Essentials of Human Anatomy & Physiology

Elaine N. Marieb, R.N., Ph.D.
Holyoke Community College

PEARSON Texas
TENTH EDITION
Texas has some of the foremost health-care centers in the nation—from large hospitals with cutting-edge technologies to small clinics that provide crucial care to people in underserved areas. Whatever field of health-care you are interested in—from infant care to geriatric services and everything in between—you are certain to find outstanding practitioners in Texas.

**MD Anderson Cancer Center**

The MD Anderson Cancer Center is one of the best cancer-care centers in the nation. It leads the nation in cancer research, cancer education, and cancer prevention. More than 80,000 people per year receive cancer care at MD Anderson. In addition, thousands of patients participate in clinical trials that help researchers develop new therapies and diagnostic tests. Medical professionals at the MD Anderson Cancer Center conduct research on lung cancer, bladder cancer, prostate cancer, ovarian cancer, head and neck cancer, pancreatic cancer, endometrial cancer, leukemia, and melanomas.
A Look at TEXAS MEDICAL CENTERS

Parkland Hospitals and Health Systems

Professionals at Parkland Hospital perform almost all medical and surgical specialties. It is one of the largest teaching hospitals in the nation. Its medical teams deliver more infants under one roof than any other hospital in the nation, averaging about 16,000 deliveries per year (more than 40 per day).

TRAUMA CENTER

Parkland is a Level 1 Trauma center, a primary-care center for Dallas County residents, and a medical and surgical referral center for North Texas and parts of Southern Oklahoma. After he was shot on Friday, November 22, 1963, President Kennedy was rushed to Trauma Room 1 at Parkland Hospital. Texas Governor John Connally, wounded in the same shooting, was treated in Trauma Room 2.

BURN CENTER

Parkland’s Burn Center is famous for its state-of-the-art treatment of burn patients, its skin-graft bank, and its burn camp for children. Almost 1,000 burn patients are rushed to its emergency department each year. Parkland’s Burn Center provides complete services to help burn patients—from emergency treatment to rehabilitation and follow-up.

Parkland’s Burn Camp is an opportunity for children and teens to interact with others who have been burned. Being burned is devastating, both physically and psychologically. At the camp, adult burn patients act as role models so children realize they can go on to lead normal, productive lives.
University of Texas Southwestern Medical Center

The University of Texas Southwestern Medical Center trains nearly 4,400 students, residents, and postdoctoral fellows each year. Every year, it conducts more than 3,500 research projects. Its doctors care for nearly 100,000 people and oversee almost two million outpatient visits annually. The medical center’s achievements include survival rates after heart attacks that are almost twice as good as the national average. It also has some of the nation’s best biology and biochemistry researchers.
The Menninger Clinic

One of the nation’s leading inpatient psychiatric hospitals, the Menninger Clinic treats adults and adolescents with complex psychiatric disorders. Its patients come from across the nation, and even from other countries.

For more than 20 years, it has ranked as one of the top hospitals in the nation for psychiatry. At the Menninger Clinic, medical teams (which include the patient) integrate medical, psychological, behavioral, and social information to develop a supportive treatment plan.

Some professionals at the clinic are working on a suicide prevention project, while others are involved in research on adult or teen patients. Some of the best professionals in psychiatry have trained at the Menninger Clinic. More than 2,000 graduates practice today in all 50 states and in 26 countries.

Texas Scottish Rite Hospital

The Texas Scottish Rite Hospital for Children is one of the nation’s leading pediatric centers that treats orthopedic conditions. It also treats related neurological disorders (such as spina bifida) and learning disorders (such as dyslexia). Admission is open to all Texas children, regardless of the family’s ability to pay.

The Texas Scottish Rite Hospital was founded in 1921 to treat children with polio. In the mid-1950s, when vaccines virtually eradicated polio, the hospital began treating other orthopedic conditions. Today, the hospital treats more than 40,000 visitors per year.
Children's Medical Center of Dallas

This hospital is one of the leading pediatric hospitals in the United States. Medical professionals treat young patients with medical issues both large and small—from routine eye exams to more serious issues, such as heart disease or cancer. The hospital also performs kidney, liver, intestine, heart, and bone marrow transplants.

Children's Medical Center is the seventh largest pediatric healthcare provider in the United States, and is the primary pediatric teaching facility for the University of Texas Southwestern Medical Center. The medical staff conducts research that helps to develop treatments and therapies for many childhood diseases.

The medical center began in the summer of 1913 when a group of nurses set up an open-air clinic on the lawn of the old Parkland Hospital. This Baby Camp and Hospital, as it was called, became the Bradford Hospital for Babies. In 1947, it became part of Children's Medical Center of Dallas.
Texas Medical Center

The Texas Medical Center, in Houston, is the largest medical complex in the entire world! It contains many of the nation's leading hospitals, doctors, researchers, medical schools, and health-care providers. More people work there (92,000) than live in some cities. It has the world's largest air ambulance service, and more heart surgeries are performed at the Texas Medical Center than anywhere else in the world. The Texas Medical Center includes fifteen hospitals; three medical schools; four nursing schools; and schools of dentistry, public health, pharmacy, and more. The Center is larger than downtown Dallas.

The Michael E. DeBakey Veterans Affairs Medical Center

The Michael E. DeBakey Veterans Affairs Medical Center is affiliated with the Baylor College of Medicine. Here students can train in fields such as nursing, dietetics, social work, and physical therapy. There are also training opportunities for health-care administration, health information technology, and medical records billing.

This medical center is one of the VA's largest hospitals, serving 27 counties in southeast Texas. At this state-of-the-art hospital, researchers study health problems, including heart disease, Hepatitis C, treatments for AIDS and HIV, and illnesses of Gulf War veterans. This research ensures that veterans have access to the latest medical and health-care technology, which leads to improved prevention, diagnosis, treatment, and control of disease and injuries.
Trinity Mother Frances Hospital

Trinity Mother Frances is a medical and surgical hospital in Tyler, Texas. It provides high-level care in nine adult specialties. It is a Primary Stroke Facility, contains a renowned heart hospital, and cares for people with seizure disorders. The medical staff at Trinity Mother Francis Hospital perform about 6,000 inpatient surgeries and 12,000 outpatient surgeries every single year. It also treats about 67,000 patients in its emergency room.

In 1937, community leaders built Tyler’s first hospital. The hospital opened a day early, on March 18, 1937, when an explosion at a school 25 miles away injured hundreds of children and teachers. Serving East Texas, the hospital offers emergency medical services; routine and specialized medical and surgical care; neonatal intensive care; maternal and child care; and neurological, orthopedic, and cardiac care.

Harris Healthcare

Harris Health professionals treat adults and children with all types of needs, including weight management, mental health care, and primary and specialty care.

Harris Health has experts in cancer care, cardiology, community medicine, geriatric medicine, HIV/AIDS care, physical medicine and rehabilitation, sleep disorders, trauma care, and women and infant services. Its close affiliation with universities keeps it abreast of the latest research, and strengthens its ability to offer leading-edge treatments and technologies.
Community Health Centers of South Central Texas

The Community Health Centers of South Central Texas provide services to people in communities with a shortage of health professionals. Once a volunteer clinic with one doctor and nurse, it now employs more than 90 workers. The center provides acute and chronic medical care, physical exams, laboratory tests, prescriptions, behavioral health services, immunizations, nutritional counseling, obstetric services, and social services, as well as family planning, HIV/AIDS testing, health education, counseling, and transportation assistance.

The clinic also refers patients to dentists and specialists in substance abuse and mental health. It is open in the evening for people who cannot receive care during normal business hours.

Carter BloodCare

Carter BloodCare is Texas’ largest blood center. It provides blood components and transfusion services for approximately 250 Texas healthcare facilities, including children’s hospitals, trauma centers, cancer centers, and transplant centers. Each year, it collects more than 330,000 units of blood at donation centers, and distributes the blood to medical centers in North, Central and East Texas. In addition, it offers medical support, laboratory services, classes, and seminars—most of which are free.

To donate blood, a person must be healthy, at least 16 years old, and weigh at least 110 pounds.
It’s been said that if you choose a job that you love, you will never have to work a day in your life. That’s how I feel every morning when I get ready for my assignment teaching Anatomy & Physiology to my students. I can honestly say that Elaine Marieb’s *Essentials of Human Anatomy & Physiology* is one of the primary reasons that I love my job. The excellent writing of the text, the clear and vivid graphics, and the strong ancillary materials facilitate student learning and make teaching pleasurable.

While a textbook should be a teaching tool and not the teacher, this book has been exceptional in helping me to get the concepts across to my students. The text was earnestly designed to be viewed by high school students. It is written at a level that is readable while still challenging students without being intimidating—ensuring that they will be ready for college-level work. It treats delicate subjects openly and clinically which increases the interest and attention level of the students. The exceptional balance between the anatomical descriptions and the clinical homeostatic physiology is presented in a manner that fully engages the students for optimal retention.

The Homeostatic Imbalance sections embedded within the text are perfectly placed for answering those ‘what if’ questions at precisely the right moment. The “A Closer Look” boxes address current and relevant topics and are extremely beneficial to the students who want to know more about that subject. Quite often, I find them reading these sections independently.

Two of my favorite ancillary components are the online quizzes and activities found in the Study Area of MasteringAandP. The students love “playing the games” and then taking the quizzes to see how well they learned the material. I love getting their scores emailed to me after they complete the assignments—it’s a win-win.

Another very helpful tool is the Instructor Resources DVD. The PowerPoint presentations are wonderful and easy to use for class notes, discussion sessions, or group-sharing exercises. I love that there are three versions of each graphic: a completely labeled one, one with leader lines only and one with just the original graphic. I can use them for study guides, quizzes, and tests. The ancillary tools also save me time in preparing and executing lesson plans, while providing students with fun, effective, and diverse self-study tools.

Most of my students have dreams of entering the health care field. To this end, the “Focus on Careers” boxes open their eyes to the multiple opportunities available to them, while the “Critical Thinking and Clinical Application” questions excite them to try to diagnose the patient with their newfound knowledge.

Marieb’s *Essentials of Human Anatomy & Physiology* is truly one of the best teaching tools on the market today, and I highly recommend it to any high school teacher.

Jamie Haid
McKinney North High School
McKinney, Texas
About the Author

For Elaine N. Marieb, R.N., Ph.D., taking the needs of nursing and other allied health students into account has always been an integral part of her teaching style. Dr. Marieb began her teaching career at Springfield College, where she taught anatomy and physiology to physical education majors. She then joined the faculty of the Biological Science Division of Holyoke Community College in 1969 after receiving her Ph.D. in zoology from the University of Massachusetts at Amherst. While teaching at Holyoke Community College, Dr. Marieb pursued her nursing education, which culminated in a Master of Science degree with a clinical specialization in gerontology from the University of Massachusetts. This experience, along with continual feedback from health care professionals (including generations of former students taught by Dr. Marieb), has inspired the unique perspective and accessibility for which this book is known.

Dr. Marieb’s commitment to students extends beyond teaching and writing. Recognizing the challenges students face, Dr. Marieb contributes to the New Directions—Pathways Program at Holyoke Community College by funding a staffed drop-in center and by providing several full-tuition scholarships each year for women who are returning to college after a hiatus or attending college for the first time. She also funds the E. N. Marieb Science Research Awards at Mount Holyoke College (which promotes research by undergraduate science majors) and has underwritten renovation and updating of one of the biology labs in Mount Holyoke’s Clapp Laboratory. Recognizing the severe national shortage of nursing faculty, Dr. Marieb also underwrites the Nursing Scholars of the Future Grant Program at the University of Massachusetts at Amherst.

In 1994, Dr. Marieb received the Benefactor Award from the National Council for Resource Development, American Association of Community Colleges, which recognizes her ongoing sponsorship of student scholarships, faculty teaching awards, and other academic contributions to Holyoke Community College. In May 2000, the science building at Holyoke Community College was named in her honor.

Dr. Marieb is an active member of the Human Anatomy and Physiology Society (HAPS) and the American Association for the Advancement of Science (AAAS). Additionally, while actively engaged as an author, Dr. Marieb serves as a consultant for the Benjamin Cummings Interactive Physiology® CD-ROM series. This text—Essentials of Human Anatomy & Physiology, Tenth Edition—is the latest expression of her commitment to the needs of students pursuing the study of A&P.

When not involved in academic pursuits, Dr. Marieb is a world traveler and has vowed to visit every country on this planet. Shorter term, she serves on the board of directors of the famed Marie Selby Botanical Gardens and on the scholarship committee of the Women’s Resources Center of Sarasota County. She is an enthusiastic supporter of the local arts and enjoys a competitive match of doubles tennis.


Texas Essential Knowledge & Skills Correlation

Essentials of Human Anatomy and Physiology Correlation Guide to Texas Essential Knowledge & Skills for Career and Technical Education, 130.206, Anatomy and Physiology

<table>
<thead>
<tr>
<th>TEKS</th>
<th>Textbook Page Numbers</th>
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<tr>
<td>1. The student conducts investigations, for at least 40% of instructional time, using safe, environmentally appropriate, and ethical practices. These investigations must involve actively obtaining and analyzing data with physical equipment, but may also involve experimentation in a simulated environment as well as field observations that extend beyond the classroom. The student is expected to:</td>
<td><strong>Lab Manual</strong>: Inside front cover, pp. 11, 172, 174, 184, 203, 215, 216, 238, 240, 254, 298, 308, 325, 335, 339</td>
</tr>
<tr>
<td>A. demonstrate safe practices during laboratory and field investigations</td>
<td></td>
</tr>
<tr>
<td>B demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.</td>
<td><strong>Lab Manual</strong>: pp. 71, 174, 215, 216, 238, 240, 254, 298, 308, 325, 339</td>
</tr>
<tr>
<td>2 The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:</td>
<td><strong>SE</strong> pp. 1, 2, 24</td>
</tr>
<tr>
<td>A know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;</td>
<td><strong>SE</strong> pp. 456, 463, 504–505</td>
</tr>
<tr>
<td>B know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;</td>
<td><strong>SE</strong> pp. 456, 463, 504–505</td>
</tr>
<tr>
<td>C know scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but they may be subject to change as new areas of science and new technologies are developed;</td>
<td><strong>SE</strong> pp. 456, 463, 504–505</td>
</tr>
<tr>
<td>D distinguish between scientific hypotheses and scientific theories;</td>
<td><strong>SE</strong> pp. 456, 463, 504–505</td>
</tr>
<tr>
<td>E plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology;</td>
<td><strong>SE</strong> pp. 24, 62, 108, 133, 180, 225, 277, 307, 336, 355, 397, 435, 463, 511, 538</td>
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### TEKS

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<th>TEKS</th>
<th>Textbook Page Numbers</th>
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<tr>
<td>F collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;</td>
<td>Throughout lab manual</td>
</tr>
<tr>
<td>H communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology–based reports.</td>
<td>SE pp. 24, 62, 108, 133, 180, 225, 277, 307, 336, 355, 397, 435, 463, 511, 538; throughout lab manual</td>
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</tbody>
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### 3 The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:

| B communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials; | SE: pp. 108, 143, 355, 356, 378, 452, 533 |
| C draw inferences based on data related to promotional materials for products and services; | SE: p. 133, 511 |
| D evaluate the impact of scientific research on society and the environment; | SE: pp. 456, 504–505 |
| E evaluate models according to their limitations in representing biological objects or events; and | SE: pp. 29, 62 |
| F research and describe the history of science and contributions of scientists. | SE: pp. 62, 108, 180, 336, 397 |

### 4 The student evaluates the energy needs of the human body and the processes through which these needs are fulfilled. The student is expected to:

<p>| C analyze the effects of energy deficiencies in malabsorption disorders such as diabetes, hypothyroidism, and Crohn’s disease; and | SE: pp. 324–325, 426, 488, 499 |
| D analyze the effects of energy excess in disorders such as obesity as it relates to cardiovascular and musculoskeletal systems. | SE: pp. 141, 172, 185, 387, 388–389, 390, 494, 504–505 |</p>
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<tr>
<th>TEKS</th>
<th>Textbook Page Numbers</th>
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<tr>
<td>5</td>
<td>The student differentiates the responses of the human body to internal and external forces. The student is expected to:</td>
</tr>
<tr>
<td>A</td>
<td>explain the coordination of muscles, bones, and joints that allows movement of the body;</td>
</tr>
<tr>
<td>B</td>
<td>investigate and report the uses of various diagnostic and therapeutic technologies;</td>
</tr>
<tr>
<td>C</td>
<td>interpret normal and abnormal contractility conditions such as in edema, glaucoma, aneurysms, and hemorrhage;</td>
</tr>
<tr>
<td>D</td>
<td>analyze and describe the effects of pressure, movement, torque, tension, and elasticity on the human body; and</td>
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<tr>
<td></td>
<td>Lab Manual: pp. 56, 57, 113–116, 194</td>
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<tr>
<td>E</td>
<td>perform an investigation to determine causes and effects of force variance and communicate findings.</td>
</tr>
<tr>
<td></td>
<td>SE: p. 225</td>
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<tr>
<td>6</td>
<td>The student examines the body processes that maintain homeostasis. The student is expected to:</td>
</tr>
<tr>
<td>A</td>
<td>investigate and describe the integration of the chemical and physical processes, including equilibrium, temperature, pH balance, chemical reactions, passive transport, active transport, and biofeedback, that contribute to homeostasis; and</td>
</tr>
<tr>
<td>B</td>
<td>determine the consequences of the failure to maintain homeostasis.</td>
</tr>
<tr>
<td>7</td>
<td>The student examines the electrical conduction processes and interactions. The student is expected to:</td>
</tr>
<tr>
<td>A</td>
<td>illustrate conduction systems such as nerve transmission or muscle stimulation;</td>
</tr>
<tr>
<td>B</td>
<td>investigate the therapeutic uses and effects of external sources of electricity on the body system; and</td>
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<td></td>
<td>SE: pp. 270–271, 365, 367</td>
</tr>
<tr>
<td>C</td>
<td>evaluate the application of advanced technologies such as electroencephalogram, electrocardiogram, bionics, transcutaneous electrical nerve stimulation, and cardioversion.</td>
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<tr>
<td>8</td>
<td>The student explores the body’s transport systems. The student is expected to:</td>
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<tr>
<td>A</td>
<td>analyze the physical, chemical, and biological properties of transport systems, including circulatory, respiratory, and excretory;</td>
</tr>
<tr>
<td>TEKS</td>
<td>Textbook Page Numbers</td>
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<tr>
<td>11 The student describes the process of reproduction and growth and development. The student is expected to:</td>
<td></td>
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<tr>
<td>C summarize the human growth and development cycle.</td>
<td></td>
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<tr>
<td>12 The student recognizes emerging technological advances in science. The student is expected to:</td>
<td></td>
</tr>
<tr>
<td>A recognize advances in stem cell research such as cord blood utilization; and</td>
<td>SE: pp. 104, 167, 253</td>
</tr>
<tr>
<td>B recognize advances in bioengineering and transplant technology.</td>
<td>SE: pp. 166–167, 520, 422, 425</td>
</tr>
</tbody>
</table>
How to use this book

This book is written with you, the student, in mind. You will find that human anatomy & physiology is more than just interesting—it is fascinating. The writing is friendly and informal, so you will enjoy reading this book, regardless of your background in science. Special features throughout will help you understand the concepts, remember the facts, and study for exams. The next few pages will walk you through those features and help you get the most out of this book.

An Engaging Writing Style
The friendly, informal writing style invites you to learn without intimidation.

You can visualize the relationship between the serosal layers by pushing your fist into a limp balloon only partially filled with air or water (Figure 4.1d). The part of the balloon that clings to your fist can be compared to the visceral serosa clinging to the organ’s external surface. The outer wall of the balloon represents the parietal serosa that lines the walls of the cavity and that, unlike the balloon, is never exposed but is always fused to the cavity wall. In the body, the serous layers are separated not by air but by a scanty amount of thin, clear fluid, called serous fluid, which is secreted by both membranes. Although there is a potential space between the two membranes, they tend to lie very close to each other.

Meaningful analogies relate anatomy & physiology to familiar concepts that you can visualize and remember.

At one time or another, all of us have heard the expressions “bone tired,” “dry as a bone,” or “bag of bones”—pretty unflattering and inaccurate images of some of our most phenomenal organs. Our brains, not our bones, convey feelings of fatigue, and bones are far from dry. As for “bag of bones,” they are indeed more obvious in some of us, but without bones to form our internal skeleton, we would creep along the ground like slugs, lacking any definite shape or form. Let’s examine how our bones contribute to overall body homeostasis.

The conversational writing style presents the material without technical jargon, but draws on the author’s years of experience as a professor and former nursing student.

The sense of humor throughout the book keeps learning fun. We want you to enjoy reading this book!

Would you be enticed by an advertisement for a coat that is waterproof, stretchable, washable, and permanent-press, that invisibly repairs small cuts, rips, and burns, and that is guaranteed to last a lifetime with reasonable care? Sounds too good to be true, but you already have such a coat—your cutaneous membrane, or skin. The skin and its derivatives (sweat and oil glands, hair, and nails) serve a number of functions, mostly protective. Together, these organs are called the integumentary (in-teg’u-men’ta-re) system.
Artwork that helps you learn

The art program is designed to help you learn and remember the human body’s different structures and functions. The dramatically updated art program uses more realistic figures, and provides more figures with integrated text so you can study the art without switching between the art and its caption.

NEW! 3-D anatomy drawings illustrate the material in a realistic style, which gives you the most accurate representation possible.

Process diagrams have been revised with improved step text, which clearly separates the steps so they are easier to follow.

Bone art is realistic, textured, and detailed. All bone art is produced by professional medical illustrators, based on extensive rounds of feedback and accuracy checking.
Brief topic boxes throughout the book present scientific information that can be applied to your daily life. When reading the topic boxes you will probably find yourself saying, “I didn’t know that,” or “Now I understand why…”

Features that pique your interest

A Closer Look

Wrinkle Wrinkle Go Away—Or I’ll Shoot You (with Botox)

When it comes to preventing wrinkles, it helps to have good genes, to use a good sunscreen, and to be frugal enough. Genes have a major role in determining—whether it’s the look of your skin or your skin’s reaction to injury. Collagen and elastin are skin proteins that keep skin firm and elastic. With age, collagen and elastin decline, leaving wrinkles and sagging skin. Laser treatments and injection-based treatments can help to reduce the appearance of wrinkles and fine lines. However, if wrinkles persist, you may want to consider a procedure such as Botox or collagen injections.

New research suggests that Botox injections may help to reduce the appearance of wrinkles by temporarily relaxing the muscles. Botox injections work by blocking the release of acetylcholine, a neurotransmitter that causes muscle contraction. By relaxing muscle fibers, Botox injections can help to smooth out wrinkles and fine lines. The effects of Botox injections last for several months, after which the muscles begin to contract again and the wrinkles return. However, with repeated treatments, the muscles and nerves adapt to the injections, leading to a gradual improvement in the appearance of wrinkles.

Focus on Careers

Forensic Scientist

You need to understand many aspects of cellular biochemistry and have the confidence to explain it to an attorney in testimony.

Forensic scientists need to understand biochemistry, cell biology, and protein analysis. Some forensic scientists perform laboratory tests to identify the cause of death, such as gunshot wounds, or to identify the source of a biological sample, such as DNA. Forensic scientists must have a strong understanding of the scientific principles that underlie their work, as well as the ability to communicate complex information to non-scientists. Forensic scientists often work long hours and may be required to work nights and weekends.

Focus on Careers boxes use interviews with working professionals to show how anatomy & physiology is important in a wide range of allied health careers. New careers have been added to this edition including Pharmacy Technician, Physical Therapy Assistant, and more.
This book is easy to use. Each chapter includes several aids that will guide you through the material, helping you preview what you’re expected to learn in each section so you can focus on the concepts and remember what you need to know.

**Objectives** are integrated into the chapter so you know what you are expected to take away from each section.

**Illustrated tables** combine text and art, and summarize important information from the text. The tables are especially helpful when studying for an exam or reviewing an important topic.

**DID YOU GET IT?** questions help you stop and think to make sure that you understand what you need to know before moving forward.

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**Figure 5.3** The structure of a long bone (humerus of arm). (a) Anterior view with longitudinal section cut away at the proximal end. (b) Petal-shaped, three-dimensional view of spongy bone and compact bone of the epiphysis. (c) Cross section of the shaft (diaphysis). Note that the outer surface of the diaphysis is covered by a periosteum, but the articular surface of the epiphysis (area of end b) is covered by hyaline cartilage.

**Structure of Bone**
- Identify the major anatomical areas of a long bone.
- Describe the microscopic structure of compact bone.
- Explain the role of bone cells and the organic matrix in making bone both hard and flexible.

**Gross Anatomy of a Long Bone**
The gross structure of a long bone is shown in Figure 5.3. The diaphysis (shaft), or shaft, makes up most of the bone’s length and is composed of compact bone. The epiphysis is covered and protected by a fibrous connective tissue.

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**Table 5.2** Common Types of Fractures

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Illustration</th>
<th>Description</th>
<th>Commonality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comminuted</td>
<td><img src="image" alt="Comminuted Fracture" /></td>
<td>Bone breaks into many fragments</td>
<td>Particularly common in older people, whose bones are more brittle.</td>
</tr>
<tr>
<td>Compression</td>
<td><img src="image" alt="Compression Fracture" /></td>
<td>Bone is crushed</td>
<td>Common in percuss bones (i.e., osteoporotic bones of older people).</td>
</tr>
<tr>
<td>Depressed</td>
<td><img src="image" alt="Depressed Fracture" /></td>
<td>Broken bone part is pressed inward</td>
<td>Typical of skull fracture.</td>
</tr>
<tr>
<td>Impacted</td>
<td><img src="image" alt="Impacted Fracture" /></td>
<td>Broken bone ends are forced into each other</td>
<td>Commonly occurs when someone attempts to break a fall with cushioned arms.</td>
</tr>
<tr>
<td>Spinal</td>
<td><img src="image" alt="Spinal Fracture" /></td>
<td>Raged break occurs when excessive twisting forces are applied to a bone</td>
<td>Common sports fracture.</td>
</tr>
<tr>
<td>Greenstick</td>
<td><img src="image" alt="Greenstick Fracture" /></td>
<td>Bone breaks incompletely, much like a green twig breaks</td>
<td>Common in children, whose bones are more flexible than those of adults.</td>
</tr>
</tbody>
</table>
Applications throughout this text help you apply what you learn to relevant clinical situations that you may encounter in other courses. By thinking through the issues, you will prepare yourself for the real world.

Critical Thinking and Clinical Application Questions

22. A nurse tells a doctor that a patient is cyanotic. What is cyanosis? What does its presence indicate?
23. Both menstruating females and males have little subcutaneous tissue. How does this affect their sensitivity to cold environmental temperatures?
24. A 40-year-old housewife is complaining to you that her vision does not seem as good as it was when she was young—but now it is as good as it was when she was young. She has several well-defined symptoms of the nasal cavity that she has been using daily, and she immediately recognized you as a doctor. Why does this mean, and why should she be concerned?
25. Martha, the mother of a 13-month-old infant, brings her child to the clinic because her skin has turned orange. Why does the pediatrician inquire about the child's diet?

Critical Thinking & Clinical Application Questions at the end of each chapter challenge you to apply what you've learned to real-world clinical situations. These also help you comprehend the material and better prepare for exams.

Homeostatic Imbalance sections offer clinical examples most relevant to those working in health fields. These sections stress the understanding that loss of homeostasis leads to pathology or disease.

Figure Questions accompany many figures to help you think beyond memorizing terms and labels. These questions help you develop a more meaningful understanding of the concepts and processes. Answers are provided at the bottom of the page.
Where to go for extra practice

No matter where or when you need extra help, we’ve got you covered. This book comes with access to MasteringA&P with Pearson eText and the Essentials of Interactive Physiology® CD-ROM, two media resources designed to help you succeed in your course.

MasteringA&P®

The Mastering platform is the most effective and widely used online homework, tutorial, and assessment system for the sciences. It delivers self-paced tutorials that focus on your course objectives, provides individualized coaching, and responds to each student’s progress. The Mastering system helps teachers maximize class time with easy to assign, customizable, and automatically graded assessments that motivate students to learn. Access to MasteringA&P is provided with the purchase of this textbook. See page XXV for access information.

Essentials of Interactive Physiology® CD-ROM

New for this edition:

• Immune System module is now included.
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Teacher Resources

Some of the teacher supplements and resources for this text are available electronically to qualified adopters on the Instructor Resource Center (IRC). Upon adoption or to preview, please go to www.PearsonSchool.com/Access_Request and select Instructor Resource Center. You will be required to complete a brief one-time registration subject to verification of educator status. Upon verification, access information and instructions will be sent to you via email.

Instructor Guide/Test Bank
This fully updated all-in-one volume provides a wealth of resources for instructors, including new resources for teaching online, chapter summaries, suggested lecture outlines, key terms, lecture hints, classroom demonstrations, student activities, and a test bank with a variety of new and revised test questions for each chapter.

Instructor Resource DVD
New for this edition, the Instructor Resource DVD (IR-DVD) organizes all instructor media resources into one convenient location. The IR-DVD includes all the figures and tables from the text in JPEG and PowerPoint® format; label-edit art with editable labels and leader lines; step-edit art that walks through multistep figures step by step; Clicker Questions and Quiz Show Game questions to encourage student interaction; A&P Flix™ animations; the Instructor Guide/Test Bank in Microsoft® Word format; and the TestGen® software and electronic test bank.

Transparency Acetates
All of the textbook figures—approximately 275 images—are included in this high-quality acetate package. Each image has been enhanced with brighter colors and bolder figure labels so that the illustrations are as easy to view as those in the book.

ExamView® Computerized Test Bank
To ensure students are learning the material you are teaching, you’ll have hundreds of questions at your fingertips within the ExamView computerized test bank CD-ROM. This flexible resource allows teachers to build, edit, print, and administer tests based on text objectives. Algorithmically based, ExamView enables teachers to create multiple but equivalent versions of the same question or test with a click of a button.


Student Resources

(For purchase only)
Learn the structures and functions of the human body from a microscopic to macroscopic level using a wide variety of visual and written exercises and activities.

Essentials of Human Anatomy & Physiology Laboratory Manual, Fifth Edition  
(For purchase only)
This brief, hands-on lab manual provides 27 concise, activity-based exercises. Each lab includes a new pre-lab quiz, learning objectives, summaries of key concepts, a variety of activities, and an integrated review sheet. The manual also includes a full-color Histology Atlas with 55 photomicrographs.

Essentials of Interactive Physiology® CD-ROM  
(Replacement CD)
Take advantage of these animated tutorials, which will give you insight into the human body with audio and visual content including a new Immune System module and redesigned interface. This resource is included with each new copy of the text. (Replacement CD is available for purchase.)
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