UPDATES AND ADDITIONS

TO THE STUDENTS

As we began this thirteenth edition of *Hole's Human Anatomy & Physiology,* we were reminded of the myths surrounding the number 13, considered lucky in some cultures and unlucky in others. It struck us that luck, good or bad, really has nothing to do with a successful textbook, or for that matter a successful career in health care. Louis Pasteur once commented, "Chance favors only the prepared mind." We hope that this textbook will help you prepare your mind as you take the first steps on your career path.

Remember that although you are working hard to successfully complete this course, you are not doing so for us, or even for your instructor. You are working for yourselves and for your future patients. Your course is not so much a hurdle as it is a steppingstone, even more so a foundation.

The theme of Learn, Practice, Assess, intended to help you master human anatomy and physiology, go beyond this book. It will be a theme as you progress through your program and even after you enter the workplace. The learning will continue, as will the need to practice, and the ultimate assessment will be your performance on the job as the professional that you become.

TO THE INSTRUCTORS

As we approached this thirteenth edition of *Hole's Human Anatomy & Physiology,* we took a look back. We had become the new author team for the seventh edition of John Hole's text. At that time we were tasked with updating and upgrading the physiology coverage of the text, which had already established itself as a classic. Our challenge was to do so without losing the essence of the book that faculty and especially students had grown to know and love. We managed to find a balance between changing what needed to be changed and retaining that which Hole had become known for. This recipe worked; the seventh edition became the most successful edition of Hole up to that point.

We now find ourselves continuing the updating and upgrading of coverage, partly because of changes in current knowledge of physiology, and partly because of changing expectations in the programs into which courses using this book lead. We are excited about these changes. Feedback from students, both locally and nationally, as well as that from reviewers, indicates that the field has seen a shift to the cellular and molecular levels, without compromising the understanding expected on the system and organismal levels. As in previous editions, one of our challenges has been to incorporate new, appropriate material without changing the overall level of the text, and without simplifying to the point of inaccuracy. As we look back over the seven editions that we have worked on as an author team, we are pleased to say that at least one things has not changed—this is the same *Hole's Human Anatomy & Physiology* that generations of students have relied on. The readability, the student-centered approach, and the basic level of selective detail remain as accessible as ever.

As more is expected from students, they need to have more tools at their disposal. Part of the challenge that instructors and authors face is to recognize that need and to provide the tools. For many editions we have integrated closely with the accompanying lab manual by Terry Martin. We were excited about the Learn, Practice, and Assess approach that was new with the twelfth edition. With this thirteenth edition, we have fully integrated this approach with the web-based assignment and assessment platform *McGraw-Hill Connect®.*

We have taken our commitment to the digital domain one step further by welcoming two digital authors, Leslie Day and Julie Pilcher, to the team. Their focus will be to ensure that the digital ancillaries integrate seamlessly with the text, meet the expectations of today's students and instructors, and at the same time retain Hole's trademark accessibility. We all hope that you will be as excited about the new features as we are. We think that even if you don't consider yourself a "computer person," you will still find the digital ancillaries valuable and easy to use (and we're quite sure that you and your students will soon grow to love them!)

—David Shier, Jackie Butler, Ricki Lewis

GLOBAL CHANGES

- Digital authors added to team to create seamless relationship between textbook and ancillaries/ digital products.
- Practice Questions are added to the legends of selected figures.
- Many new vignettes and small boxes.
- New color for enlargement arrows, to make them stand out more clearly.
- Consistent distinction between events occurring at a synapse and events involving impulse conduction.
- We have consistently avoided the names of specific individuals in boxes and clinical application pieces. We feel that the interest gained by including names is outweighed by the need to instill in our students the importance of patient confidentiality in the context of privacy laws.

UPDATES AND ADDITIONS

Selected Specific Changes At-A-Glance

Chapter	Topic	Change	Rationale
1	Scientific method	Introduced in chapter/expanded in Appendix A	Reviewer request
1	Directional terms	Rewritten	Clarity, detail
1	Anatomical terms	Rewritten	Clarity, consistency
2	Mass versus weight	New box	Accuracy
2	Buffers	Added as outcome	Clarity
3	Reprogrammed cells	New vignette	Update
3	Gene expression	New material	Update
3	Organelles	Functions added	Update, balance
4	Fate of pyruvic acid	Modified figure 4.9	Clarity
4	Definiton of chromosome (fig. 4.11)	Text and modified figure 4.19	Accuracy, detail
5	Muscle (skeletal, smooth, and cardiac)	New micrographs and corresponding line art (figs. 5.28, 5.29, and 5.30)	Clarity, consistency of magnification
5	Integrative Assessments	Added organ micrograph	Provide more opportunity for critical thinking
6	Skin's strength and flexibility	New vignette	New information
6	Vitamin D production in the skin	Rewritten	Clarity
6	Immune function of skin, dendritic cells	New material	Clarity, detail
6	Indoor tanning and skin cancer	Rewritten	Update, more clinical approach
6	Fingerprints	Rewritten	Clarity, update
7	Preventing Fragility Fractures	New vignette	Clinical relevance
7	Phalanges versus fingers (fig. 7.15)	Better labelling	Clarity
7	Trochlea (fig. 7.43) and trochlear notch (fig. 7.44)	Better labelling	Clarity
7	Alveolar arch (fig. 7.29)	Better labelling	Clarity
7	True and false pelves	Rewritten	Clarity, expanded discussion
8	Origin/insertion	Rewritten	Clarity, accuracy
8	Joint movements	Rewritten, deleted potentially confusing hyperextension from figure 8.10	Clarity
9	Thick and thin muscle filaments	Figure 9.4 redone	Accuracy, clarity
9	Neuromuscular junction (fig. 9.8a)	Redrawn to better show telodendria (although this detail is not mentioned in the text)	Accuracy, reviewer concern
9	Stimulus for contraction	Reorganized and rewritten to include ion gradients and the concept of an action potential, with reference to more detail in chapter 10	Clarity
9	Distinction between myosin heads and crossbridges	Rewritten, relabelled figure 9.10	Clarity, accuracy
9	Origin versus insertion	Rewritten	Clarity
9	Agonist versus prime mover	Rewritten	Clarity
9	Partial tetany introduced	Rewritten	Clarity
10	Overview of neuronal function	Rewritten	Clarity
10	Action potential, impulse conduction, and synaptic transmission	Rewritten to clearly distinguish among these terms	Clarity, consistency
10	Action potential	Rewritten to refer back to chapter 9	Clarity, consistency
10	Relationship of CNS/PNS, sensory/motor	Figures 10.2 and 10.7 modifiifed	Clarity
10	Axonal regeneration	Rewritten, figure 10.10 modified	Clarity
10	Local potential changes; mechanism of inhibition	Rewritten	Clarity, clinical relevance
10	Facilitation	Rewritten to reflect current model of a presynaptic mechanism	Update

Selected Specific Changes At-A-Glance *(cont.)*

Chapter	Topic	Change	Rationale
11	Traumatic brain injury	New vignette	Update
11	Meninges	Figure 11.1 redone	Clarity
11	Lateral horn	New micrograph and line art (fig. 11.6)	Clarity
11	Reflexes	Rewritten in terms of synaptic connections and different levels of spinal cord.	Clarity, consistency
11	Relationship between upper and lower motor neurons	Rewritten	Clarity
11	Sensory and motor speech areas	Rewritten	Clarity, update
11	Pons and respiration	Rewritten to be consistent with updated chapter 19	Update
11	Myotomes	Included in section on dermatomes	Consistency, clinical relevance
11	Segmental innervation	Box added	Clinical relevance
12	Sensation and perception	Rewritten	Clarity, consistency
12	Receptor cells versus receptor molecules	Rewritten	Clarity
12	Vibration transfer in middle ear	Rewritten	Clarity
12	Sound volume perception in terms of more frequent action potentials	Rewritten	Clarity
12	Refraction disorders	New figure	Accuracy
13	Roles of T3 and T4	Rewritten	Clarity, accuracy
13	cAMP	Modified figure 13.6	Clarity, accuracy
13	Second messenger mechanism	Binding site and active site added to figure 13.7	Clarity
13	Steroid hormones and amplification effect of multiple mRNAs	Text added	Clarity, consistency
13	Effects of epinephrine and norepinephrine	Table 13.10 rewritten	Clarity, accuracy
14	Collection and centrifugation of blood sample	Photos added to figure 14.1	Update, clarity
14	Platelet plug formation	Redrawn figure 14.17	Clarity, accuracy
14	Integrative Assessments	Added photograph of blood typing	Provide more opportunity for critical thinking
15	Cardiovascular system overview	New figure 15.1	Clarity
15	Terminology for oxygenation of blood	"Oxygen-rich" and "oxygen-poor" adopted throughout	Update
15	SA node and depolarization pathway	Figure 15.18 redrawn	Accuracy
15	Systemic and pulmonary circulations and pathway through the heart	Figures 15.1, 15.10, and 15.40 redone to highlight topic in common context	Clarity
15	Events at SA node	Rewritten in terms of action potential generation	Clarity, consistency
15	Preload and afterload	Rewritten in terms of end-diastolic volume and cardiac workload	Clarity, clinical relevance
15	Colloid osmotic pressure	Rewritten to include this term consistently	Clarity, consistency
16	Spleen anatomy	Rewritten	Clarity, accuracy
16	Body defenses	New figure 16.15 schematic representation	Clarity
16	Primary and secondary immune response	Graphs in figure 16.21 separated into two panels	Clarity
16	Asthma and allergies	New small box	Clinical relevance
17	Enterogastric reflex	Role of parasympathetic activity relabelled in figure 17.22	Clarity
18	Read the Fine Print	New vignette	Relevancy
18	Ketones and fat catabolism	Redrawn figure 18.4	Accuracy
18	Vitamin D deficiency	Figure 18.11, replaced photo with line drawing showing multiple effects	Clarity, clinical relevance
18	Healthy eating	New figure 18.20, "ChooseMyPlate.gov"	Update

Selected Specific Changes At-A-Glance *(cont.)*

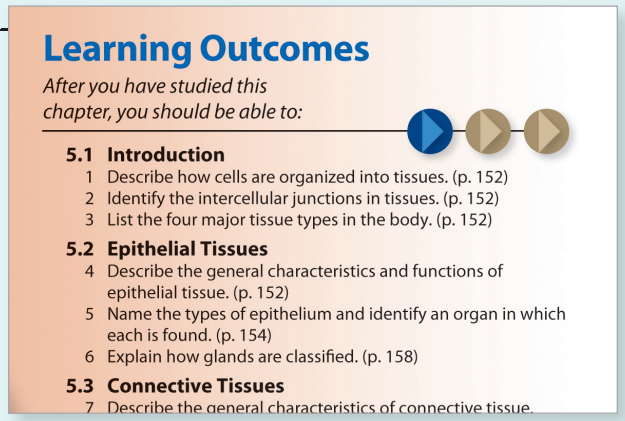
Chapter	Topic	Change	Rationale
19	Effects of Cigarette Smoking	Clinical Application 19.1 rewritten	Clarity
19	Spirometry, measurements	Rewritten to exclude residual volume	Clarity
19	Respiratory Volumes and Capacities	Table 19.4 rewritten	Clarity
19	Basic rhythm of breathing	New figure 19.28 and updated figure 19.29	Update
19	Bronchial asthma and emphysema	Clinical Application 19.3 rewritten	Clarity
19	Exercise and breathing	Clinical Application 19.4 rewritten	Update
20	Afferent and efferent arterioles	Anatomical differences rewritten and moved to part on glomerular filtration	Accuracy, clarity
20	Net filtration pressure	Figure 20.18 matches figure 15.30 on capillary filtration	Consistency
20	Filtration rate	Rewritten to reflect roles of afferent and efferent arterioles	Clarity
20	Control of filtration rate	Rewritten to reflect actions of sympathetic nervous system	Clarity
21	Compartment distribution of isotonic saline	Box rewritten	Clarity, clinical relevance
21	Caffeine as a diuretic	Deleted from box	Update
21	Edema	Part of Clinical Application 21.1 rewritten	Clarity
21	Actions of parathyroid hormone	Figure 21.8 modified	Clarity
22	Spermatogenesis	Figure 22.9 redrawn to show chromosome number	Clarity
22	Prostate cancer	New Clinical Application 22.1	Update
22	Carcinoma in situ	New small box with AMA guidelines for Pap smear test	Update
22	Contraceptives	"Morning after pill" box rewritten, added new hormone-releasing IUD	Clarity, Update
23	Postmortem Sperm and Egg Retrieval	Added egg retrieval to the vignette	Update
23	Embryonic development	Section reordered for better flow	Clarity
24	Chromosome terminology	Figure 24.1 updated to reflect changes in figure 4.11	Update
24	Penetrance and Expressivity	Section reordered	Clarity
24	Varying nature of height	Parts of figure 24.7 repositioned for easier comparison	Clarity
24	Genetics and personalized medicine	New section	Update

LEARN, PRACTICE, ASSESS

This book is organized with **Learning Outcomes and Assessments.**

LEARN

Learning Outcomes open the chapters, and are closely linked to Chapter Assessments and Integrative Assessments/Critical Thinking questions found at the end of each chapter.

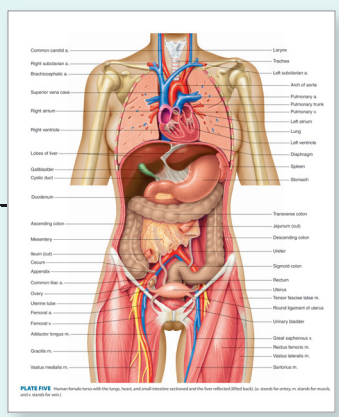


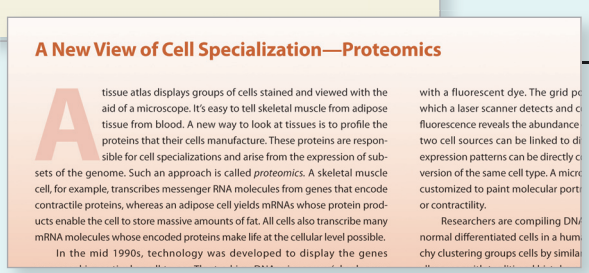
Learning tools to help you succeed...

Check out the **Preview Chapter, Foundations for Success,** on page 1. The Preview Chapter was specifically designed to help students **LEARN** how to study at the collegiate level and efficiently use the tools available to them. It provides helpful study tips.

Understanding Words help you remember scientific word meanings. Examine root words, stems, prefixes, suffixes, and pronunciations to build a solid anatomy and physiology vocabulary.

Reference Plates offer vibrant detail of body structures.





Chapter Opening Vignettes introduce each topic. Taken from headlines and scientific journal reports, they extend the student's view of the chapter content.

LEARN, PRACTICE, ASSESS

PRACTICE

After each major section, a question or series of questions tests the student's understanding of the material. If he or she cannot answer these practice question(s), the student will want to reread that section.

PRACTICE

1 What is a tissue?
2 What are the different types of intercellular junctions?
3 List the four major types of tissue.

Interesting applications help students practice and apply their knowledge...

Cancer cells secrete a substance that dissolves basement membranes, enabling the cells to invade tissue layers. Cancer cells also produce fewer adhesion proteins, or none at all, which allows them to spread into surrounding tissue.

Boxed Information connects chapter ideas to clinical situations, discusses changes in organ structure and function, and introduces new medical technology or experiments.


5.1 FROM SCIENCE TO TECHNOLOGY

Nanotechnology Meets the Blood-Brain Barrier

Nanotechnology is helping drug developers to circumvent a problem in drug delivery based on an anatomical impediment—the close attachments of the cells that form tiny blood vessels in the brain. Like a tight line of police officers keeping out a crowd, the blood-brain barrier is a 400-mile network of capillaries in the brain whose cells are firmly attached by overlapping tight junctions. These cells also lack the scattered vesicles and windowlike clefts in other capillaries. In addition, star-shaped brain cells called astrocytes wrap around the barrier.

The blood-brain barrier shields brain tissue from toxins and biochemical fluctuations that could be overwhelming. It also allows selective drug delivery. Certain antihistamines, for example, do not cause drowsiness because they cannot breach the barrier. But this protection has a trade-off—the brain cannot take up many therapeutic drugs that must penetrate to be effective.

For decades researchers have attempted to deliver drugs across the barrier by tagging compounds to substances that can cross, and injecting substances that temporarily relax the tight junctions. More recently, researchers have applied nanotechnology to the problem of circumventing the blood-brain barrier. Nanotechnology is the application of structures smaller than 100 billionths of a meter (100 nanometers) in at least one dimension.

Nanoparticles that can cross the blood-brain barrier are made of combinations of oils and polymers, with a neutral or slightly negative charge (positively charged particles are toxic). In one application, anesthetics or chemotherapeutics are loaded into fatty bubbles (liposomes) that are in turn placed in nanoparticles. This delivery system masks the part of the drug that cannot cross the barrier and slows release of the drug, which diminishes side effects.

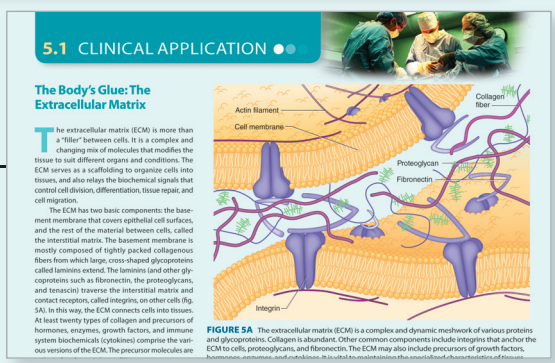
In another application, insulin is delivered in inhaled nanoparticles 10 to 50 nanometers in diameter. Originally developed to provide insulin to people with diabetes instead of injecting it, clinical trials are showing that nanoparticle delivery of insulin is also helpful in maintaining memory in people who have mild cognitive impairment or Alzheimer disease. ■

From Science to Technology previews the technological applications of knowledge in anatomy and physiology that students are likely to encounter in the future and explains how and why the technology was developed.

NEW! A Glimpse Ahead icon prompts the student to look ahead to learn more about the topic.

A GLIMPSE AHEAD | To Chapter 9

Dense irregular connective tissue surrounds individual skeletal muscles *(fascia)*, and separates each muscle into


5.1 CLINICAL APPLICATION

The Body's Glue: The Extracellular Matrix

The extracellular matrix (ECM) is more than a "filler" between cells. It is a complex and changing mix of molecules that modifies the tissue to suit different organs and conditions. The ECM serves as a scaffolding to organize cells into tissues, and also relays the biochemical signals that control cell division, differentiation, tissue repair, and cell migration.

The ECM has two basic components: the basement membrane that covers epithelial cell surfaces, and the rest of the material between cells, called the interstitial matrix. The basement membrane is mostly composed of tightly packed collagenous fibers from which large, cross-shaped glycoproteins called laminins extend. The laminins (and other glycoproteins such as fibronectin, the proteoglycans, and tenascin) traverse the interstitial matrix and contact receptors, called integrins, on other cells (fig. 5A). In this way, the ECM connects cells into tissues. At least twenty types of collagen and precursors of hormones, enzymes, growth factors, and immune system biochemicals (cytokines) comprise the various versions of the ECM. The precursor molecules are

FIGURE 5A The extracellular matrix (ECM) is a complex and dynamic meshwork of various proteins and glycoproteins. Collagen is abundant. Other common components include integrins that anchor the ECM to cells, proteoglycans, and fibronectin. The ECM may also include precursors of growth factors, hormones, enzymes, and cytokines. It is vital to maintaining the specialized characteristics of tissues.

Reconnect Icon prompts the student to review key concepts found in previous chapters that will assist in their understanding of new information.

RECONNECT

To Chapter 3, Movements Into and Out of the Cell, page 106.

Clinical Applications encourage students to explore information on related pathology, historical insights, and clinical examples that they are likely to encounter in their careers.

AP|R **NEW! Anatomy and Physiology Revealed icons** found in figure legends. These icons indicate that there is a direct link to APR available in the eBook provided with ConnectPLUS for this title!

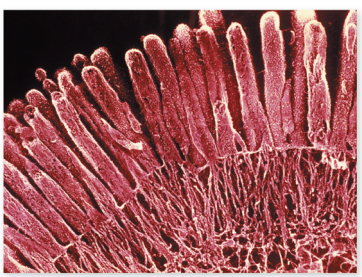
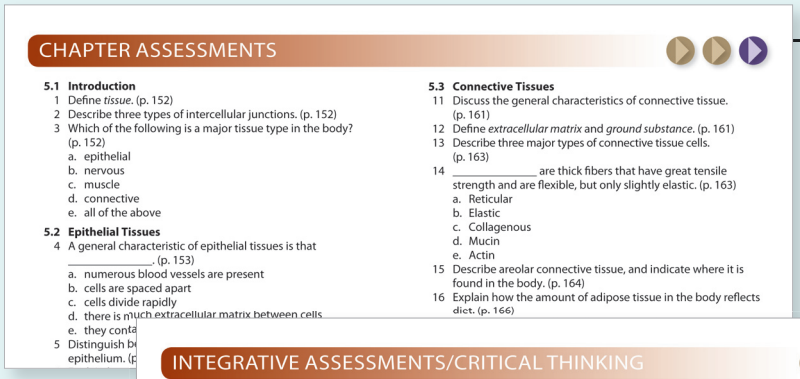


FIGURE 5.5 AP|R A scanning electron micrograph of microvilli, which fringe the free surfaces of some columnar epithelial cells (33,000×).

ASSESS

Tools to help students make the connection and master anatomy & physiology!



CHAPTER ASSESSMENTS

5.1 Introduction

1 Define *tissue*. (p. 152)
2 Describe three types of intercellular junctions. (p. 152)
3 Which of the following is a major tissue type in the body? (p. 152)
a. epithelial
b. nervous
c. muscle
d. connective
e. all of the above

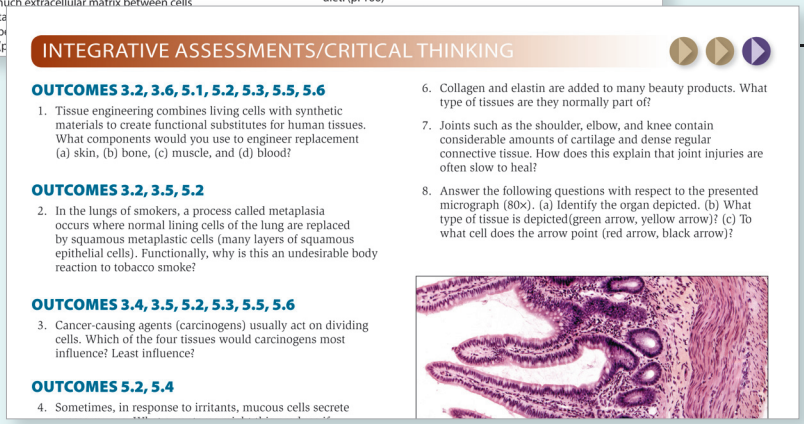
5.2 Epithelial Tissues

4 A general characteristic of epithelial tissues is that _____. (p. 153)
a. numerous blood vessels are present
b. cells are spaced apart
c. cells divide rapidly
d. there is much extracellular matrix between cells
e. they conta
5 Distinguish b
epithelium. (p

5.3 Connective Tissues

11 Discuss the general characteristics of connective tissue. (p. 161)
12 Define *extracellular matrix* and *ground substance*. (p. 161)
13 Describe three major types of connective tissue cells. (p. 163)
14 _____ are thick fibers that have great tensile strength and are flexible, but only slightly elastic. (p. 163)
a. Reticular
b. Elastic
c. Collagenous
d. Mucin
e. Actin
15 Describe areolar connective tissue, and indicate where it is found in the body. (p. 164)
16 Explain how the amount of adipose tissue in the body reflects diet. (p. 166)

Chapter Assessments found at the end of each chapter check student's understanding of the chapter's Learning Outcomes. The Chapter Assessment numbers correspond directly to the Learning Outcomes.



INTEGRATIVE ASSESSMENTS/CRITICAL THINKING

OUTCOMES 3.2, 3.6, 5.1, 5.2, 5.3, 5.5, 5.6

1. Tissue engineering combines living cells with synthetic materials to create functional substitutes for human tissues. What components would you use to engineer replacement (a) skin, (b) bone, (c) muscle, and (d) blood?

OUTCOMES 3.2, 3.5, 5.2

2. In the lungs of smokers, a process called metaplasia occurs where normal lining cells of the lung are replaced by squamous metaplastic cells (many layers of squamous epithelial cells). Functionally, why is this an undesirable body reaction to tobacco smoke?

OUTCOMES 3.4, 3.5, 5.2, 5.3, 5.5, 5.6

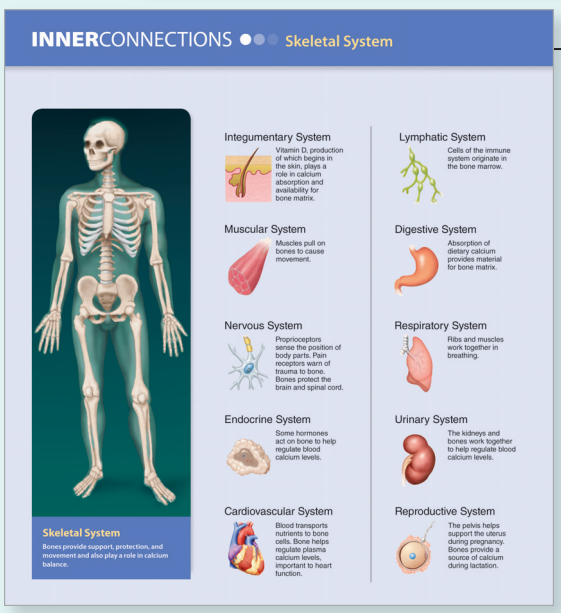
3. Cancer-causing agents (carcinogens) usually act on dividing cells. Which of the four tissues would carcinogens most influence? Least influence?

OUTCOMES 5.2, 5.4

4. Sometimes, in response to irritants, mucous cells secrete

6. Collagen and elastin are added to many beauty products. What type of tissues are they normally part of?
7. Joints such as the shoulder, elbow, and knee contain considerable amounts of cartilage and dense regular connective tissue. How does this explain that joint injuries are often slow to heal?
8. Answer the following questions with respect to the presented micrograph (80×). (a) Identify the organ depicted. (b) What type of tissue is depicted(green arrow, yellow arrow)? (c) To what cell does the arrow point (red arrow, black arrow)?

Integrative Assessments/Critical Thinking questions relate information from various Learning Outcomes within a chapter (and frequently from previous chapters) and apply that information.



INNERCONNECTIONS Skeletal System

Skeletal System
Bones provide support, protection, and movement and also play a role in calcium balance.

Integumentary System
Vitamin D, production of which begins in the skin, plays a role in calcium absorption and availability for bone matrix.

Lymphatic System
Cells of the immune system originate in the bone marrow.

Muscular System
Muscles pull on bones to cause movement.

Digestive System
Absorption of dietary calcium provides material for bone matrix.

Nervous System
Proprioceptors sense the position of body parts. Pain receptors warn of trauma to bone. Bones protect the brain and spinal cord.

Respiratory System
Ribs and muscles work together in breathing.

Endocrine System
Some hormones act on bone to help regulate blood calcium levels.

Urinary System
The kidneys and bones work together to help regulate blood calcium levels.

Cardiovascular System
Blood transports nutrients to bone cells. Bone helps regulate plasma calcium levels, important to heart function.

Reproductive System
The pelvis helps support the uterus during pregnancy. Bones provide a source of calcium during lactation.

InnerConnections conceptually link the highlighted body system to every other system. These graphic representations review chapter concepts, make connections, and stress the "big picture" in learning and applying the concepts and facts of anatomy and physiology.

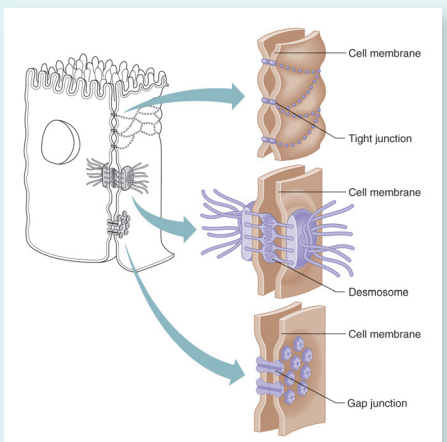


FIGURE 5.1 Intercellular junctions. Tight junctions fuse cell membranes, desmosomes are "spot welds," and gap junctions form channels linking the cytoplasm of adjacent cells.

Q: *Which intercellular junction is the most likely to allow substances to move from one cell to another?*

Answer can be found in Appendix G on page 938.

Q: NEW! Figure Questions allow an additional assessment. These are found on key figures throughout the chapter.