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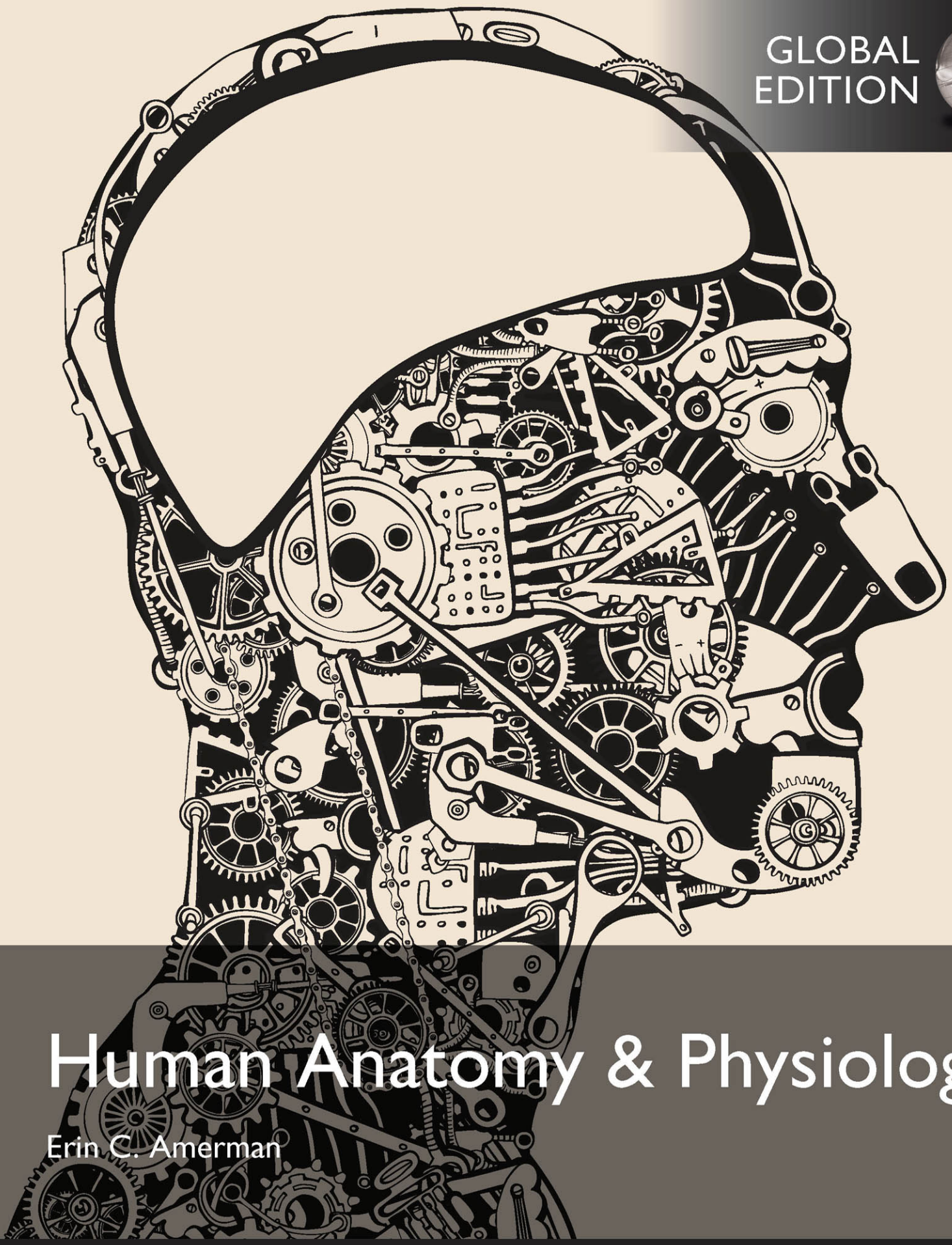


Human Anatomy & Physiology

Erin C. Amerman

ALWAYS LEARNING

PEARSON

Quick Reference

CORE PRINCIPLES in A&P

referenced throughout this book

In Chapter 1, Amerman introduces **four core principles** and highlights them throughout the book to remind you of the overall theme of human anatomy and physiology – homeostasis – and the core principles that revolve around maintaining it.

Feedback loops are homeostatic control mechanisms in which a change in a regulated variable causes effects that *feed back* and in turn affect that same variable.

The form of a structure best suits its function.

A gradient is present any time more of something exists in one area than in another and the two areas are connected.

Cells in the body generally communicate via electrical signals or chemical messengers to coordinate functions in the body.

phag/o-, eat: *autophagy* = self eating; condition of a cell digesting itself
pharyng/o-, throat: *glossopharyngeal* = pertaining to the tongue and throat
phleb/o-, vein: *phlebotomy* = incision into a vein
phot/o-, light: *photophobia* = fear or dislike of light
phys/i-, function: *pathophysiology* = study of the altered physiology of disease states
pin/o-, drink: *pinocytosis* = condition of cell drinking
plex/u-, network, twisted: *nerve plexus* = network of nerves
pneum/o-, pneumat/o-, air, breath: *pneumothorax* = air in the thoracic cavity
pneumon/o-, lung: *pneumonitis* = inflammation of the lung
pod/o-, foot: *podiatrist* = medical specialist of the foot and ankle
proct/o-, rectum: *proctoscope* = instrument used to examine the rectum
pseud/o-, false: *pseudoanemia* = pallor of mucous membranes and skin without other signs of true anemia
psych/i-, mind: *psychopathology* = study of diseases of the mind
pulmon/o, lung: *intrapulmonary* = within the lung
pyel/o-, pelvis: *pyelonephritis* = inflammation of the renal pelvis
py/o-, pus: *pyoderma* = condition causing pus to form in the skin
pyr/o-, fire: *pyrolysis* = breakdown of a chemical by elevated temperature
ren/i-, kidney: *adrenal* = pertaining to an area next to the kidney
rhin/o-, nose: *rhinorrhea* = drainage from the nose
sarc/o-, flesh, soft tissue: *sarcolemmal* = pertaining to the outer covering of a muscle fiber (the plasma membrane)
scler/o-, hard: *scleroderma* = hardening of the skin
sigm/o-, S-shaped: *sigmoidoscopy* = examination of the S-shaped portion of the colon
sin/u-, cavity: *sinusoid* = resembling a sinus or cavity
son/o-, sound: *sonogram* = data recorded using sound waves
spir/o-, breathe: *spirometry* = measurement of breathing
stat/i-, to stop, standing still: *hydrostatic* = pertaining to fluids not in motion
systol/i-, contract, standing together: *systolic pressure* = blood pressure during the heart's contraction
therm/o-, temperature: *thermogenesis* = generation of heat
thromb/o-, clot: *thrombosis* = abnormal condition of a blood clot
tom/o-, cut, slice: *dermatome* = instrument that takes slices of skin
tox/o-, poison, toxin: *neurotoxin* = toxin causing damage to the nervous system
tympan/o-, drum: *tympanoplasty* = reconstruction of the eardrum
urin/o, urine: *oliguria* = production of little urine
vas/o-, vascul/o, vessel: *extravascular* = outside a blood vessel
vesic/o-, vesicul/o-, bladder, small sac: *vesiculotomy* = surgical incision of the seminal vesicle
viscer/o-, organ: *visceral* = pertaining to an organ
vit/a-, life: *vital* = pertaining to life

Quick Reference

CORE PRINCIPLES in A&P
referenced throughout this book

In Chapter 1, Amerman introduces **four core principles** and highlights them throughout the book to remind you of the overall theme of human anatomy and physiology – homeostasis – and the core principles that revolve around maintaining it.

CORE PRINCIPLE
Feedback Loops

Feedback loops are homeostatic control mechanisms in which a change in a regulated variable causes effects that *feed back* and in turn affect that same variable.

CORE PRINCIPLE
Structure-Function

The form of a structure best suits its function.

CORE PRINCIPLE
Gradients

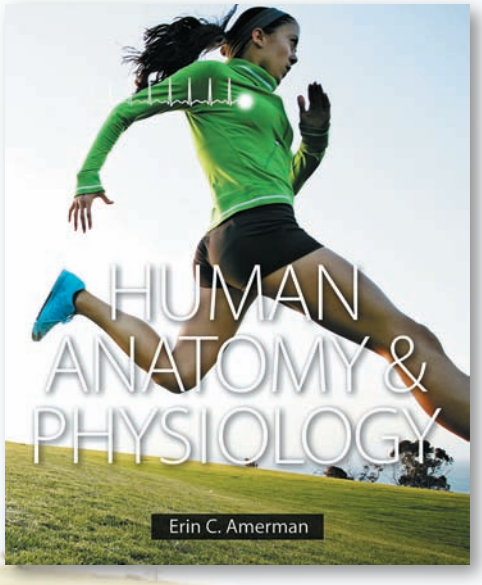
A gradient is present any time more of something exists in one area than in another and the two areas are connected.

CORE PRINCIPLE
Cell-Cell Communication

Cells in the body generally communicate via electrical signals or chemical messengers to coordinate functions in the body.

Amerman is with you every step of the way

Three key tools to help you succeed in A&P 1



Amerman text

- Read textbook explanations you can understand.
- Study figures that help you focus on **one-concept-at-a-time.**
- Get coaching on the tough topics via **Concept Boosts.**

2

3

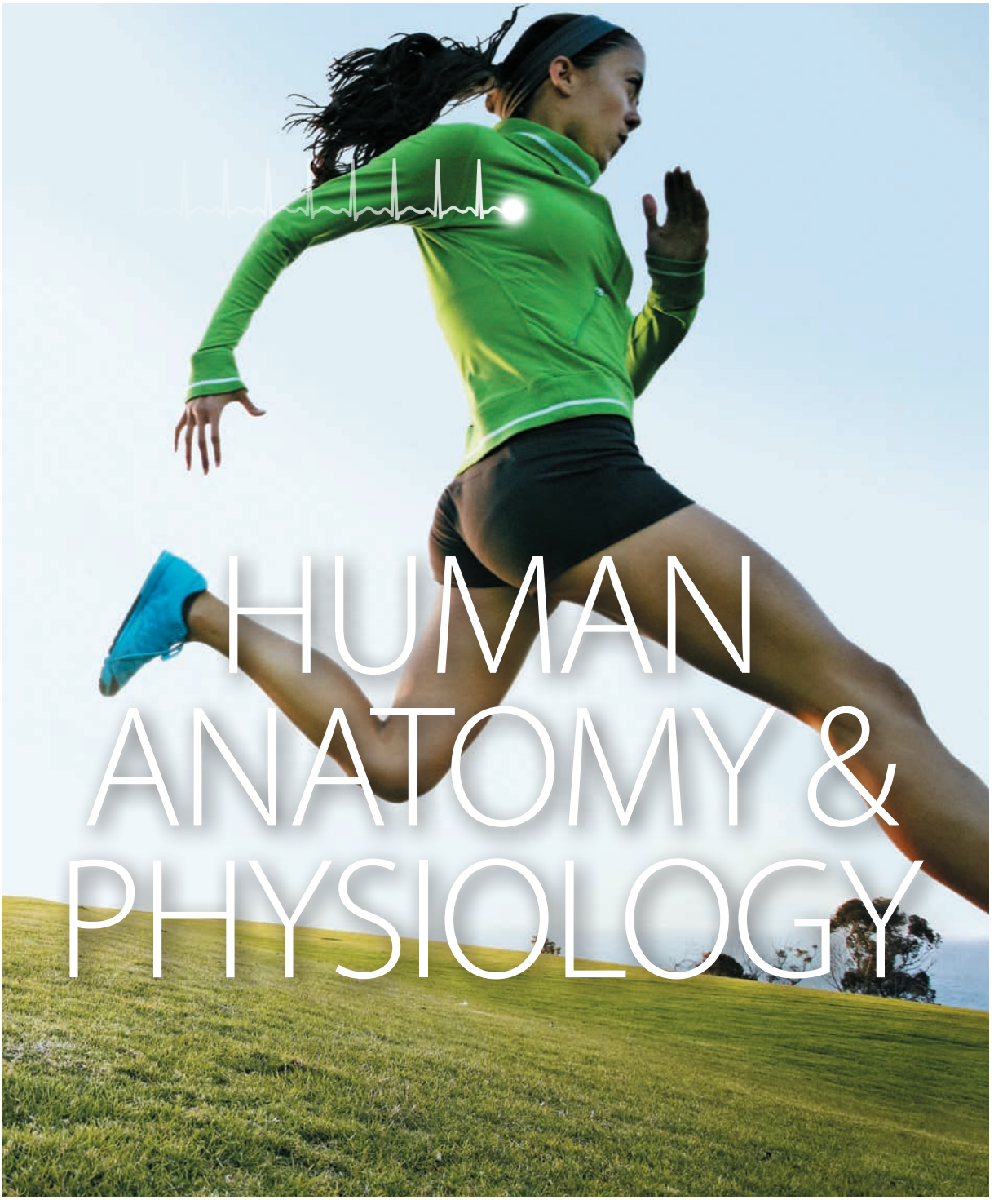
Big Picture figures with Animations

- Scan the QR code and watch **Big Picture figures** come alive as Amerman narrates physiological events. With these **mobile-ready Big Picture Animations,** you can study A&P on-the-go, anywhere, any time.
- Play with interactive quizzes for each animation, where you can draw, predict, apply and more.

If you don't have a QR code reader on your smart phone, go to your phone's app store and download one of the free QR reader apps.

MasteringA&P®

- Access **MasteringA&P** assignments for Concept Boost Video Tutors and Big Picture Animations, Practice Quizzes, *Practicing A&P: Active-Learning Worksheets*, **NEW!** Interactive Physiology 2.0, and more.



HUMAN ANATOMY & PHYSIOLOGY

Erin C. Amerman
Florida State College at Jacksonville

PEARSON

This book is dedicated to Elise, Chris, my mom, and all of my students—past, present, and future.
—Erin Amerman

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Erin C. Amerman

Erin Amerman teaches anatomy and physiology at Florida State College at Jacksonville; she has been involved in anatomy and physiology education for more than 14 years as an author and professor. She received a B.S. in cellular and molecular biology from the University of West Florida and a doctorate in podiatric medicine from Des Moines University. She is also the author of the best-selling *Exploring Anatomy and Physiology in the Laboratory*, now in its second edition, with Morton Publishing Company. Erin is deeply committed to helping her students succeed in the A&P course and to generating curiosity and excitement about the material and its application in their future health careers. She is a member of the Human Anatomy and Physiology Society (HAPS) and enjoys attending the annual HAPS conferences, especially when they are in locations that have ample hiking opportunities and many different species of snake.

When not writing or teaching, Erin enjoys spending time with her family and her menagerie of rescued cats, dogs, pet rats, snakes, tetras, and a turtle. She also practices karate and kobudo (she recently earned her second black belt) and loves photographing the local wildlife around her home in rural northern Florida. She can often be found hiking around the prairie with a camera and snake hook in hand.

Virginia Irintcheva

Media Author

Virginia Irintcheva is the author of the Big Picture Animations and interactive figures and assessments in MasteringA&P®. She also served as an editorial advisor and reviewer of key concepts in this book. She is an associate professor at Black Hawk College in Moline, Illinois, where she has been teaching courses in anatomy and physiology, medical terminology, and biology for more than 8 years. Virginia was born and raised in Bulgaria. She earned a B.S. in biology and Spanish from St. Louis University, under whose auspices she studied in Madrid, Spain, as well as in Missouri. She received her Ph.D. in pharmacological and physiological sciences in 2006 from that school. Her primary research interests are cell signaling and, specifically, the effects of the coagulation protein thrombin and the family of Ras proteins on cell growth and proliferation. As a teacher, her fundamental goal is to create an environment of effective communication by promoting mutual respect and successful learning. Virginia strives to teach her students not only what to learn but also how to learn and why they are learning.

Outside the classroom, Virginia likes to travel, visit family in Europe, snowboard, hike with her dog, and ride her horse.

Preface

To the Student

Welcome to the fascinating study of the human body! Though you and I might never meet in person, I consider you and every other student who uses this textbook to be "my" student. Just as I want to ensure the success of the students in my classroom, I am similarly invested in your success. For this reason, this book was designed with *you* in mind—every feature, study tool, and media presentation is intended to help you achieve your goals.

This book was written not only for you, but also *about* you. The great thing about human A&P is that no matter what your goals are, it is relevant to your life. Human A&P is you; it's also me, your family, your friends, and indeed every human who ever lived or will live. There's nothing in the study of A&P that is irrelevant or esoteric, because every single detail revolves around you and your life. How many other courses can make that claim?

So dive right in and begin to explore the science of you. I sincerely hope that you enjoy your study of human A&P and find it as fascinating and wondrous as I do.

—Dr. Amerman
erin.amerman2014@gmail.com

To the Instructor

Why a New A&P Textbook?

I get the question "Why did you write this book?" quite regularly. The short answer to this is that writing and teaching are just in my DNA somewhere. For the long answer, we have to look back in time and start with my 5-year-old self.

When I was in kindergarten, I was placed with another kid, Kyle, into a separate group for reading time because we were the only two kids in the class who could already read. It struck my 5-year-old brain as inconceivable that so many of my classmates couldn't read. Reading was so *easy;* anyone could do it! Maybe, I reasoned, they just needed a book to teach them how to read. So I gathered up some construction paper and crayons and got to writing. And thus my first "textbook" was born: *The Bird and Mr. Bear.*

Fast forward a few years to my medical school education. While in medical school, I co-taught a human physiology course, and during my first class I had one of those "aha" moments: Teaching somehow just "felt right." I connected with my students, and they connected with me. This feeling only grew over the next two semesters. But still, I was in medical school, and who would be crazy enough to go through the pain of medical school, graduate, and then not ever practice as a physician?

Well, it turns out that *I* was crazy enough to do just that. I was lucky enough to find a full-time position teaching anatomy and physiology. And while I loved teaching, there were far more challenges than I had anticipated. My students were different from my former classmates. The difference wasn't in intelligence—my students were smart. But, this new generation of students seemed to be ill-prepared for the rigors of a college science course. They lacked study skills, they had little to no background in science, and—alarmingly—they couldn't read or understand their textbooks. For these reasons, so many bright, motivated students struggled with the course.

As a teacher, this was the last thing I wanted to see. So I did the same thing I did in kindergarten: grabbed some paper and started writing. First came my own lab exercises, which were followed by lecture outlines and notes. As I wrote, I "Amermanized" the content (a term coined by a student) with concise prose, simple diagrams, stories/analogies, and active learning exercises. My students' responses were enthusiastic; indeed, many asked if they could return their textbooks and just use my notes instead.

A vision for a new textbook began to form in my mind: one for today's students. It would:

- be written at a level my students could understand and, at the same time, still provide the information they need;
- anticipate where they need help with the science and provide the necessary in-the-moment coaching; and
- reduce cognitive overload and present information—in both text *and* art—in manageable chunks that are more easily digestible.

Eight years later, my vision finally became reality with the publication of *Human Anatomy & Physiology.* I am thrilled to be able to offer this text and its ancillary materials and I sincerely hope it has a positive impact on students' lives and education. This is what I have wanted since *The Bird and Mr. Bear*—to help people learn.

Key Features

Many of the key features found in this textbook, the companion workbook, and media came directly from my experience teaching and working with a range of students and seeing what helps them learn. These features include the following:

- **How to Succeed in A&P** in Chapter 1 introduces students to core study skills, including how to manage time, how to take notes, and how to study for an A&P exam. I also guide students through how to use the textbook, workbook, and online tools.
- Recurring **Core Principles** icons appear throughout the book and remind students to recall and apply four core principles introduced in Chapter 1: Structure-Function, Feedback Loops, Gradients, and Cell-Cell Communication.
- Over 50 **Concept Boosts** and **Study Boosts** coach students on key A&P concepts that are often difficult or tricky. Additional emphasis is placed on explaining challenging topics, often incorporating familiar analogies and simple illustrations, giving students a boost in fully understanding the content.
- **Concept Boost Video Tutors** walk students through selected Concept Boost topics that are particularly tough to understand.

These Video Tutors are assignable in MasteringA&P® and are also available in the Study Area of MasteringA&P.

- **One-concept-at-a-time art** focuses on teaching one concept per figure so that a student can instantly grasp the key idea without being distracted by a sea of details. For key physiology concepts, unique sequence figures unpack information systematically so that each scene contains only the most important information, again making it easier for today's students to focus on key details.
- **In-the-moment visual reminders** of key foundational science concepts appear as needed to help students recall and apply given concepts.
- **Big Picture figures** visually summarize key physiological processes and anatomy concepts, highlighting only what is most important.
- Mobile-ready **Big Picture Animations** with interactive quizzes bring the Big Picture figures to life and help reinforce students' understanding of each step in a key process. These animations are assignable in MasteringA&P and are also available in the Study Area of MasteringA&P.
- **HAPS-based Learning Outcomes** begin each module within a chapter. Additionally, the assessments in MasteringA&P are organized by these Learning Outcomes.
- **Pronunciations** use phonetic sounds (instead of traditional symbols) to help students learn correct pronunciations.
- **Flashback** questions encourage students to think about previously learned concepts they will need to apply in order to understand upcoming discussions.
- **Quick Check** questions appear throughout each module to test students' basic understanding of the material. Answers to Quick Check questions are available in the Study Area of MasteringA&P.
- **Apply What You Learned** questions at the end of each module ask students to think critically and apply what they've just learned to a real-world scenario.
- **A&P in the Real World** features highlight clinical conditions and disorders that illustrate and reinforce key A&P concepts discussed in the chapter.
- **Chapter running case studies** with assessments challenge students to apply their knowledge of key A&P concepts to a real-world clinical scenario, while allowing instructors to "flip" the classroom and incorporate critical thinking and/or group activities. These cases can be found in the Instructor's Guide in MasteringA&P and are also assignable in MasteringA&P.
- ***Practicing A&P: Active-Learning Workbook*** helps engage the kinesthetic learner with labeling, drawing, and build-your-own summary-table exercises that students can complete as they read the textbook. This workbook is available as downloadable PDF worksheets in the Study Area of MasteringA&P.

The Development Story

Making this book, including the text, the art, and the media, was an intensive, collaborative process. Each draft of the manuscript was sent to A&P instructors and other content experts to evaluate the breadth, depth, and accuracy of coverage; the art program; and the overall pedagogical effectiveness. Our team worked closely together to analyze the feedback and determine which changes were necessary to improve each chapter. Each subsequent draft took into account the reviewers' feedback to make sure that we identified the key challenging concepts that students struggle with and that we included a way to help students better understand those concepts (such as giving them closer attention via a Concept Boost, or "unpacking" a complex topic gradually over a series of well-paced figures).

Accuracy and Currency

During the production process, when art was rendered and each book page was laid out, we went through another extensive reviewing process to ensure that accuracy and clarity were maintained in all materials. We also reviewed the pages with various focus groups to be certain that the final presentation delivers an effective, reader-friendly experience for students and instructors alike.

One of our goals was ensuring that this book is not only accurate but also as up-to-date as possible. Key topics throughout the book were researched, and in some cases we updated our presentation to reflect current understanding. Examples include up-to-date discussions of endocytosis and calcium homeostasis, of new evidence suggesting that PTH is the main regulatory hormone in humans and calcitonin is not as relevant as we once thought, of learning and memory in the central nervous system chapter, and of increased public health concern about children not being vaccinated because parents believe vaccines are linked to autism.

Class-Tested and Approved

Anatomy and physiology students across the country also contributed to the development of *Human Anatomy & Physiology*. Over 4000 students provided feedback through extensive class testing prior to publication. We asked students to use the chapters in place of, or alongside, their current A&P textbook during their course. We then asked them to evaluate numerous aspects of the text, including how clear and understandable the writing style is, how well it explains and coaches on difficult topics, whether the text helps them see the "big picture" of key physiology processes and anatomy concepts, whether the figures are easier to read and understand, and how well the Big Picture Animations help them to visualize and grasp physiology topics. Through these student reviews, the strengths of *Human Anatomy & Physiology* were put to the test, and it passed. Overwhelmingly, the majority of the students who class tested it would prefer to use this textbook over their current textbook.

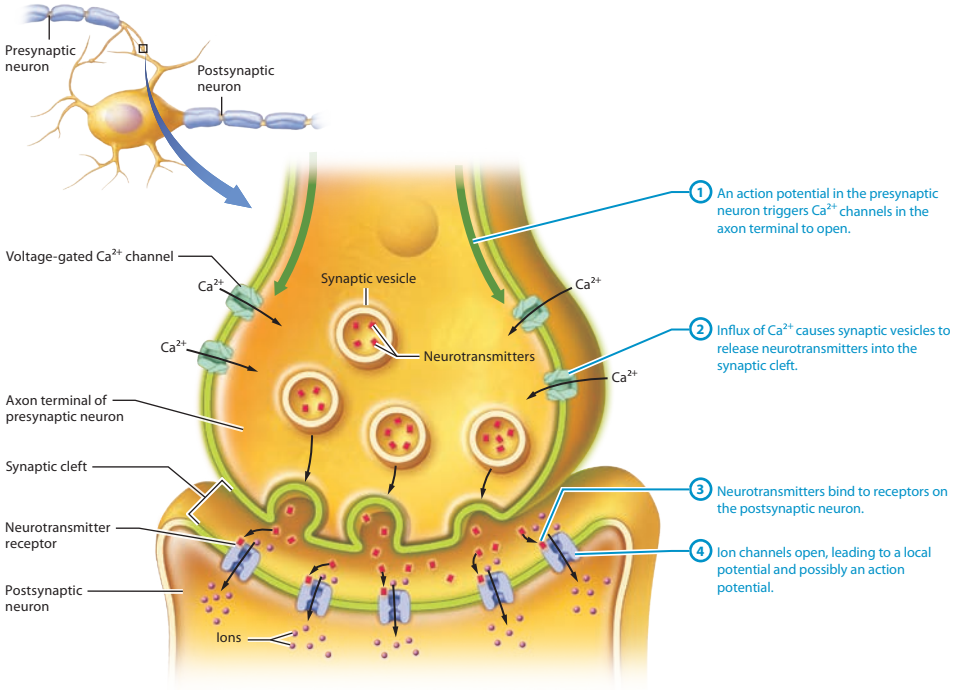
In addition, our market development team interviewed over 75 A&P instructors, gathering feedback on how well the text builds conceptual understanding, how well the author coaching helps demystify tough or tricky concepts, and how well the *A&P in the Real World* boxes illustrate key concepts and cover key clinical topics. Instructors also reported on the accuracy and depth of the content overall. All comments, suggestions, and corrections were analyzed and addressed by the author and editorial team prior to publication.

Are your students overwhelmed by the amount of information in the course?

One-concept-at-a-time art

Drawing from her experience in the classroom and the latest research in cognitive science, Amerman reduces cognitive overload by visually unpacking key information using one-concept-at-a-time art and Big Picture figure visual summaries.

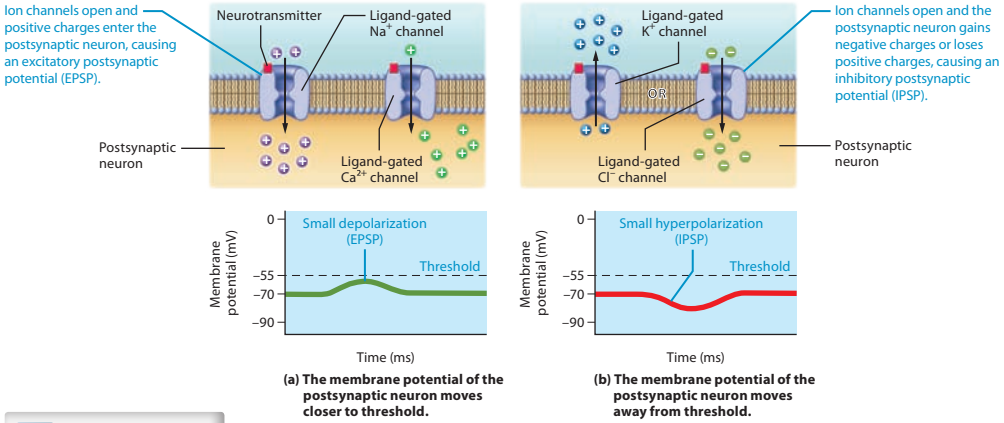
This figure shows the first concept: how synaptic transmission occurs at a chemical synapse.



Play animation @MasteringA&P®

Figure 11.23 Events at a chemical synapse: synaptic transmission.

This figure shows the second concept: how postsynaptic potentials are triggered.



(a) The membrane potential of the postsynaptic neuron moves closer to threshold.

(b) The membrane potential of the postsynaptic neuron moves away from threshold.

Play animation @MasteringA&P®

Figure 11.24 Postsynaptic potentials.

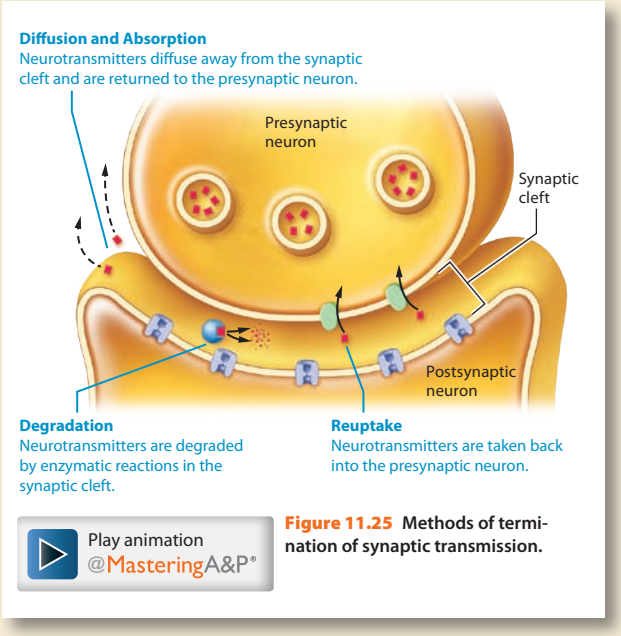
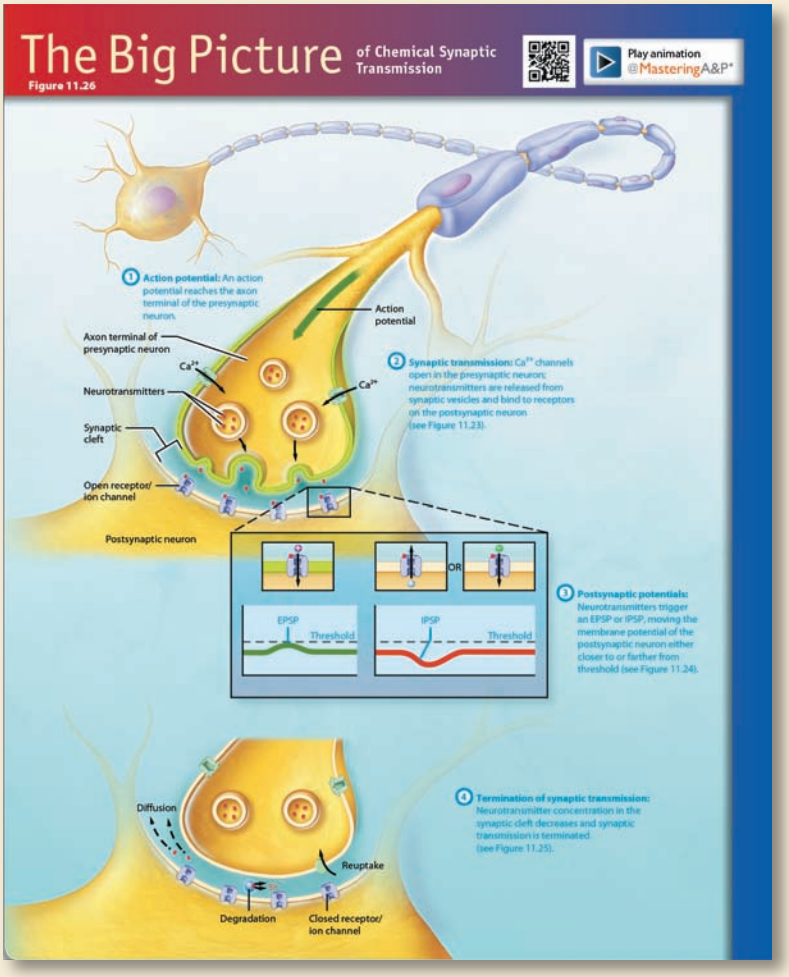


Figure 11.25 **Methods of termination of synaptic transmission.**

The next figure shows the third concept: how synaptic transmission is terminated.

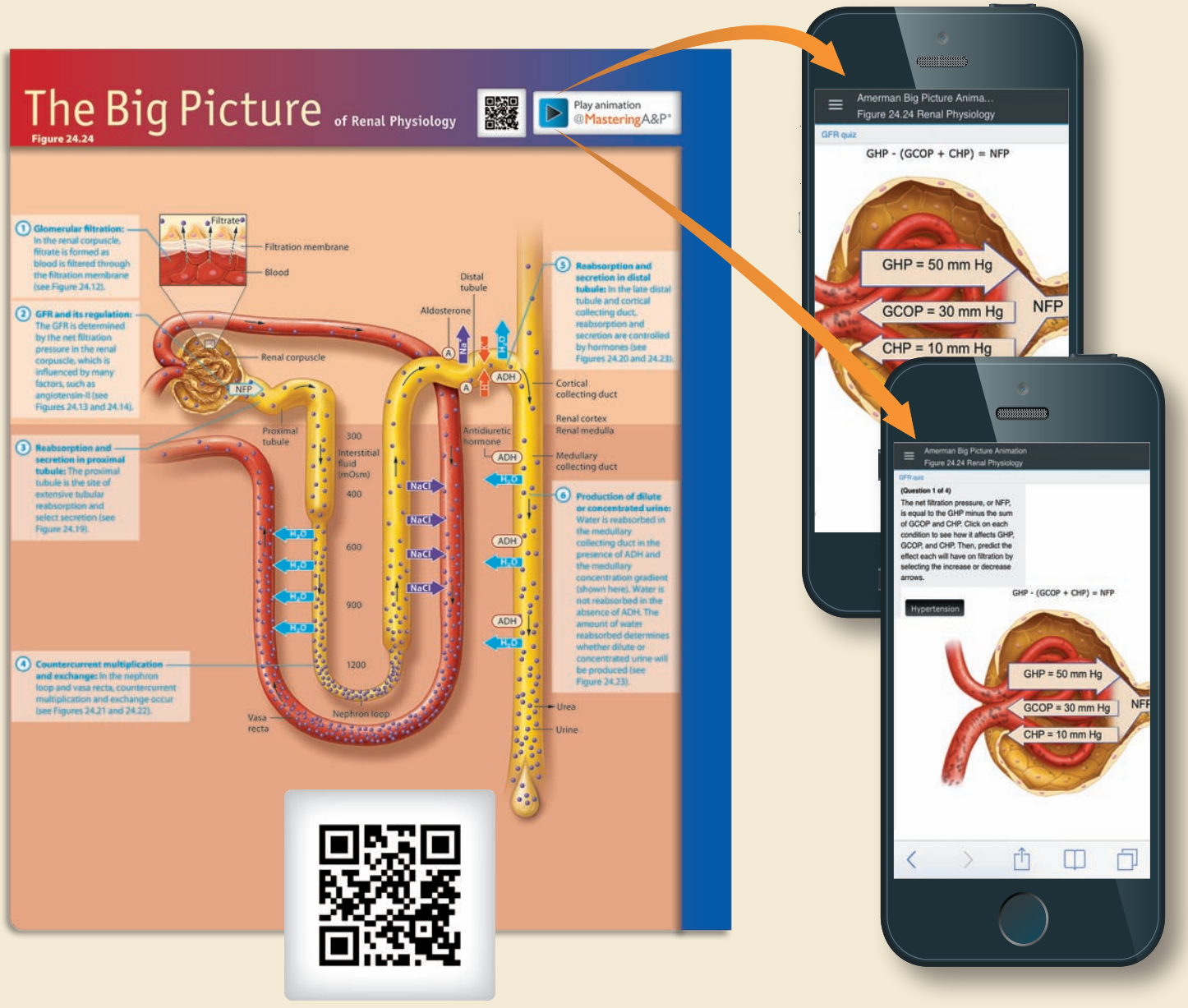


The Big Picture figure summarizes the key events of chemical synaptic transmission.

Would your students benefit from another mode of learning A&P concepts?

Big Picture Animations

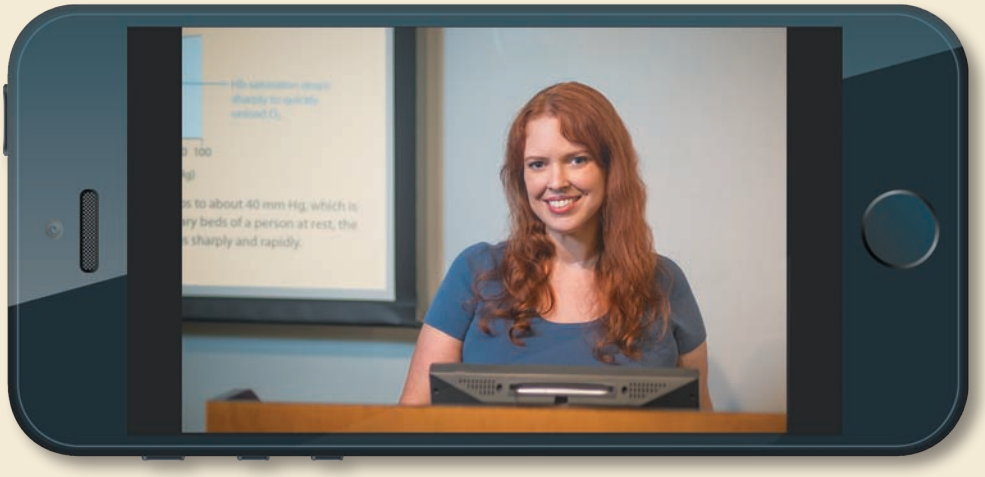
With Amerman's mobile-ready Big Picture Animations, students can study and review A&P topics anywhere, any time. These animations help students visualize events occurring at the molecular level and reflect the same terminology and explanations found in the Amerman textbook to ensure a consistent learning experience. Each animation is narrated by Amerman and includes interactive quizzes with instant feedback. These animations are also assignable in MasteringA&P® and are available in the Study Area of MasteringA&P.

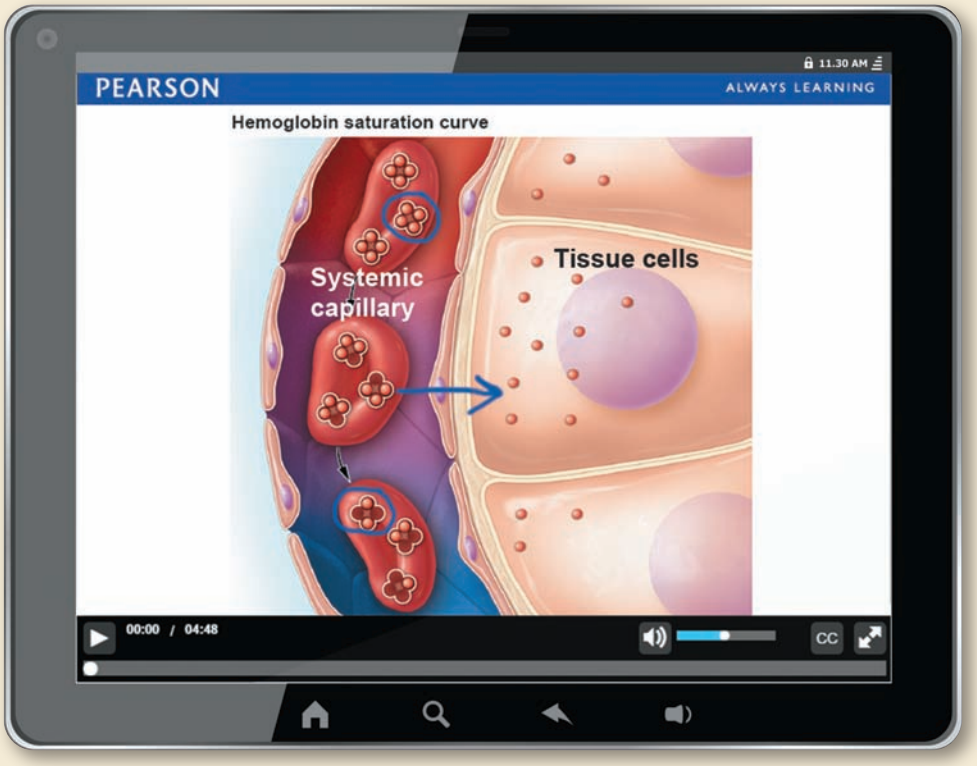


Scan to watch Figure 24.24.

Concept Boost Video Tutors

Students get just-in-time coaching on-the-go with Amerman's mobile-ready Concept Boost Video Tutors. Select Video Tutors feature the author talking directly to students and coaching them through tough-to-understand or tricky topics. These Video Tutors are assignable in MasteringA&P® and are also available in the Study Area of Mastering A&P.





"The Big Picture Animations are AWESOME! I truly love the way they are presented—plus, the quizzes that follow are sure to engage my students and give them the immediate feedback they expect."

—William Huber, St. Louis Community College at Forest Park

Are there concepts you know in advance your students will struggle with?

Concept Boosts

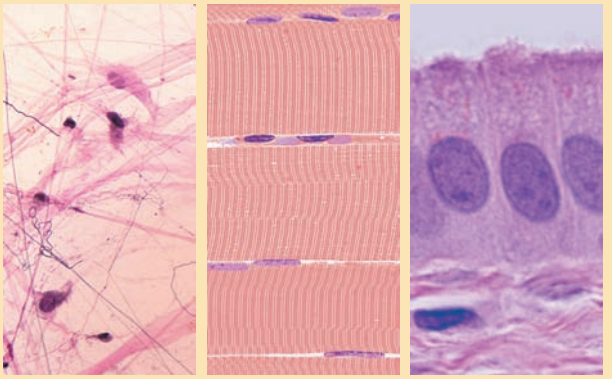
In her classroom, Amerman gives her students extra coaching in advance of those tough-to-understand concepts, *right when they need it,* and she has built that same strategy into her textbook. She anticipates where students will need extra help and then provides just-in-time coaching via Concept Boosts. Each Concept Boost focuses on tough-to-understand or tricky concepts.

> Amerman is first and foremost a great teacher and it shows. She anticipates where students get tripped up and provides the extra help. Her writing style is simple and straight to the point. She writes much like how an instructor teaches a lecture, which I love.
>
> **—Richard Gonzalez Diaz, Seminole State**

ConceptBOOST

"But It All Looks Pink!" Part 2

In Part 1 of this Concept Boost, we discussed how to orient yourself to the different components of a tissue section. Now we'll take it a step further and identify the tissue from which a section was taken. Let's try it with these examples:



Example A Example B Example C

This isn't as difficult as it appears, particularly if you use a methodical, step-by-step approach:

1. **Identify the cells and the ECM.** Start with the basics you were given in the first part of this Concept Boost (on p. 128) and label the cells you see in Examples A, B, and C. Now move on to the ECM. Remember, the ECM consists only of ground substance and protein fibers. The ground substance will generally stain a uniform color (or simply appear clear). The protein fibers can take on various forms in different tissues, but they will generally stain darker than the ground substance, and they will always lack nuclei. Identify the protein fibers and ground substance in Examples A, B, and C.
2. **Notice how the cells are shaped and arranged.** Are the cells packed tightly together, or are they widely spaced? Do they form a continuous sheet, as in epithelial tissue—or do they seem to be surrounded by ECM, as in connective tissue? Are the cells all identical, or are there clearly different types? Do the cells have "arms" extending from a central body? Explain how the cells are shaped and arranged in Examples A, B, and C.
3. **Notice how the ECM is arranged.** Is the ECM confined to one specific part of the tissue, or is it spaced evenly between the cells? Does ground substance predominate, or are protein fibers the main elements? What types of protein fibers can you see? Explain how the ECM is arranged in Examples A, B and C.
4. **Determine the class of tissue.** Using your analysis in the preceding steps, now you are ready to identify the class of tissue. Determine the type of tissue in Examples A, B, and C. ■

Answers: A: loose connective tissue, B: skeletal muscle tissue, C: simple columnar epithelium

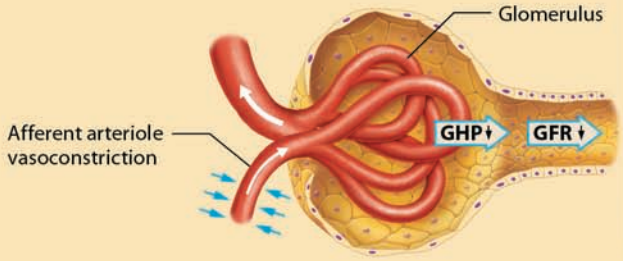
ConceptBOOST

How Changes in Arteriolar Diameter Influence the GFR

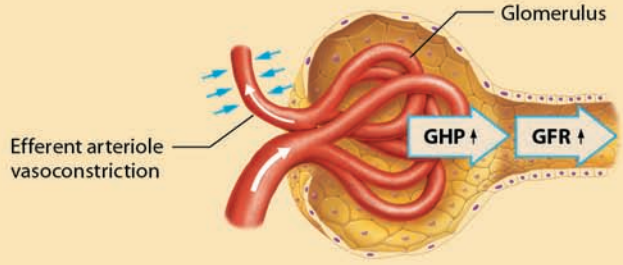
As we discussed earlier, filtration will occur only when a net pressure gradient in the glomerulus drives fluid out of the blood and into the capsular space. The size of this gradient determines how much filtration takes place—a small gradient will lead to only minimal filtration, whereas a large gradient leads to heavy filtration. Several factors determine the size of the pressure gradient i the glomerulus, but one of the most easily adjustable factors is th diameter of the afferent (entering) and efferent (leaving) arteriole When either arteriole constricts or dilates, this changes the glomerular hydrostatic pressure (GHP), and therefore the entire net pressure gradient also changes.

You can think of blood flowing in and out of the glomerulus as being similar to water flowing in and out of a sink, where the afferent arteriole is the faucet, the basin is the glomerulus, and th efferent arteriole is the drainpipe. Keep this analogy in mind as w explore how this mechanism works:

- Vasoconstriction of the afferent arteriole "turns down the faucet." This allows less blood to flow into the glomerulus, which decreases the GHP and the GFR:

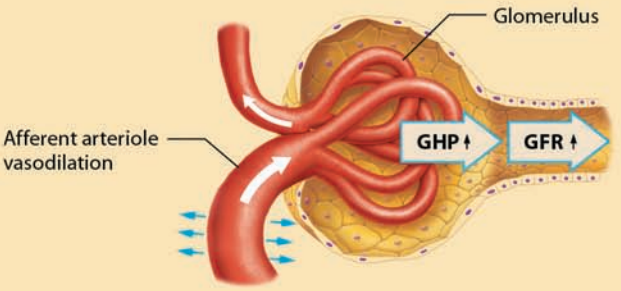


- Vasoconstriction of the efferent arteriole "clogs the drain." This causes blood to back up within the glomerulus, which increases the GHP and thus increases the GFR:

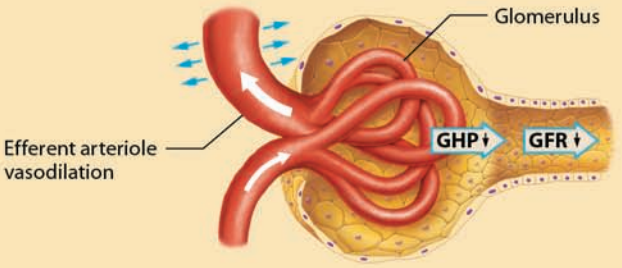


Vasodilation has the opposite effects:

- Vasodilation of the afferent arteriole "turns up the faucet." This increases the GHP and the GFR:



- Vasodilation of the efferent arteriole "unclogs the drain," allowing increased flow out of the glomerulus. This decreases the GHP and the GFR:



In the upcoming sections, you'll see that the main mechanisms the body uses to control or maintain GFR work by causing one or more of these physical changes. ■

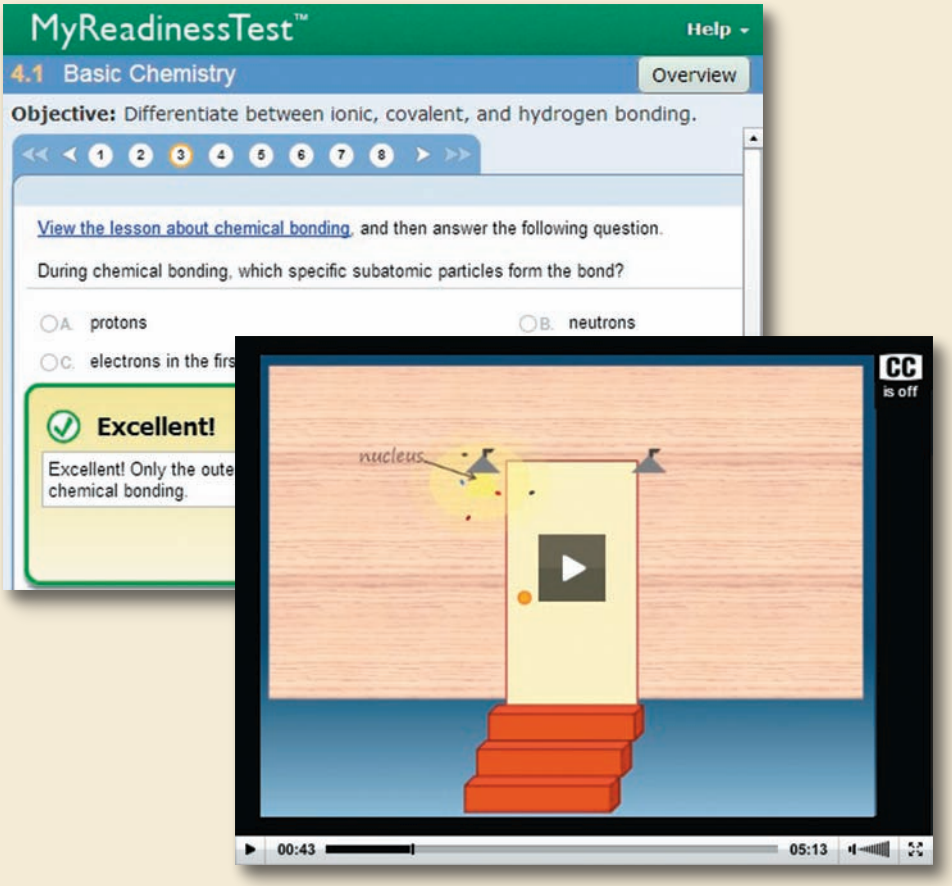
Are your students prepared for the rigor of A&P?

MyReadinessTest™

MyReadinessTest for A&P prepares students *before* their A&P course begins.

Students can get free online access the moment they register for your A&P course. MyReadinessTest assesses students' proficiency in study skills and foundation concepts in science and math, and tutors them in core areas where they need additional practice and review, before they even set foot in an A&P classroom. It offers:

- **Student online access** upon registration for their A&P course
- **Diagnostic Test and Cumulative Test** based on learning outcomes from a widely used primer, *Get Ready for A&P* by Lori Garrett
- **Personalized Study Plan** based on students' test results that includes practice questions with tutorials
- **Flexible Testing** that allows instructors to edit the Diagnostic Test or implement their own placement test or exit exam
- **Gradebook** that automatically records students' results

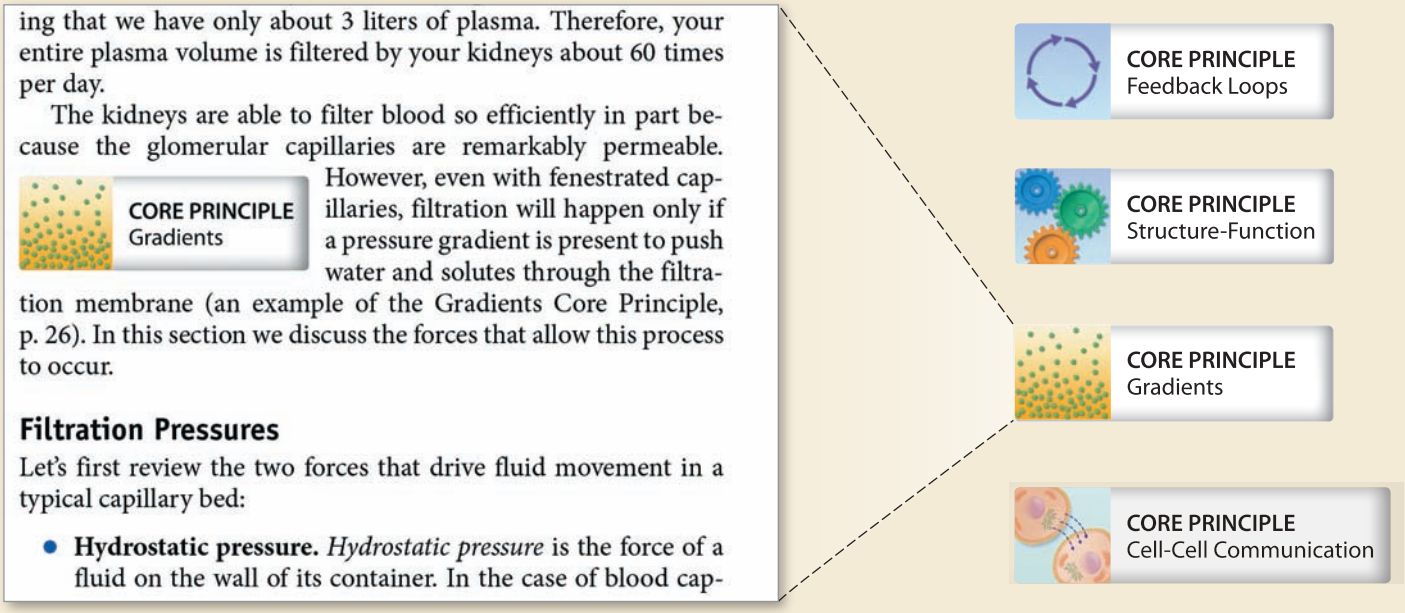


How to Succeed in A&P

Amerman includes a special section, "How to Succeed in A&P," in Chapter 1, with discussion of how to manage time, how to take notes, how to study for an A&P exam, and how to use the textbook, the companion *Practicing A&P: Active-Learning Workbook,* and online tools.

Core Principles

In Chapter 1, Amerman introduces **four core principles** and then highlights them throughout the textbook to remind students of the overall theme of human anatomy and physiology—homeostasis—and show how the core principles revolve around maintaining it.


ing that we have only about 3 liters of plasma. Therefore, your entire plasma volume is filtered by your kidneys about 60 times per day.

The kidneys are able to filter blood so efficiently in part because the glomerular capillaries are remarkably permeable. However, even with fenestrated capillaries, filtration will happen only if a pressure gradient is present to push water and solutes through the filtration membrane (an example of the Gradients Core Principle, p. 26). In this section we discuss the forces that allow this process to occur.

CORE PRINCIPLE
Gradients

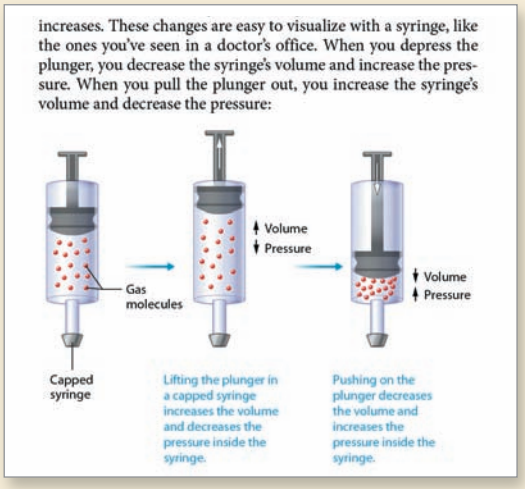
Filtration Pressures

Let's first review the two forces that drive fluid movement in a typical capillary bed:

- **Hydrostatic pressure.** *Hydrostatic pressure* is the force of a fluid on the wall of its container. In the case of blood cap-

In-the-Moment Visual Reminders

In addition to coaching via Concept Boosts, Amerman provides in-the-moment visual reminders of key foundational science concepts students need to recall and apply to understand a given concept.


increases. These changes are easy to visualize with a syringe, like the ones you've seen in a doctor's office. When you depress the plunger, you decrease the syringe's volume and increase the pressure. When you pull the plunger out, you increase the syringe's volume and decrease the pressure:

Do your students understand A&P concepts the first time they encounter them?

MasteringA&P® Assignable Content

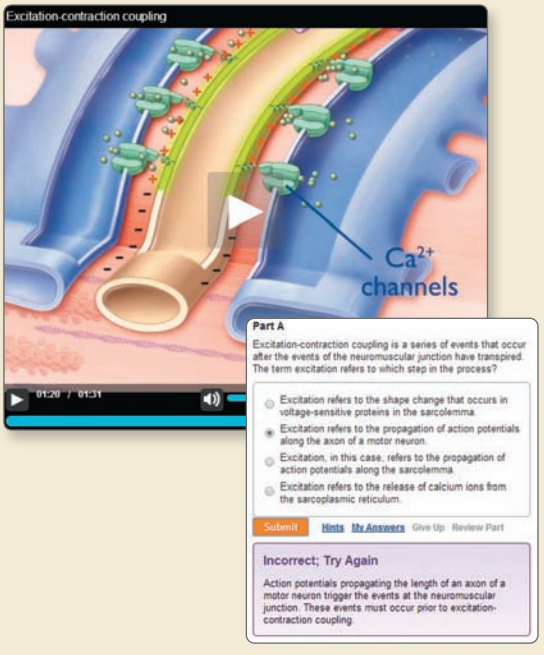
With MasteringA&P, students get it by doing self-paced tutorials that reflect your course objectives, provide personalized coaching, and respond to each student's progress. Coaching activities include immediate specific wrong-answer feedback and hints that emulate the office-hour experience to focus the students' learning and keep them on track.

MasteringA&P helps instructors maximize their class time with easy-to assign, customizable, and automatically graded assignments that motivate students to learn outside of class and arrive better prepared for lecture and lab. Pre-built MasteringA&P courses and assignments are available to get you started easily and quickly.

Assignable Coaching Activities include:

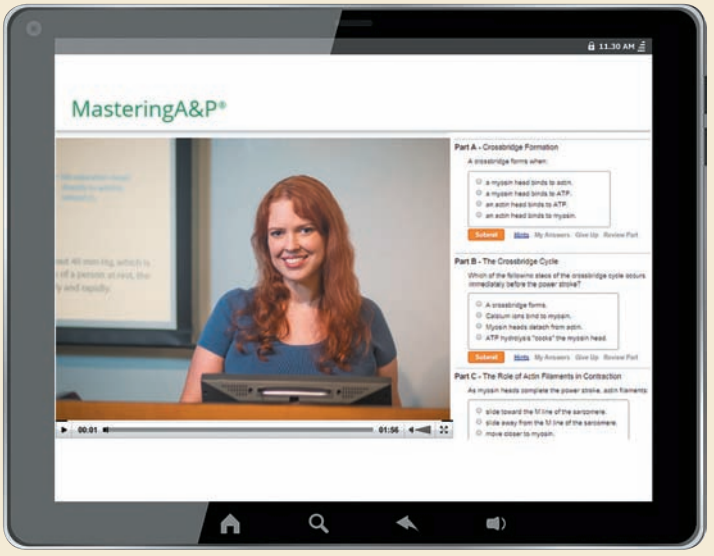
Big Picture Animation Activities

The Big Picture Animation Activities help students visualize physiological events occurring at the molecular level and reinforce understanding of key concepts learned in the chapter. These mobile-ready animations are narrated by the author and reflect the same terminology and explanations found in the Amerman textbook. Activity assignments include multiple-choice questions with hints and specific wrong-answer feedback, interactive ranking and sorting exercises, and labeling activities.



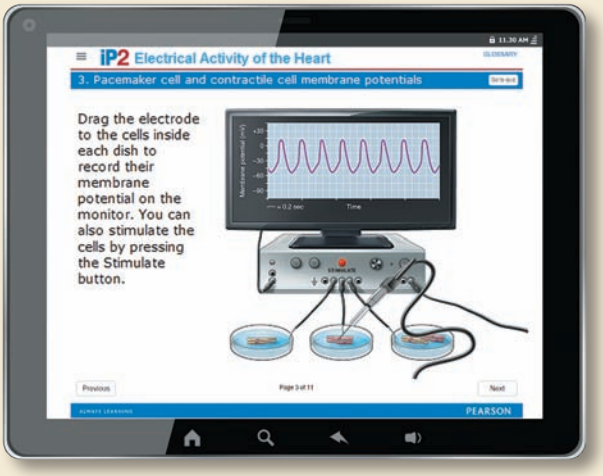
Concept Boost Video Tutor Activities

These videos and assignments feature the author talking directly to students and coaching them through tough-to-understand or tricky topics.



Interactive Physiology 2.0 Activities

This award-winning tutorial program helps students advance beyond memorization to a genuine understanding of complex physiological processes. I.P. 2.0 features brand-new graphics, quicker navigation, and more robust interactivity, so students can explore, draw, predict, and more. Includes activities for 2.0 and 1.0.

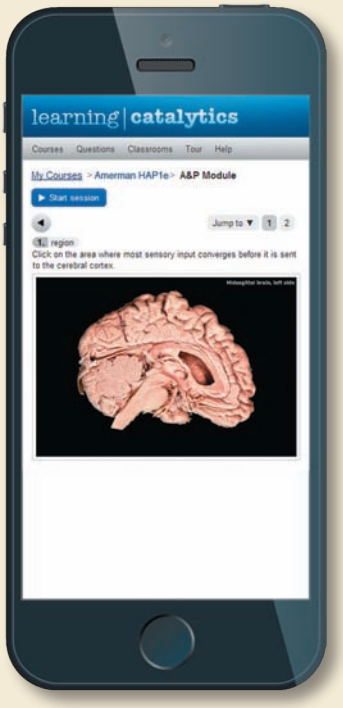


A&P Flix Activities

These 3D movie-quality animations of key physiological processes include coaching activity assignments that use a variety of question types and levels.

Learning Catalytics

This classroom lecture tool is a "bring your own device" engagement, assessment, and classroom intelligence system. With Learning Catalytics, instructors can flip the classroom and assess students in real time using open-ended tasks to probe their understanding. Students use their smartphone, tablet, or laptop to respond to questions in class.



Also Assignable in MasteringA&P

- **NEW!** *Get Ready for A&P* Learning Styles Assessment
- *Get Ready for A&P* Diagnostic Test, Chapter Tests, and Cumulative Test
- *Get Ready for A&P* Video Tutors
- Chemistry Review Activities
- Reading Quiz questions
- Art-labeling and Sequence-the-steps Activities
- Art-based questions
- Chapter Running Case for each chapter in Amerman
- Chapter Test questions
- Test Bank Questions
- Clinical Case Study Coaching Activities
- PAL 3.0 Test Bank with images
- **NEW!** Bone and Dissection Videos
- PhysioEx 9.1 with assessments

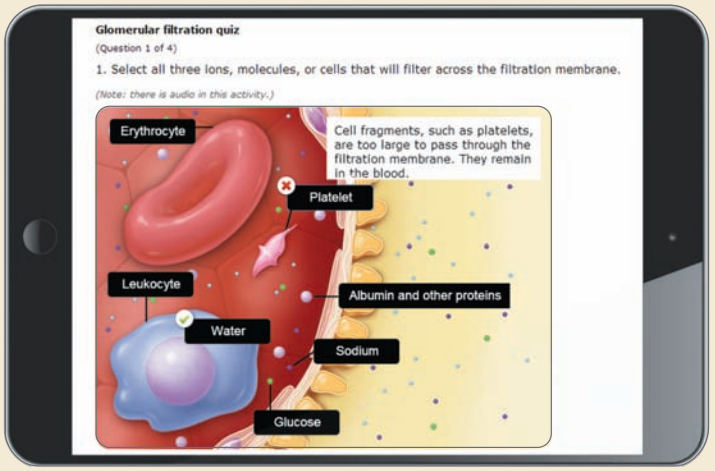
Do your students have the tools to suit their different learning styles?

MasteringA&P® Study Area

The Study Area includes a wide selection of study and practice tools to engage students and meet the needs of different learning styles and study strategies.

Big Picture Animations

Narrated by the author, these animations help students visualize key physiological processes and reinforce student understanding via interactive self-quizzing with immediate feedback.



Concept Boost Video Tutors

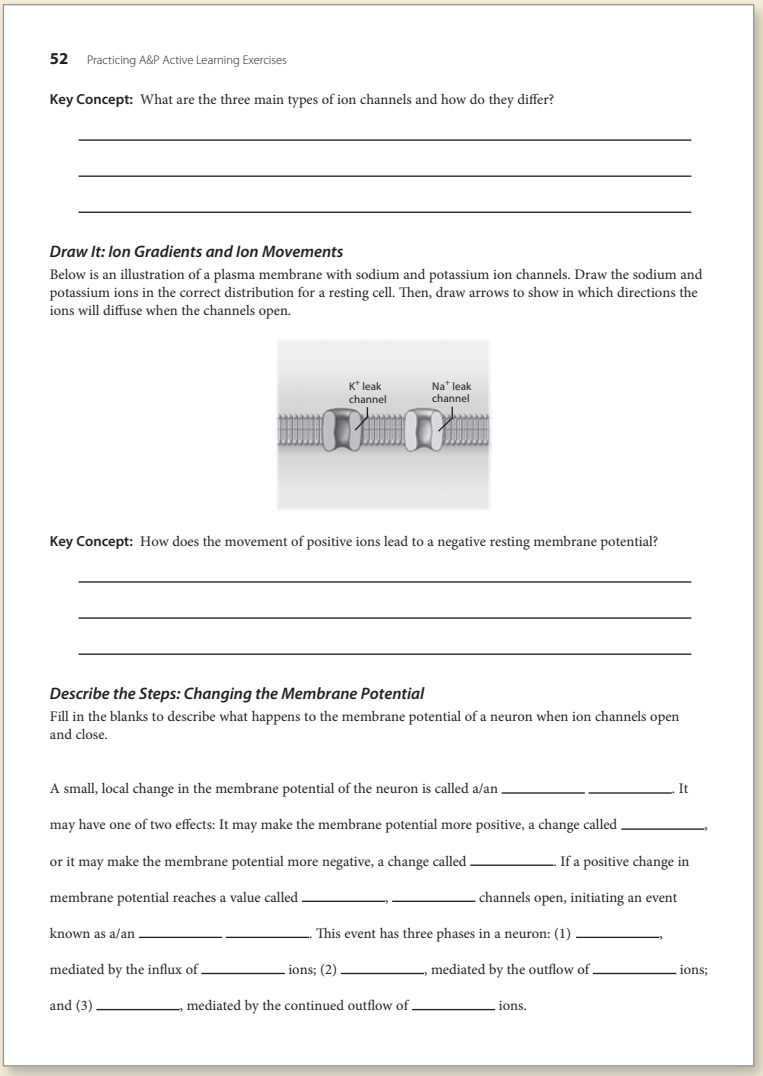
These videos of select Concept Boosts highlighted in the textbook feature author Amerman teaching directly to students and coaching them through tough-to-understand or tricky topics.

Practice quizzes, art-labeling, and sequence-the-step activities

A rich variety of practice quizzes and activities gives visual and kinesthetic learners varied practice learning key structures and processes.

Practicing A&P: Active-Learning Worksheets

These worksheets written by Amerman help engage the kinesthetic learner with labeling, drawing, and build-your-own-summary-table exercises that students can complete *as they read the textbook*. Available in downloadable PDFs in the Study Area of MasteringA&P®.



52 Practicing A&P Active Learning Exercises

Key Concept: What are the three main types of ion channels and how do they differ?

_____

_____

_____

Draw It: Ion Gradients and Ion Movements

Below is an illustration of a plasma membrane with sodium and potassium ion channels. Draw the sodium and potassium ions in the correct distribution for a resting cell. Then, draw arrows to show in which directions the ions will diffuse when the channels open.

Key Concept: How does the movement of positive ions lead to a negative resting membrane potential?

_____

_____

_____

Describe the Steps: Changing the Membrane Potential

Fill in the blanks to describe what happens to the membrane potential of a neuron when ion channels open and close.

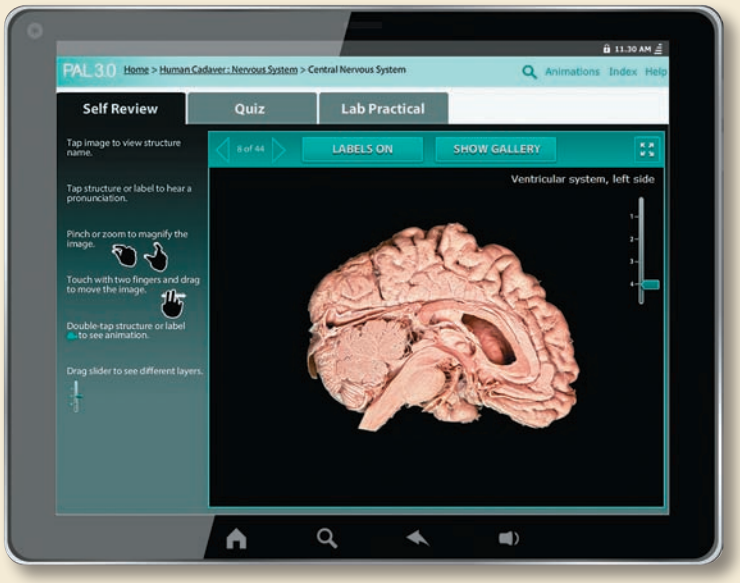
A small, local change in the membrane potential of the neuron is called a/an _____ _____. It may have one of two effects: It may make the membrane potential more positive, a change called _____, or it may make the membrane potential more negative, a change called _____. If a positive change in membrane potential reaches a value called _____, _____ channels open, initiating an event known as a/an _____ _____. This event has three phases in a neuron: (1) _____, mediated by the influx of _____ ions; (2) _____, mediated by the outflow of _____ ions; and (3) _____, mediated by the continued outflow of _____ ions.

Author podcasts

Narrated by the author, these podcasts give on-the-go students and auditory learners the opportunity to review the tough topics in A&P. Available as downloadable MP3 audio files in the Study Area of MasteringA&P.

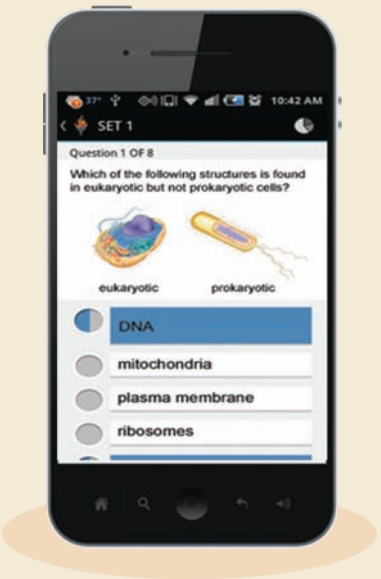
Practice Anatomy Lab™

PAL is a virtual anatomy study tool that gives students 24/7 access to the most widely used lab specimens including human cadaver, anatomical models, histology, cat, and fetal pig. PAL 3.0™ includes randomized multiple-choice quizzes and fill-in-the-blank lab practical questions.



Dynamic Study Modules

Designed to enable students to study effectively on their own, Dynamic Study Modules help them quickly access and learn the concepts they need to be more successful on quizzes and exams. These flashcard-style questions adapt to a student's performance and include art and explanations from the Amerman textbook to cement the student's understanding. Modules can also be assigned in MasteringA&P.



Also Available in the Study Area

- *Get Ready for A&P*
- Student Lecture Outlines
- Answers to Chapter Quick Check questions
- Chapter Running Cases
- Clinical case studies
- eText
- Interactive Physiology 2.0 and 1.0
- A&P Flix 3D animations
- PAL 3.0 app
- Bone and Dissection Videos
- PhysioEx 9.1

Instructor Supplements

Instructor Resource Material with PowerPoint® Lecture Outlines

by Suzanne Pundt

- All illustrations and photos from the text as presentation-ready labeled and unlabeled JPEG files
- All illustrations and photos from the text as presentation-ready editable PowerPoint® files
- Customizable PowerPoint® lecture presentations including embedded Big Picture Animations, Concept Boost Video Tutors, Interactive Physiology, and A&P Flix
- *Instructor Guide with Chapter Running Case Studies* in Microsoft Word®
- *Student Lecture Outlines* in Microsoft Word®
- Test Bank in Microsoft Word®
- TestGen test generation and management software

Instructor Guide with Chapter Running Case Studies for Human Anatomy & Physiology

by Christopher Amerman

Includes chapter learning outcomes, suggested lecture outlines, and chapter running case studies with questions that are tied directly to the chapters in the Amerman textbook. Available via MasteringA&P

Student Lecture Outlines for Human Anatomy & Physiology

by Patty Bostwick Taylor

Fill-in-the-blank chapter outlines ask students to fill in key details, allowing them to stay engaged during lecture. Available as customizable Word files via MasteringA&P

Printed Test Bank for Human Anatomy & Physiology

by Patty Bostwick Taylor

Contains thousands of test questions including multiple-choice, matching, true/false, short answer, and essay. Available via MasteringA&P

Acknowledgments

Believe it or not, this book you are now holding has been nine and a half years in the making. When I first started writing it, my daughter wasn't even 2 years old; now she is halfway through fifth grade. But I was certainly not alone on this journey, as a huge number of people were involved in bringing this book to life. Saying a simple "thank you" in the acknowledgments seems so insufficient given the quality and quantity of their contributions, but these thanks are genuine and heartfelt.

I will start with my family because they lived for nine and a half years with the day-to-day stresses that come with a project of this magnitude. Were it not for the help and understanding of my husband Chris Amerman, my daughter Elise, my mother Cathy Young, and my dear friend David Ferguson, this book would have never been completed. They served as a source of unwavering support, encouragement, and ideas. Elise was also incredibly patient and understanding with how much I had to work, and I am so thankful for that. I should also thank my dogs for making sure to bark and howl each and every time I was in a phone meeting, and my cats for never failing to lie exactly in the middle of whatever I was trying to do.

Next is the core team of the book, which I've come to think of as parts of the brain, each performing absolutely vital functions that maintained homeostasis of the whole book. First is Serina Beauparlant, who, as editor-in-chief, is our brainstem. She has tirelessly performed all of those critical behind-the-scenes functions, ranging from wrangling budgets and securing administrative support to running focus groups and analyzing reviewer feedback. It has been Serina's driving force that kept the book alive over these long years. Simply put, without her, there would be no book.

Our team's cerebral hemispheres are our two brilliant developmental editors: Suzanne Olivier and Laura Southworth. As our text development editor, Suzanne is the left cerebral hemisphere. Her ability to logically and patiently approach a chapter from a "big picture" perspective ensured our chapters maintained a consistent narrative flow. It's impossible to overstate her role—not only did Suzanne always manage to find a chapter's sticking points, but she also always proposed solutions to these problems that made the chapter better. The readability, logical flow, and text-art coordination of this book are largely due to Suzanne's efforts.

Laura Southworth, as our art development editor, is the right cerebral hemisphere. Laura not only is a very talented artist but also has an incredible ability to analyze a figure and work magic to make it teach better. This is in part due to her amazing skill for visual-spatial layout (a skill I absolutely lack), which is arguably the most important part of a figure. No matter what we gave her or how rough our ideas or sketches, Laura turned it into gold. This is why "Let's ask Laura" became our mantra when Suzanne and I were working on a chapter. Any time we were perplexed by a figure, Laura unfailingly found a solution.

The role of team thalamus was played by project editor/manager Nicole Tache (neé Graziano). This is a high compliment, as without a functional thalamus, absolutely nothing can get done! Just as the thalamus processes and routes information into and out of the cerebral hemispheres, Nicole processes, edits, and sorts all material for the chapters and supplements for this project. Basically, without Nicole, we would have all been utterly lost.

Rounding out the team is Barbara Yien, our cerebellum. Barbara has been involved with this project from the very start, first as a project editor and now as the Director of Development. Her even-keeled approach has helped troubleshoot scheduling, budgeting, and our marketing efforts. Whenever we come to a sticking point, we look to Barbara, who always manages to find a way to correct the "motor error" and keep everything balanced and on track.

(Now that I've written this, I'm wondering exactly what part of the brain I represent on the team. The basal nuclei? Maybe the hypothalamus? Hopefully not the pineal gland, as I don't want to make my students sleepy. . . .)

Every member of this core "brain" team deserves the highest praise for their skills, dedication, and willingness to persistently climb the mountain that was this book. I am beyond grateful to them for this, and I am also deeply thankful for their friendship.

Assisting the core team was a group of incredibly talented people without whom the book could not have happened: art development editor Elisheva Marcus and text development editor Alice Fugate; our indomitable marketing team of Allison Rona, Derek Perrigo, Michelle Cadden, Leslie Allen, Jessica Moro, Mansour Bethoney, Patrice Jones, Tim Galligan, Christy Lesko, and Yez Alayan; design director Mark Ong; copyeditor Bonnie Boehme; photo researcher Maureen Spuhler; media development editor Eric Leaver; the Pearson media team, including Lauren Fogel, Stacy Treco, Laura Tommasi, Caroline Power, Katie Foley, Cheryl Chi, Kristen Sanchez, Aimee Pavy, Sarah Young-Dualan, and Kyle Doctor; our production team of Nancy Tabor, Jane Hoover, Caroline Ayres, Dorothy Cox, and Kirsten Forsberg; our manufacturing buyer Stacey Weinberger; Animated Biomedical Productions; and editorial assistant Arielle Grant.

Next I want to thank and acknowledge everyone who contributed to the book, including Virginia Irintcheva, who authored the script and storyboards for the book's animations and interactive figures and assessments in MasteringA&P; Chris Amerman, who contributed Chapter 8 and authored the Instructor Guide; Bert Atsma and Mark Seifert, who contributed Chapter 9; Sheri Boyce, who contributed Chapter 15; Karen Keller, who contributed Chapters 26 and 27; Patty Bostwick Taylor, who authored the Test Bank, Student Lecture Outlines, and Dynamic Study Modules; Suzi Pundt, who authored the PowerPoint lecture slides; Jeff Engel, who provided answers to

the Quick Check questions; Betsy Brantley, who reviewed the book's clinical coverage; Winston Charles Poulton, who helped produce the Concept Boost Video Tutors; photographer John Wilson White and model Luiza Silva, who contributed the body movements photos in Chapter 8; and William Karkow, Nina Zanetti, Patricia Wilhelm, and Tom Appleton, who carefully reviewed/contributed light micrographs for select chapters. Each of these people devoted a huge amount of time and effort to this project—as I'm sure they will tell you, authoring materials is hard work! I am so grateful that each of them was willing to share his or her talents and play a role in the success of this project. I am also grateful to the Editorial Consultants who provided invaluable feedback on teaching ideas and carefully accuracy-checked pages and to all of the many academic reviewers, class testers, and focus group attendees who have shared their time, expertise, and ideas with us.

I would also like to sincerely thank Lauren Harp, Executive Marketing Manager. I met Lauren in 2005 when she was the marketing manager for natural sciences. She passed my name along to Serina as a potential author after we had a two-hour-long conversation in my office about what I would like to see in a textbook. Had she not done this, *Human Anatomy & Physiology* likely wouldn't exist.

Finally, none of this would have been possible without the unwavering support of Vice President and Editorial Director of Life Sciences Frank Ruggirello, Managing Director of Pearson Science Paul Corey, Editorial Director of Pearson Science Adam Jaworski, and Finance Director of Pearson Science Hogan Nymberg. All have supported this project from the beginning, and it was only because of their continued encouragement and belief in our team that you are holding this book right now. They have my eternal gratitude for allowing us to bring our vision to life.

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