

Gale Sloan Thompson


SECOND EDITION

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# UNDERSTANDING ANATOMY & PHYSIOLOGY

*A Visual, Auditory, Interactive Approach*





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**Overcome your fears and build your confidence**  
The author listened to students like you. She designed a text that divides a seemingly huge volume of information into manageable sections.

274

### Structures of the Heart

Key structures of the heart include the pericardium, the heart wall, the chambers, and the valves.

**The Pericardium**  
Surrounding the heart is a double-walled sac called the **pericardium**. Anchored by ligaments and tissue to surrounding structures, the pericardium has two layers: the fibrous pericardium and serous pericardium.

The **fibrous pericardium**—a loose-fitting sac of strong connective tissue—is the outermost layer.

The **serous pericardium**, which consists of two layers, covers the heart's surface.

At the heart's base, the serous pericardium folds back on itself to form the:

- parietal layer**, which lines the inside of the fibrous pericardium, and the
- visceral layer**, which covers the heart's surface.

Between these two layers is the **pericardial cavity**. This cavity contains a small amount of serous fluid, which helps prevent friction as the heart beats.

**The Heart Wall**  
The heart wall consists of three layers:

- The **endocardium** lines the heart's chambers, covers the valves, and continues into the vessels. It consists of a thin layer of squamous epithelial cells.
- The **myocardium**, composed of cardiac muscle, forms the middle layer. It's the thickest of the three layers and performs the work of the heart.
- The **epicardium**, which consists of a thin layer of squamous epithelial cells, covers the heart's surface. Also known as the visceral layer of the serous pericardium, the epicardium is closely integrated with myocardium.

**FAST FACT**  
The endocardium is very smooth, an important characteristic that helps keep blood from clotting as it fills the heart's chambers.

## Chapter 14 HEART

The human heart beats about 100,000 times in one day and about 35 million times in a year. During an average lifetime, the human heart will beat more than 2.5 billion times.

The heart could be called the engine of life. This incredibly powerful organ works constantly, never pausing. Composed of a type of muscle found nowhere else in the body, the heart works to pump blood throughout the body, delivering oxygen-rich blood to organs and tissues and returning oxygen-poor blood to the lungs.

About the size of a fist, the heart lies in the thoracic cavity in the **mediastinum**, a space between the lungs and beneath the sternum. The

**Base:** Where the great vessels enter and leave the heart.

**Apex:** The point of maximum impulse, where the strongest beat can be felt or heard.

**FAST FACT**  
The study of the heart and the treatment of related disorders is called **cardiology**.

**Master the language of A&P**  
New terms are defined right in the text, making it easy for you to build an A&P vocabulary.

**Expand your knowledge**  
“Fast Facts” are important points of information related to specific body systems that help you build a firm foundation in A&P.

# DESIGNED FOR HOW YOU LEARN

Welcome to the challenging but rewarding world of anatomy and physiology.

Whatever your learning style...looking, listening, doing, or a little bit of each... this interactive approach to anatomy & physiology is designed just for you.

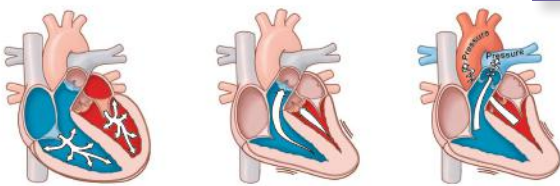
288

### Stroke Volume

Stroke volume—the second factor affecting cardiac output—is never 100% of the volume in the ventricles. Typically, the ventricles eject 60% to 80% of their blood volume. This percentage is called the **ejection fraction**. An ejection fraction significantly lower than this indicates that the ventricle is weak and may be failing.

#### Factors Affecting Stroke Volume

Stroke volume is affected by three factors—**preload**, **contractility**, and **afterload**.



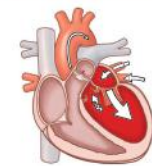
- Preload**
  - Preload is the amount of tension, or stretch, in the ventricular muscle just before it contracts.
  - The more blood entering the heart, the more the ventricle stretches.
  - Example: Think of shooting a rubber band. The tension, or stretch, placed on the rubber band before you shoot it is its preload.
- Contractility**
  - Contractility is the force with which ventricular ejection occurs.
  - The more the ventricle is stretched (within limits), the more forcefully it will contract. This is known as **Starling's law of the heart**.
  - Because the amount of blood in the ventricle at the end of diastole determines how much the ventricle is stretched, the more blood returned to the heart each minute, the more forcefully it will contract. Too much blood, however, can overstretch the heart's muscle, causing it to lose elasticity.
  - Example: The more you stretch the rubber band, the more it will contract when it's released, and the farther it will fly. Likewise, an old rubber band that has been overstretched isn't as elastic as a new one and won't fly as far when released.
- Afterload**
  - The forces the heart must work against (such as the pressure of the blood in the arteries) to eject its volume of blood is called the afterload.
  - An increase in afterload (such as high blood pressure) opposes the ejection of blood from the ventricles, which decreases stroke volume.
  - Example: If you try to shoot a rubber band under water, the pressure of the water (the afterload) will resist the forward movement of the rubber band.

## Life lesson: Congestive heart failure

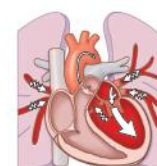
**Congestive heart failure (CHF)** results when either ventricle fails to pump blood effectively. This can occur because the ventricle is weakened from a myocardial infarction. Also, prolonged high blood pressure or incompetent heart valves, both of which force the heart to work harder, can weaken the ventricles. Chronic lung disease places a strain on the right ventricle, because diseased lungs make it more difficult for the right ventricle to pump blood into pulmonary circulation. Over time, this can lead to failure of the right ventricle, called right-sided heart failure. Failure of the left ventricle is called left-sided heart failure.

Symptoms of congestive heart failure vary according to the side of the heart affected. Keep in mind, however, that the failure of one ventricle places an added strain on the other ventricle. Eventually, both ventricles fail.

### Left Ventricular Failure



If the left ventricle fails, it falls behind in ejecting all of the blood it receives from the lungs.



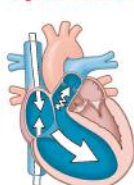
Consequently, blood backs up in the lungs.



This causes:

- Shortness of breath
- A buildup of fluid in the lungs (pulmonary edema)
- Coughing

### Right Ventricular Failure



If the right ventricle fails, it falls behind in ejecting all of the blood it receives from the systemic circulation.



Blood backs up into the veno cava and throughout the peripheral vascular system.



This results in:

- Generalized swelling throughout the body (systemic edema)
- Enlargement of the liver and spleen
- Pooling of fluid in the abdomen (ascites)
- Distension of the jugular veins
- Swelling of the ankles, feet, and fingers

#### FAST FACT

Adults with diabetes have a two to eight times greater risk of developing heart failure. That's partly because the disease process of diabetes damages the heart muscle.

### That Makes Sense

Factors that affect contractility are called **inotropic agents**. (Tip: To help remember this term, think "in." An **IN-**otropic agent affects the myocardium's ability to contract **IN-**ward.) Agents that increase contractility (positive inotropic agents) include excess calcium and epinephrine. Agents that decrease contractility (negative inotropic agents) include a calcium deficiency as well as a potassium excess.

Factors that influence heart rate are called **chronotropic agents**. (Tip: The prefix **chron-** refers to time, as in a chronology. Therefore, chronotropic refers to how many times the heart beats within a certain time period.) Agents that increase heart rate (positive chronotropic agents) include epinephrine and low levels of calcium. Agents that decrease heart rate (negative chronotropic agents) include acetylcholine and excess levels of potassium.

### Retain what you've learned

"That Makes Sense" boxes use practical examples, restatements, and mnemonics to help you remember the material.

### Explore real-life examples

"Life Lesson" boxes make anatomy and physiology pertinent to daily life by applying material to clinical situations.

## Identify your strengths and weaknesses

Answer the “Test Your Knowledge” questions at the end of every chapter to make sure you understand the material while you assess your progress.

### Test Your Knowledge

- The point of maximum impulse of the heart is at the:
  - mediastinum.
  - base.
  - apex.
  - aorta.
- The portion of the heart wall that lines the heart's chambers is the:
  - epicardium.
  - myocardium.
  - pericardium.
  - endocardium.
- On an electrocardiogram, the QRS complex represents:
  - atrial depolarization.
  - ventricular depolarization.
  - ventricular repolarization.
  - impulse transmission from the atria to the ventricles.
- The cardiac cycle is:
  - the amount of blood pumped.
  - the amount of blood in the ventricle.
  - the amount of blood in the atrium.
  - the amount of blood in the aorta.

#### Answers: Chapter 14

- Correct answer: c. The mediastinum is the space between the lungs in which the heart lies. The base

### The Heart Valves

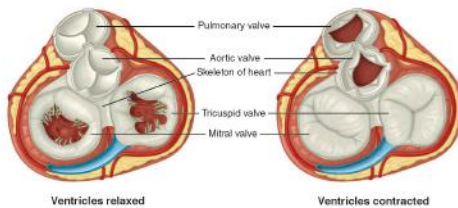
To ensure that blood moves in a forward direction through the heart, the heart contains four valves: one between each atrium and its ventricle and another at the exit of each ventricle. Each valve is formed by two or three flaps of tissue called **cusps** or **leaflets**.

The **atrioventricular (AV) valves** regulate flow between the atria and the ventricles.

- The right AV valve—also called the **tricuspid valve** (because it has three leaflets)—prevents backflow from the right ventricle to the right atrium.
- The left AV valve—also called the **bicuspid valve** (because it has two leaflets), or, more commonly, the **mitral valve**—prevents backflow from the left ventricle to the left atrium.

The **semilunar valves** regulate flow between the ventricles and the great arteries. There are two semilunar valves:

- The **pulmonary valve** prevents backflow from the pulmonary artery to the right ventricle.
- The **aortic valve** prevents backflow from the aorta to the left ventricle.



### The Heart Skeleton

A semi-rigid, fibrous, connective tissue called the **skeleton of the heart** encircles each valve. Besides offering support for the heart, the skeleton keeps the valves from stretching; it also acts as an insulating barrier between the atria and the ventricles, preventing electrical impulses from reaching the ventricles other than through a normal conduction pathway.



### The Body AT WORK

Valves open and close in response to pressure changes within the heart. For example, when a ventricle relaxes, the pressure within that ventricle drops. The AV valve leaflets hang limply, allowing blood to flow through the open valve into the ventricle. As the ventricle fills, pressure in the ventricle rises. After filling, the ventricle begins to contract and the pressure rises even more. This increased pressure pushes against the cusps of the AV valve, causing it to snap closed. When pressure in the ventricle exceeds the pressure “downstream,” the semilunar valve pops open, allowing blood to flow out into the area of lower pressure.

## Understand how the body functions

“The Body at Work” explains how physiological processes work.

## Build your vocabulary

A “Review of Terms” lets you quickly locate short definitions for the key terms in every chapter. Use the audio glossary online at [DavisPlus.com](http://DavisPlus.com) to hear pronunciations of the terms.

### Review of Key Terms

**Arterioles:** The forces that impede the flow of blood out of the heart

**Aortic valve:** Heart valve that prevents backflow from the aorta to the left ventricle

**Aorta:** Pointed end of the heart, the origin of the point of maximum impulse

**Atrioventricular (AV) node:** Group of pacemaker cells in the interatrial septum that relays impulses from the SA node to the ventricles

**Atrium:** The upper chamber of each ventricle of the heart

**Automaticity:** The unique ability of cardiac muscle to contract without nervous stimulation

**Baroreceptors:** Pressure sensors in the aorta and carotid arteries that detect changes in blood pressure; also called stretch receptors

**Base:** Broadest part of the heart; where great vessels enter and leave

**Basic cycle:** The series of events that occur from the beginning of one heartbeat to the beginning of the next

**Basic output:** The amount of blood pumped by the heart in 1 minute

**Baroreceptors:** Sensors in the aortic arch, carotid arteries, and medulla that detect increased levels of carbon dioxide, decreased levels of oxygen, and decreases in pH

**Chordae tendinae:** Tendinous cords that connect the edges of the AV valves to the papillary muscles to prevent inversion of the valve during ventricular systole

**Coronary arteries:** Vessels that deliver oxygenated blood to the myocardium

**Coronary sinus:** Large transverse vein on the heart's posterior that returns blood to the right atrium

**Diastole:** The period of cardiac muscle relaxation

**Electrocardiogram (ECG):** Record of the electrical currents in the heart

**Endocardium:** The endothelial membrane that lines the chambers of the heart

**Epicardium:** The serous membrane on the surface of the myocardium

**Mediastinum:** Space between the lungs and beneath the sternum

**Mitral valve:** The valve that regulates blood flow between the left atrium and left ventricle

**Myocardium:** The middle layer of the heart wall; composed of cardiac muscle

**Pericardial cavity:** Space between the visceral and parietal layers of the serous pericardium that contains a small amount of serous fluid

**Pericardium:** The membranous fibrous sac enclosing the heart and the bases of the great vessels

**Preload:** The amount of tension, or stretch, in the ventricular muscle just before it contracts

**Proprioceptors:** Sensors in muscles and joints that signal the cardiac center of changes in physical activity

**Pulmonary valve:** Heart valve that prevents backflow from the pulmonary artery to the right ventricle

**Purkinje fiber:** Nerve-like processes that extend from the bundle branches to the ventricular myocardium; form the last part of the cardiac conduction system

**Rhythmicity:** Term applied to the heart's ability to beat regularly

**Semilunar valves:** The two valves that regulate flow between the ventricles and the great arteries

**Sinoatrial node:** The heart's primary pacemaker, where normal cardiac impulses arise

**Stroke volume:** The amount of blood ejected by the heart with each beat

**Systole:** Contraction of the chambers of the heart

**Tricuspid valve:** The right atrioventricular valve, which regulates flow between the right atrium and right ventricle

**Ventricles:** The two lower chambers of the heart

### Own the Information

To make the information in this chapter part of your working memory, take some time to reflect on what you've learned. On a separate sheet of paper, write down everything you recall from the chapter. After you're done, log on to the [DavisPlus](http://DavisPlus) website, and check out the Study Group podcast and Study Group Questions for the chapter.

#### Key Topics for Chapter 14:

- The size, location, and key structures of the heart
- Sounds made by the heart
- Heart chambers, valves, and great vessels
- Blood flow through the heart
- Coronary circulation
- Cardiac conduction and ECGs
- Cardiac cycle
- Cardiac output and the factors affecting cardiac output

## Build a complete understanding of A&P

“Own the information” is a detailed plan of study that shows you how to absorb what you need to know about the most important concepts.

# SEE, LISTEN, and DO...

Don't miss all of the ways to help you learn.



## BEYOND THE TEXT...

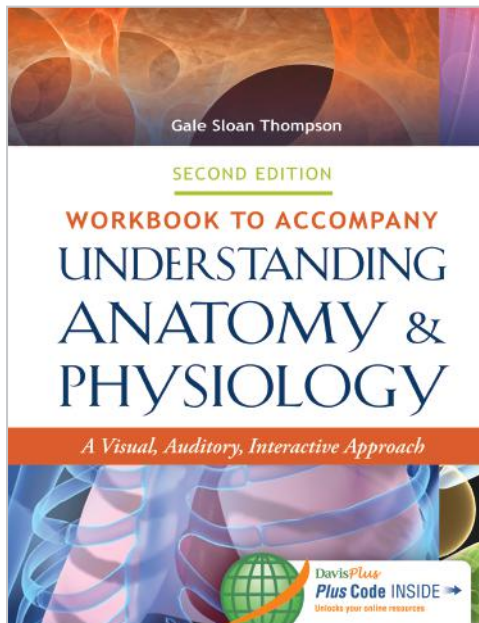
There's so much more online to help you excel in class, on exams, and in the lab.

The *Plus* Code on the inside front cover unlocks a wealth of learning resources.

Visit [www.DavisPlus.com](http://www.DavisPlus.com) today!



- **Animations**  
Watch the full-color animations that show you how physiological processes work while a narrator explains step by step.
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- **Interactive Exercises**  
Complete the image-based “Body Language” labeling and matching exercises to find out what you know and don't know.
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- **Flash Cards**  
Read each chapter and then “Test Yourself” to make sure that you understand the material.
- **Audio Podcasts**  
Listen to the “Chapter in Brief” summary for each chapter and to students in a “Study Group” as they quiz each other.

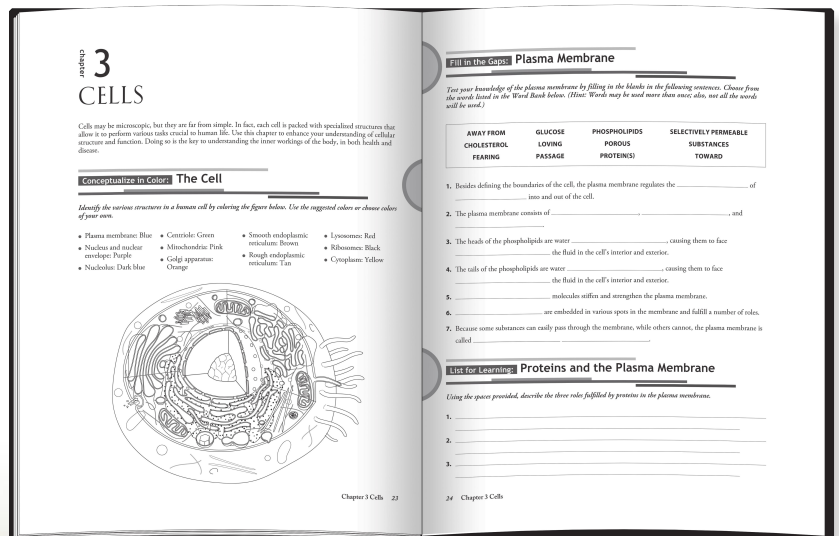


## Workbook (Available for purchase separately.)

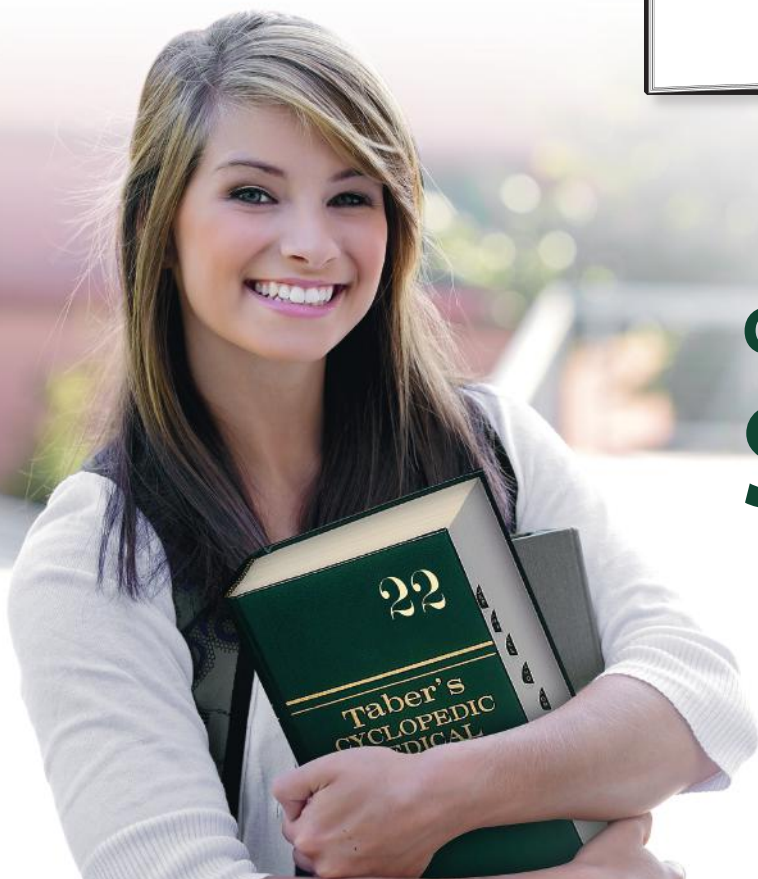
### Take a hands-on approach to A&P!

Rely on the Workbook to help you quickly identify your strengths and weaknesses and learn where to focus your study time. Each chapter in the Workbook corresponds to a chapter in the text. Turn study time into game time with...

- Conceptualize in Color
- Sequence of Events
- Puzzle It Out
- Make a Connection
- List for Learning
- Drawing Conclusions
- Fill in the Gaps
- Just the Highlights
- Describe the Process
- Illuminate the Truth



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www.fadavis.com

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*Publisher, Nursing:* Lisa B. Houck  
*Director of Content Strategy:* Darlene D. Pedersen  
*Content Project Manager II:* Victoria White  
*Illustration & Design Manager:* Carolyn O'Brien  
*Project Manager, Digital Solutions:* Kate Crowley

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# PREFACE

Even as you read this sentence, your body is performing amazing feats. Electrical impulses are rocketing through your brain at over 200 miles per hour. Hundreds of muscles continually tense and relax to keep you in an upright position and to allow your eyes to track across the words on this page. A specific muscle—your heart—is contracting and relaxing at regular intervals to propel blood throughout your body. In fact, your blood will make two complete trips around your body before you finish reading this preface.

Even more amazing is the fact that the vast array of cells, tissues, organs, and organ systems making up your body arose from just two simple cells—an egg and a sperm. Consider, too, that you are genetically unique: out of the over 6 billion people populating the earth, no two individuals are completely alike. That is reason to marvel.

Artists and scientists have long been captivated by the human body. For centuries, artists have studied the body's outward form, focusing on the movement and shape of muscles and bones when rendering works of art. Scientists, on the other hand, yearned to discover the mysteries inside the body. For almost 3,000 years, scientists have explored the depths of the human body: not just how it is put together, but how and why it functions as it does. Exploration continues today, with the latest discovery being that of the human microbiome. Indeed, this one discovery has set the medical community abuzz with its implications for human health.

For you, the journey to discovery begins with reading this book. Contained on these pages is information about which ancient scientists only dreamed. This information will enlighten you about your own body; what's more, it will arm you with knowledge that is foundational to any health- or sports-related career.

Truly, before you can understand a body in illness, you must understand how it functions in health. For example, without a thorough knowledge of fluid and electrolyte balance, how can you explain why chronic vomiting or diarrhea can cause irregular electrical activity in the heart? Without an understanding of how the cardiovascular and respiratory systems interrelate, how will you grasp why chronic lung disease can lead to heart failure? How can you

appreciate the need for caution in administering antibiotics without an understanding of the human microbiome? Consequently, you must learn—really *learn* and not just memorize—the information contained in this book.

There is much to learn, to be sure; but don't be overwhelmed. *Understanding Anatomy & Physiology* breaks the information into “bite-sized” pieces, making topics easier to understand and also to remember. As you read the text—and you *must* read the text—you'll be drawn naturally to vibrant figures that will illuminate what you're reading. Being able to see a structure while you're reading about it will make learning easier. Also, consult the inside back cover of this book to discover your particular learning style; then take advantage of the ancillary materials most likely to help you learn.

You *can* learn this. By the end of this course, understanding the body's form and function can become second nature. While tackling this class may seem like an impossible marathon, you can indeed get to the finish line. As with any marathon, the keys are to follow a plan (read the book); don't skip workouts (review and study daily); and take it step by step (study each chapter in sequence). You *will* get there.

Jane Sloan Thompson



# ACKNOWLEDGMENTS

*Understanding Anatomy & Physiology*, 2nd edition, remains a unique work in the field of anatomy and physiology textbooks. As always, I am grateful for the vision and forward-thinking of Lisa Houck, Publisher. Her commitment to making *Understanding Anatomy & Physiology* a leader in its field is illustrated by her push for a second edition so that we could include a chapter on the revolutionary discovery of the human microbiome. Thank you, Lisa, as always, for your tenacity, drive, and commitment to excellence.

I am also grateful to Victoria White, managing editor. Pulling off a second edition of a book with such a vast array of ancillary materials was no small task. Overseeing all aspects of this project—ranging from coordinating the schedules of myriad departments down to the minutiae of ensuring that each correction passed through every ancillary—required both skill and patience. Thank you, Victoria, for never compromising in your efforts to ensure that the second edition would surpass the first in both completeness and accuracy.

A special thanks, too, goes to Naomi Adams, for her invaluable review. Naomi scrutinized every page of the book and workbook and painstakingly reviewed each and every ancillary. I remain impressed by her breadth of knowledge of nursing and anatomy and physiology; I am, perhaps, even more impressed by her keen eye and attention to detail. Thank you, Naomi, for the obvious care and concern you took when reviewing this work; it is much better for having passed across your desk.

A book for visual learners would, obviously, not be effective without hundreds of vivid illustrations. Stretching the artists and compositors into new territory required that the text be integrated with the art during layout. As always, Carolyn O'Brien, Art Director, expertly led her team to incorporate all changes with precision.

The vast array of ancillary materials, including the animations, online quizzes, Body Language, Study Group, and Chapter in Brief depended upon the skills of many others. This talented group of individuals was headed up by Kate Crowley.

I would also like to thank the reviewers, who are listed separately, for their willingness to review various chapters. Their specialized knowledge of anatomy and physiology helped me improve the scope of the book and also hone the accuracy of the information presented. Having the input of those who work with students on a daily basis, and who understand the areas with which students struggle, was invaluable in helping me make the topic of anatomy and physiology more clear, concise, and relevant to the lives of students.

Last, but certainly not least, I want to thank Jaelyn Lux, Marketing Manager, and her entire sales force for their enthusiasm for this product. I appreciate their energy in not only exploring the attributes and unique features of this package but also in promoting those features to instructors at various schools and colleges. I look forward to hearing the feedback they receive from instructors and students as to how to make *Understanding Anatomy & Physiology* even better.

*To Bob: Thank you for always believing, not just in my work, but in me. Your love, your support, and your encouragement mean the world.*

# CONSULTANTS

Naomi Adams, RN, AA, BN  
*Owner, Adams Medical-Legal Consulting*  
Woodbridge, VA

Bruce A. Fenderson, PhD  
*Professor of Pathology, Anatomy &  
Cell Biology*  
Thomas Jefferson University  
Philadelphia, PA

# REVIEWERS

Tetteh Abbeyquaye, PhD  
*Assistant Professor*  
Quinsigamond Community College  
Worcester, MA

Janice Ankenmann, RN, MSN,  
CCRN, FNP-C  
*Professor*  
Napa Valley College  
Napa, CA

Dan Bickerton, MS  
*Instructor*  
Ogeechee Technical College  
Statesboro, GA

Anne L. Brown, RN, BSN  
*Nursing Instructor*  
Broome-Tioga BOCES  
Binghamton, NY

Susan E. Brown, MS, RN  
*Faculty*  
Riverside School of Health Careers  
Newport News, VA

Henry Steven Carter, MS, CRC, CVE  
*Coordinator of Continuing and  
Workforce Education/Instructor*  
El Centro College  
Dallas, TX

Thea L. Clark, RN, BS, MS  
*Coordinator Practical Nursing*  
Tulsa Technology Center  
Tulsa, OK

Ginny Cohrs, RN, BSN  
*Nursing Faculty*  
Alexandria Technical College  
Alexandria, MN

Tamera Crosswhite, RN, MSN  
*Nursing Instructor*  
Great Plains Technology Center  
Frederick, OK

Fleurdeliza Cuyco, BS, MD  
*Dean of Education*  
Preferred College of Nursing, Los  
Angeles  
Los Angeles, CA

Judith L. Davis, RN, MSN, FNP  
*Practical Nursing Instructor*  
Delta-Montrose Technical College  
Delta, CO

Carita Dickson, RN  
*LVN Instructor*  
San Bernadino Adult School LVN  
Program  
San Bernadino, CA

Teddy Dupre, MSN  
*Instructor*  
Capital Area Technical College  
Baton Rouge, LA

Hisham S. Elbatarny, MB BCh, MSc,  
MD  
*Professor*  
St. Lawrence College—Queen's  
University  
Kingston, Ontario

Alexander Evangelista  
*Adjunct Faculty*  
The Community College of  
Baltimore County  
Baltimore, MD

John Fakunding, PhD  
*Adjunct Instructor*  
University of South Carolina, Beaufort  
Beaufort, SC

Kelly Fleming, RN, BN, MSN  
*Practical Nurse Facilitator*  
Columbia College  
Calgary, Alberta

Ruby Fogg, MA  
*Professor*  
Manchester Community College  
Manchester, NH

Cheryl S. Fontenot, RN  
*Professor*  
Acadiana Technical College  
Abbeville, LA

Shena Borders Gazaway, RN, BSN,  
MSN  
*Lead Nursing/Allied Health Instructor*  
Lanier Technical College  
Commerce, GA

Daniel G. Graetzer, PhD  
*Professor*  
Northwest University  
Kirkland, WA

Dianne Hacker, RN, MSN  
*Nursing Instructor*  
Capital Area School of Practical  
Nursing  
Springfield, IL

Leslie K. Hughes, RN, BSN  
*Practical Nursing Instructor*  
Indian Capital Technology Center  
Tahlequah, OK

Constance Lieseke, CMA (AAMA),  
MLT, PBT (ASCP)  
*Medical Assisting Faculty Program  
Coordinator*  
Olympic College  
Bremerton, WA

Julie S. Little, MSN  
*Associate Professor*  
Virginia Highlands Community  
College  
Abingdon, VA

C. Kay Lucas, MEd, BS, AS  
*Nurse Educator*  
Commonwealth of Virginia  
Department of Health Professions  
Henrico, VA

Barbara Marchelletta, CMA (AAMA),  
CPC, CPT  
*Program Director, Allied Health*  
Beal College,  
Bangor, ME

Nikki A. Marhefka, EdM, MT  
(ASCP), CMA (AAMA)  
*Medical Assisting Program Director*  
Central Penn College  
Summerdale, PA

Jean L. Mosley, CMA (AAMA), AAS,  
BS  
*Program Director/Instructor*  
Surry Community College  
Dobson, NC

Elaine M. Rissel Muscarella, RN, BSN  
*LPN Instructor*  
Jamestown, NY

Brigitte Niedzwiecki, RN, MSN  
*Medical Assistant Program Director and  
Instructor*  
Chippewa Valley Technical College  
Eau Claire, WI

Jill M. Pawluk, RN, MSN  
*Nursing Instructor*  
The School of Nursing at Cuyahoga  
Valley Career Center  
Brecksville, OH

Kathleen Hope Rash, MSN, RN  
*Curriculum & Instructional Resource  
Coordinator*  
Riverside Schools of Nursing  
Newport News, VA

Amy Fenech Sandy, MS, MS  
*Dean, School of Sciences*  
Columbus Technical College  
Columbus, GA

Marianne Servis, RN, MSN  
*Nurse Educator/Clinical Coordinator*  
Career Training Solutions  
Fredericksburg, VA

Glynda Renee Sherrill, RN, MS  
*Practical Nursing Instructor*  
Indian Capital Technology Center  
Tahlequah, OK

Cathy Soto, PhD, MBA, CMA  
El Paso Community College  
El Paso, TX

Joanne St. John, CMA  
*Adjunct Instructor—Health Science*  
Indian River State College  
Fort Pierce, FL

Diana A. Sunday, RN, BSN,  
MSN/ED  
*Nurse Educator—Practical Nursing  
Program*  
York County School of Technology  
York, PA

Joyce B. Thomas, CMA (AAMA)  
*Instructor*  
Central Carolina Community College  
Pittsboro, NC

Marianne Van Deursen, MS Ed,  
CMA (AAMA)  
*Medical Assisting Program  
Director/Instructor*  
Warren County Community College  
Washington, NJ

Monna L. Walters, MSN, RN  
*Director of Vocational Nursing Program*  
Lassen Community College  
Susanville, CA

Amy Weaver, MSN, RN, ACNS-BC  
*Instructor*  
Youngstown State University  
Youngstown, OH

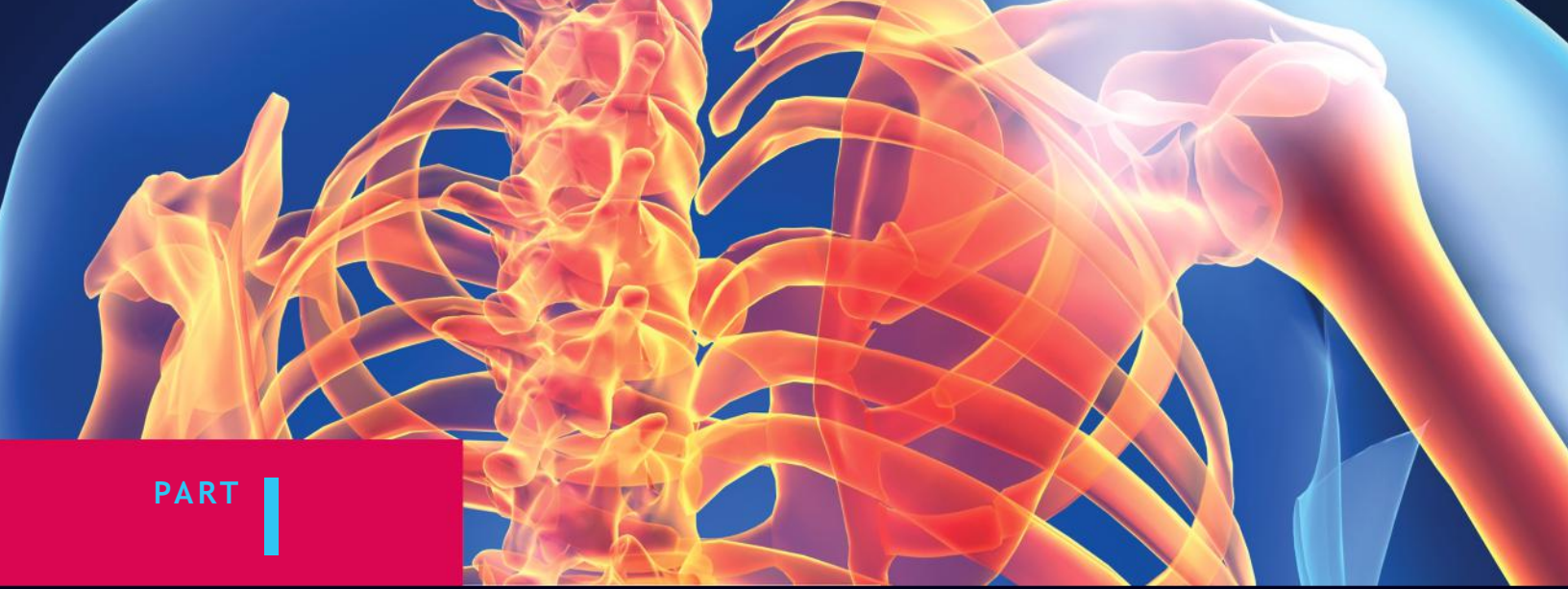


# CONTENTS

<b>PART I</b>	<b>ORGANIZATION OF THE BODY</b>
chapter 1	Orientation to the Human Body 2
chapter 2	Chemistry of Life 16
chapter 3	Cells 36
<b>PART II</b>	<b>COVERING, SUPPORT, AND MOVEMENT OF THE BODY</b>
chapter 4	Tissues 56
chapter 5	Integumentary System 70
chapter 6	Bones & Bone Tissue 82
chapter 7	Skeletal System 96
chapter 8	Joints 118
chapter 9	Muscular System 130
<b>PART III</b>	<b>REGULATION AND INTEGRATION OF THE BODY</b>
chapter 10	Nervous System 158
chapter 11	Sense Organs 204
chapter 12	Endocrine System 228
<b>PART IV</b>	<b>MAINTENANCE OF THE BODY</b>
chapter 13	Blood 252
chapter 14	Heart 272
chapter 15	Vascular System 292
chapter 16	Lymphatic & Immune Systems 314
chapter 17	Respiratory System 336
chapter 18	Urinary System 356
chapter 19	Fluid, Electrolyte, & Acid-Base Balance 372
chapter 20	Digestive System 388
chapter 21	Nutrition & Metabolism 410
chapter 22	Human Microbiome 428
<b>PART V</b>	<b>CONTINUITY</b>
chapter 23	Reproductive Systems 443
chapter 24	Pregnancy & Human Development 464
chapter 25	Heredity 482
	Index 493

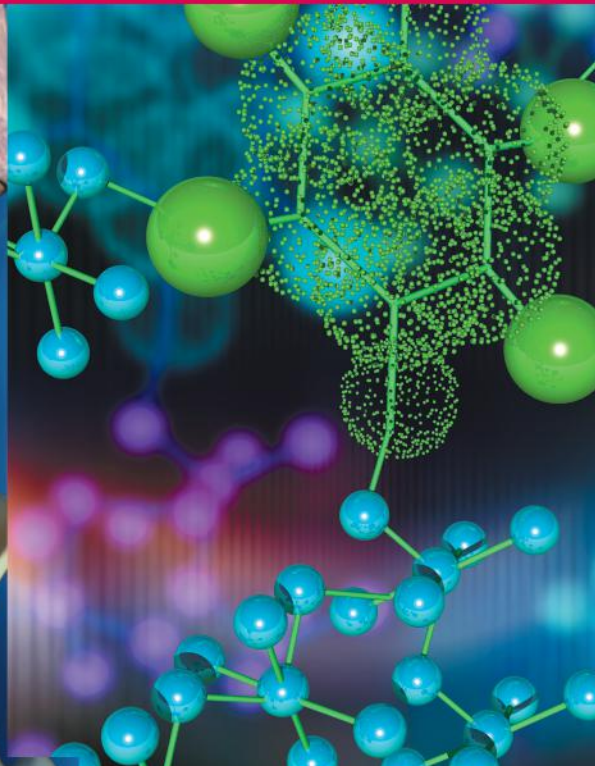
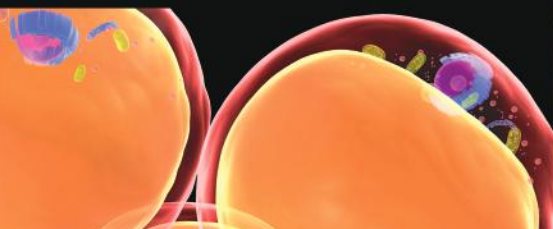






PART |

# ORGANIZATION OF THE BODY





## CHAPTER OUTLINE

Organization of the Body

Organ Systems

Anatomical Terms

Homeostasis

## LEARNING OUTCOMES

1. Define anatomy and physiology.
2. Describe the organization of the body from the very simple to the very complex.
3. Name the 11 organ systems and identify key functions of each.
4. Define commonly used directional terms.
5. Name the body planes and describe how each dissects the body.
6. Identify common body regions.
7. Identify and describe the major body cavities.
8. Name the nine abdominal regions and identify organs found in each.
9. Name the four abdominal quadrants.
10. Define homeostasis.
11. Explain the process of homeostasis through both negative and positive feedback.



# ORIENTATION TO THE HUMAN BODY

*More than 6 billion human bodies currently reside on the earth.*

*While each is individually unique, all have the same basic design and structure.*

The structure of the body, **anatomy**, is closely entwined with how it functions, **physiology**. Once you learn the structure of a specific part of the body, you'll naturally want to know how it works. Learning normal anatomy and physiology will also help you grasp the changes and symptoms that occur with certain disease processes. The study of the processes that disturb normal function is called **pathophysiology**. (*Patho* means suffering or disease; therefore, *pathophysiology* refers to diseased functioning.)

As an example, in a later chapter, you'll learn that the lungs consist of a series of tubes, called bronchi, and that the smallest of these bronchi end in tiny sacs, called alveoli. That's a very basic description of the structure, or anatomy, of the lung. From there, you'll learn that oxygen is absorbed into the bloodstream through the alveoli. That's how the lung functions: its physiology. Armed with that information, you can then comprehend why someone becomes short of breath if the bronchi become narrowed (such as during an acute asthmatic attack) or blocked (such as from a tumor).

The human body is an amazing organism. It is intricate and complex, but all of its processes make sense. Embark on this journey to study anatomy and physiology as you would any great adventure: with interest, excitement, *and* determination. Remember: you're learning about *yours elf!*

## The Body AT WORK

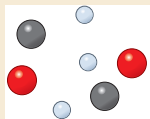
*We're all aware that people look different on the outside. But did you know that people can vary internally as well? The art in this book reflects the anatomy typical of most people. However, variations do occur. For example, some people are born with only one kidney; others have an extra bone in their feet; still others have carotid arteries that follow an atypical route. Perhaps the most extreme example of anatomical variation is called situs inversus. In this inherited condition—affecting about 1 in 10,000 people—the organs are reversed. Instead of the spleen, pancreas, sigmoid colon, and most of the heart being on the left, they're on the right. Likewise, the gallbladder, appendix, and most of the liver are on the left instead of on the right.*

## FAST FACT

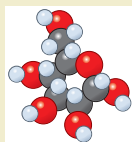
Although Aristotle of Greece made the first recorded attempts to study anatomy in 380 B.C., the first atlas of anatomy wasn't published until 1543 A.D.

# Organization of the Body

The human body is organized in a hierarchy, ranging from the very simple (a microscopic atom) to the very complex (a human being). Specifically:



**ATOMS** link together to form...



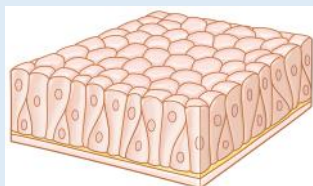
**MOLECULES.** Molecules are organized into various structures, including...



**ORGANELLES,** the metabolic units within a cell that perform a specific function necessary to the life of the cell. Examples include mitochondria—the powerhouses that furnish the cell's energy—and the cell's nucleus. Organelles are contained within...



**ORGANS,** which are structures of two or more tissue types working together to carry out a particular function. Examples include the heart, stomach, and kidney. Organs then form...



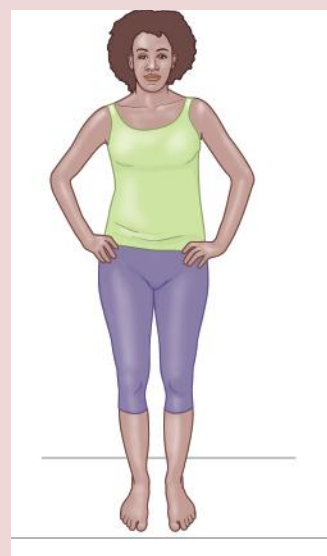
**TISSUES,** which are specialized groups of cells with similar structure and function. Tissues come together to form...



**CELLS,** the smallest living units that make up the body's structure. Cells group together to form...



**ORGAN SYSTEMS,** which are groups of organs that all contribute to a particular function. All of the organ systems together form...



**A HUMAN ORGANISM:** one complete individual.

## The Body AT WORK

The body contains four types of tissues:

- **Epithelial tissue** covers or lines body surfaces; examples include the outer layer of the skin, the walls of capillaries, and kidney tubules.
- **Connective tissue** connects and supports parts of the body; some transport and store materials; examples include bone, cartilage, and adipose tissues.
- **Muscle** contracts to produce movement; examples include skeletal muscles and the heart.
- **Nerve tissue** generates and transmits impulses to regulate body function; examples include the brain and nerves.

# Organ Systems

The human body consists of 11 organ systems. The organs of each system contribute to a particular function. However, some organs belong to more than one system. Specifically, the pharynx is part of both the respiratory and the digestive systems, and the male urethra belongs to both the reproductive and urinary systems.



Consists of skin, hair, and nails

Key functions:

- Protection
- Temperature regulation
- Water retention
- Sensation

**Integumentary system**



Consists of bones, cartilage, and ligaments

Key functions:

- Protection of body organs
- Support
- Movement
- Blood formation

**Skeletal system**

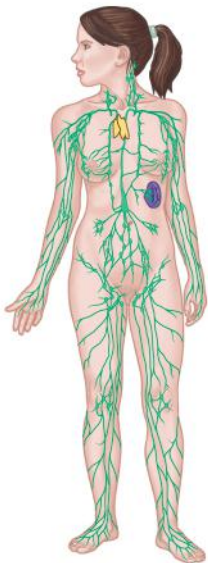


Consists primarily of skeletal muscles

Key functions:

- Movement
- Posture
- Heat production

**Muscular system**

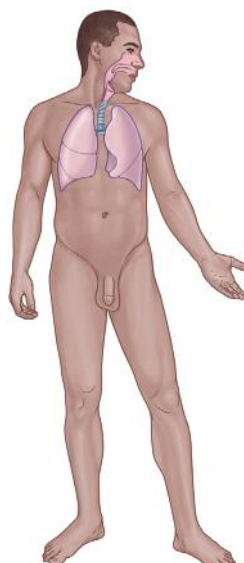


Consists of lymph nodes, lymphatic vessels, lymph, thymus, spleen, and tonsils

Key functions:

- Role in fluid balance
- Production of immune cells
- Defense against disease

**Lymphatic system**



Consists of the nose, pharynx, larynx, trachea, bronchi, and lungs

Key functions:

- Absorption of oxygen
- Discharge of carbon dioxide
- Acid-base balance
- Speech

**Respiratory system**

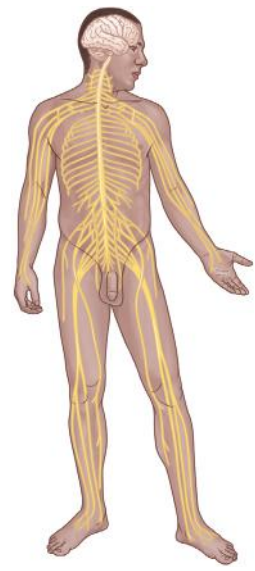


Consists of the kidneys, ureters, urinary bladder, and urethra

Key functions:

- Excretion of wastes
- Regulation of blood volume and pressure
- Control of fluid, electrolyte, and acid-base balance

**Urinary system**

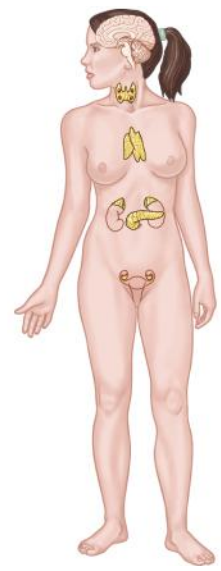


Consists of the brain, spinal cord, nerves, and sense organs

Key functions:

- Control, regulation, and coordination of other systems
- Sensation
- Memory

**Nervous system**

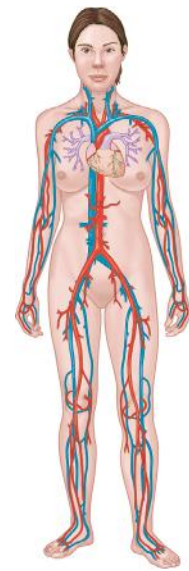


Consists of the pituitary gland, adrenals, pancreas, thyroid, parathyroids, and other organs

Key functions:

- Hormone production
- Control and regulation of other systems

**Endocrine system**

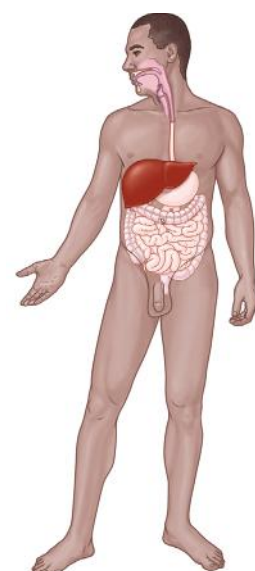


Consists of the heart, arteries, veins, and capillaries

Key functions:

- Distribution of oxygen, nutrients, wastes, hormones, electrolytes, immune cells, and antibodies
- Fluid, electrolyte, and acid-base balance

**Circulatory system**

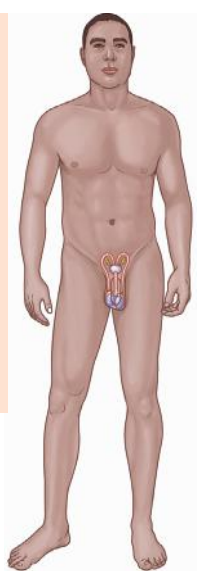


Consists of the stomach, small and large intestines, esophagus, liver, mouth, and pancreas

Key functions:

- Breakdown and absorption of nutrients
- Elimination of wastes

**Digestive system**



Consists of the testes, vas deferens, prostate, seminal vesicles, and penis

Key functions:

- Production and delivery of sperm
- Secretion of sex hormones

**Male reproductive system**



Consists of the ovaries, fallopian tubes, uterus, vagina, and breasts

Key functions:

- Production of eggs
- Site of fertilization and fetal development
- Birth
- Lactation
- Secretion of sex hormones

**Female reproductive system**

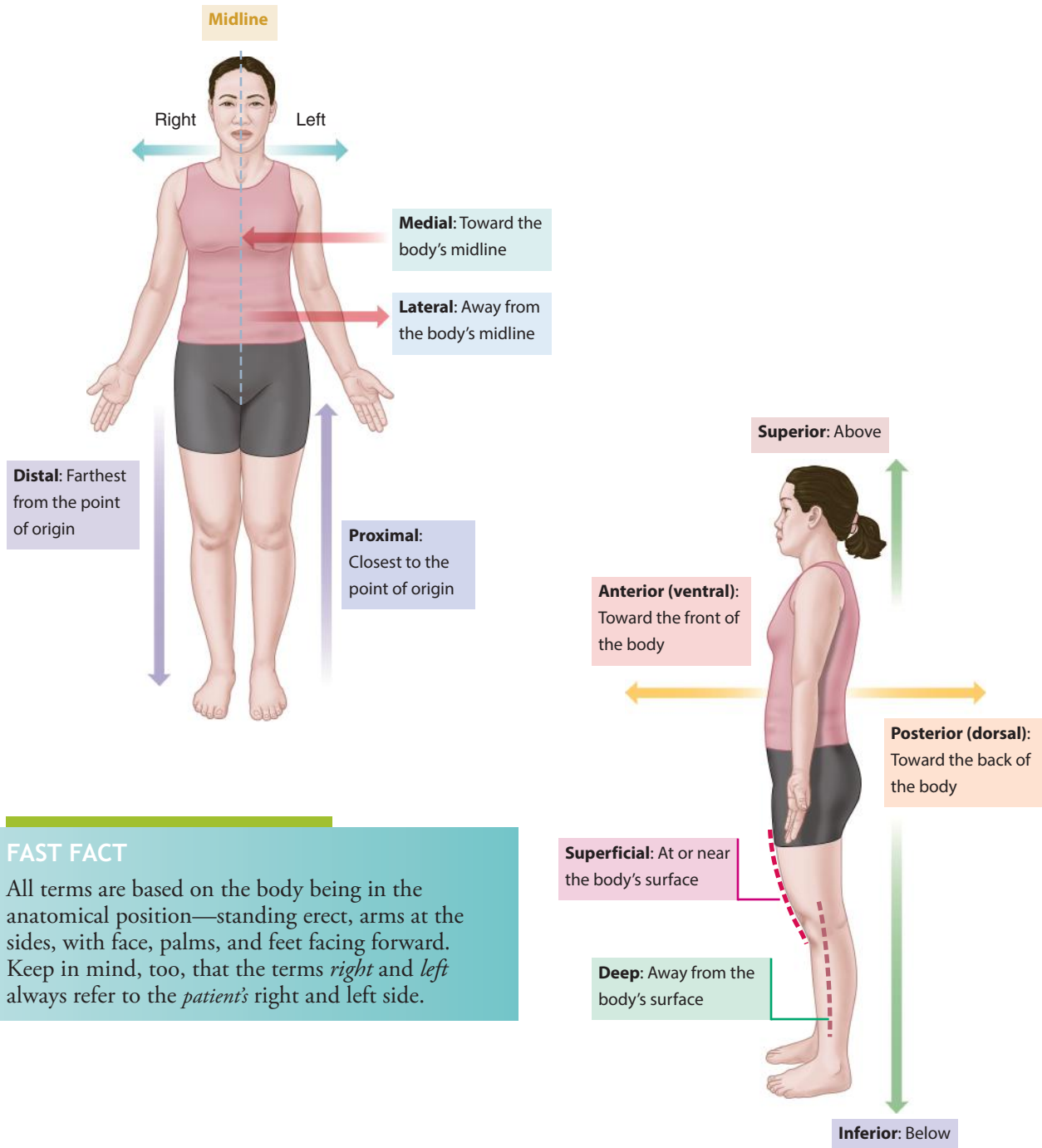
# Anatomical Terms

Terms are crucial for navigating your way around the human body. Besides being used to identify the location of various body parts, the use of proper terms ensures accurate communication between health-care providers.

Because the body is three-dimensional, a number of different terms are needed. These include directional terms as well as terms for body planes, body regions, and body cavities.

## Directional Terms

Directional terms are generally grouped in pairs of opposites.



### FAST FACT

All terms are based on the body being in the anatomical position—standing erect, arms at the sides, with face, palms, and feet facing forward. Keep in mind, too, that the terms *right* and *left* always refer to the *patient's* right and left side.

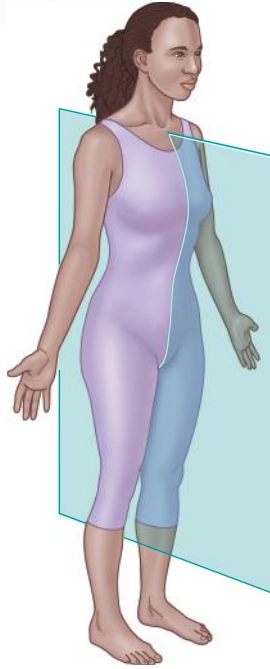


## Body Planes

Body planes divide the body, or an organ, into sections.

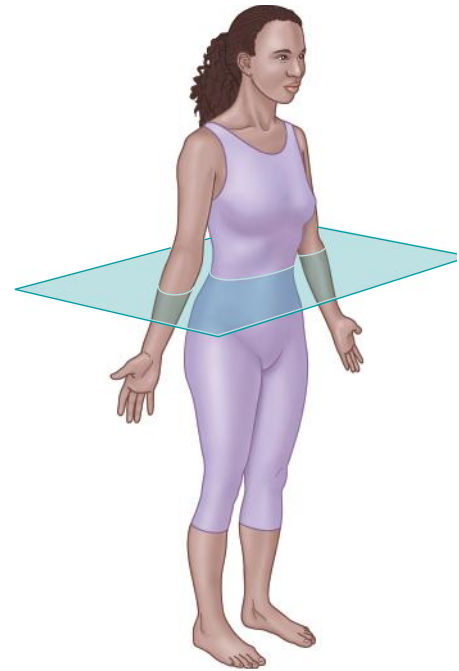
### Sagittal Plane

- Divides the body lengthwise into right and left sides
- Called a *midsagittal* plane if the section is made exactly at midline
- Often used in illustrations to reveal the organs in the head or pelvic cavity



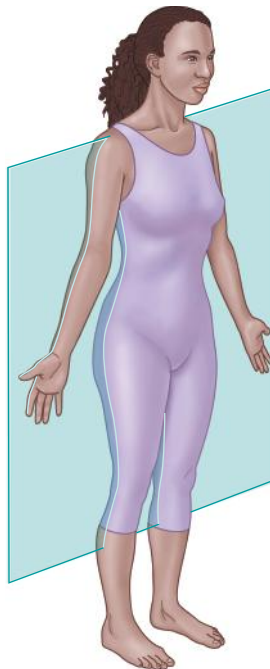
### Transverse Plane

- Divides the body horizontally into upper (superior) and lower (inferior) portions
- Also called a *horizontal* plane
- Used by CT scanners to reveal internal organs



### Frontal Plane

- Divides the body lengthwise into anterior and posterior portions
- Also called a *coronal* plane
- Often used in illustrations to show the contents of the abdominal and thoracic cavities



### FAST FACT

The frontal plane is also called a coronal plane because the line of the plane crosses the top, or crown, of the head. The word *coronal* comes from a Latin word meaning crown.

## Body Regions

The illustration below shows the terms for the different regions of the body. These terms are used extensively when performing clinical examinations and medical procedures.

