PRINCIPLES OF HUMAN ANATOMY

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PREFACE

AUDIENCE

Designed for the introductory course in human anatomy, *Principles of Human Anatomy* assumes no previous study of the human body. The text has been geared to students in biological, medical, and health-oriented programs. Among the students specifically served by this volume are those aiming for a career as a nurse, medical assistant, physician's assistant, medical laboratory technologist, radiologic technologist, respiratory therapist, dental hygienist, physical therapist, mortician, and medical record keeper. However, because of the scope of the text, *Principles of Human Anatomy* may also be useful for students in the liberal arts and physical education.

OBJECTIVES

Because the subject matter of human anatomy is an exceedingly large and complex body of knowledge to present in an introductory course, I have attempted to present unified concepts and data considered useful to a basic understanding of the structure of the human body. I have minimized data unessential to this objective. My second principal objective has been to present the material at a reading level that can be handled by the average student. In accordance with this objective, I have not avoided technical vocabulary or vital, but difficult, concepts. Rather, I have attempted to develop step-by-step, easy-to-comprehend explanations of each concept.

THEMES

This textbook departs from the approaches of other anatomy texts in that somewhat more emphasis is given to physiology and disorders. I feel that it is motivationally and conceptually more effective to present basic anatomy with some reference to function. This framework is especially true of certain systems of the body, such as the nervous system. It makes little sense to present students with anatomical detail without applying the anatomy to function because structure determines function. By including function, this text will give students a better understanding of anatomical concepts. Moreover, I feel that a study of anatomy should include frequent reference to clinical situations. For this reason, I have included disorders that can be understood once the normal anatomy is learned. The disorders are treated under a special heading, called "Applications to Health," in selected chapters. The basic content of this book is anatomy, but by presenting it within the context of physiology and disorders, it should be more readily assimilated by the student.

ORGANIZATION

The book is organized by systems rather than by regions. The first chapter provides students with an introduction to the levels of structural organization, body cavities, anatomical terms, directional terms, planes of the body, surface anatomy, and units of measurement. Then, a generalized cell is used to demonstrate the basic features of cells. Tissue organization is presented through descriptions of the structure, functions, and locations of the principal kinds of epithelium and connective tissue. The histology of bone, muscle, nervous tissue, and blood is dealt with under the relevant organ systems. The skin and its accessory structures are utilized to acquaint the student with the organ and system level of organization.

The first body system studied in detail is the skeletal system. This is accomplished by examining the principal features of osseous tissue, the axial skeleton, the appendicular skeleton, and articulations. Then the muscular system is analyzed through a study of muscle tissue and the locations and actions of the principal muscles of the body.

The student is next introduced to the blood vascular and lymphatic systems. The chapter includes a study of blood, interstitial fluid, lymph, the heart, blood vessels, circulatory routes, and lymphatic structures.

The next major area of emphasis is the nervous system. Students are introduced to the structure and physiology of nervous tissue, the spinal cord and spinal nerves, the brain and cranial nerves, and the autonomic system. The structure and function of the visual, auditory, gustatory, and olfactory receptors are also considered.

Attention is then turned to a discussion of the anatomy and physiology of the endocrine system and reproductive systems. Here the interrelationships between hormones and reproduction are established.

The text concludes with a description of the respiratory system, digestive system, and urinary system.

Discussions of all major body systems include some reference to physiology, disorders, and a listing of pertinent key terms.

SPECIAL FEATURES

The text contains a number of special learning aids for students, including the following:

1. "Student Objectives" appear at the beginning of each chapter. Each objective describes a knowledge or skill the student should acquire while studying the chapter. (See "Note to the Student" for an explanation of how the objectives can be utilized.) End-of-chapter "Review Questions and Problems" are designed specifically to help meet the stated objectives. In addition, each "Chapter Summary in Outline" provides a checklist of major topics the student should learn. The end-of-chapter material concludes with a list of "Selected Readings."
2. The health-science student is generally expected to learn a great deal about the anatomy of certain organ systems—specifically, bones, skeletal muscles, blood vessels, and nerves. In these high anatomy areas, I have pulled many anatomical details out of the narrative and placed them in Exhibits, most of which are closely tied to illustrations. This method organizes the data and deemphasizes rote learning of concepts presented in the narrative.
3. An unusually large number of disorders is described in the section entitled "Applications to Health" in appropriate chapters. The topics provide review of normal anatomy and physiology and allow the student to see why the study of anatomy is fundamental to a career in any of the health fields.
4. Glossaries of selected "Key Terms" appear at the end of every chapter that deals with a major body system.
5. Photomicrographs and electron micrographs are frequently accompanied by adjacent labeled diagrams that amplify and aid observation.
6. There are numerous roentgenograms, especially of bones. These are labeled and designed to provide students with an opportunity to transfer anatomical knowledge to clinical situations.
7. Many students find muscle identification an onerous task. To help the student, I have provided the following learning aids: The illustrations of muscles are shown with duplicates of the drawings that are used for bone identification. In this way, the student is given consistent points of reference. I have also presented a brief section on the criteria for naming skeletal muscles. Each Exhibit dealing with muscles also contains a listing of prefixes, suffixes, roots, and definitions for each muscle discussed. These will help the student understand why a particular skeletal muscle is so named.
8. Another distinctive feature of this textbook is the inclusion of a very large number of photomicrographs of various tissues of the body. These are designed to help the student understand anatomy at the microscopic level.
9. A comprehensive "Glossary" of important terms used in the textbook, with a pronunciation key, concludes the book.

SUPPLEMENTARY MATERIAL

A complimentary Instructor's Manual accompanies *Principles of Human Anatomy.* For each chapter of the textbook, the Manual contains a listing of key instructional concepts, selected audiovisual materials, and twenty multiple-choice questions. A directory of the distributors of the audiovisual materials is also provided. The questions have been carefully designed to evaluate student understanding of data, concepts, clinical situations, and their applications.

ACKNOWLEDGMENTS

Since the inception of this textbook, Canfield Press has provided me with the services of several individuals who reviewed various portions of the manuscript at different times. These reviewers provided me with invaluable assistance in preparing the manuscript. Among those to whom I wish to express my deepest gratitude for reviewing the outline of the manuscript are George W. Bond, Jr., of Fitchburg State College; John W. Douthit, of Mt. San Antonio College; Ralph P. Eckerlin, of Northern Virginia Community College; John P. Harley, of Eastern Kentucky University; Louise B. Katz, of Sinclair Community College; Francis C. Monette, of Boston University; Harry S. Reasor, Jr., of Miami-Dade Junior College; and Alfreda G. Suskie, of Mohawk Valley Community College. The following individuals reviewed the entire first draft of the manuscript: Shirley Davis, of Montgomery College; Bruce Grayson, of the University of Miami at Coral Gables; Ronald Plakke, of the University of Northern Colorado; and Martha Van Bolt, of Charles Stewart Mott Community College. Each has made an outstanding contribution to the textbook. The difficult task of reviewing the artwork was undertaken by Richard Sugerman, of Wichita State University, and Ernest Gardner, of the University of California at Davis. Both art reviewers provided me with many excellent suggestions for improving the illustrations. The final manuscript review was done by Richard Mast, of Miami-Dade Junior College, North. His helpful suggestions and pointed comments are greatly appreciated. All of the reviewers have helped me to develop an accurate, logical, and pedgogically sound presentation of human anatomy.

I am especially pleased with the superb quality of the line drawings. The bulk of the artwork was prepared by Nelva B. Richardson. Her talent, inspiration, and cooperation have made the art program a distinctive feature of the textbook. Selected pieces of art were ably and imaginatively prepared by Marsha J. Dohrmann.

I wish to particularly acknowledge Victor B. Eichler, of Wichita State University, and Steve Harper, for providing me with many excellent photographs and photomicrographs and John C. Bennett, of St. Mary's Hospital in San Francisco, for supplying many high-quality roentgenograms. Gratitude is also extended to the many other individuals, publishers, and companies that provided photographs, photomicrographs, and electron micrographs.

The editorial assistance provided by Canfield Press for the development of this project has been outstanding. I wish to express my appreciation to R. Wayne Oler, Editor-in-Chief and Associate Publisher, who offered me all the resources of Canfield Press to successfully complete the project; Howard Boyer, Senior Editor, who personally supervised and became involved in all phases of the project, providing continuous guidance and encouragement; Pearl C. Vapnek, Production Editor, who coordinated the various facets of the project; and Alice S. Goehring, who brought copyeditorial consistency and accuracy to the final manuscript.

All drafts of the manuscript were typed by Geraldine C. Tortora, my wife. She also handled all secretarial duties related to the project, for which I am deeply grateful.

I would like to invite readers of this book to send their reactions and suggestions concerning the book to me at the address given below. These responses will be helpful to me in formulating plans for subsequent editions.

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NOTE TO THE STUDENT

At the beginning of each chapter is a listing of "Student Objectives." Before you read the chapter, please read the objectives carefully. Each objective is a statement of a skill or knowledge that you should acquire. To meet these objectives, you will have to perform several activities. Obviously, you must read the chapter very carefully and if there are sections of the chapter that you do not understand after one reading, you should reread those sections before continuing. In conjunction with your reading, pay particular attention to the Figures and Exhibits; they have been carefully coordinated to the textual narrative. At the each of each chapter are three other guides that you may find useful. The first, "Chapter Summary in Outline," is a concise summary of important topics discussed in the chapter. This section is designed to consolidate the essential points covered in the chapter, so that you may recall and relate them to one another. The second guide, "Review Questions and Problems," is a series of questions designed specifically to help you meet your objectives. After you have answered the questions, you should return to the beginning of the chapter and reread the objectives to determine whether or not you have achieved the goals. The final guide, "Selected Readings," lists pertinent materials on the chapter topics for supplementary examination.

CONTENTS

CHAPTER 1

AN INTRODUCTION TO THE HUMAN BODY

STUDENT OBJECTIVES

After you have read this chapter, you should be able to:

1. Define anatomy, with its subdivisions, and physiology
2. Determine the relationship between structure and function
3. Compare the levels of structural organization that comprise the human body
4. Define a cell, a tissue, an organ, a system, and an organism
5. List by name and location the principal body cavities and their major organs
6. Describe the subdivisions of the abdominopelvic cavity into nine regions and four quadrants
7. Define the anatomical position
8. Compare common and anatomical terms used to describe the external features of the body
9. Define directional terms used in association with the body
10. Describe the common anatomical planes of the body
11. Identify by visual inspection or palpation various surface features of the head, neck, trunk, upper extremity, and lower extremity
12. Define the common metric units of length, mass, and volume, and their English equivalents, that are used in measuring the human body

You are about to begin a study of the human body in order to learn not only how your body is organized but also, in many instances, how it functions. The study of the human body involves many branches of science, each of which contributes to a more comprehensive understanding of the parts of your body and how they work. Once you learn how your body normally works, you can understand what happens to your body when it is injured, diseased, or placed under stress.

Two branches of science that will help you understand your body parts and functions are anatomy and physiology. **Anatomy** refers to the study of *structure* and the relationships among structures. Anatomy is a very broad science, and the study of structure becomes more meaningful when specific aspects of the science are considered. For example, **gross anatomy** deals with structures that can be studied without using a microscope. Another kind of anatomy, **systemic anatomy,** covers particular systems of the body, such as the system of nerves, spinal cord, and brain, or the system of heart, blood vessels, and blood. **Regional anatomy** is a division of anatomy dealing with a specific region of the body, such as the head, neck, chest, or abdomen. **Developmental anatomy** is the study of development from the fertilized egg to the adult form. **Embryology** is generally restricted to the study of development from the fertilized egg to the end of the eighth week in utero. Other branches of anatomy are **pathological anatomy,** the study of structural changes caused by disease, and **histology,** the microscopic study of the structure of tissues and cells.

Whereas anatomy and its branches deal with structures of the body, **physiology** deals with the *functions* of the body parts. In other words, physiology is concerned with how a part of the body actually works. As you will see in later chapters, physiology cannot be completely separated from anatomy. It is for this reason that limited reference will be made to physiology, even though the primary concern of this text is anatomy. Each structure of the body is custom-modeled to carry out a particular set of functions. For instance, the interior of the nose is lined with hairs that allow the nose to perform the function of filtering dust from inhaled air. Bones are able to function as rigid supports for the body because they are constructed of hard minerals. In a sense, then, the structure of a part determines what functions it will perform. In turn, body functions often influence the size, shape, and health of the structures. For example, glands perform the function of manufacturing chemicals. Some of these chemicals stimulate bones to build up minerals so they become hard and strong. Other chemicals cause the bones to give up some of their minerals so they do not become too thick or too heavy.

HOW ARE YOU PUT TOGETHER?

The human body consists of several levels of structural organization that are associated with one another in several ways. The lowest level of structural organization, the *chemical level,* includes all chemical substances essential for maintaining life. All these chemicals are made up of atoms joined together in various ways (Figure 1–1). The chemicals, in turn, are put together to form the next higher level of organization, the *cellular level.* **Cells,** as you probably know, are the basic structural and functional units of the organism. Among the many kinds of cells found in your body are muscle cells, nerve cells, and blood cells. Figure 1–1 shows several isolated cells from the lining of the stomach. Each of these cells has a different structure, and each performs a different job.

From the cellular level, the next higher level of structural organization is the *tissue level.* **Tissues** are made up of groups of similar cells that perform a specific function. For example, when the isolated cells shown in Figure 1–1 are joined together, they form a tissue called *epithelium,* which lines the stomach. Each kind of cell in the tissue has a specific function. Mucous cells produce mucus, a slime that lubricates food as it passes through the stomach. Parietal cells produce acid in the stomach, and chief cells produce enzymes needed to digest proteins. Other examples of tissues in your body are muscle tissue, connective tissue, and nervous tissue.

In many places in the body, different kinds of tissues are joined together to form an even higher level of organization, the *organ level.* **Organs** are groups of two or more different tissues that perform a particular function. Examples of organs are the heart, liver, lungs, brain, and stomach. Referring to Figure 1–1, you will see that the stomach is an organ since it consists of two or more kinds of tissues. Three of the tissues that make up the stomach are shown here. The serous layer (also called the serosa) protects the stomach and reduces friction when the stomach moves and rubs against other organs. The muscle tissue layers of the stomach contract to mix food and pass the food on to the next digestive organ. The epithelial tissue layer produces mucus, acid, and enzymes.

The next higher level of structural organization in the body is the *system level.* A **system** consists of

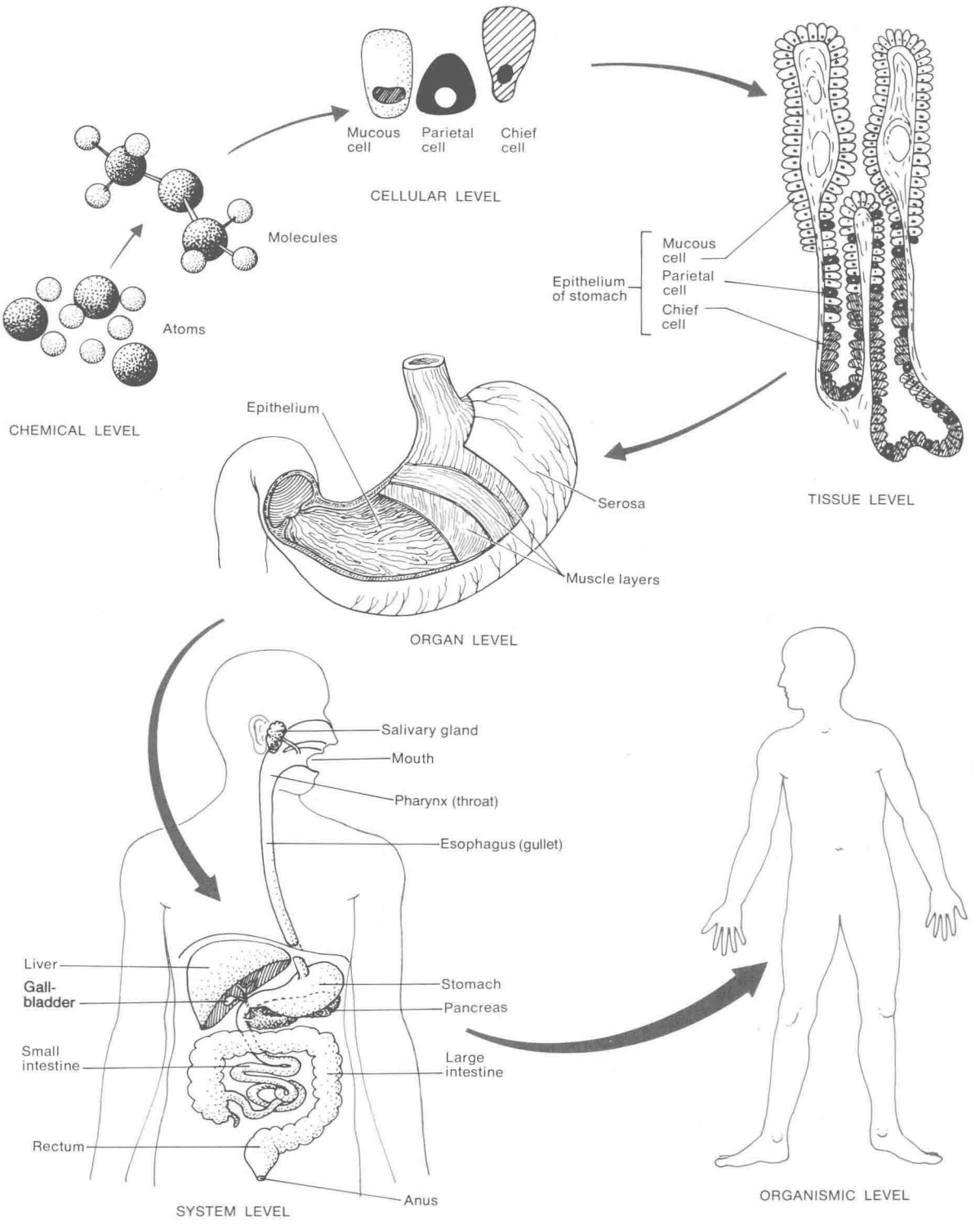


Figure 1–1. Levels of structural organization that compose the human body.

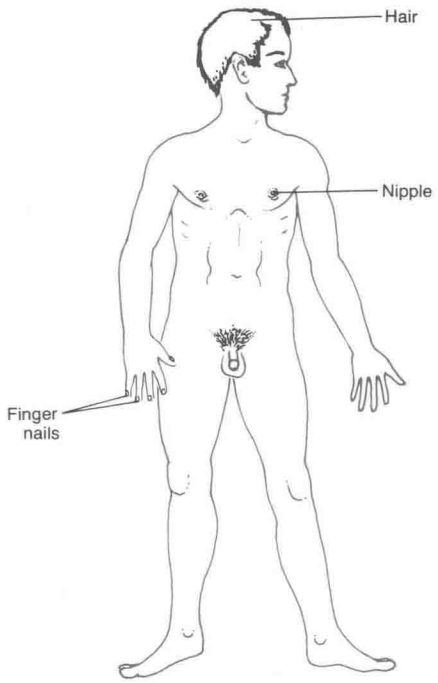
an association of organs that have a common function. The digestive system, which functions in the breakdown of food, comprises the mouth, saliva-producing glands, throat, esophagus, stomach, small intestine, large intestine, rectum, liver, gallbladder, and pancreas. All the parts of the body functioning with each other constitute the total **organism.**

In the chapters that follow, you will examine the anatomy and physiology of the following body systems: integumentary (pertaining to the skin), skeletal, muscular, nervous, endocrine (pertaining to hormones), circulatory, respiratory, digestive, urinary, and reproductive. Exhibit 1–1 contains a listing of these systems, their representative organs, and their general functions.

The systems are presented in the Exhibit in the order in which they will be studied in later chapters.

Exhibit 1–1. PRINCIPAL SYSTEMS OF THE HUMAN BODY, REPRESENTATIVE ORGANS, AND FUNCTIONS

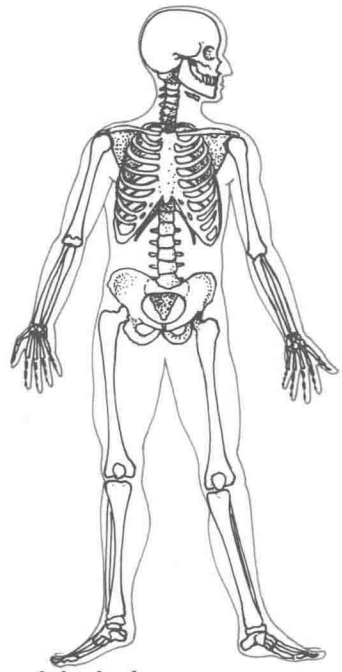
1. INTEGUMENTARY



The skin and its associated structures such as hair, nails, and glands

FUNCTION: Protects the body, regulates body temperature, and eliminates wastes

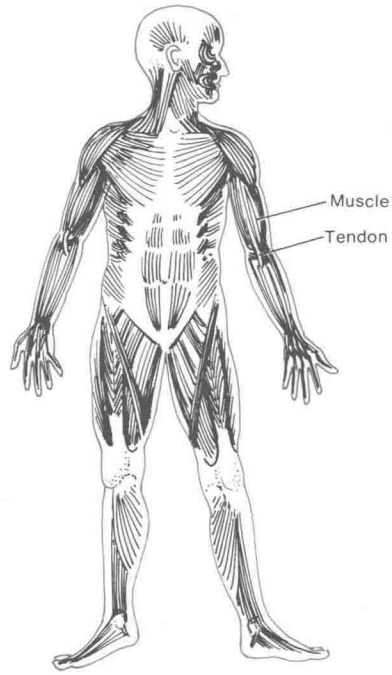
2. SKELETAL



All the bones of the body

FUNCTION: Supports and protects the body, gives leverage, produces blood cells, and stores minerals

3. MUSCULAR



All the muscle tissue of the body, including skeletal, visceral, and cardiac

FUNCTION: Allows movement, maintains posture, and produces heat