

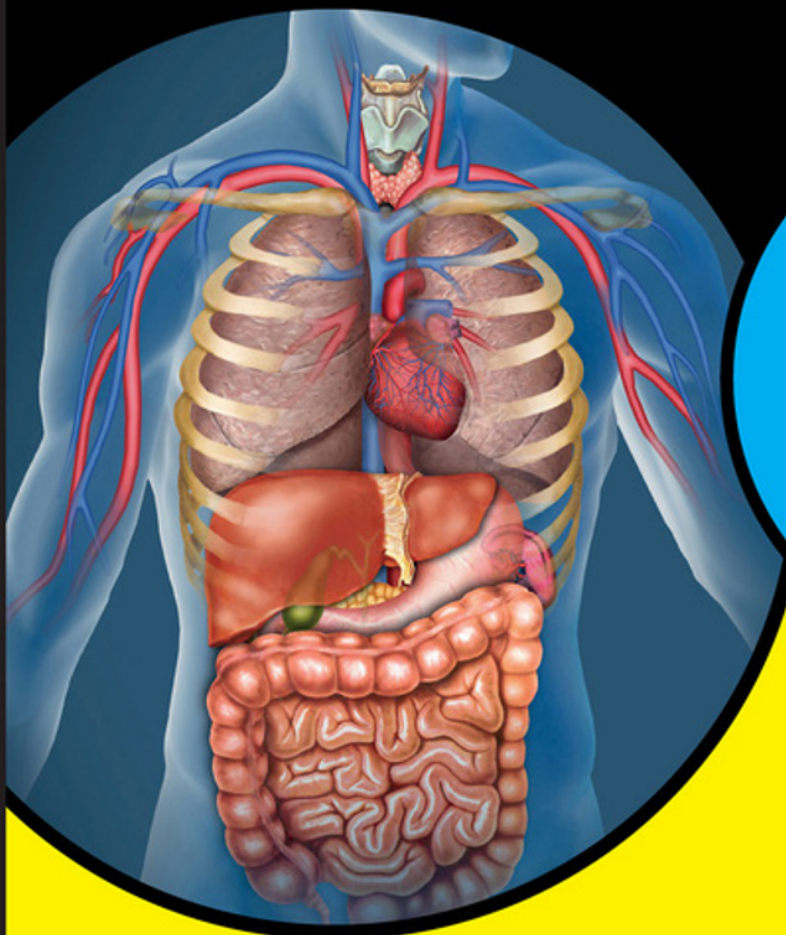
LEARNING MADE EASY



3rd Edition

Anatomy & Physiology

for
dummies
A Wiley Brand



Explore the body's
inner workings

Understand the body's
structures and systems

Grasp anatomical
terminology

Erin Odyia

Anatomy and physiology teacher

Maggie Norris

Freelance science writer



Anatomy & Physiology

3rd Edition

by Erin Ody and Maggie Norris

**for
dummies®**
A Wiley Brand

Anatomy & Physiology For Dummies®, 3rd Edition

Published by: **John Wiley & Sons, Inc.**, 111 River Street, Hoboken, NJ 07030-5774, www.wiley.com

Copyright © 2017 by John Wiley & Sons, Inc., Hoboken, New Jersey

Published simultaneously in Canada

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except as permitted under Sections 107 or 108 of the 1976 United States Copyright Act, without the prior written permission of the Publisher. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at <http://www.wiley.com/go/permissions>.

Trademarks: Wiley, For Dummies, the Dummies Man logo, Dummies.com, Making Everything Easier, and related trade dress are trademarks or registered trademarks of John Wiley & Sons, Inc., and may not be used without written permission. All other trademarks are the property of their respective owners. John Wiley & Sons, Inc., is not associated with any product or vendor mentioned in this book.

LIMIT OF LIABILITY/DISCLAIMER OF WARRANTY: WHILE THE PUBLISHER AND AUTHOR HAVE USED THEIR BEST EFFORTS IN PREPARING THIS BOOK, THEY MAKE NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS BOOK AND SPECIFICALLY DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. NO WARRANTY MAY BE CREATED OR EXTENDED BY SALES REPRESENTATIVES OR WRITTEN SALES MATERIALS. THE ADVICE AND STRATEGIES CONTAINED HEREIN MAY NOT BE SUITABLE FOR YOUR SITUATION. YOU SHOULD CONSULT WITH A PROFESSIONAL WHERE APPROPRIATE. NEITHER THE PUBLISHER NOR THE AUTHOR SHALL BE LIABLE FOR DAMAGES ARISING HEREFROM.

For general information on our other products and services, please contact our Customer Care Department within the U.S. at 877-762-2974, outside the U.S. at 317-572-3993, or fax 317-572-4002. For technical support, please visit <https://hub.wiley.com/community/support/dummies>.

Wiley publishes in a variety of print and electronic formats and by print-on-demand. Some material included with standard print versions of this book may not be included in e-books or in print-on-demand. If this book refers to media such as a CD or DVD that is not included in the version you purchased, you may download this material at <http://booksupport.wiley.com>. For more information about Wiley products, visit www.wiley.com.

Library of Congress Control Number: 2017932045

ISBN 978-1-119-34523-7 (pbk); ISBN 978-1-119-34530-5 (ebk); ISBN 978-1-119-34536-7 (ebk)

Manufactured in the United States of America

10 9 8 7 6 5 4 3 2 1

Contents at a Glance

Introduction	1
Part 1: Locating Physiology on the Web of Knowledge	5
CHAPTER 1: Anatomy and Physiology: The Big Picture	7
CHAPTER 2: What Your Body Does All Day	27
CHAPTER 3: A Bit about Cell Biology	43
Part 2: Sizing Up the Structural Layers	71
CHAPTER 4: Getting the Skinny on Skin, Hair, and Nails	73
CHAPTER 5: Scrutinizing the Skeletal System	89
CHAPTER 6: Muscles: Setting You in Motion	117
Part 3: Talking to Yourself	141
CHAPTER 7: The Nervous System: Your Body's Circuit Board	143
CHAPTER 8: The Endocrine System: Releasing Chemical Messages	167
Part 4: Exploring the Inner Workings of the Body	187
CHAPTER 9: The Cardiovascular System: Getting Your Blood Pumping	189
CHAPTER 10: The Respiratory System: Breathing Life into Your Body	215
CHAPTER 11: The Digestive System: Beginning the Breakdown	231
CHAPTER 12: The Urinary System: Cleaning Up the Act	253
CHAPTER 13: The Lymphatic System: Living in a Microbe Jungle	271
Part 5: Life's Rich Pageant: Reproduction and Development	295
CHAPTER 14: The Reproductive System	297
CHAPTER 15: Change and Development over the Life Span	323
Part 6: The Part of Tens	341
CHAPTER 16: Ten (Or So) Chemistry Concepts Related to Anatomy and Physiology	343
CHAPTER 17: Ten Phabulous Physiology Phacts	349
Index	357

Table of Contents

INTRODUCTION	1
About This Book	2
Foolish Assumptions	2
Icons Used in This Book	3
Beyond the Book	3
Where to Go from Here	4
 PART 1: LOCATING PHYSIOLOGY ON THE WEB OF KNOWLEDGE	 5
CHAPTER 1: Anatomy and Physiology: The Big Picture	7
Scientifically Speaking	7
How anatomy and physiology fit into science	8
Anatomy, gross and otherwise	10
A Little Chat about Jargon	11
Creating better communication	11
Establishing precise terminology	11
Looking at the Body from the Proper Perspective	13
Getting in position	13
Dividing the anatomy	15
Mapping out your regions	15
Casing your cavities	19
Organizing Yourself on Many Levels	21
Level I: The cellular level	23
Level II: The tissue level	23
Level III: The organ level	23
Level IV: The organ system level	23
Level V: The organism level	24
 CHAPTER 2: What Your Body Does All Day	 27
Transferring Energy: A Body's Place in the World	28
Building Up and Breaking Down: Metabolism	28
Why your cells metabolize	29
How your cells metabolize	30
Staying in Range: Homeostasis	33
Maintaining a constant temperature: Thermoregulation	34
Swimming in H ₂ O: Fluid balance	35
Adjusting the fuel supply: Blood glucose concentration	35
Measuring important variables	36

Growing, Replacing, and Renewing	37
Growing	37
Replacing	37
Repairing parts	39
Healing wounds	39
Lasting parts	40
CHAPTER 3: A Bit about Cell Biology	43
The Functions of Cells	43
Building themselves	44
Building tissues	45
Transforming energy	45
Making and transporting products	45
Communicating	46
Seeing the Inside of Eukaryotic Cells	46
Containing the cell: Cell membrane	48
Controlling the cell: Nucleus	51
Cytoplasm	51
Internal membranes	52
Powering the cell: Mitochondria	52
The protein factory	53
Lysosomes	54
Building Blocks That Build You	54
Joining together: The structure of macromolecules	54
Polysaccharides	55
Lipids	55
Proteins	56
Nucleic acids	57
Genes and Genetic Material	58
Traiting you right	59
Gene structure	59
Synthesizing protein	60
The Cell Cycle	62
Cells that divide, cells that don't	62
Interphase	64
DNA replication	64
Mitosis	64
Organizing Cells into Tissues	67
Connecting with connective tissue	67
Continuing with epithelial tissue	68
Mixing it up with muscle tissue	70
Getting nervous about nervous tissue?	70

PART 2: SIZING UP THE STRUCTURAL LAYERS 71

CHAPTER 4: Getting the Skinny on Skin, Hair, and Nails 73

Functions of the Integument	74
Structure of the Integument	75
Touching the epidermis	75
Exploring the dermis	79
Getting under your skin: The hypodermis	81
Accessorizing Your Skin	81
Now hair this	81
Nailing nails	82
Nothing's bland about glands	82
Your Skin Saving You	84
Controlling your internal temperature	85
Your skin is sensational	85
Your skin is self-healing	86
Pathophysiology of the Integument	86
Skin cancer	86
Dermatitis	87
Alopecia	87
Nail problems as signs of possible medical conditions	88

CHAPTER 5: Scrutinizing the Skeletal System 89

Reporting for Duty: The Jobs of Your Skeleton	90
Checking Out the Skeleton's Makeup	90
Caring about connective tissue	90
The structure of a bone	93
Classifying bones	94
Bone Growth and Remodeling	95
The Axial Skeleton	96
Keeping your head up: The skull	97
Setting you straight on the curved spinal column	99
Being caged can be a good thing	101
The Appendicular Skeleton	102
Wearing girdles: Everybody has two	103
Going out on a limb: Arms and legs	105
Joints and the Movements They Allow	110
Categorizing the types of joints	110
Knowing what your joints can do	111
Pathophysiology of the Skeletal System	113
Abnormal curvature	113
Osteoporosis	113
Cleft palate	114
Arthritis	114
Fractures	115

CHAPTER 6: Muscles: Setting You in Motion	117
Functions of the Muscular System	118
Supporting your structure	118
Moving you	118
Poised positioning	119
Maintaining body temperature	119
Pushing things around inside	119
Talking about Tissue Types	121
Defining unique features of muscle cells	121
Skeletal muscle	123
Cardiac muscle	125
Smooth muscle	125
Getting a Grip on the Sliding Filament	126
Assembling a sarcomere	126
Telling the fiber to contract	127
Contracting and releasing the sarcomere	128
Naming the Skeletal Muscles	129
Starting at the top	130
Twisting the torso	132
Spreading your wings	135
Getting a leg up	136
Pathophysiology of the Muscular System	138
Muscular dystrophy	139
Muscle spasms	139
Fibromyalgia	140

PART 3: TALKING TO YOURSELF 141

CHAPTER 7: The Nervous System: Your Body's Circuit Board	143
Integrating the Input with the Output	144
Nervous tissues	144
Neurons	145
Neuroglial cells	146
Nerves	147
Ganglia and plexuses	147
Integrated Networks	147
Central nervous system	148
Peripheral nervous system	149
Thinking about Your Brain	150
Keeping conscious: Your cerebrum	152
Making your moves smooth: The cerebellum	152
Coming up roses: Your brain stem	153
Regulating systems: The diencephalon	154

Following fluid through the ventricles	154
Blood-brain barrier	155
Transmitting the Impulse	156
Across the neuron	156
Across the synapse	158
Making Sense of Your Senses	161
Touch.	162
Hearing and balance.	162
Sight.	163
Olfaction	164
Taste	165
Pathophysiology of the Nervous System	166
Chronic pain syndrome	166
Multiple sclerosis.	166
Macular degeneration.	166
CHAPTER 8: The Endocrine System: Releasing Chemical Messages.	167
Homing In on Hormones	168
Hormone chemistry	168
Hormone sources	169
Hormone receptors.	171
Grouping the Glands.	172
The taskmasters: The hypothalamus and pituitary	173
Controlling metabolism	175
Getting the gonads going.	178
Enteric endocrine	180
Other endocrine glands	182
Pathophysiology of the Endocrine System	183
Abnormalities in insulin metabolism	183
Thyroid disorders	184
Androgen insensitivity	186
PART 4: EXPLORING THE INNER WORKINGS OF THE BODY.	187
CHAPTER 9: The Cardiovascular System: Getting Your Blood Pumping	189
Getting Substances from Here to There	190
Carrying Cargo: Your Blood and What's in It.	190
Watering down your blood: Plasma	190
Transporting oxygen and carbon dioxide: Red blood cells.	191
Plugging along with platelets.	192
Putting up a good fight: White blood cells.	192

Looking at Your Blood Vessels	193
Starting with the arteries	193
Cruising through the capillaries	194
Visiting the veins	196
Cardiac Anatomy	197
Sizing up the heart's structure	197
Examining the heart's tissues	199
Supplying blood to the heart	200
Cardiac Cycle	201
Generating electricity	201
Moving blood through the heart	204
The heartbeat	205
Physiology of Circulation	206
On the beating path: The circuits of blood through the heart and body	206
Putting your finger on your pulse	208
Going up, going down, holding steady: Blood pressure	208
Not going with the flow	209
Pathophysiology of the Cardiovascular System	210
Cardiac disorders	210
Vascular disorders	211
Blood disorders	212

CHAPTER 10: **The Respiratory System: Breathing**

Life into Your Body	215
Functions of the Respiratory System	215
Nosing around Your Respiratory Anatomy	216
Nose	216
Pharynx	217
Trachea	219
Lungs	219
Diaphragm	220
Breathing: Everybody's Doing It	220
Normal breathing	221
Breathing under stress	221
Controlled breathing	222
Gas Exchange	224
The respiratory membrane	224
The trade-off	225
Pathophysiology of the Respiratory System	226
Hypoxemia	226
Airway disorders	227
Lungs	228

CHAPTER 11: The Digestive System: Beginning the Breakdown	231
Functions of the Digestive System	232
The Alimentary Canal	233
Examining the walls of the digestive tract	233
Starting with the mighty mouth	234
Pharynx and esophagus: Not Egyptian landmarks.	235
Stirring it up in your stomach	236
Moving through the intestines	238
Accessory Organs	240
The liver delivers	241
Pancreas	243
The Breakdown	244
Pathophysiology of the Digestive System	246
Diseases of the oral cavity	246
Disorders of the stomach and intestines.	246
Bowel syndromes	248
Diseases of the accessory organs	249
CHAPTER 12: The Urinary System: Cleaning Up the Act	253
Functions of the Urinary System	253
Structures of the Urinary System	255
Putting out the trash: Kidneys	255
Holding and releasing	257
The Yellow River	259
Composition of urine	259
Filtering the blood	261
Selectively reabsorbing	261
Expelling urine	263
Maintaining Homeostasis	264
Fluid balance and blood pressure.	264
Regulating blood pH	265
Pathophysiology of the Urinary System	267
Kidney pathologies	267
Urinary tract pathologies	268
CHAPTER 13: The Lymphatic System: Living in a Microbe Jungle	271
Functions of the Lymphatic System	272
Loving Your Lymphatic System	273
Lymphing along	273
Structures of the lymphatic system	274
Identifying Immune System Cells	277
Looking at leukocytes	278

Lymphocytes	279
Phagocytizing leukocytes	280
Examining Immune System Molecules	280
Histamine	281
Chemical defense	281
Antigens	281
Antibodies	282
Complement system proteins	283
Immune System Mechanisms	284
Phagocytosis	284
Degranulation	285
Inflammation is swell	285
Adaptive Immunity	286
Cell-mediated immunity	286
Humoral immunity	287
Secondary immunity	289
Immunization	289
Pathophysiology of the Immune System	289
The immune system and cancer	289
Immune-mediated diseases	290
Infectious diseases	292

PART 5: LIFE'S RICH PAGEANT: REPRODUCTION AND DEVELOPMENT

295

CHAPTER 14: The Reproductive System

297

Functions of the Reproductive System	297
Producing Gametes	298
Meiosis	299
Female gametes: Ova	299
Male gametes: Sperm	301
Determining sex	302
The Female Reproductive System	303
Organs of the female reproductive system	303
Cycling approximately monthly	307
The Male Reproductive System	310
The organs of the male reproductive system	310
Seminal fluid and ejaculation	312
Pausing for Pregnancy	313
Steps to fertilization	313
Implantation	314
Adapting to pregnancy	314
Labor and delivery	316

Pathophysiology of the Reproductive System.	318
Infertility	318
Sexually transmitted infections.	318
Premenstrual syndromes.	319
Endometriosis	319
Cryptorchidism	320
Hypogonadism.	320
Erectile dysfunction.	320
Pathophysiology of pregnancy	320
Pregnancy loss.	322
CHAPTER 15: Change and Development over the Life Span	323
Programming Development	324
Stages of development.	324
Dimensions of development	324
Development before Birth	326
Free-floating zygote to protected embryo	326
Dividing development into trimesters	329
The Human Life Span	331
Changes at birth	331
Infancy and childhood	333
Adolescence	334
Young adulthood.	335
Middle age	336
Growing creaky	336
PART 6: THE PART OF TENS.	341
CHAPTER 16: Ten (Or So) Chemistry Concepts Related	
 to Anatomy and Physiology	343
Energy Can Neither Be Created Nor Destroyed	344
Everything Falls Apart	344
Everything's in Motion	345
Probability Rules	345
Polarity Charges Life	346
Water Is Special	346
Fluids and Solids	347
Under Pressure	348
Redox Reactions Transfer Electrons.	348

CHAPTER 17: Ten Phabulous Physiology Phacts	349
Unique to You: Hands, Fingers, Thumbs	349
Nothing's Better than Mother's Milk	350
It's Apparent: Your Hair Is Different	350
The Only Thing You Have to Fear Is	351
You Smell Well!	352
Microbes: We Are Their World	353
The Pesky Appendix	354
Talkin' about Breath Control	355
Taking Your First Breath	355
Is Blood Really Blue?	356
INDEX	357

Introduction

Congratulations on your decision to study human anatomy and physiology. The knowledge you gain from your study is of value in many aspects of your life.

Begin with the most obvious: the social value of this knowledge. Human anatomy and physiology is always a suitable topic of discussion in social situations because it allows people to talk about their favorite subject (themselves) in a not-too-personal way. Thus, some particularly interesting detail of anatomy and physiology is an ideal conversation opener with attractive strangers or horrifying shirt-tail relatives. (First, though, be completely clear in your mind about the boundary between scientific anatomy and physiology on the one hand and personal clinical details on the other.) Choose the specific topic carefully to be sure of having your intended effect. For example, telling a young boy that he has the same density of hair follicles on his body as a chimp does will probably please him. Telling his teenage sister the same thing may alienate her. Use this power carefully!

A little background in anatomy and physiology should be considered a valuable part of anyone's education. Health and medical matters are part of world events and people's daily lives. Basic knowledge of anatomy and physiology gets you started when trying to make sense of the news about epidemics, novel drugs and medical devices, and purported environmental hazards, to name just a few examples. Anatomy and physiology prepare you to be a more well-rounded, knowledgeable person and will help you be a better parent, spouse, care-giver, neighbor, friend, or colleague.

Knowledge of anatomy and physiology may also benefit your own health. Sometimes, comprehension of a particular fact or concept can help drive a good decision about long-term health matters, like the demonstrated benefits of exercise, or it may help you take appropriate action in the context of a specific medical problem, like an infection, an infarction, a cut, or a muscle strain. You may understand your doctors' instructions better during a course of treatment, which may give you a better medical outcome.

About This Book

This book guides you on a quick walk-through of human anatomy and physiology. It doesn't have the same degree of technical detail as a textbook. It contains relatively little in the way of lists of important anatomical structures, for instance.

We expect that most readers are using this book as a complementary resource for course work in anatomy and physiology at the high-school, college, or career-training level. Most of the information overlaps with the information available in your other resources. However, sometimes a slightly different presentation of a fact or of the relationship between facts can lead to a small "aha!" Some technical details in your more comprehensive resources may become easier to master after that. Consider reading the relevant chapter prior to class. That way, when your instructor covers the content, it'll be more likely to stick!

The goals of this book are to be informal but not unscientific; brief but not sketchy; and information-rich but accessible to readers at many levels. We've tried to present a light but serious survey of human anatomy and physiology that you can enjoy for the sake of the information it imparts and that will help you perform well on your tests. As always, the reader is the judge of its success.

You won't find clinical information in this book. Chapters 4 through 15 have a pathophysiology section that uses disorders and disease states to explore the details of some physiological processes, but this book contains nothing related to patient care or self-care. It's also not a health and wellness manual or any kind of lifestyle book.

Within this book, you may note that some web addresses break across two lines of text. If you're reading this book in print and want to visit one of these web pages, simply key in the web address exactly as it's noted in the text, pretending as though the line break doesn't exist. If you're reading this as an e-book, you've got it easy — just click the web address to be taken directly to the web page.

Foolish Assumptions

When we wrote this book, we tried to keep you in mind. We're guessing that you fall into one of these categories:

» **Formal student:** You're a high-school or college student enrolled in a basic anatomy and physiology course for credit, or a student in a career-training program for a certification or credential. You need to pass an exam or

otherwise demonstrate understanding and retention of data, terminology, and concepts in human anatomy and physiology.

- » **Informal student:** You're not enrolled in a credit course, but gaining some background in human anatomy and physiology is important to you for personal or professional reasons.
- » **Casual reader:** Here you are with a book on your hands and a little time to spend reading it. And it's all about you!

Icons Used in This Book

The little round pictures that you see in the margins throughout this book are icons that alert you to several different kinds of information.



TIP

The Tip icon lets you know what you can do to improve your understanding of an anatomical structure.



REMEMBER

The Remember icon serves to jog your memory. Sometimes, the text is information that we think you should permanently store in your anatomy and physiology file. Other times, the info here makes a connection between what you're reading and related information elsewhere in the book.



TECHNICAL
STUFF

The Technical Stuff icon flags extra information that takes your understanding of anatomy or physiology to a slightly deeper level, but the text isn't essential for understanding the organ system under discussion.

Beyond the Book

In addition to the material in the print or e-book you're reading right now, this product also comes with some access-anywhere goodies on the web. Check out the free Cheat Sheet for more on everything from anatomical terms to the anatomical planes of the body and more. To get this Cheat Sheet, simply go to www.dummies.com and type **Anatomy & Physiology For Dummies Cheat Sheet** in the Search box.

Where to Go from Here

If you're a formal student (that is, one who's enrolled or planning to enroll in a formal course in human anatomy and physiology), you may get the most benefit by becoming familiar with this book a week or two before your course begins. Flip to the color plates in the center of the book to get started. The illustrations, charming as well as scientific, are arranged to follow the flow of the text, and the callouts indicate important technical terminology.

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.

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.

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

Chapter 1

Anatomy and Physiology: The Big Picture

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).

(continued)

(continued)

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
Respiratory system	pulmon-, bronch-	lung, windpipe
Digestive system	gastr-, enter-, dent-, hepat-	stomach, intestine, teeth, liver
Urinary system	ren-, neph-; ur-	kidney; urinary
Lymphatic system	lymph-, leuk-, -itis	lymph, white, inflammation
Reproductive system	andr-, uter-	male, uterine

But why do these terms have to be Latin and Greek syllables and word fragments? Why should you have to dissect and put back together a term like *iliohypogastric*? Well, the terms that people use in common speech are understood slightly differently by different people, and the meanings are always undergoing change. Not so long ago, for example, no one speaking plain English used the term *laptop* to refer to a computer or *hybrid* to talk about a car. It's possible that, not many years from now, almost no one will understand what people mean by those words. Scientists, however, require consistency and preciseness to describe the things they talk about in a scientific context. The relative vagueness and changeability of terms in plain English makes this impossible. In contrast, Greek and Latin stopped changing centuries ago: *ilio*, *hypo*, and *gastro* have the same meaning now as they did 200 years ago.



TIP

Every time you come across an anatomical or physiological term that's new to you, see if you recognize any parts of it. Using this knowledge, go as far as you can in guessing the meaning of the whole term. After studying Table 1-1 and the other vocabulary lists in this chapter, you should be able to make some pretty good guesses.

Looking at the Body from the Proper Perspective

Remember that story about a friend of a friend that went in to have a foot amputated only to awaken from surgery to find they removed the wrong one? This story highlights the need for a consistent perspective to go with the jargon. Terms that indicate direction make no sense if you're looking at the body the wrong way. You likely know your right from your left, but ignoring perspective can get you all mixed up. This section shows you the anatomical position, planes, regions, and cavities, as well as the main membranes that line the body and divide it into major sections.

Getting in position

Stop reading for a minute and do the following: Stand up straight. Look forward. Let your arms hang down at your sides and turn your palms so they're facing forward. You are now in *anatomical position* (see Figure 1-1). Unless you are told otherwise, any reference to location (diagram or description) assumes this position. Using anatomical position as the standard removes confusion.

The following list of common anatomical descriptive terms (direction words) that appear throughout this and every other anatomy book may come in handy:

- » **Right:** Toward the patient's right
- » **Left:** Toward the patient's left
- » **Anterior/ventral:** Front, or toward the front of the body
- » **Posterior/dorsal:** Back, or toward the back of the body
- » **Medial:** Toward the middle of the body
- » **Lateral:** On the side or toward the side of the body
- » **Proximal:** Nearer to the point of attachment or the trunk of the body

- » **Distal:** Farther from the point of attachment or the trunk of the body (think "distance")
- » **Superficial:** Nearer to the surface of the body
- » **Deep:** Farther from the surface of the body
- » **Superior:** Above or higher than another part
- » **Inferior:** Below or lower than another part

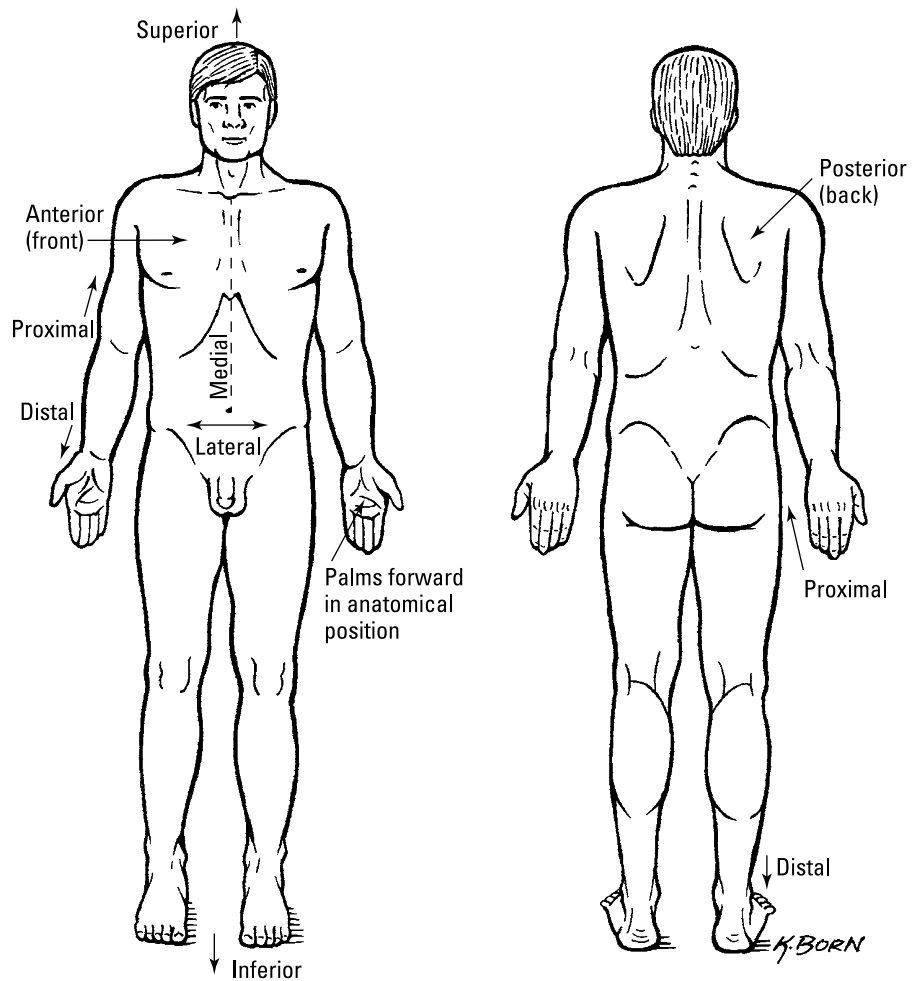


FIGURE 1-1:
The standard
anatomical
position.

Illustration by Kathryn Born, MA