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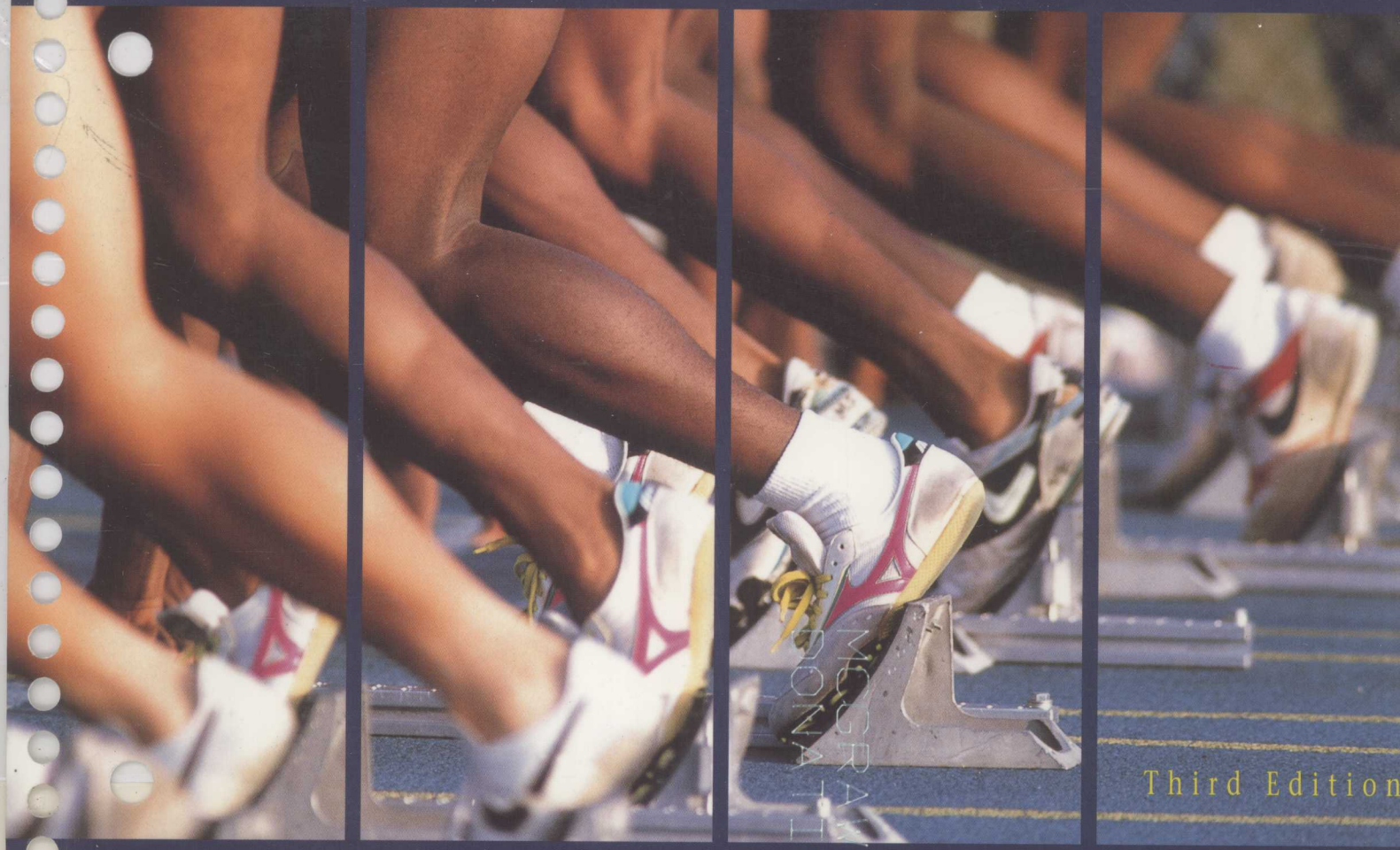
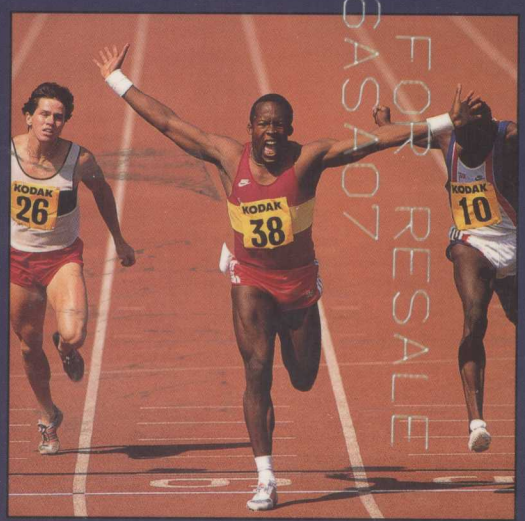


Third Edition

Anatomy & Physiology

LABORATORY TEXTBOOK • ESSENTIALS VERSION



Third Edition

Anatomy & Physiology

LABORATORY TEXTBOOK · ESSENTIALS VERSION

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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.

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PREFACE

This *Essentials Version* of the *Anatomy and Physiology Laboratory Textbook* presents the fundamentals of human anatomy and physiology in a manner that is appropriate for students in allied health programs such as practical nursing, radiologic technology, medical assisting, and dental assisting. These students usually take a one-semester course in human anatomy and physiology and need a laboratory text that provides coverage of the fundamentals without the clutter of excessive details and unneeded terminology. While maintaining the strengths of the *Short Version,* this *Essentials Version* is shorter, more concise, and less rigorous to better serve these students.

Exercise Format

Each of the thirty-eight exercises begins with a short list of objectives that outline the minimal learning responsibilities for the students. The exercises are basically self-directing, which minimizes the need for lengthy introductions by the instructor.

Instructors will find that the listing of required equipment and materials on the first page of each exercise facilitates laboratory preparation. The exercises use standard equipment and materials that are usually available in most biology departments.

Three exercises utilize electronic equipment. For investigating muscle contraction, instructors have a choice of using either the Narco Bio-Systems Physiograph in Exercise 20 or the Intelitool Physiogrip in Exercise 21. Exercise 32, Respiratory Physiology, offers options of using either nonelectronic equipment (Propper spirometers) or the Intelitool Spirocomp to determine lung volumes. Exercises using the Intelitool systems contain directions for three computer platforms: Apple II (ProDOS), Macintosh (System 6.0.8 or higher), and IBM or compatible PC (MS-DOS 3.3 or higher, or Windows 95).

Each exercise topic is covered at a reduced level of difficulty appropriate for the student audience and presented in a direct, concise manner in simple English to facilitate student learning. Numerous illustrations and many photomicrographs are correlated with the text to improve understanding.

The necessary key terms are in bold print to aid students in building a vocabulary of anatomical and physiological terms.

Laboratory procedures are distinct from and follow the discussion of the exercise topic. They are presented in a concise, stepwise manner to guide the student. Activities consist of (1) labeling illustrations, (2) dissections, (3) study of specimens and models, (4) physiological experiments, and (5) microscopic studies. A major dissection specimen, such as the cat or fetal pig, is not included. Instead, a rat dissection is used in a single exercise to acquaint students with the basic organization of organ systems in mammals. If you wish to use the cat or fetal pig as a major dissection animal, please examine a copy of the *Intermediate Cat* or *Intermediate Fetal Pig* versions of the *Anatomy and Physiology Laboratory Textbook.*

Pedagogical Design

The pedagogical design calls for students to develop an understanding of each exercise topic by (1) labeling the illustrations using information presented in the text and (2) completing corresponding portions of the laboratory report. Where appropriate, students are asked to color code anatomical parts to reinforce learning. Usually, students should complete these activities *before* coming to the laboratory or proceeding with the other laboratory studies.

The *laboratory reports* are designed to guide and reinforce student learning and provide a convenient site for recording data and making diagrams of observations. They are located at the back of the book to better control the pagination and to keep the book brief. The corresponding laboratory report should be removed from the back of the book whenever students *begin* working on an exercise. Removing the reports prevents page flipping and facilitates completing the laboratory report. Completed laboratory reports should be kept in the student's notebook. Instructors may choose to either post the answer keys from the *Instructor's Manual* so students can check their work or collect and grade the laboratory reports. The design of the laboratory reports makes them easy to grade.

Students in the target group typically have difficulty in learning the necessary anatomical and physiological terminology, especially the correct spellings. Experience has shown that students learn key terms

and their correct spellings more easily if they write the terms. Thus, the laboratory reports are structured so that students are required to write the names of key terms rather than simply provide a matching letter or number.

Microscopic study is another difficult area for these students since they have trouble locating histological structures on slides when using diagrams as a reference. This problem is largely overcome by the inclusion of full-color photomicrographs of common tissues and of selected histological subjects. These are found in the Histology Atlas and in Exercise 37, The Endocrine Glands.

Instructor's Manual

The accompanying *Instructor's Manual* provides additional aid for the instructor: (1) a composite list of equipment and supplies, (2) operational suggestions, and (3) answer keys for the laboratory reports.

Adopters are encouraged to contact the authors regarding any problems and to submit constructive suggestions that will improve future editions.

Acknowledgments

We also recognize the helpful suggestions provided by the following reviewers: Martha W. Andrus, Grambling State University; John R. Capeheart, University of Houston-Downtown; Dale L. Clayton, Southwestern Adventist University; Phillip Eichman, University of Rio Grande; Stephanie King, Wood College; Katharine Lawrence, Cochise College; Amy G. Ouchley, University of Louisiana at Monroe; Janice J. Weber, Huron University; Douglas R. Zehr, William Penn College.

To the Student

This laboratory textbook has been designed to help you master the fundamentals of human anatomy and physiology, which provide the basis of the health-related professions. An understanding of anatomical structures, physiological processes, terminology, and techniques will give you the basic knowledge that is essential for success in your chosen field.

Each exercise begins with a list of learning objectives to guide your study. The sequence of activities in each exercise is established to facilitate the development of your understanding. Follow the sequence; don't skip around.

The activities consist of (1) labeling illustrations, (2) dissections, (3) study of specimens and models, (4) physiological experiments, and (5) microscopic study. Follow the directions for each activity with care to enhance your success in the laboratory. Work carefully and thoughtfully. Remember, the objective is to learn the material, not just to complete the exercise.

Each exercise has a *laboratory report,* located in the back of the book, that you are to complete as you work through the exercise. Remove it from the book when you *start* the exercise so that you can complete it without page flipping. Completed laboratory reports may be kept in your notebook.

Labeling Illustrations

Most of the exercises are designed so that you will learn anatomy by labeling illustrations from the information provided in the text. This process helps you to understand the relationships between anatomical features, and it facilitates learning. Correctly labeled illustrations are then used as references when examining specimens and models. Use them for study and review purposes. Usually, the illustrations should be labeled *before* coming to the laboratory session.

Dissections

The dissections will include freshly killed rats and animal parts obtained from a slaughterhouse. The purpose of dissection is to expose anatomical parts for observation and study. Strive to cut as little as possible to achieve this goal. Use the scalpel sparingly. Most dissections can be accomplished with scissors, forceps, and probe.

Experiments

Before performing any experiment, read the directions completely through so that you have a good understanding of the experiment. Be sure that you have all of the equipment and materials required to complete the experiment before starting. Then, carefully follow the directions.

Microscopic Study

An examination of prepared slides enables you to visualize and understand the cytological or histological structure of specimens. Correlate your observations with the text, diagrams, and photomicrographs of the Histology Atlas. If drawings are required, make them with care and label the structures. In this way, you will understand the microscopic structures more quickly and better prepare yourself for lab practicums.

Laboratory Reports

Complete the laboratory reports independently to maximize your understanding. The laboratory reports are purposely designed so that you must write the key terms involved in the exercise, sometimes more than once. This format is used because writing the terms enables you to learn them more easily, especially their correct spellings.

General Operations

Success in the laboratory can be increased by following a few simple guidelines.

1. Be on time to class so that you will hear the comments and directions given by your instructor.
2. Follow your instructor's directions. Take notes on any changes in the equipment, materials, or procedures.

3. Keep your work area free of clutter. Extraneous items should be located elsewhere during the laboratory session.
4. Bring your textbook to the laboratory for reference.
5. Use equipment and materials with care. Report any problems or accidents to your instructor immediately.
6. Work independently, but be cooperative and helpful in team assignments.
7. Do not eat, drink, or smoke in the laboratory.

CONTENTS

Exercise 1

Introduction to Human Anatomy

Objectives

After completing this exercise, you should be able to:

1. Correctly use directional and regional terms in describing the location of anatomical structures.
2. Identify the external body regions and body cavities on charts or a torso model.
3. Contrast the types of body sections used in anatomical studies.
4. Describe the organs and membranes of the body cavities.
5. Define all terms in bold print.

Materials

Human torso model with removable organs

Human anatomy is the study of the structures composing the human body and their interrelationships. The description of anatomical features requires the use of specific *anatomical terminology* that provides precise meaning. It is important that you learn the terminology presented in this exercise as quickly as possible because these terms will be used frequently throughout your study of the human body. In this exercise, you will be introduced to the anatomical terminology that is used to describe (1) relative positions of structures, (2) body sections or planes, (3) external features and body regions, and (4) body cavities and their membranes.

Directional Terms

The relative position of body structures is communicated through the use of **directional terms.** These terms typically occur as pairs, with the members of each pair having opposite meanings. For example, *anterior* means toward the front of the body, and *posterior* means toward the back of the body. Most directional terms apply to organs of the body as well as to the body as a whole. Learn the meanings of the directional terms in Table 1.1.

When directional terms are used to describe the relative positions of body parts, it is assumed that the body is in a standard position called the *anatomical position.* In this position, the body is erect with arms at the sides and with the palms of the hands facing forward (anteriorly). The anatomical position is shown in Figures 1.1 and 1.2.

TABLE 1.1
Directional Terms

Term	Meaning
Anterior (ventral)	Toward the front or abdominal surface of the body
Posterior (dorsal)	Toward the back of the body
Superior (cephalad)	Toward the head
Inferior (caudad)	Away from the head
Medial	Nearer the midline of the body
Lateral	Farther from the midline of the body
Proximal	Nearer the attachment of an extremity to the trunk
Distal	Farther from the attachment of an extremity to the trunk
External (superficial)	Toward or on the body surface
Internal (deep)	Away from the body surface
Parietal	Pertaining to the outer boundary of body cavities
Visceral	Pertaining to the internal organs

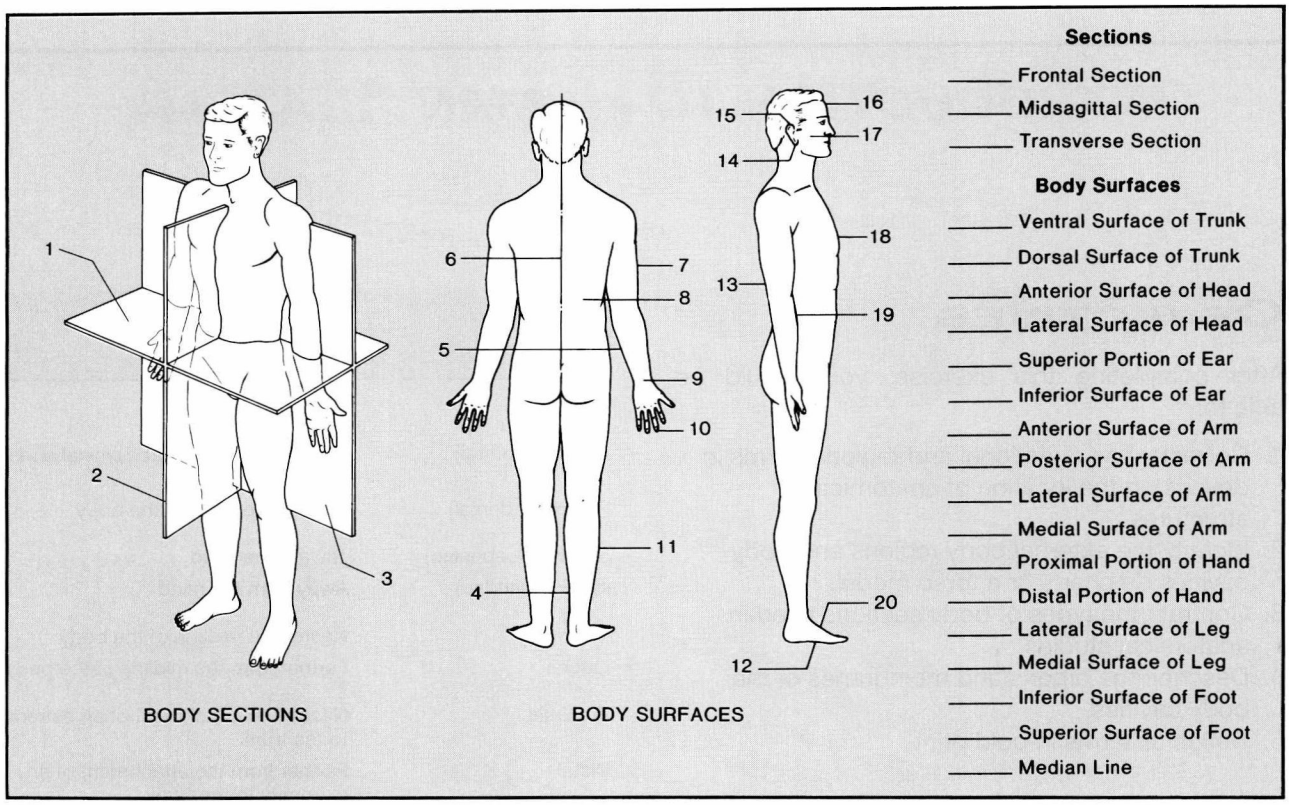
Body Sections

To observe the relative positions of internal structures, it is necessary to view them in sections that have been cut through the body. These sections, or planes, are applicable both to the whole body and to individual organs. See Figure 1.1.

Sagittal sections are parallel to the longitudinal (long) axis of the body and divide the body into left and right portions. A **midsagittal section** is made along the **median line** and divides the body into *equal* left and right halves.

Frontal (coronal) sections divide the body into anterior and posterior portions and are perpendicular to sagittal sections but parallel to the longitudinal axis.

Figure 1.1 Body sections and surfaces. Note that the body is in the anatomical position.



Transverse (horizontal) sections divide the body into superior and inferior portions and are perpendicular to the longitudinal axis of the body.

ASSIGNMENT

Check your understanding of directional terms, body sections, and body surfaces by labeling Figure 1.1. Place the correct number of each section and surface in the space in front of the labels listed. Record your responses for Figure 1.1 on Laboratory Report 1, which begins on page 235.

Regional Terminology

Specific anatomical terms are used to identify the various regions of the body. The **trunk** is the main portion of the body to which the **head, upper extremities** (arms), and **lower extremities** (legs) are attached. These major divisions are subdivided into smaller regions that are identified by specific anatomical terms. Refer to Figures 1.2 and 1.3 as you study this section on terminology.

Trunk

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

The **dorsum,** or posterior surface, of the trunk may be subdivided into the costal, lumbar, and gluteal regions. The **costal region** is that portion over the ribs. The lower back between the ribs and hips is the **lumbar,** or **loin, region.** The **gluteal region** refers to the **buttocks,** rounded eminences of the rump.

Two regions are located on the lateral surfaces of the trunk. The armpit area is known as the **axilla.** The region lateral and adjacent to the lumbar region is the **flank.**

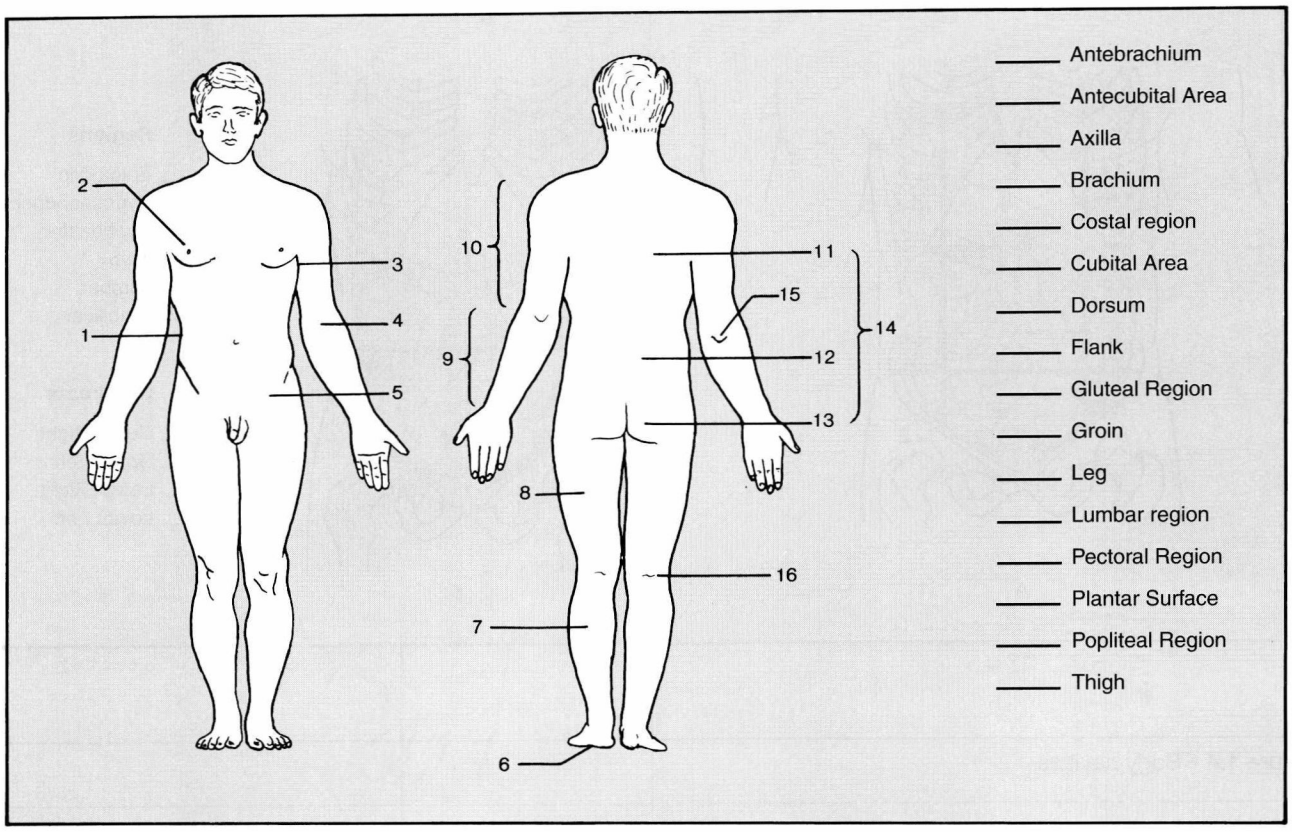
Upper Extremity

The **shoulder** is formed by the attachment of the upper extremity to the trunk. The upper arm is called the **brachium,** and the forearm is the **antebrachium.** The posterior surface of the arm at the elbow is the **cubital region;** the anterior surface of the arm at the elbow is the **antecubital region.**

Lower Extremity

The proximal (upper) part of the lower extremity is the **thigh,** and the portion between the knee and ankle is called the **leg.** The fleshy posterior part of the

Figure 1.2 Regional terminology.



leg is called the **calf.** The anterior surface of the knee is the **patellar area,** and the posterior surface of the knee is the **popliteal region.** The sole of the foot is the **plantar surface.**

Abdominal Divisions

Underlying internal organs may be located by dividing the abdominal surface into either nine regions or four quadrants. Anatomists prefer to divide the abdominal surface into nine regions formed by the intersecting of two vertical and two transverse planes as shown in Figure 1.3, illustration A.

The **umbilical region** is the central area that includes the umbilicus (navel). On each side of the umbilical region are the left and right **lumbar regions.** Just above the umbilical region is the **epigastric region,** which is between the left and right **hypochondriac regions.** Below the umbilical region is the **hypogastric,** or **pubic, region,** which is between the left and right **iliac regions.**

Health-care professionals often use a simpler system in which the abdomen is divided into quadrants by perpendicular vertical and transverse planes that intersect at the umbilicus. See Figure 1.3, illustration B. This division forms four quadrants: upper right, upper left, lower right, and lower left.

ASSIGNMENT

Label Figures 1.2 and 1.3 and record your responses on the laboratory report.

Body Cavities

Internal organs are located within body cavities. There are two major body cavities, the dorsal cavity and the ventral cavity, as shown in Figure 1.4. These cavities are named after the body surface nearest to them.

The **dorsal body cavity** consists of the **cranial cavity,** which contains the brain, and the **spinal cavity,** which contains the spinal cord.

The **ventral body cavity** consists of the **thoracic cavity,** which houses the lungs, heart, and other thoracic organs, and the **abdominopelvic cavity,** which contains most of the internal organs. A thin, dome-shaped sheet of muscle, the **diaphragm,** separates the thoracic and abdominopelvic cavities.

The thoracic cavity is divided into left and right portions by the **mediastinum,** a membranous partition that contains the heart, trachea, esophagus, and thymus gland. The **pericardial cavity,** containing

Figure 1.3 Abdominal regions and quadrants.

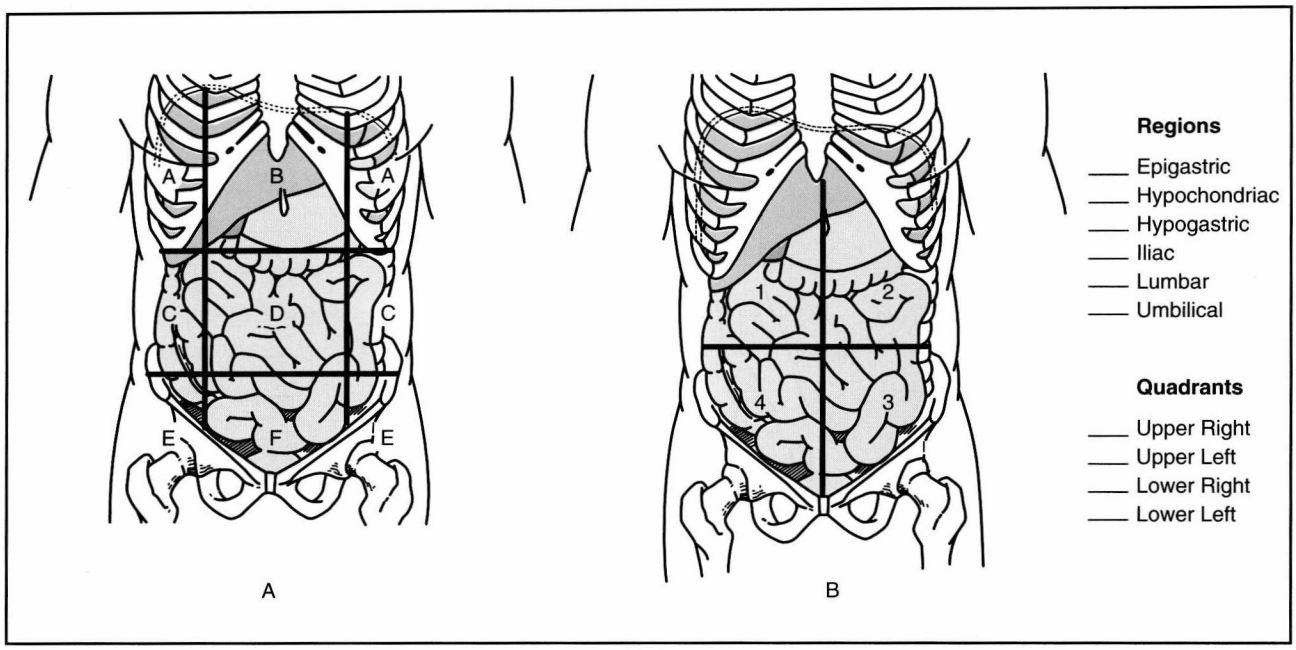


Figure 1.4 Body cavities.

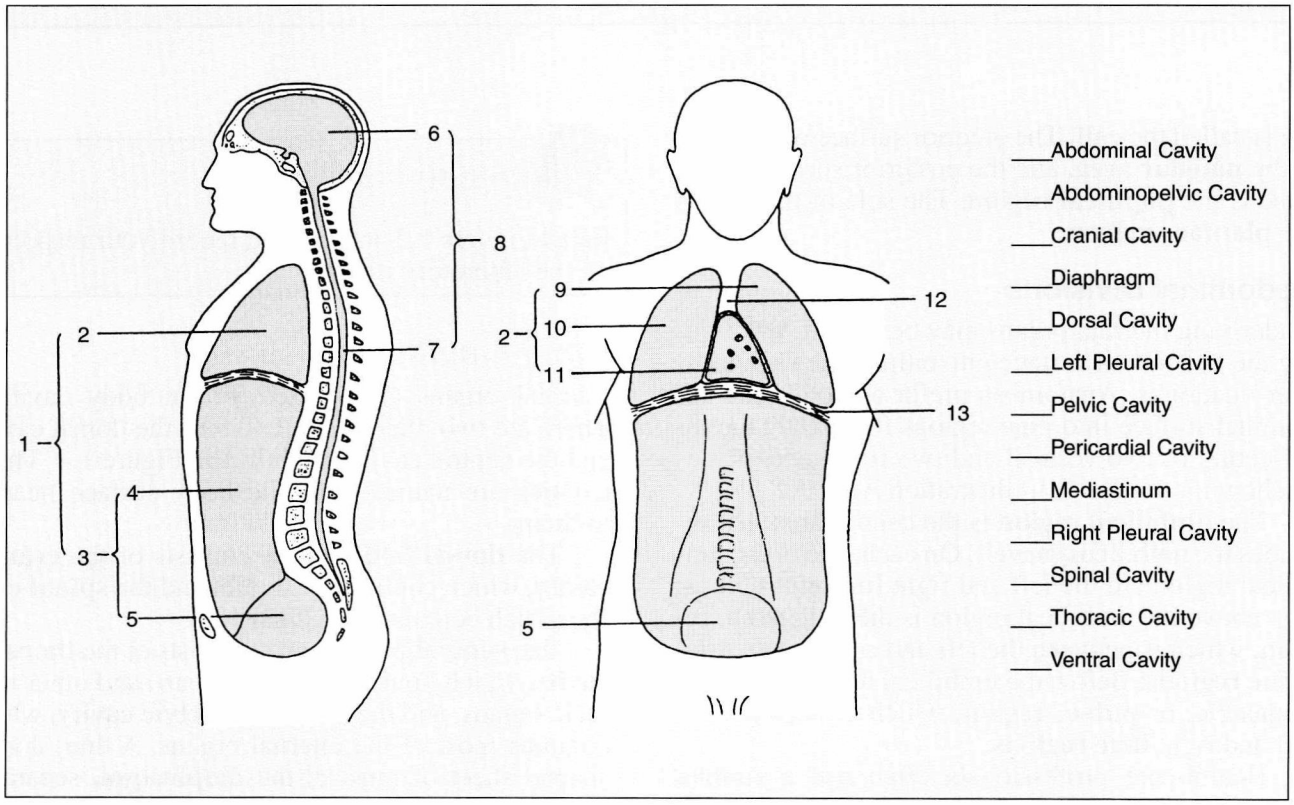
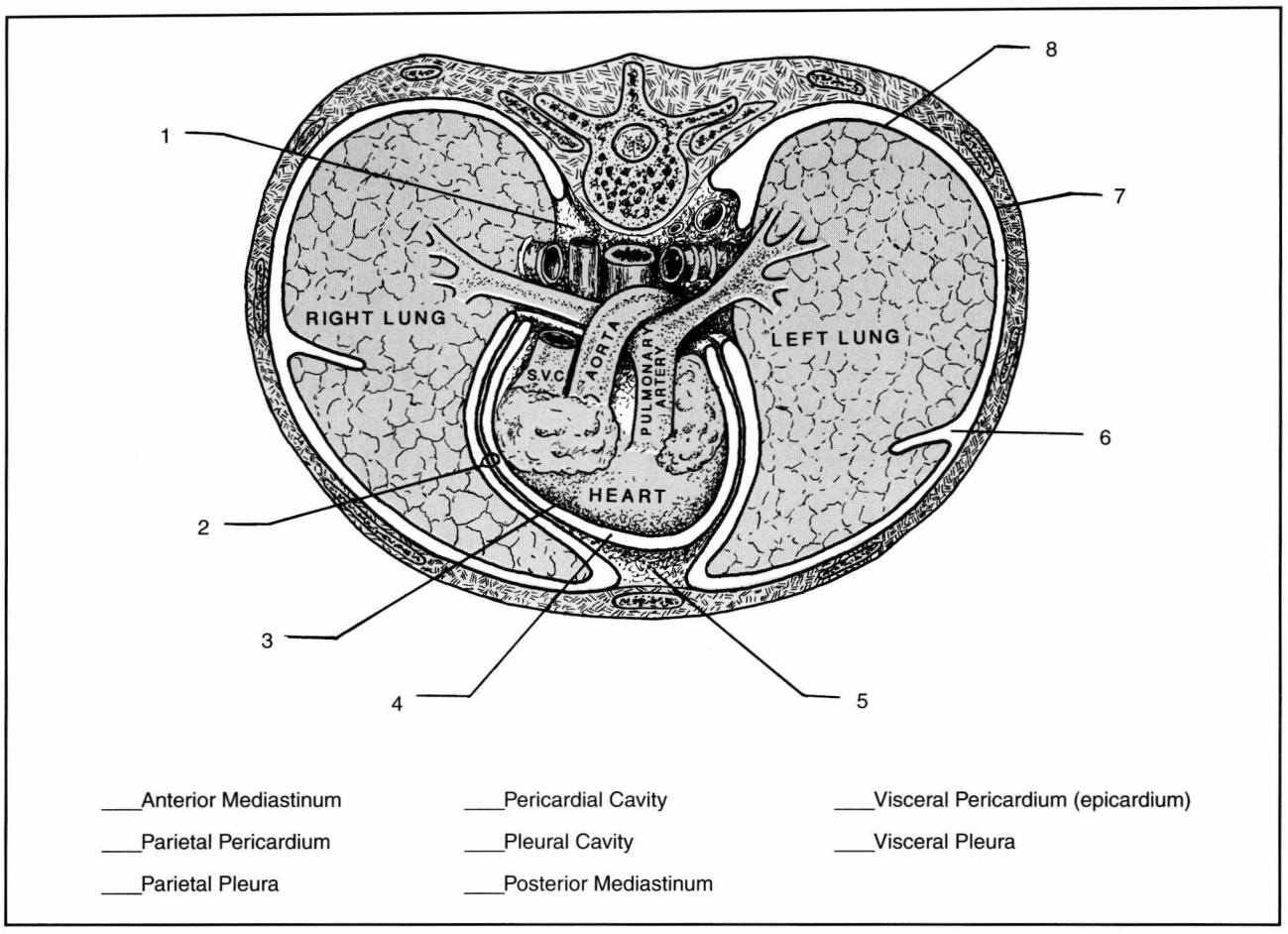


Figure 1.5 Transverse section through thorax.



the heart, is within the mediastinum. The right and left **pleural cavities** contain the lungs.

The abdominopelvic cavity consists of (1) the **abdominal cavity,** which contains the stomach, intestines, liver, gallbladder, pancreas, spleen, and kidneys, and (2) the **pelvic cavity,** which contains the urinary bladder, sigmoid colon, and rectum. In females, it also contains the uterus, uterine tubes, and ovaries.

Membranes of Body Cavities

The body cavities are lined with membranes that provide protection and support for the internal organs. Refer to Figures 1.5 and 1.6 as you read this section.

Dorsal Cavity Membranes

The dorsal cavity is lined by three membranes that are collectively called the **meninges.** The outermost membrane is tough and fibrous; the other two membranes are more delicate. The thin innermost membrane closely envelops the brain and spinal cord.

Ventral Cavity Membranes

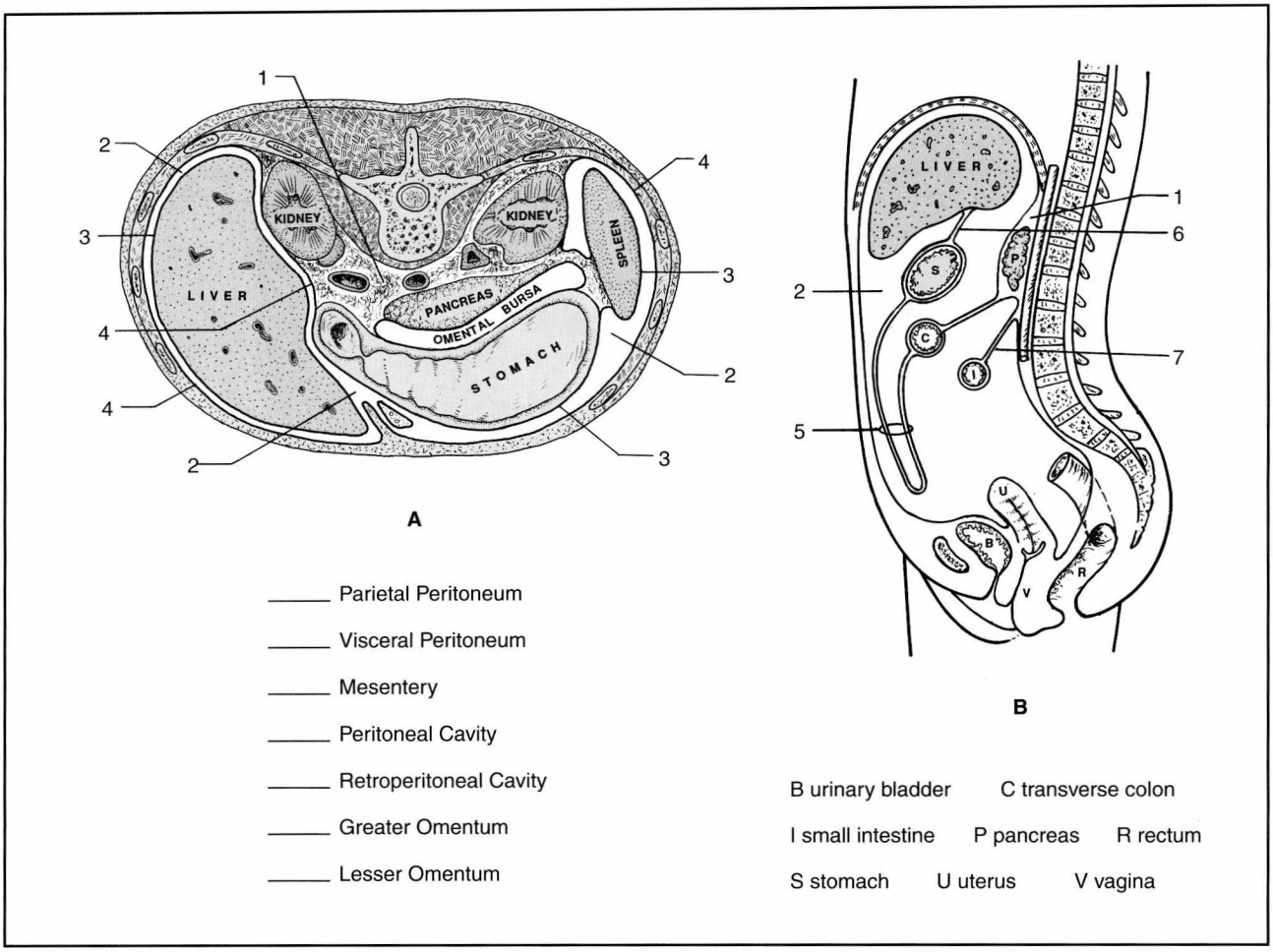
The membranes lining the ventral cavity are **serous membranes** that secrete a watery fluid called *serous fluid.* Their moist, slippery surfaces reduce friction between internal organs and the walls of the ventral cavity as the organs move.

Thoracic Cavity Membranes

The inner walls of the left and right portions of the thoracic cavity are lined by the **parietal pleurae;** the lungs are covered with the **visceral (pulmonary) pleurae.** The parietal and visceral pleurae are separated only by a thin layer of serous fluid. This moist, potential space between the pleural membranes is known as the **pleural cavity.** Note in Figure 1.5 that the pleural membranes are continuous with the membranes forming the mediastinum.

The heart is enclosed within the **pericardium.** The **visceral pericardium,** or **epicardium,** is a thin serous membrane that is tightly attached to the exterior surface of the heart. Exterior to the epicardium is the loose-fitting, double-layered **parietal pericardium.**

Figure 1.6 Transverse and longitudinal sections of the abdominal cavity.



The inner layer of the parietal pericardium is a serous membrane, but the outer one is fibrous and very strong. The **pericardial cavity** is the potential space between the visceral and parietal pericardia.

Abdominal Cavity Membranes

The **peritoneum** lines the abdominal cavity. The **parietal peritoneum** lines the inner abdominal wall, and the **visceral peritoneum** covers the surface of the abdominal organs. The potential space between the visceral and parietal peritonea is the **peritoneal cavity.** See Figure 1.6. The kidneys are located in the **retroperitoneal region** (posterior to the peritoneum), so only part of their surfaces is covered with the parietal peritoneum.

Double-layered folds of the peritoneum, called **mesenteries,** extend from the cavity wall to the abdominal organs. The mesenteries support the abdominal organs, and they contain nerves and blood vessels serving the organs. A large mesenteric fold, the **greater omentum,** extends inferiorly from the stomach over the intestines and loops back up to join with the transverse colon (part of the large intestine). A smaller mesenteric fold, the **lesser omentum,** extends between the liver and the stomach.

The peritoneum does not line the pelvic cavity. It extends inferiorly only to cover the superior surface of the urinary bladder.

ASSIGNMENT

1. Label Figures 1.4, 1.5, and 1.6 and record the labels on the laboratory report.
2. Using a human torso model (a) locate the surface features and body cavities, (b) identify the major organs of each cavity, and (c) locate the organs within each of the nine abdominal regions and four abdominal quadrants.
3. Complete the laboratory report.

Exercise 2

BODY ORGANIZATION

OBJECTIVES

After completing this exercise, you should be able to:

1. List the organ systems and describe their general functions.
2. List the component organs for each organ system.
3. Locate and identify the organs in the ventral cavity of the rat.
4. Define all terms in bold print.

Materials

Freshly killed rat
Dissecting pan with wax bottom
Dissecting instruments and pins
Human torso model with removable organs

The human body is composed of a hierarchy of organizational levels. From simplest to most complex, they are chemical, cellular, tissue, organ, and organ system. Components of each organizational level work together to maintain **homeostasis,** the relative constancy of the body's normal internal environment.

Organ Systems

Most of the functions of the body are performed by organ systems. An **organ** is a structure that is (1) composed of two or more tissues, (2) has a definite shape, and (3) performs specific functions. The heart is an example of an organ. An **organ system** is a group of organs that function in a coordinated manner to perform specific functions. The cardiovascular system, which is composed of blood, heart, blood vessels, and spleen, is an example of an organ system.

In this exercise, you will study an overview of the components and general functions of the organ systems of the body in order to gain a general understanding of body organization and function. See Figures 2.1 and 2.2. Then you will dissect a freshly killed rat to observe the mammalian body organization, body cavities, and organs of the ventral cavity.

The Integumentary System

The skin, including hair, nails, associated glands, and sensory receptors, constitutes the integumentary system. The **skin** consists of two layers, an outer **epidermis** and an inner **dermis,** which protect the underlying tissues from mild abrasions, excessive water loss, microorganisms, and ultraviolet radiation. Perspiration secreted by sweat glands contains water and waste materials similar to dilute urine. The evaporation of perspiration cools the body surface.

The Skeletal System

The skeletal system forms the framework of the body and provides support and protection for softer organs and tissues. It consists of **bones, cartilages,** and **ligaments.** In conjunction with skeletal muscles, the skeleton forms lever systems that enable movement. In addition, **red bone marrow** produces blood cells.

The Muscular System

The contraction of muscles provides the force that enables movement. **Skeletal muscles** are attached to bones by **tendons** and constitute nearly half of the body weight. Their contractions move body parts during walking, eating, and other activities.

Two other types of muscle tissue occur in the body: smooth and cardiac. *Smooth muscle* is found in walls of hollow organs. *Cardiac muscle* occurs in the walls of the heart.

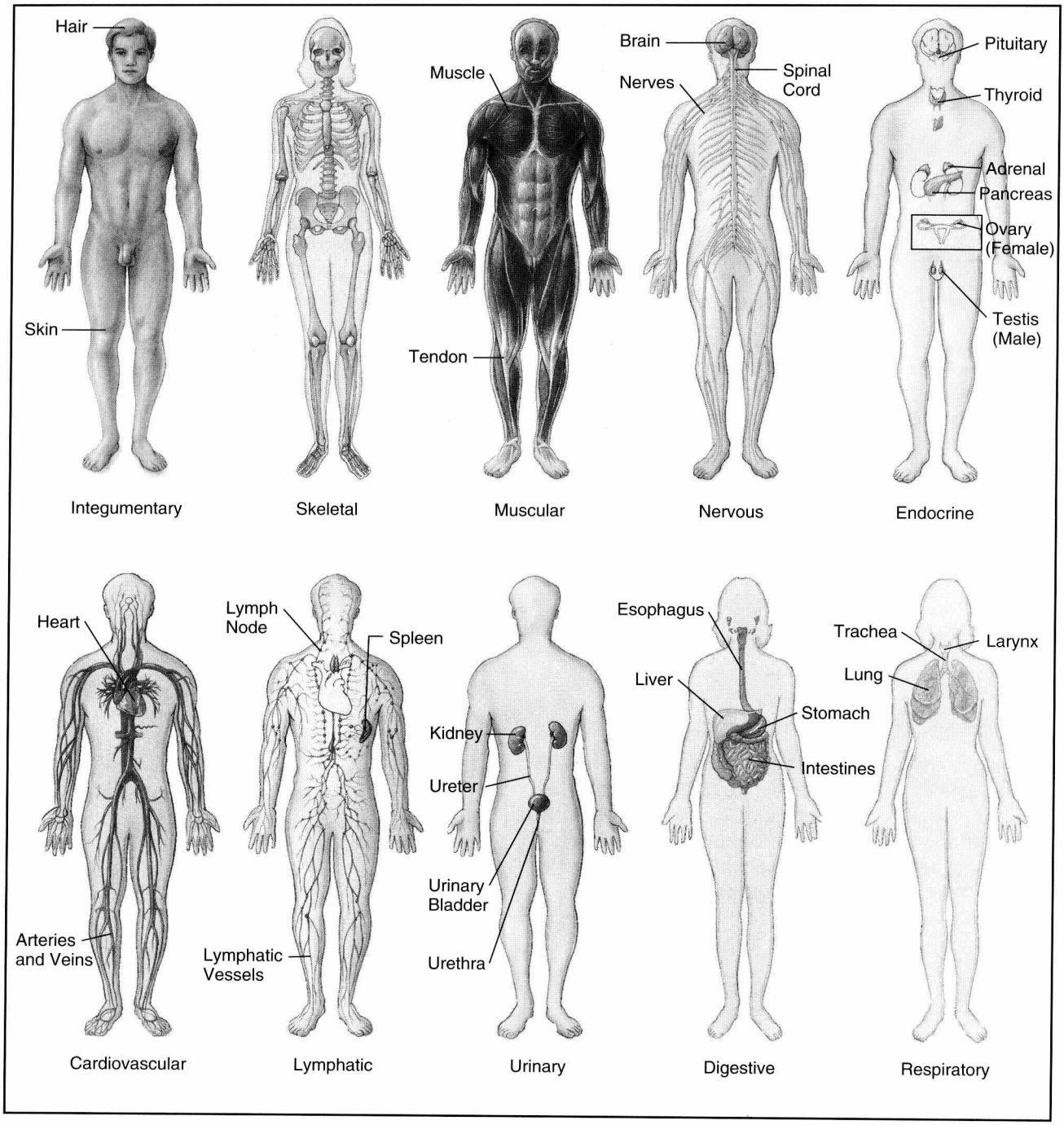
The Nervous System

The nervous system is a complex, highly organized system consisting of the **brain, spinal cord, cranial** and **spinal nerves,** and **sensory receptors.** These components work together to enable rapid perception and interpretation of the environment and the almost instantaneous coordination of body functions. The human brain is responsible for the intelligence, will, self-awareness, and emotions characteristic of humans.

The Endocrine System

The endocrine system consists of small masses of glandular tissue that secrete hormones. Hormones, which are chemical messengers, are absorbed by the

Figure 2.1 Ten of the eleven human organ systems.

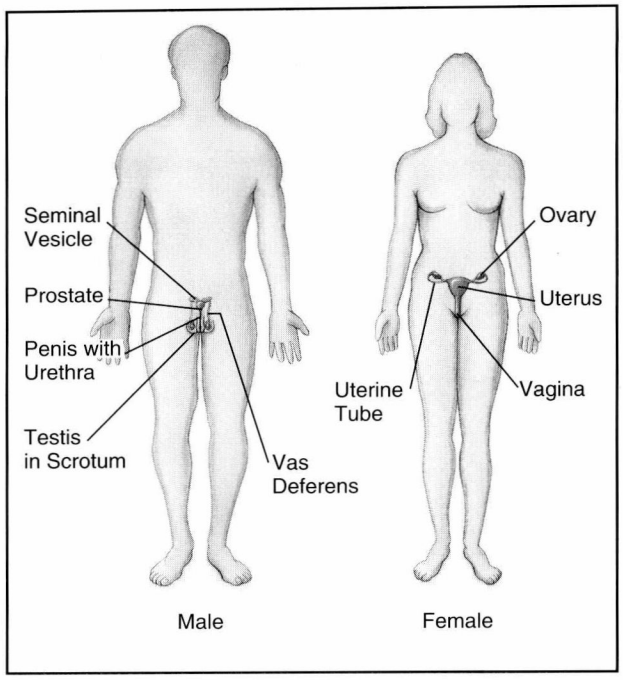


blood and transported throughout the body, where they bring about the chemical control of body functions. The larger masses of endocrine tissues occur in the **endocrine glands: pituitary, thyroid, parathyroid, thymus, adrenal, pancreas, pineal, ovaries,** and **testes.** Smaller masses of hormone-producing tissues occur in other organs, such as the kidneys, heart, and placenta, and in the digestive tract.

The Cardiovascular System

The **heart, arteries, veins, capillaries, spleen,** and **blood** constitute the cardiovascular system. These components work together to transport materials such as oxygen, carbon dioxide, nutrients, wastes, and hormones throughout the body. Contractions of the heart circulate the blood through the blood vessels. Blood, consisting of cells and plasma, is the

Figure 2.2 Male and female reproductive systems.



transporting agent and also provides the primary defense against disease organisms. The spleen serves as a blood reservoir and removes worn-out red blood cells from circulation.

The Lymphatic System

The lymphatic system consists of **lymphoid tissue** and a network of **lymphatic vessels** that collect fluid from interstitial spaces (spaces between cells) and return it to large veins under the collarbones. Tissue or interstitial fluid is called **lymph** after it enters a lymphatic vessel. En route, lymph passes through **lymph nodes,** nodules of lymphoid tissue, that remove cellular debris and microorganisms. Lymphoid tissue is found in many organs, such as the spleen, thymus, tonsils, adenoids, liver, intestines, and bone marrow.

The Respiratory System

The exchange of oxygen and carbon dioxide between the atmosphere and the blood is enabled by the respiratory system. It consists of air passageways and gas-exchange organs. The passageways are the **nasal cavity, nasopharynx, larynx, trachea,** and **bronchi.** The gas exchange organs are the **lungs.**

The Digestive System

The digestive system converts large nonabsorbable food molecules into smaller nutrient molecules that can be absorbed into the blood. Digestion involves mechanically breaking food into smaller particles and mixing them with digestive fluids and chemically breaking large molecules into smaller molecules. The digestive tract consists of the **mouth, pharynx, esophagus, stomach, small intestine,** and **large intestine.** Major digestive glands are the **salivary glands, liver,** and **pancreas.**

The Urinary System

The nitrogenous wastes of metabolism and excess water and minerals are removed from the blood and body by the urinary system. The **kidneys** remove wastes and excess materials from the blood to form urine, which is carried by two **ureters** to the **urinary bladder** for temporary storage. Subsequently, urine is voided via the **urethra.**

The Reproductive System

Continuity of the species is the function of the male and female reproductive systems. The male reproductive system consists of a pair of sperm-producing **testes** located in the **scrotum;** two tubes, the **vasa deferentia,** which carry sperm to the **urethra; accessory glands** that secrete fluids for sperm transport; and the **penis,** the male copulatory organ. The female reproductive system consists of a pair of **ovaries** that produce ova, two **uterine tubes** that carry the ova to the **uterus, accessory glands** that secrete lubricating fluids, and the **vagina,** the female copulatory organ and birth canal.

ASSIGNMENT

1. Complete the laboratory report for this exercise.
2. Locate the major organs of the organ systems on the human torso model.

Rat Dissection

You will work in pairs to perform this part of the exercise. Your principal objective in the dissection is to *expose the organs for study, not to simply cut up the animal.* Most cutting will be performed with scissors. The scalpel blade will be used only occasionally, but the flat blunt end of the handle will be used frequently for separating tissues.

Skinning the Ventral Surface

1. Pin the four feet to the bottom of the dissecting pan as illustrated in Figure 2.3. Before making any incision, examine the oral cavity. Note the large **incisors** in the front of the mouth, which are used for biting off food particles. Force the mouth open sufficiently to examine the flattened **molars** at the back of