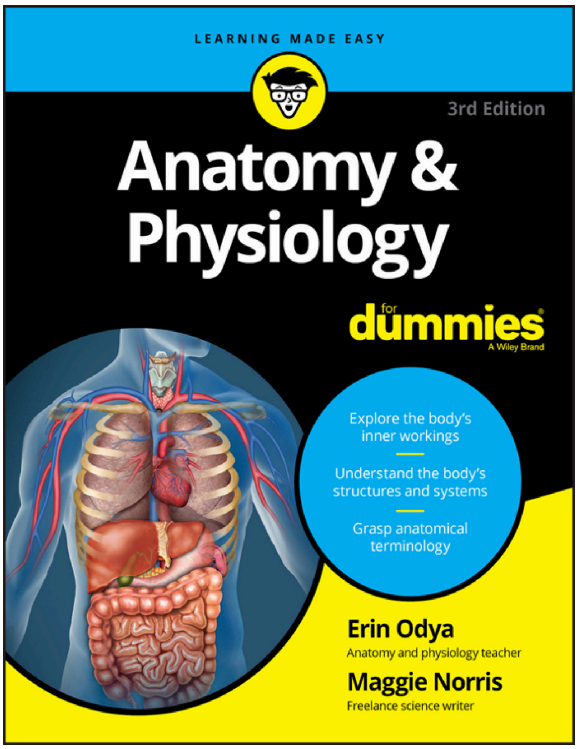


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Then peruse the book as you would any science book; look at the table of contents and the index. Read the Introduction. (See, you've started already!) Then start reading chapters. Look at the figures, especially the color plates, as you read. You'll probably be able to get through the entire book in just a couple of sittings. Then go back and reread chapters you found particularly interesting, relevant, or puzzling. Study the illustrations carefully. The line drawings as well as the color plates are keyed closely to the text and often clarify important facts. Pay attention to technical terminology; your instructors will use it and expect you to use it, too.

If you're a casual reader (you're not enrolled in a formal course in anatomy and physiology and have little or no background in biology), the following approach may work well. Take some time with the color plates at the center of the book. They give you a good feel for the flow of information (and a good feeling about the human body). Then read the book straight through, beginning to end. Look at the figures, especially the color plates, as you read. After you've been through it all quickly once, go back and reread chapters you found particularly interesting, relevant, or puzzling. Make a habit of studying the illustrations while reading the related text. Don't sweat too much over terminology; for your purposes, saying "of my lungs" communicates as well as "pulmonary." (If you also enjoy word games, though, you can get started on a whole new vocabulary.) Keep the book handy for future reference the next time you wonder what the heck they're talking about in a TV drug ad. The color plates alone make it worth space on your bookshelf.

Part 1

Locating Physiology on the Web of Knowledge

IN THIS PART …

Get acquainted with the basics of anatomy and physiology.

Find out about metabolism — all the chemical reactions that keep you alive.

Learn how we keep everything in check — maintaining balance in our bodies.

Brush up on biochemistry.

Find the fundamentals of cell biology.

See how cells organize into tissues.

Chapter 1

Anatomy and Physiology: The Big Picture

IN THIS CHAPTER

- **Placing anatomy and physiology in a scientific framework**
- **Jawing about jargon**
- **Looking at anatomy: planes, regions, and cavities**
- **Delineating life's levels of organization**

Human *anatomy* is the study of the human body's structures — all the parts that make up the physical body itself. *Physiology* is the study of how the human body works; how all the anatomical parts function together to keep an individual alive. Anatomy and physiology are bound together. As such, this book abandons the old technique of learning all the anatomy and then the physiology as though the two were independent. Here, we examine each body system, identify the structures within that system, and then discuss their functions.

Scientifically Speaking

Human anatomy and physiology are closely related to *biology,* which is the study of living things and their relationship with the rest of the universe, including all other living things. If you've studied biology, you understand the basics of how organisms operate. Anatomy and physiology narrow the science of biology by looking at the specifics of one species: *Homo sapiens.*



REMEMBER Anatomy is form; physiology is function. You can't talk about one without talking about the other.

THE ANATOMY AND PHYSIOLOGY OF EVERYTHING ELSE

Scientifically speaking, human biology isn't more or less complex, specialized, or cosmically significant than the biology of any other species, and all are interdependent. Every species of animal, plant, and fungus on the planet has both anatomy and physiology. So does each species of *protist* (one-celled creatures, like amoebae) and bacteria. At the cellular level (see Chapter 3), all these groups are astoundingly similar. At the levels of tissues, organs, and organ systems, plants are very different from animals, and both plants and animals are equally dissimilar to fungi.

Each of these major groups, called a *kingdom,* has its own characteristic anatomy and physiology. It's evident at a glance to everyone at the beach that a starfish and a human are both animals, while the seaweed in the tide pool and the cedar tree on the shoreline are both plants. Obvious details of anatomy (the presence or absence of bright green tissue) and physiology (the presence or absence of movement) tell that story. The different forms within each kingdom have obvious differences as well: The cedar must stand on the shore, but the seaweed would die there. The starfish can move from one place to another within a limited range, while humans can (theoretically) go anywhere on the planet and survive there for at least a while. Scientists use these differences to classify organisms into smaller and smaller groups within the kingdom, until each organism is classified into its own special group.

Not that human anatomy and physiology aren't special. Humans' bipedal posture and style of locomotion are very special . There's nothing like a human hand anywhere except at the end of a human arm. Perhaps most special of all is the anatomy and physiology that allows (or maybe compels) humans to engage in science: our highly developed brain and nervous system. It's entirely within the norms of evolutionary theory that people would be most interested in their own species, so more humans find human anatomy and physiology more interesting than the anatomy and physiology of the tree. From here on, we're restricting our discussion to the anatomy and physiology of our own species.

How anatomy and physiology fit into science

Biologists base their work on the assumption that every structure and process, no matter how tiny in scope, must somehow contribute to the

survival of the individual. So each process — and the chemistry and physics that drive it — must help keep the individual alive and meeting the relentless challenges of a continually changing environment. Although anatomy and physiology combined are classified as a subsection of biology, it's truly an interdisciplinary science.

Human *pathophysiology* is the study of "human anatomy and physiology gone wrong." (The prefix *path-* is Greek for "suffering.") It's the interface of human biology and medical science. *Clinical medicine* is the application of medical science to alleviate an anatomical or physiological problem in an individual human.

Pathophysiology and clinical medicine aren't the subject of this book, but we discuss applications of them when they're particularly relevant to the physiology. You're probably using this book to supplement instructional material in career training for a clinical environment, so the information throughout the book is slightly slanted in that direction. We chose the conditions that we briefly examine to demonstrate some characteristic of the system, especially its interaction with other systems, but we don't discuss diagnosis or treatment.

TAXONOMY OF *HOMO SAPIENS*

Taxonomy is the science that seeks to classify and organize living things, expressed as a series of mutually exclusive categories. The highest (most inclusive) category is domain, of which there are three: Archea, Eubacteria, Eukaryota. Each of these domains is split into kingdoms, which are further divided until each individual organism is its own unique species. Outside of bacteria, all living things fall under the Eukaryota domain; the kingdoms are: Protista, Fungi, Plantae, and Animalia. Within each kingdom, the system classifies each organism into the hierarchical subgroups (and sometimes sub-subgroups) of phylum, class, order, family, genus, and species. Here's the breakdown of humankind:

Kingdom Animalia: All animals.

Phylum Chordata: Animals that have a number of structures in common, particularly the *notochord,* a rodlike structure that forms the body's supporting axis.

Subphylum Vertebrata: Animals with backbones.

Superclass Tetrapoda: Four-footed vertebrates.

Class Mammalia: Tetrapods with hair. Other classes of the vertebrata are Pisces (fish), Amphibia (frogs), Aves (birds), and Reptilia (scaly things).

Order Primates: Mammals with more highly developed brains, flexible hips and shoulders, and prehensile hands and feet (able to grasp).

Superfamily Hominoidea: Apes (chimpanzees, gorillas, orangutans, humans).

Family Hominidae: Great apes, including humans.

Genus Homo: The human species is the only surviving species of our genus, though this genus included several species in the evolutionary past.

Species Sapiens: All species are given a two-part Latin name, in which the genus name comes first and a species epithet comes second. The biologists who name species sometimes try to use a descriptor in the epithet. For humans, they could have chosen "bipedal" or "talking" or "hairless," but they chose "thinker."

Variety Sapiens: Some species get a "varietal" name, usually indicating a difference that's obvious but not necessarily important from an evolutionary point of view. The human species has one other variety, *Homo sapiens neanderthalensis,* which has been extinct for tens of thousands of years. All humans living since then are of one species variety, *Homo sapiens sapiens.* In the evolutionary classification of humans, there's no biologically valid category below species variety.

Anatomy, gross and otherwise

Some biologists specialize in the anatomy and physiology of animals at various hierarchical levels (horses, fish, frogs) or particular organs (mammalian circulatory systems, olfaction in fish, insect hormones). Some focus solely on humans, others concentrate on other species, and still others examine the areas of overlap between humans and other animal species. These various areas of study contribute to our knowledge of biology in general and have important applications in clinical medicine. The work of anatomists contributes to medical advances, such as improved surgical techniques and the development of bioengineered prostheses.

Throughout this book, you encounter some information from each major subset of anatomy, including

- **Gross anatomy:** The study of the large parts of an animal body — any animal body — that can be seen with the unaided eye. That's the aspect of anatomy we concentrate on in this book.

- **Histologic anatomy:** The study of different tissue types and the cells that comprise them. Histologic anatomists use a variety of microscopes to study the cells and tissues that make up the body.
- **Developmental anatomy:** The study of the life cycle of the individual, from fertilized egg through adulthood, senescence (aging), and death. Body parts change throughout the life span. For information about human developmental anatomy, see Chapter 15.
- **Comparative anatomy:** The study of the similarities and differences among the anatomical structures of different species, including extinct species. Information from comparative anatomy can help scientists understand the human body's structures and processes. For example, comparing the anatomy of apes to that of humans shows us what particular structures allow for our ability to walk upright on two legs.

A Little Chat about Jargon

Why does science have so many funny words? Why can't scientists just say what they mean, in plain English? Good question, with a two-part answer.

Creating better communication

Scientists need to be able to communicate with others in their field. They say what they mean (most of them, most of the time, to the best of their ability), but what they mean can't be said in the English language that people use to talk about routine daily matters.

Like people working in every field, scientists develop vocabularies of technical terminology and other forms of jargon so they can better communicate with other scientists. It's important that the scientist sending the information and the scientist receiving it both use the same words to refer to the same phenomenon. To understand anatomy and physiology, you must know and use the same terminology, too. The jargon can be overwhelming at first, but understanding the reason for it

and taking the time to learn it before diving into the complicated content will make your learning experience less painful.

Establishing precise terminology

The second part of the answer starts with a little chat about jargon. Contrary to the belief of some, jargon is a good thing. *Jargon* is a set of words and phrases that people who know a lot about a particular subject use to talk together. There's jargon in every field (scientific or not), every workplace, every town, even every home. Families and close friends almost always use jargon in conversations with one another. Plumbers use jargon to communicate about plumbing. Anatomists and physiologists use jargon, much of which is shared with medicine and other fields of biology, especially human biology.

Scientists try to create terminology that's precise and easy to understand by developing it systematically. That is, they create new words by putting together existing and known elements. They use certain syllables or word fragments over and over to build new terms. With a little help from this book, you'll soon start to recognize some of these fragments. Then you can put the meanings of different fragments together and accurately guess the meaning of a term you've never seen before, just as you can understand a sentence you've never read before. Table 1-1 gets you started, listing some word fragments related to the organ systems we cover in this book.

TABLE 1-1 Technical Anatomical Word Fragments

Body System	*Root or Word Fragment*	*Meaning*
Skeletal system	os-, oste-; arth-	bone; joint
Muscular system	myo-, sarco-	muscle, striated muscle
Integument	derm-	skin
Nervous system	neur-	nerve
Endocrine system	aden-, estr-	gland, steroid
Cardiovascular system	card-, angi-, hema-, vaso-	heart (muscle), vessel, blood vessels