

GLOBAL
EDITION



Essentials of Human Anatomy & Physiology

ELEVENTH EDITION

Elaine N. Marieb



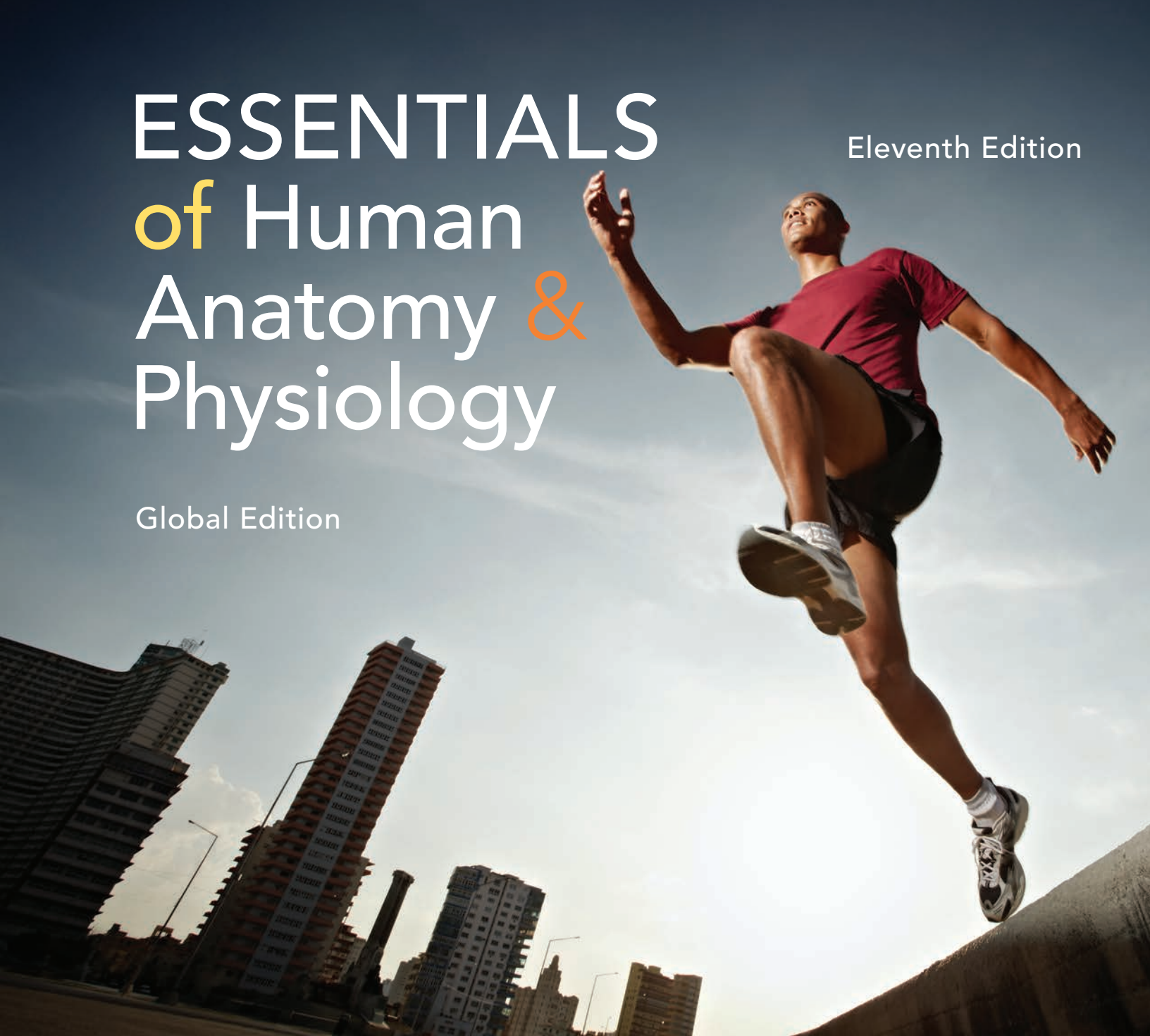
ALWAYS LEARNING

PEARSON

ESSENTIALS of Human Anatomy & Physiology

Eleventh Edition

Global Edition



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

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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.

In January 2012, Florida Gulf Coast University named a new health professions facility: the Dr. Elaine Nicpon Marieb Hall. This facility contains laboratories in the School of Nursing that simulate an operating room, intensive-care unit, a labor and delivery room, and general medical surgical suites. She has also established a scholarship endowment for nontraditional students in the health professions and an endowment to enhance the activities of faculty, students, and staff within the health professions to support education, research, and community outreach.

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 Pearson *Interactive Physiology*® CD-ROM series. This text—*Essentials of Human Anatomy & Physiology*, Eleventh 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.

New to the Eleventh Edition

This edition has been thoroughly updated. Specific chapter-by-chapter changes include:

Chapter 1: The Human Body: An Orientation

- New photos of the anatomical position, planes of the body, and MRI scans (Figure 1.6).
- New photo showing the nine abdominopelvic regions (Figure 1.9).
- New Critical Thinking and Clinical Application Question on carpal tunnel syndrome.

Chapter 2: Basic Chemistry

- New coverage of glycolipids (Table 2.5).
- New photo showing water's high surface tension (Figure 2.9).
- New descriptions of amino acid structures (Figure 2.17).

Chapter 3: Cells and Tissues

- New, illustrated Table 3.1: Parts of the Cell: Structure and Function.
- New Concept Link discussing phospholipids as polar molecules.
- New Concept Link discussing the molecular structure of DNA.
- New Concept Link discussing the joining of amino acids by enzymes into peptide bonds, in relation to translation.
- New clinical photo showing post-burn contracture scars, in Homeostatic Imbalance 3.3.

Chapter 4: Skin and Body Membranes

- New clinical photo showing cradle cap in a newborn baby, in Homeostatic Imbalance 4.4.
- New clinical photos of burns (Figure 4.11); cold sores, impetigo, and psoriasis (Figure 4.12); and skin cancer (Figure 4.13).
- New Concept Link discussing the relationship between mitosis, cell division, and cancer.

Chapter 5: The Skeletal System

- New Concept Link discussing the levels of structural organization, in relation to the gross anatomy of a long bone.
- New clinical photo of a child with rickets, in Homeostatic Imbalance 5.1.
- New Concept Link discussing the relationship between regional body terms and bone names, in relation to the axial skeleton.
- New Concept Link discussing the properties of tissues that form the joints.

Chapter 6: The Muscular System

- New Concept Link comparing ATP to a tightly coiled spring.
- New illustrations showing muscle action (Figure 6.14).
- New clinical photo of a patient with myasthenia gravis, in Homeostatic Imbalance 6.4.

Chapter 7: The Nervous System

- New Concept Link relating the concept of a feedback loop to the nervous system.
- New illustrated Table 7.1: Functions of Major Brain Regions.
- New clinical photo of a patient with cerebral palsy, in Homeostatic Imbalance 7.11.

Chapter 8: Special Senses

- New Concept Link relating the basic functions of the nervous system to each of the special senses.
- New clinical photo of an infant with strabismus, in Homeostatic Imbalance 8.11.

Chapter 9: The Endocrine System

- New Concept Link comparing a hormone's relationship to its target cells with that of an enzyme to its substrate.

- New photo of individuals with disorders of pituitary growth hormones (Figure 9.6).
- New clinical photo of the lips of a patient with the hyperpigmentation of Addison's disease, in Homeostatic Imbalance 9.6.

Chapter 10: Blood

- New Concept Link discussing the structure of globular proteins.
- New Concept Link relating the concept of negative feedback to low blood oxygen levels.
- New clinical photo of a thrombus occluding a small pulmonary blood vessel in a human lung, in Homeostatic Imbalance 10.3.

Chapter 11: The Cardiovascular System

- New clinical photo of a prosthetic aortic heart valve, in Homeostatic Imbalance 11.2.
- New Concept Link relating one-way generation of an action potential to heart rhythm.
- New Concept Link relating the portal circulation that links the hypothalamus of the brain and the anterior pituitary gland to hepatic portal circulation.
- New Concept Link relating the passive process of filtration to blood flow.
- New Concept Link discussing epinephrine.

Chapter 12: The Lymphatic System and Body Defenses

- New Concept Link discussing hydrostatic and osmotic pressures.
- New Concept Link discussing the functions of lymphatic vessels.
- New Concept Link discussing the function of the thymus to produce hormones, in relation to lymphoid organs.
- New clinical photo of an abscess, in Homeostatic Imbalance 12.2.
- New Concept Link relating blood antigens to self-antigens.

Chapter 13: The Respiratory System

- New Concept Link discussing mucous membranes.
- New Concept Link relating pressure changes that drive filtration and blood flow to the mechanics of breathing.
- New clinical photo of a colored chest X-ray film showing a collapsed lung, in Homeostatic Imbalance 13.7.
- New Concept Link discussing blood pH, in relation to gas transport.

Chapter 14: The Digestive System and Body Metabolism

- New Concept Link discussing the function of papillae.
- New Concept Link discussing the basic function of valves.
- New Concept Link discussing hydrolysis reactions.
- New clinical photo of a baby with a cleft lip and palate, in Homeostatic Imbalance 14.15.

Chapter 15: The Urinary System

- New Concept Link discussing filtration as a passive process.
- New Concept Link discussing pH as a measure of hydrogen ion concentration, in relation to tubular secretion.
- New clinical photo of a urogram showing the presence of a kidney stone, in Homeostatic Imbalance 15.3.
- New Concept Link discussing the concept of interrelationships among organ systems, in relation to regulation of water intake and output.

Chapter 16: The Reproductive System

- New clinical photo of abnormal sperm, in Homeostatic Imbalance 16.2.
- New Concept Link discussing the tropic hormone, FSH.
- New Concept Link discussing the concept of the feedback loop.

Introducing *Essentials of Human Anatomy and Physiology*, 11th edition, Global Edition

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Bring A&P Concepts to Life

A CLOSER LOOK A Wrinkle Out of Time

When it comes to preventing wrinkles, it helps to have good genes, to not smoke, to use a good sunscreen, and to think pleasant thoughts. Good genes speak for themselves—it's partly the luck of the draw whether you look your age or not. Smoking ages the skin by increasing production of an enzyme that destroys collagen. Collagen supports the skin and provides it with elasticity, so with less of it, wrinkles appear. UV radiation damage from too much unprotected exposure to the sun causes elastic fibers to clump, which results in leathery skin. For those wrinkled by years of smoking and sun damage, a surgical face-lift that removes the excess and sagging skin followed by laser resurfacing or microdermabrasion seems to be the only way to banish the wrinkles.

However, for those who sport frown lines, furrowed brows, or crow's feet due to frequent and repetitive facial expressions, cosmetic injections of Botox may be the answer to regaining younger-looking skin. Botulinum toxin type A, more familiarly called Botox Cosmetic, is a toxin produced by the bacterium that causes botulism, a dreaded form of food poisoning. Used in injectable doses (considerably less than the amount that would induce botulism), the toxin helps

nerve to muscles). By inhibiting the underlying muscles' ability to contract, existing lines are smoothed out and nearly invisible in a week.

Botox was approved in 1989 to treat two eye muscle disorders—blepharospasm (uncontrollable blinking) and strabismus (misaligned eyes). The discovery that Botox could be used cosmetically was pure luck—physicians using the toxin to counter abnormal eye contractions noticed that the vertical frown lines between the eyes (which make people look tired, angry, or displeased) had softened.

The recent rise in popularity of Botox "shots" has led to changes in the way it is marketed. Some physicians buy the toxin in bulk and arrange "Botox parties" or "Botox happy hours," get-togethers for 10 to 15 people,



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Bring the Real World into the Classroom

FOCUS ON CAREERS

Pharmacy Technician

To recognize how medications affect patients, pharmacy technicians need thorough understanding of anatomy and physiology.

When most people get a new medication, they open up the package and toss out the little pamphlet that goes into detail about how the medication works. Not Chris Green. "I love reading the package inserts," says Green, the lead pharmacy technician at a CVS drugstore in Birmingham, Alabama. Green's enthusiasm for those details is a lifesaver for his customers. Pharmacy technicians are a vital link in the chain between doctor and patient.

Although pharmacy technicians are legally prohibited from talking with patients about their symptoms, they can translate medical jargon, and discuss a medication's side effects and other precautions the patient may need to take. For example, doctors may recommend that patients who are on certain

Green started working as a cashier at a drugstore when he was in high school and gradually became interested in the pharmacy itself.

"I was interested in how drugs work, how they can help people and improve their health," he says.

Having earned a bachelor's degree in biology, Green emphasizes that pharmacy technicians must have a good grasp of the sciences, especially basic chemistry and anatomy and



Pharmacy technicians must have a good grasp of anatomy and physiology to understand each drug's chemical properties.

the patient is already taking. Drug interactions happen commonly when you have multiple doctors. "Sometimes, we'll get two ACE inhibitors in the same category from two different doctors [prescribed for the same patient], and that could be lethal," Green says.

Pharmacy technicians work in retail and mail-order pharmacies, hospitals, nursing homes, assisted living facilities, and anywhere else patients have high needs for medication. As the Baby Boom