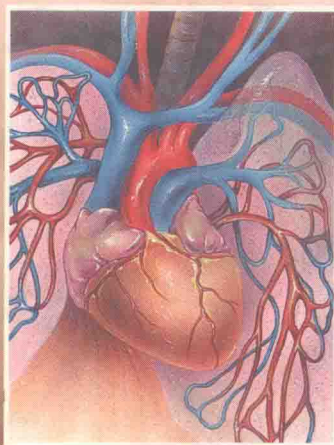
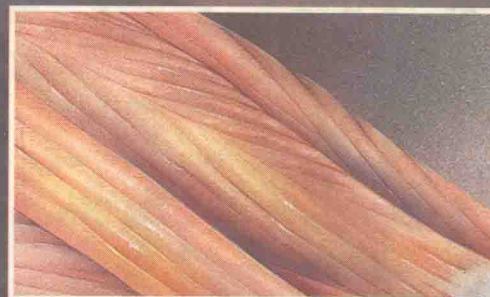
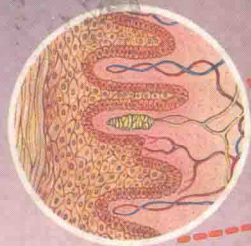


PRINCIPLES *of*  
ANATOMY *and*  
PHYSIOLOGY  
SIXTH EDITION



GERARD J. TORTORA  
NICHOLAS P. ANAGNOSTAKOS



SIXTH EDITION

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# PRINCIPLES OF ANATOMY AND PHYSIOLOGY

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Principles of Anatomy and Physiology, Sixth Edition

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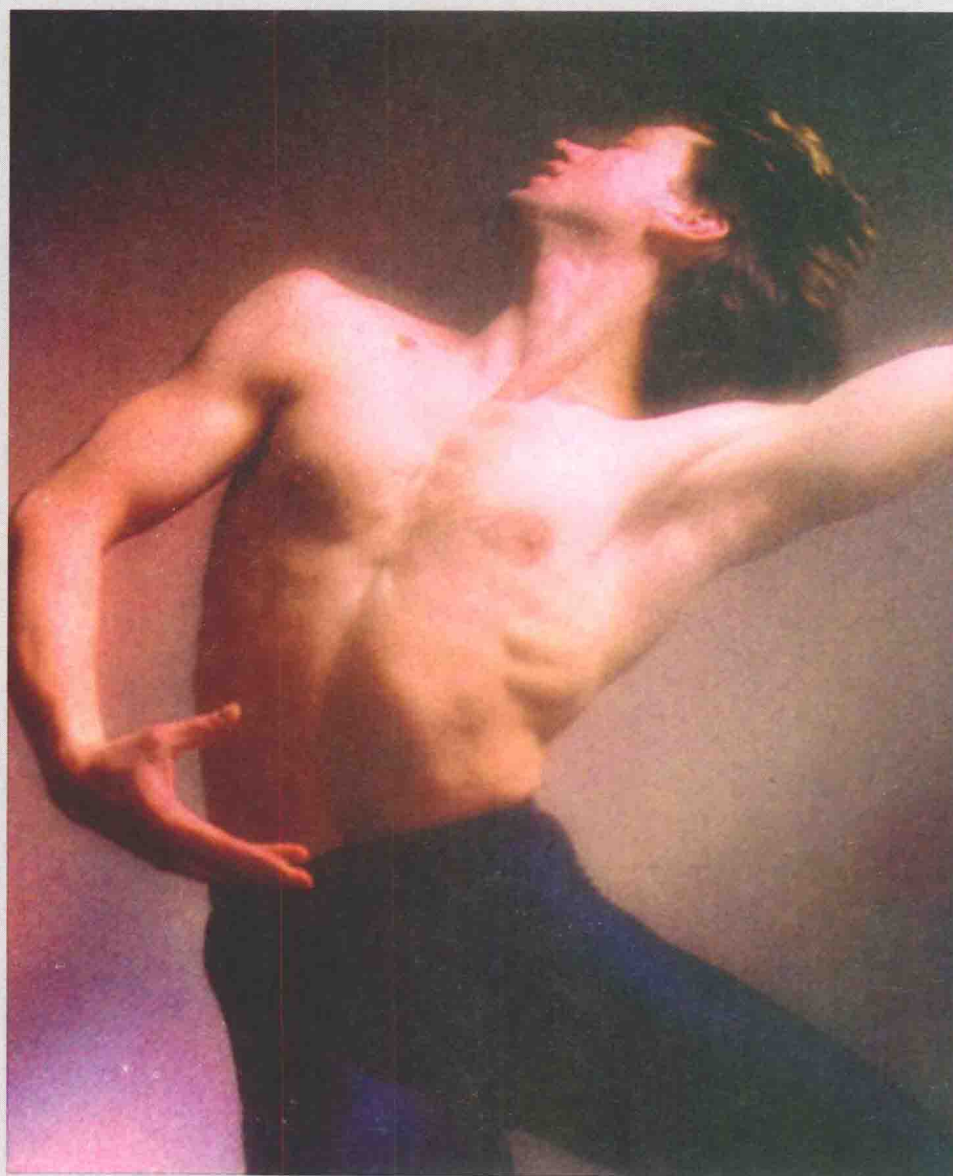
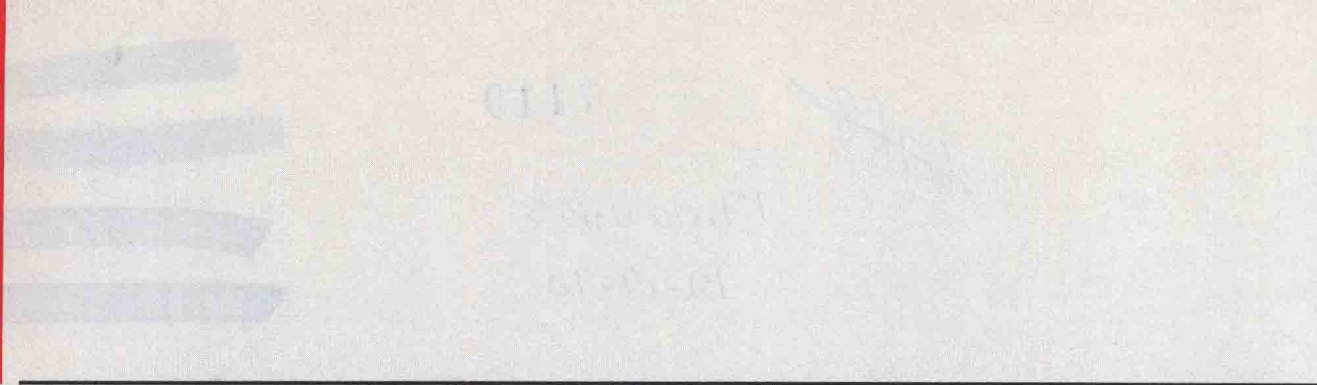
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# PRINCIPLES OF ANATOMY AND PHYSIOLOGY



# PREFACE

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***Principles of Anatomy and Physiology***, Sixth Edition, is designed for use in an introductory course in anatomy and physiology and assumes no previous study of the human body. The text is geared to students in health-oriented, medical, and biological programs who are aiming for careers as nurses, medical assistants, physicians' assistants, medical laboratory technologists and technicians, perfusionists, radiation therapy technologists and radiographers, respiratory therapists, dental hygienists, physical and occupational therapists, surgical assistants and technologists, diagnostic medical sonographers, cytotechnologists and histologic technologists, electroencephalographic (EEG) technologists, emergency medical technicians-paramedics, nuclear medicine technologists, morticians, and medical record administrators and technicians. Because of its scope, the text is also useful for students in the biological sciences, science technology, liberal arts, and physical education and in premedical, pre dental, and prechiropractic programs.

## OBJECTIVES

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The objectives of the sixth edition are (1) to provide a basic understanding and working knowledge of the human body and (2) to present this essential material at a level that average students can handle.

Throughout, the goal has been to eliminate barriers to a ready comprehension of the structure and function of the human body. It is recognized, however, that some technical vocabulary and difficult concepts are vital to the course. Such material is developed in step-by-step, easy-to-understand explanations that avoid needlessly difficult technical vocabulary and syntax.

## THEMES

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As in previous editions, two major themes still dominate the book: **homeostasis** and **pathology**. Throughout, the book shows students how dynamic counterbalancing forces maintain normal anatomy and physiology. Pathology is viewed as a disruption in homeostasis. Accordingly, a number of clinical topics and disorders are presented and contrasted with previously learned normal processes.

## ORGANIZATION

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Based on comments by numerous reviewers and users, the book follows the same unit and topic sequence as its five earlier editions. It is divided into five principal areas of concentration. Unit 1, Organization of the Human Body, provides an understanding of the structural and functional levels of the body, from molecules to organ-systems. Unit 2, Principles of Support and Movement, analyzes the anatomy and physiology of the skeletal system, articulations, and the muscular system. Unit 3, Control Systems of the Human Body, emphasizes the importance of the nerve impulse in the immediate maintenance of homeostasis, the role of receptors in providing information about the internal and external environment, and the significance of hormones in maintaining long-range homeostasis. Unit 4, Maintenance of the Human Body, illustrates how the body maintains itself on a day-to-day basis through the mechanisms of circulation, respiration, digestion, cellular metabolism, urinary functions, and buffer systems. Unit 5, Continuity, covers the anatomy and physiology of the reproductive systems, development, and the basic concepts of genetics.

## GENERAL CHANGES

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1. Medical tests have been added to most chapters. The commonly employed tests provide information on diagnostic value, procedure, and normal values (when appropriate).

2. All of the art in Chapter 11 and much of the art in Chapter 28 has been redrawn using a new rendering technique.

3. A chapter outline has been added to each chapter to help students overview the sequence of topics.

4. Student objectives are now numbered.

5. Page numbers have been added to review questions to help students locate the answers.

6. Phonetic pronunciations have been added to medical terminology lists.

7. New line art has been placed adjacent to the epithelial tissue photomicrographs in Chapter 4.

8. Shock and homeostasis have been moved from Chapter 20 to Chapter 21, inflammation has been moved from Chapter 4 to Chapter 22, and regulation of food intake has been moved from Chapter 24 to Chapter 25.

9. Abbreviations (formerly Appendix C) and Eponyms Used in This Text (formerly Appendix D) are now found inside the covers of the text. Also added to the covers is a new section dealing with terms used in prescription writing.

10. Selected Readings now appear at the ends of each chapter rather than grouped at the end of the book.

11. In addition to updating and expanding the physiology throughout, several new pieces of physiology art have been added.

In the sixth edition, the strengths of the previous editions have been maintained. Revisions made for the new edition, based on extensive reviewer feedback, have focused on updating certain topics and strengthening the coverage of physiology. Among the specific changes made in topic coverage in the sixth edition are the following:

## UNIT 1. ORGANIZATION OF THE HUMAN BODY

Chapter 1 has been expanded to include a new exhibit that summarizes representative structures found in the nine abdominopelvic regions. There is a new section on medical imaging that includes conventional radiography, computed tomography (CT) scanning, dynamic spatial reconstruction (DSR), magnetic resonance imaging (MRI), ultrasound (US), positron emission tomography (PET), and digital subtraction angiography (DSA). A new section on homeostasis and disease has also been included.

Chapter 2 contains new clinical applications on lasers, fat substitutes, and DNA fingerprinting; new sections on polar and nonpolar covalent bonds and the solvating property of water; and expanded coverage of levels of organization of proteins.

New to Chapter 3 are a clinical application on liposomes and drug therapy and discussions of the packaging of DNA in chromosomes, bulk flow, ligands, the microtrabecular lattice, DNA replication, and grading and staging tumors. Several new scanning electron micrographs (SEMs) of cell organelles have also been added. Among the topics revised are the structure, chemistry, and functions of the plasma membrane; lysosomal structure and functions; extracellular materials; cell division; and cells and cancer.

In Chapter 4 there is a new section on adhesion proteins and integrins and a new clinical application on Marfan syndrome. Membranes are now discussed before muscle and nervous tissue. In response to many requests by users, new line art has been placed adjacent to the epithelial tissue photomicrographs. Several new color photomicrographs have been added as replacements.

Changes in Chapter 5 include new clinical applications dealing with moles, liver spots, Retin-A and wrinkles, and skin grafts; new sections on scar formation and types of skin cancer; and a revised discussion of the histology of the epidermis.

## UNIT 2. PRINCIPLES OF SUPPORT AND MOVEMENT

New to Chapter 6 are a medical test that deals with bone scanning; a clinical application on manganese and bone growth; and a section that discusses exercise and the skeletal system. The sections dealing with the histology of bone, homeostasis of bone, and osteoporosis have been revised.

In Chapter 7, there are new clinical applications on why scientists study bones and on temporomandibular joint (TMJ) syndrome; new sections on the bones of the orbits and treating herniated discs; and several new color photos of bones.

Chapter 9 contains a new medical test on arthrocentesis; a new discussion of the first transplant of an entire human knee; and a new exhibit on selected joints of the body according to definition, structural type, and movements permitted.

Chapter 10 has been revised considerably in response to user feedback. A new medical test on electromyography and new clinical applications on “second wind” and hypotonia and hypertonia have been added. There are new discussions of energy for muscular contraction, muscle action potential, factors that affect muscle tension, and regeneration of muscle tissue. Revised topics include oxygen debt, muscle fatigue, types of skeletal muscle fibers, muscular dystrophies, and abnormal contraction. Several new pieces of art have been added to demonstrate physiological concepts and several pieces have been redrawn.

Chapter 11 has been revised extensively. First, there are new exhibits and illustrations on muscles of the soft palate; muscles that move the wrist, hand, and fingers; intrinsic muscles of the hand; and intrinsic muscles of the foot. Also, every muscle exhibit now contains an overview section that focuses on the muscles under consideration. Several new cross-sectional illustrations have been added, as well as illustrations of the triangles of the neck and movements of the thumb. Another striking change is the use of a new technique for illustrating skeletal muscles. A new, detailed section on running injuries has been added.

## UNIT 3. CONTROL SYSTEMS OF THE HUMAN BODY

Chapter 12 has been updated in response to user feedback to include new sections on electrical synapses, muscle action potentials, and presynaptic inhibition. Among the revised areas are regeneration of neurons, voltage-sensitive channels, the effect of “crack” on neurotransmitters, and impulse propagation.

In Chapter 13, new medical tests on spinal tap and myelography have been added. The section on peripheral nerve damage and repair has been revised.

Chapter 14 contains new sections on brain damage,

transient ischemic attack, and delirium. There is also a new medical test on electroencephalography, a new summary exhibit on neurotransmitters and neuropeptides, and new line art of the ventricles of the brain, brain stem, hypothalamus, limbic system, and origin of cranial nerves. Discussions of the blood-brain barrier, hypothalamus, limbic system, cerebellar structure and function, Parkinson's disease, cerebrovascular accident, multiple sclerosis, dyslexia, Alzheimer's disease, and Tay-Sachs disease have been revised.

Chapter 15 contains new clinical applications on anesthesia and coma, a new section on chronic and acute pain, and new line art of the reticular formation. The sections on generator and receptor potentials and memory have been revised.

In Chapter 17, a new clinical application on corneal surgery has been added. Also new are medical tests on tonometry, ophthalmoscopy, visual acuity, and audiometry. Several illustrations have been redrawn. The discussions of contact lenses, perforated eardrum, cataract, and conjunctivitis have been revised.

Chapter 18 has been updated by the inclusion of a new medical test on thyroid function and new sections on up-regulation and down-regulation, hormonal interactions (permissive effect, synergism, antagonism), milk let-down reflex, growth factors, and the link between stress and immunity. There are also several new color photos of endocrine disorders.

## UNIT 4. MAINTENANCE OF THE HUMAN BODY

Chapter 19 contains new medical tests dealing with erythrocyte sedimentation rate, reticulocyte count, hematocrit, histocompatibility testing, differential white blood cell count, complete blood count, blood typing, prothrombin time, and bleeding time. There are also new clinical applications related to taking blood samples, blood doping, and plasmapheresis. New material has been added on platelet structure and function, hemostatic control mechanisms, chronic fatigue syndrome, and colony-stimulating factors. Extrinsic and intrinsic clotting, polycythemia, and infectious mononucleosis have been revised.

In Chapter 20, new medical tests on serum enzyme studies; resting, stress, and ambulatory electrocardiograms; thallium imaging; and lipid profile have been added. Among the new sections are rheumatic fever, left ventricular assist device, hemopump, and stents. The revised topics include free radicals, artificial heart, heart murmur, coronary angiography, cardiac catheterization, development and treatment of atherosclerosis, and flutter and fibrillation. The section on shock has been moved to Chapter 21.

New topics in Chapter 21 are medical tests on digital subtraction angiography and Doppler ultrasound, a clinical application on edema, a section on shock and ho-

meostasis, and illustrations of the branches of the celiac, superior mesenteric, and inferior mesenteric arteries. In response to user comments, the section on cardiovascular physiology (blood flow, blood pressure, resistance, vasomotor control, and exercise and the cardiovascular system) have been revised and new physiological illustrations have been added. Another notable change is the illustration of schemes of arterial distribution and venous drainage within exhibits, instead of as separate illustrations.

Chapter 22 contains a new medical test on lymphangiography, new clinical applications on metastasis and immunotherapy, and new summary exhibits on components of the lymphatic system and lymphokines. Among the revised topics are nonspecific resistance, phagocytosis, inflammation (moved from Chapter 4), complement, antibodies, T cells and cellular immunity, functions of macrophages, AIDS, and hypersensitivity.

New to Chapter 23 are medical tests dealing with bronchography, lung scans, pulmonary function tests, and arterial blood gas and a clinical application on rhinoplasty. The discussions of inspiration, expiration, tuberculosis, and pulmonary embolism have been revised.

Chapter 24 contains a new clinical application on root canal therapy, new medical tests on gastroscopy, liver function tests, oral cholecystogram, fecal occult blood, sigmoidoscopy and colonoscopy, and barium swallow and barium enema. There are also new sections on the functions of the liver, lipoproteins, dietary fiber, and colorectal cancer and new line art on the histology of the gastrointestinal tract. Revised sections include those dealing with jaundice, periodontal disease, anorexia nervosa, and bulimia. The section on regulation of food intake has been moved to Chapter 25.

New topics in Chapter 25 include a clinical application on carbohydrate loading and sections dealing with generation of ATP, chemiosmosis, hypothermia, malnutrition, and morbid obesity. The sections on metabolism, oxidation-reduction reactions, Krebs cycle, electron transport chain, regulation of body temperature, and fever have been revised.

Chapter 26 has new medical tests on cystoscopy, urinalysis, blood urea nitrogen, and creatinine; a new disorder, nephrotic syndrome; and several new physiology illustrations. The revised topics include glomerular filtration, tubular reabsorption, tubular secretion, renal clearance, renal failure, and extracorporeal shock wave lithotripsy.

In response to user feedback, the coverage of functions, regulation, and disorders related to electrolytes in Chapter 27 has been expanded greatly. The coverage of acid-base imbalances has also been increased along with a new summary exhibit.

## UNIT 5. CONTINUITY

New topics in Chapter 28 include medical tests on semen analysis, Pap smear, colposcopy, cone biopsy, endocervical curettage, mammography, and laparoscopy; new clin-

ical applications on cancer of the prostate gland and signs of ovulation; and sections on cervical mucus, mifepristone (RU 486), sympto-thermal method of birth control, genital warts, benign prostatic hyperplasia, transurethral sonography, and vulvovaginal candidiasis. Spermatogenesis, oogenesis, sexually transmitted diseases, impotence, dysmenorrhea, premenstrual syndrome, and toxic shock syndrome have been revised. Much of the art in this chapter has been redrawn using a new technique.

In Chapter 29, there are new medical tests on fetal ultrasonography and electronic fetal monitoring; new clinical applications on placenta previa, fetomaternal hemorrhage, umbilical cord accidents, fetal surgery, fetal-tissue transplantation, fertility and body fat, and karyotyping; and a new section dealing with diagnosis of pregnancy, exercise and pregnancy, Apgar scoring, aneuploidy, Klinefelter syndrome, Turner syndrome, metafemale syndrome, fragile X syndrome, separation of conjoined twins, and testis-determining factor. The sections on in vitro fertilization, the placenta, lactation, and genetics have been revised.

## SPECIAL FEATURES

As in previous editions, the book contains numerous learning aids. Users of the book have cited the pedagogical aids as one of the book's many strengths. All of the tested and successful learning aids of previous editions have been retained in the sixth edition, and several new ones have been added. These special features are:

**1. Student Objectives.** Each chapter opens with a comprehensive list of Student Objectives. Each objective describes a knowledge or skill students should acquire while studying the chapter. (See *Note to the Student* for an explanation of how the objectives may be used.) In this edition, the Student Objectives are numbered.

**2. Chapter Outline.** New to the sixth edition, each chapter now contains an outline of its contents to help students preview the sequence of topics.

**3. Study Outline.** A study outline at the end of each chapter provides a brief summary of major topics. This section consolidates the essential points covered in the chapter so that students can recall and relate the points to one another. Page numbers given beside major headings in the outlines make it easy to refer to topics within chapters.

**4. Review Questions.** Review questions at the end of each chapter provide a check to see if the objectives stated at the beginning of the chapter have been mastered. Page numbers have been added to the questions to help students locate the answers. After answering the questions, students should reread the objectives to determine whether they have met the goals.

**5. Exhibits.** Health-science students are generally expected to learn a great deal about the anatomy of certain organ-systems, specifically, skeletal muscles, articulations, blood vessels, and nerves. To avoid interrupting the discussion of concepts

and to organize the data, anatomical details have been presented in tabular form in exhibits, most of which are accompanied by illustrations. New summary exhibits have been added to the sixth edition, especially in relation to physiological principles.

**6. Disorders: Homeostatic Imbalances.** Abnormalities of structure or function are grouped at the end of appropriate chapters in sections titled "Disorders: Homeostatic Imbalances." These sections provide a review of normal body processes and demonstrate the importance of the study of anatomy and physiology to a career in any of the health fields. All disorders have been updated and several new ones have been added.

**7. Phonetic Pronunciations.** Throughout the text, phonetic pronunciations are provided in parentheses for selected anatomical and physiological terms. These pronunciations are given at the point where the terms are introduced and are repeated in the Glossary of Terms. Many new phonetic pronunciations have been added in the sixth edition. The *Note to the Student* explains the pronunciation key.

**8. Medical Terminology.** Glossaries of selected medical terms appear at the end of appropriate chapters; these listings are entitled "Medical Terminology." All of the glossaries have been revised for the sixth edition and phonetic pronunciations have been added.

**9. Clinical Applications.** Throughout the text, clinical applications are boxed off for greater emphasis. Many new ones have been added.

**10. Medical Tests.** New to the sixth edition are selected, commonly performed medical tests within appropriate chapters. Diagnostic value, procedure, and normal values, when applicable, are given for each medical test. It should be noted that the procedures described for the various medical tests are commonly used ones; other alternative procedures or variations also exist.

**11. Line Art.** The line drawings in the book are large so that details are easily seen. In the sixth edition, a large number have been redrawn (see especially Chapters 11 and 28) and many new ones have been added, many pertaining to physiology. Full color is used throughout to differentiate structures and regions.

**12. Photographs.** The photographs amplify the narrative and the line drawings. Numerous photomicrographs (in full color), scanning electron micrographs, and transmission electron micrographs enhance the histological discussions. Color photographs of specimens and regional dissections clarify gross anatomy discussions. New photographs have been added throughout.

**13. Appendixes.** Appendix A, Measurements, summarizes U.S., metric, and apothecary units of length, mass, volume, and time. Appendix B, Normal Values for Selected Blood and Urine Tests, contains a listing of normal values for the principal constituents of these fluids.

**14. Inside Front and Back Cover.** Three helpful listings have been placed on the inside of the front and back covers. Abbreviations (formerly Appendix C) is an alphabetical list of commonly encountered medical abbreviations, and it has been expanded for the sixth edition. Eponyms Used in This Text

(formerly Appendix D) is an alphabetical list of commonly encountered eponyms and the corresponding current terminology. (Eponyms are cited in the text in parentheses immediately following the preferred current terms.) Terms Used in Prescription Writing is entirely new, and consists of a listing of abbreviations, derivations, and English equivalents.

**15. Glossaries.** Two glossaries appear at the end of the book. The first deals with combining forms, prefixes, and suffixes. The second is a comprehensive glossary of terms. Both have been greatly updated and expanded.

**16. Selected Readings.** All new lists have been prepared for the sixth edition, and they now appear at the end of each chapter.

## SUPPLEMENTS

The following supplementary items are available to accompany the sixth edition of *Principles of Anatomy and Physiology*:

**1. Instructor's Manual.** A new and considerably revised Instructor's Manual by Judith Lanum Mohan of Case Western Reserve University has been prepared for the sixth edition. Each chapter contains a chapter synopsis, a list of major concepts, a set of suggested activities, a discussion of clinical applications, suggestions for supplementary lecture material, a set of problem-solving essay questions for students, and lists of audiovisual aids. A set of student self-test questions is also included.

**2. Transparencies.** One hundred forty full-color transparencies will be available. The set contains illustrations that come from the text and were selected because they are frequently discussed in class.

**3. Slides.** Two sets totaling two hundred forty full-color slides are available for those professors who do not wish to use transparencies; 140 slides are from the text, and the remaining 100 are cadaver slides from Gosling et al., *Atlas of Human Anatomy*.

**4. Test Bank.** An entirely new Test Bank has been prepared for the sixth edition by John Dustman of Indiana University Northwest. This expanded Test Bank contains 3000 questions in a variety of formats (true-false, multiple-choice, completion, matching, and essay). The Test Bank is available in standard printed format as well as on Harper Test (a microcomputer-based test generator for the IBM PC, Apple II series, and Macintosh computers).

**5. Learning Guide.** By Kathleen S. Prezbindowski and Gerard J. Tortora, the *Learning Guide* is designed to help students learn anatomy and physiology. At the start of each chapter a *framework* permits students to visualize relationships among key concepts and terms. It is designed for both an introduction and a review of the chapter content. The framework provides a one-page synthesis of the chapter. It allows students to see "the forest," complete and organized, and also "the trees" (key terms). *Wordbytes* introduce prefixes, suffixes, and word roots

of key terms. *Checkpoints* do not simply ask for repetition of text material, but challenge students to check progress as they handle new information in a variety of learning activities: labeling and coloring diagrams, placing physiological events in sequence, filling in paragraphs, matching, and multiple choice. *Clinical challenges* present students with opportunities for application of content. To enhance the effectiveness of the exercises, answers are provided for key-concept exercises so that the student has immediate feedback. A Mastery Test at the end of each chapter provides the student with a means of evaluating his or her learning of the chapter material and also gives practice for classroom testing situations.

**6. Atlas of Human Anatomy with Integrated Text** by J. A. Gosling et al. With a unique combination of photographs of cadaver dissections, accompanying diagrams and concise text, this volume provides the student with a better understanding of human anatomy.

**7. Slide Atlas of Human Anatomy.** Based on the material in the *Atlas of Human Anatomy with Integrated Text*, this collection of 506 slides includes every photograph from the text.

**8. Laboratory Manuals.** A laboratory manual with cat dissections by Patricia J. Donnelly and George A. Wistreich is available for students to purchase. Included in the manual are comparisons to the human body and full-color cadaver photographs. Another laboratory manual, written by Victor Eroschenko, features the cadaver. It is ideally suited for allied-health science students. Illustrations are taken from the text and show the student various structures in greater detail. An Instructor's Manual to accompany *Laboratory Manual for Anatomy and Physiology: With Cat Dissections* is available.

**9. Medical Terminology: An Illustrated Guide** by Barbara J. Cohen of Delaware County Community College. Provides students with a solid command of medical language. Suitable as a classroom text or self-study workbook, *Medical Terminology* is easy to read, inviting, concise, and attractive. Basic terminology is organized by body systems. Each chapter has a brief overview of the system, illustrations, an introduction of pertinent word parts with examples of their use, and numerous exercises. An Instructor's Manual to accompany Cohen's *Medical Terminology: An Illustrated Guide* is available. A printed Test Bank to accompany Cohen's *Medical Terminology: An Illustrated Guide* is also available.

**10. Software.** The following software packages are available for the IBM PC, Apple II series, Apple IIGs, and Macintosh computers. They include interactive tutorials, dissection simulations, and flashcards. Demonstration disks will be made available through your local representative should you wish to preview any of the programs.

**BIOSOURCE.** Four tutorial packages featuring a high degree of interaction, high-resolution graphics, and extensive multiple-choice testings on unprotected diskettes. These products include *Skeletal Muscle Anatomy and Physiology*, *Neuromuscular Concepts*, and *The Human Brain*. For the Apple II series and IBM.

**HOMEOSTASIS.** Focuses on the hypothalamus brain and the maintenance of the blood glucose level as it demonstrates

visually how body temperature is maintained. A self-tutorial that tests the students' understanding of the material and leads them through simple experiments is included. For the Apple II series and IBM PC computers.

**BODY LANGUAGE.** A drill program designed to help students identify and name anatomical structures. Both matching and spelling drills are included for approximately 200 anatomical diagrams covering the major body systems. For the Apple II, Apple IIgs, and IBM PC computers.

**ANATOMIST.** Based on *The Anatomy Coloring Book*, this Hypercard tutorial incorporates audio pronunciations as well as in-depth discussions of each body region and system. The *Anatomist* also emphasizes the interrelation between parts and enables the students to "navigate" through various regions of the bodily functions. For the Apple Macintosh.

**HYPERCARD STACKS FOR ANATOMY AND PHYSIOLOGY.** Both a tutorial and a simulation, each organ stack includes textual material, graphics, and animation. By using the concept of hypertext, students may study the topics in any order they wish. A self-test of multiple-choice questions follows each topic. For the Apple Macintosh computer.

**COMPUTER SIMULATION FOR THE LABORATORY.** Also consisting of Hypercard stacks, this software is based on *Laboratory Manual for Anatomy and Physiology with Cat Dissections*, Third Edition, by Patricia J. Donnelly and George A. Wistreich. Each stack investigates anatomical structures and allows the students to explore the organization of the body through cat dissection simulations. For the Apple Macintosh computer.

**FLASH!.** Encourages students to learn vocabulary through comprehensive testing of both terms and definitions. The terms are organized around *Principles of Anatomy and Physiology*, Sixth Edition, so that students can quiz themselves after each chapter. For the Apple II series and IBM PC computers.

**SENSORY AND MOTOR BRAIN.** A tutorial dealing with the cerebral cortex. The cat brain is used to show the response of the animal to stimulation. For the Apple II series and IBM PC.

**11. Coloring Books.** For student purchase, these coloring books are available:

- The Anatomy Coloring Book, by W. Kapit and L. Elson
- The Physiology Coloring Book, by W. Kapit, R. Macey, and E. Meisami
- The Human Brain Coloring Book, by M. Diamond, A. Scheibel, and L. Elson

**12. Interactive Videos.** An interactive video package, *Laser Touch Anatomy*, developed at Cuyahoga Community College, has been developed for student use. Five tutorials are provided for each section: general tutorial, fill-in-the-blank quiz, touch-screen quiz, vocabulary building exercises, and hear and spell exercises. Equipment requirements include an IBM PC/XT with 360-ICB floppy disk, 512-kB Memory, 20-MB hard-disk drive, serial port, laser disk player, and a touch-screen monitor

**13. Cadaver Dissection Videos.** A series of three videos introducing the student to the circulatory, muscular, and nervous systems of the body. Cadaver dissection illustrations

from the book and animation are used to enhance the student's understanding of the human body.

**14. Media Policy.** Per Harper & Row's media policy for adopters, the following videos are available:

- The New Womb
- Windows on the Body
- Generation to Generation: Genetic Screening, Counseling, and Therapy
- Blood: The Vital Humor
- To Hear a Pin Drop

**15. Grades.** A new program from Harper & Row that enables you to use your personal computer to enter and store students' quiz, test, and exam scores. You can also calculate intermediate and final grades using either point on percentage scores For the IBM PC or compatible personal computers.

**16. Gross Anatomy Tutorial.** This package of 9 disks provides a comprehensive review of anatomy for your students. EGA graphics are used, and many of the illustrations have been taken from *Principles of Anatomy and Physiology*, Sixth Edition. The software package will also drive some of the new videodisks available.

**17. Integrator.** This supplement has been designed to help professors organize assignments and lectures around the entire ancillary package. For every chapter in the book, the *Integrator* identifies similar materials that can be drawn from the supplements to enhance the student's understanding of the subject.

For further information on the supplement package to accompany *Principles of Anatomy and Physiology*, Sixth Edition, please contact your local representative or:

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the knowledge that so many have benefitted from using it has provided an even greater reward. My deepest thanks go to all of you, past, present, and future.

As the acknowledgements indicate, the participation of many individuals of diverse talent and expertise is required in the production of a textbook of this scope and complexity. For this reason, readers and users of the sixth edition are invited to send their reactions and suggestions

to me so that plans can be formulated for subsequent editions.

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## NOTE TO THE STUDENT

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At the beginning of each chapter is a listing of **Student Objectives**. Before you read the chapter, please read the objectives carefully. Each objective is a statement of a skill or knowledge that you should acquire. To meet these objectives, you will have to perform several activities. Obviously, you must read the chapter carefully. If there are sections of the chapter that you do not understand after one reading, you should reread those sections before continuing. In conjunction with your reading, pay particular attention to the figures and exhibits; they have been carefully coordinated with the textual narrative.

At the end of each chapter are two and sometimes three other learning guides that you may find useful. The first, **Study Outline**, is a concise summary of important topics discussed in the chapter. This section is designed to consolidate the essential points covered in the chapter, so that you may recall and relate them to one another. The second guide, **Review Questions**, is a series of questions designed specifically to help you master the objectives. A third aid, **Medical Terminology**, appears in some chapters. This is a listing of terms designed to build your medical vocabulary. After you have answered the review questions, you should return to the beginning of the chapter and reread the objectives to determine whether you have achieved the goals.

As a further aid, we have included pronunciations for many terms that may be new to you. These appear in parentheses immediately following the new words, and they are repeated in the Glossary of Terms at the back of the book. (Of course, since there will always be some conflict among medical personnel and dictionaries about pronunciation, you will come across variations in different sources.) Look at the words carefully and say them out loud several times. Learning to pronounce a new word will help you remember it and make it a useful part of

your medical vocabulary. Take a few minutes now to read the following pronunciation key, so it will be familiar as you encounter new words. The key is repeated at the beginning of the Glossary of Terms.

### PRONUNCIATION KEY

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1. The strongest accented syllable appears in capital letters, for example, bilateral (bī-LAT-er-al) and diagnosis (dī-ag-NŌ-sis).

2. If there is a secondary accent, it is noted by a single quote mark ('), for example, constitution (kon'-sti-TOO-shun) and physiology (fiz'-ē-OL-ō-jē). Any additional secondary accents are also noted by a single quote mark, for example, decarboxylation (dē'-kar-bok'-si-LĀ-shun).

3. Vowels marked with a line above the letter are pronounced with the long sound as in the following common words:

ā as in *māke*

ē as in *bē*

ī as in *ivy*

ō as in *pōle*

4. Vowels not so marked are pronounced with the short sound as in the following words:

e as in *bet*

i as in *sip*

o as in *not*

u as in *bud*

5. Other phonetic symbols are used to indicate the following sounds:

a as in *above*

oo as in *sue*

yoo as in *cute*

oy as in *oil*

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