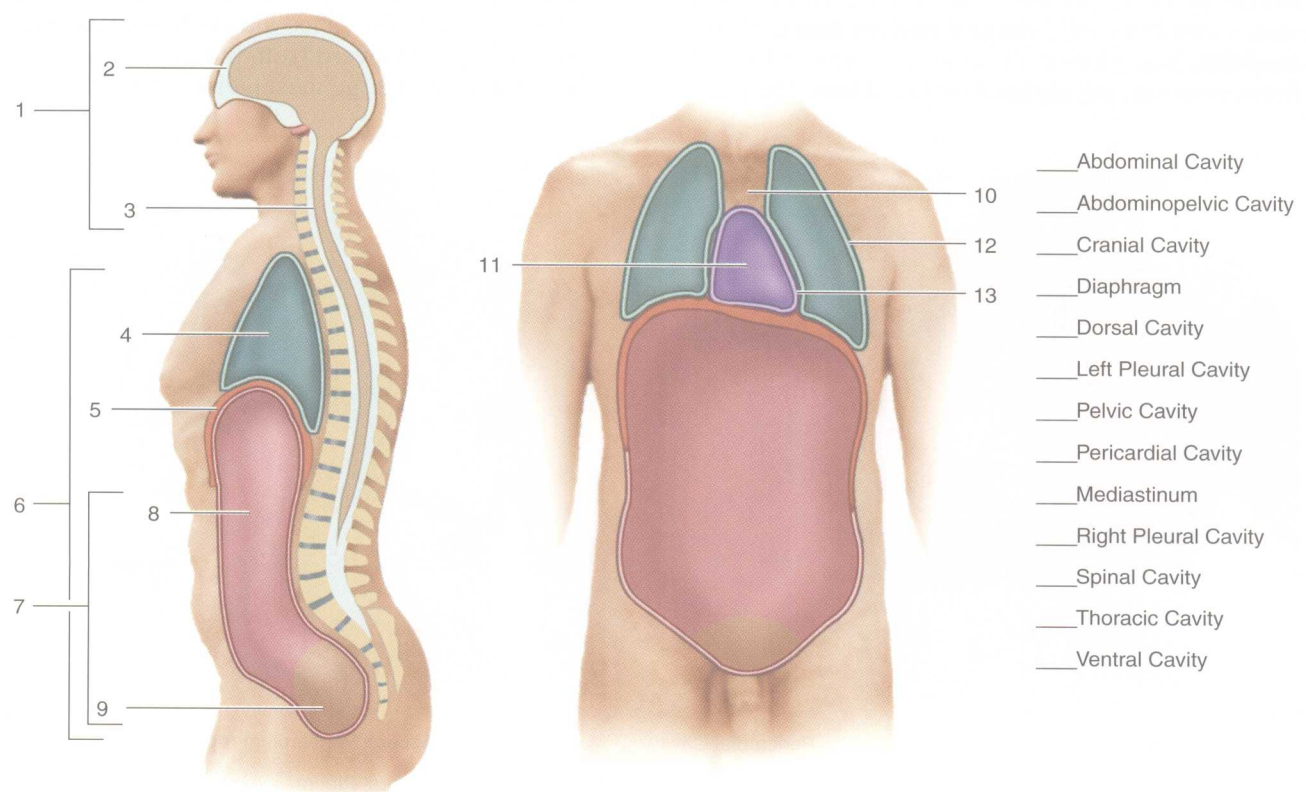


Figure 2.1 Body cavities.

cavities. The **abdominal cavity** contains the stomach, liver, gallbladder, pancreas, spleen, kidneys, and intestines. The **pelvic cavity** is the most inferior portion of the abdominopelvic cavity and contains the urinary bladder, sigmoid colon, rectum, uterus, and ovaries.

Body Cavity Membranes

The body cavities are lined with serous membranes that provide a smooth surface for the enclosed internal organs. Although these membranes are quite thin, they are strong and elastic. Their surfaces are moistened by a self-secreted *serous fluid* that facilitates ease of movement of the viscera against the cavity walls.

Thoracic Cavity Membranes

The membranes that line the walls of the right and left thoracic compartments are called **parietal pleurae** (*pleura*, singular). The lungs, in turn, are covered with **visceral** (pulmonary) **pleurae**. Note in Figure 2.2 that these pleurae are continuous with each other. The potential cavity between the parietal and visceral pleurae is the **pleural cavity**. Inflammation of the pleural membranes results in a condition called *pleurisy*.

Within the broadest portion of the mediastinum lies the heart. It, like the lungs, is covered by a thin serous membrane, the **visceral pericardium**, or **epicardium**. Surrounding the heart is a double-layered fibroserous sac, the **parietal pericardium**. The inner

layer of this sac is a serous membrane that is continuous with the epicardium of the heart. Its outer layer is fibrous, which lends considerable strength to the structure. A small amount of serous fluid produced by the two serous membranes lubricates the surface of the heart to minimize friction as it pulsates within the parietal pericardium. The potential space between the visceral and parietal pericardia is called the **pericardial cavity**.

Abdominal Cavity Membranes

The serous membrane of the abdominal cavity is the peritoneum. It does not extend deep down into the pelvic cavity, however; instead, its most inferior boundary extends across the abdominal cavity at a level that is just superior to the pelvic cavity. The top portion of the urinary bladder is covered with the peritoneum.

In addition to lining the abdominal cavity, the peritoneum has double-layered folds called **mesenteries**, which extend from the dorsal body wall to the viscera, holding these organs in place. These mesenteries contain blood vessels and nerves that supply the viscera enclosed by the peritoneum.

That part of the peritoneum attached to the body wall is the **parietal peritoneum**. The peritoneum that covers the visceral surfaces is the **visceral peritoneum**. The potential cavity between the parietal and visceral peritoneums is called the **peritoneal cavity**.

Extending downward from the inferior surface of the stomach is a large mesenteric fold called the

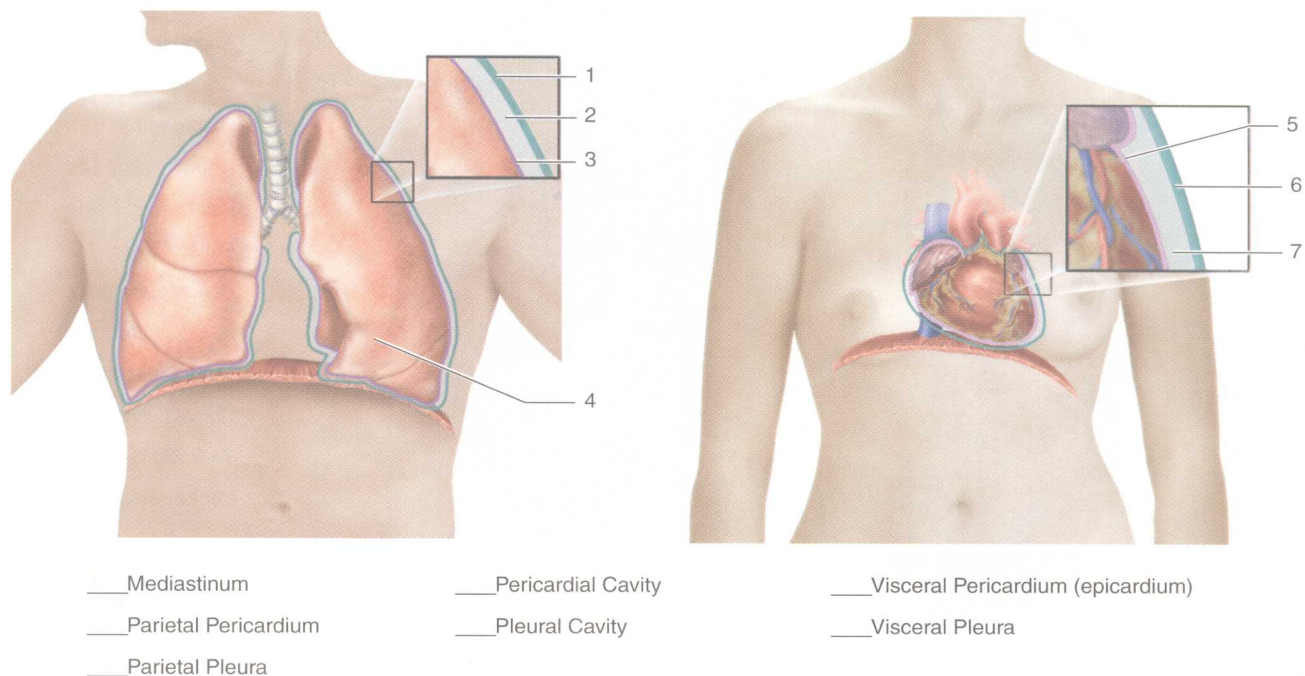


Figure 2.2 The thorax.

greater omentum. This double-membrane structure passes downward from the stomach in front of the intestines, sometimes to the pelvis, and back up to the transverse colon, where it is attached. Because it is folded upon itself it is essentially a double mesentery consisting of four layers. Protuberance of the abdomen in obese individuals is due to fat accumulation in the greater omentum.

A smaller mesenteric fold, the **lesser omentum**, extends between the liver and the superior surface of the stomach and a short portion of the duodenum.

Assignment:

Label figures 2.1, 2.2, and 2.3.

Laboratory Report

Complete Laboratory Report 1, 2 by answering the questions that pertain to this exercise.

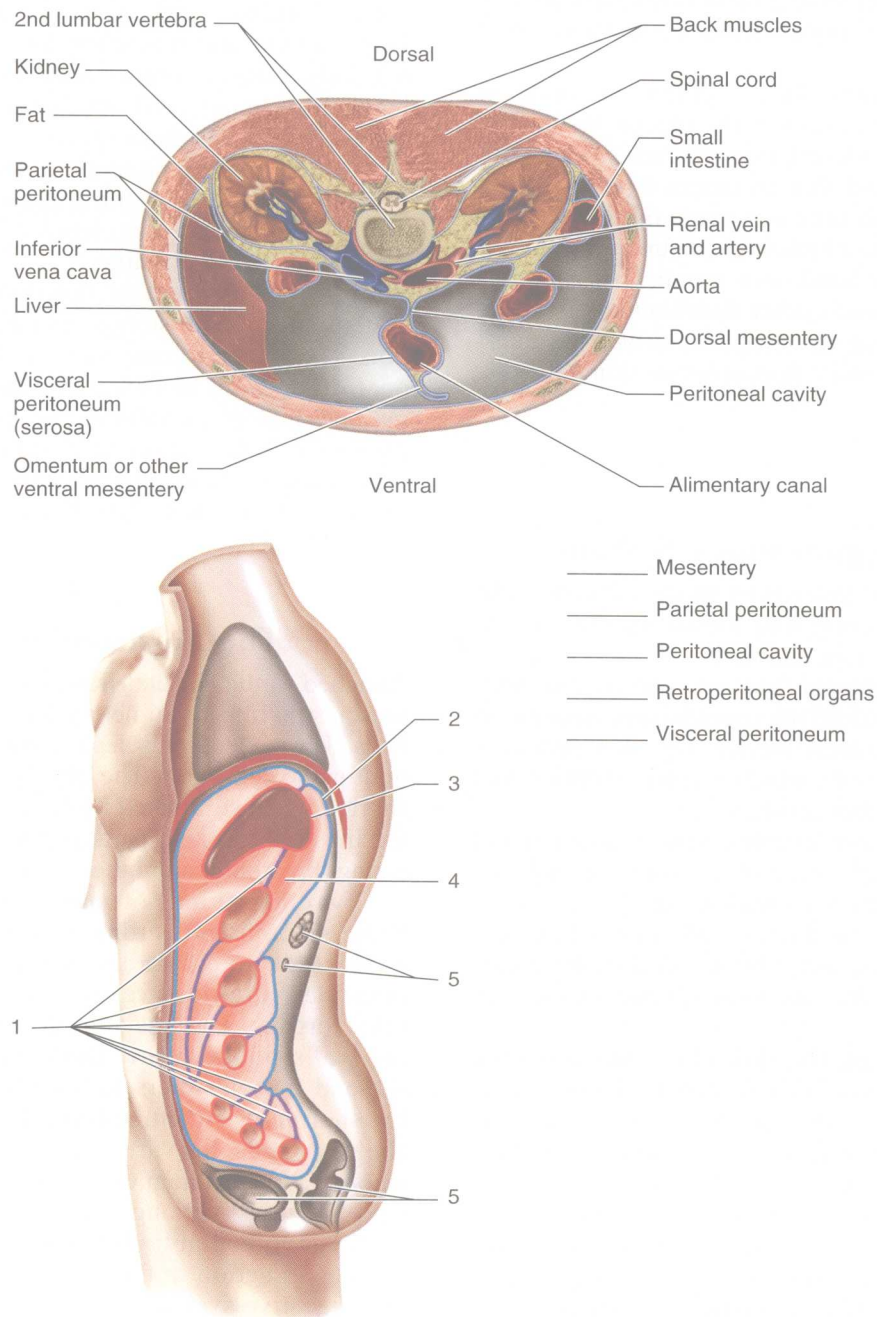


Figure 2.3 Transverse and longitudinal sections of the abdominal cavity.

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Organ Systems:
Rat Dissection

During this laboratory period we will dissect a freshly killed rat to perform a cursory study of the majority of the organ systems. Since rats and humans have considerable anatomical and physiological similarities, much will be learned here about human anatomy.

Before beginning the dissection, however, it will be necessary to review the eleven systems of the body. A brief description of each system follows. Keep in mind that an **organ** is defined as a structure composed of two or more tissues that performs one or more physiological functions. A **system**, on the other hand, is a group of organs that directly relate to each other functionally. To make the dissection more meaningful, answer the questions on the Laboratory Report *before* doing the dissection.

The Integumentary System

The Latin word *integumentum* means covering. The body surface covering that makes up this system includes the skin, hair, and nails.

The skin's principal function is to prevent bodily invasion by harmful microorganisms. In addition to being a mechanical barrier, the skin produces sweat and sebum (oil), which contain antimicrobial substances for further protection.

The skin also aids in temperature regulation and excretion. The evaporation of perspiration cools the body. The fact that perspiration contains many of the same excretory products found in urine indicates that the kidneys are aided by the skin in the elimination of water, salts, and some nitrogenous wastes from the blood.

To some extent, the skin also plays a role in nutrition. Evidence of this is seen in the way vitamin D forms in the skin's deeper layers when a vitamin D precursor in those cells is exposed to ultraviolet rays of sunlight.

As long as the skin remains intact, the internal environment is protected. However, serious skin injury, such as deep burns, may result in excessive serous fluid loss and electrolytic imbalances.

The Skeletal System

The skeletal system forms a solid framework around which the body is constructed. It consists of bones, cartilage, and ligaments. This system provides support and protection for the softer parts of the body. Delicate organs such as the lungs, heart, brain, and spinal cord are protected by the bony enclosure of the skeletal system.

In addition to protection, the bones provide points of attachment for muscles, which act as levers when the muscles contract. This arrangement makes movement possible.

Two other important functions of the skeletal system are mineral storage and blood cell production. The mineral component of bones provides a pool of calcium, phosphorous, and other ions that may be utilized to stabilize the mineral content of the blood. With respect to blood cell genesis, both red and white blood cells are formed in the red marrow of certain bones of the body.

The Muscular System

Attached to the skeletal framework of the body are muscles that make up nearly half the weight of the body. The skeletal muscles consist primarily of long multinucleated cells. The ability of these cells to shorten when stimulated by nerve impulses enables the muscles to move parts of the body in walking, eating, breathing, and other activities.

Two other kinds of muscle tissue exist in the body: smooth and cardiac. Smooth muscle tissue is the type found in the walls of the stomach, intestines, arteries, veins, urinary bladder, and other organs. Cardiac muscle tissue is found in the walls of the heart. Both types function like skeletal muscle fibers in that they perform work by shortening (contraction). However, whereas skeletal muscles are voluntarily controlled, smooth and cardiac muscle tissues are involuntarily regulated. Although skeletal muscles are primarily involved in limb movement, some skeletal muscles function in the reproductive, respiratory, and digestive systems.