# Preface

While the fifth edition of *Concepts of Human Anatomy and Physiology* has taken on a fresh, new look and has changed in other significant ways, we have made every effort to retain those features that have contributed to the great popularity of this text over the years. Of major importance, the fifth edition is consistent with previous editions in its focus on unifying concepts as a means of integrating factual information. Just as importantly, a clear and interesting narrative, carefully rendered and attractive illustrations, and numerous pedagogical devices continue to be central in enabling students to assimilate a large body of information and to place what they have learned in a meaningful context.

As in previous editions, the material is organized so that instructors may tailor required text readings to their individual course needs. Because the text is designed for students who do not have extensive science backgrounds but who plan to enter health or other careers that require considerable knowledge of anatomy and physiology, the chapters in the opening unit present basic chemical, cellular, biological, and anatomical concepts. The chapters in the remaining four units then take a detailed approach to the anatomy and physiology of organs and systems. Throughout the text, we continue to promote the view of anatomy and physiology as dynamic sciences that serve as foundations for the health professions.

Having said this, we have no doubt that the fifth edition is the strongest by far. We are confident that it can be of immense value in helping students achieve learning objectives, in fostering in them a love of and respect for the science of human anatomy and physiology, and in persuading them to continue in the field.

## What's New, Revised, or Improved

Followers of previous editions will quickly note the major physical improvements in the fifth edition. We have also added new material in light of recent scientific findings, taking care to connect new developments to basic principles. Listed below are some of the major fifth-edition changes.

### New Content

A great deal of new information has been incorporated into this edition. These include the following changes:

*Some of the New Topics Added*

- Skin cancer
- ICE proteins
- Telomeres and telomerase
- Peroxisomes
- Aquaporins
- Serotonin and neuropeptide Y as neurotransmitters
- Nicotinic ACh receptors in brain
- Retrograde dendritic potentials
- Thermal receptors and nociceptors
- Mesolimbic and nigrostriatal dopamine pathways
- Nuclear receptor proteins
- Tyrosine kinase second messenger system
- Adhesion molecules
- Dendritic cells as antigen presenters
- FAS and FAS ligand
- Function of the enterochromaffin-like (ECL) cells of the gastric mucosa
- Guanylin and uroguanylin
- Retinoic acid nuclear receptors
- Adipose tissue physiology
- Leptin and its actions
- Obesity
- Brown fat and $\beta_3$-adrenergic receptors
- Effect of weightlessness on calcium balance and bones
- Male contraception
- The human sexual response

*Some of the Revised Sections*

- Chemiosmotic presentation and number of ATP generated
- Symport and antiport concepts added to coupled transport discussion
- Voltage-gated ion channels
- Neurotransmitter release from axons
- Alzheimer's disease
- REM sleep, reticular formation, and medial temporal lobe
- Paracrine and autocrine regulators
- Cross-bridge cycle
- Muscle metabolism during exercise
- Cardiovascular adaptations to exercise
- Mechanisms of smooth muscle relaxation
- Functions of neutrophils
- Stem cell differentiation, with added discussion of cytokines
- Physiology of lymphatic vessels
- Frank–Starling law
- Capillary dynamics (Starling equilibrium)
- Hypertension and congestive heart failure
- Nonspecific immune recognition and function
- AIDS and AIDS treatments

- Central regulation of breathing
- Respiration during exercise
- Structure and function of the vasa recta
- ADH action and diabetes insipidus
- Atrial natriuretic peptide
- Regulation of gastric acid secretion
- Catecholamine regulation of metabolism
- Thyroxine regulation of metabolism
- Regulation of human parturition

*Some Expanded Topics*

- p53, with additional information about p21
- Dopaminergic receptors
- Physiology of taste, including role of gustducin
- Physiology of olfaction
- Effects of urea in concentrating the urine
- Benefits of breastfeeding the neonate
- Enteric nervous system
- Body weight homeostasis
- Nutrition and fatty acids
- Vitamins
- Regulation of eating
- Cholecystokinin physiology
- Mast cell function
- Regulation of insulin secretion and mode of insulin action
- Treatment for diabetes mellitus
- Regulation of peristaltic contractions

## New Clinical Investigations

Case Studies appear at the beginning of most of the chapters. These hypothetical situations are indicative of the type of clinical material that will be presented in the chapters. The solution to the case study is presented at the end of the chapter following the last major section.

## New Critical Thinking Questions

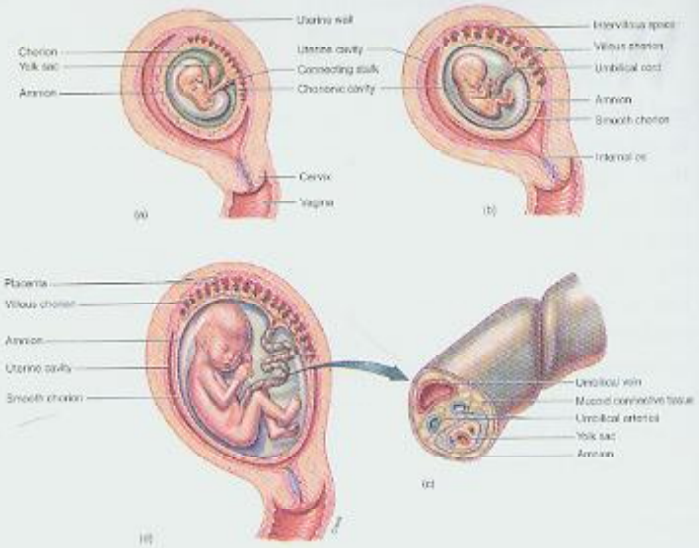
Following each chapter summary, sets of objective, essay and critical thinking questions give students the opportunity to obtain feedback as to the depth of their understanding and learning. They challenge students to use the chapter information in novel ways toward the solution of practical problems. The correct responses to the objective questions are provided in Appendix A (page 985).

## New and Revised Illustrations

An already outstanding illustration program has been greatly improved in this edition, which features nearly 40% new or revised illustrations. The figure legends have been modified to enhance the identification of a figure and improve the readability of the legend.

**Figure 30.16**

**The formation of the umbilical cord and other extraembryonic structures.**
These structures are depicted in sagittal sections of a gravid uterus from week 4 to week 22. (a) A connecting stalk forms as the developing amnion expands around the embryo, finally meeting ventrally. (b) The umbilical cord begins to take form as the amnion ensheathes the yolk sac. (c) A cross section of the umbilical cord showing the embryonic vessels, mucoid connective tissue, and the tubular connection to the yolk sac. (d) By week 22, the amnion and chorion have fused, and the umbilical cord and placenta have become well-developed structures.




## NEXUS

Toward the end of each chapter, or group of chapters, on a particular body system, newly designed and revised interrelationship charts, called NEXUS, tie the functional aspects of one body system to each of the other systems, underscoring the concept of homeostasis. Each listed interaction has a page reference in blue for students to read for additional information. This is analogous to the hyperlinks of an Internet web page, and can be used in a similar manner to pursue related concepts of interest.


NEXUS

*Some Interactions of Metabolism Concepts with the Other Body Systems*

## New Design

A conscious effort has been made to make this book more readable with a fresh, clean design with fewer interruptions in the narrative.

## Under Development

Near the end of most system chapters is a discussion that includes exhibits and explanations of the morphogenic events involved in the development of a body system. Placement near the end of a chapter ensures that the terminology needed to understand the embryonic structures has been introduced. In a few chapters, an Under Development feature follows the relevant discussion of a specific body part or region; this occurs, for example, in sections on the skull, brain and spinal cord, ear and eye, and pituitary gland.

## A More Personal Approach

It has been our experience that beginning students in anatomy and physiology are often intimidated by a very formal, academic writing style. In this edition, the language has been relaxed to engage the reader and make learning more enjoyable. Simple analogies are frequently used to promote understanding of concepts. The level of difficulty has been carefully controlled, recognizing the wide variation in motivation and background that typifies a broad spectrum of students.

# Learning Aids: A Guide to the Student

The pedagogical devices in this text are designed to help you learn anatomy and physiology. Don't just read this text as you would a novel. Interact with it, using the pedagogical devices as tools. The more you use these tools, the more effective and enjoyable your study will become.

## Chapter Introductions

The opening page of each chapter contains an overview of the contents of the chapter in outline form. Page numbers are indicated to guide you to the major sections. Learning objectives are also included, and should be checked both before and after studying each section of a chapter.

## Concept Statements

One of the unique attributes of this text is the way in which major sections are introduced. Each of these sections is prefaced by a concept statement—a succinct expression of the main idea presented in the section. These concept statements will help you gain an overview before encountering the details.

## Terminology Aids

The first time each technical term appears in the narrative, it is set off by boldface or italic type and is often followed by a phonetic pronunciation in parentheses. In this fifth edition, many new phonetic pronunciations have been added.

## Word Derivations

The derivations of many terms are provided in footnotes at the bottom of the page on which the terms are introduced. Don't skip over these footnotes; they are often interesting in themselves. Furthermore, if you know how a word was derived, it becomes more meaningful and is easier to remember. You can identify the roots of each term by referring to the glossary of prefixes and suffixes on the inside front cover of the text.

## Clinical Applications

Set off from the text narrative are short paragraphs highlighted by accompanying topic icons. This interesting information is relevant to the discussion that precedes it, but more importantly, it demonstrates how basic scientific knowledge is applied. New clinical applications—some of topical interest—have been added to the fifth edition, and others have been updated. The two icons used are as follows:

Clinical information is indicated by a stethoscope. These sections explore selected medical applications of the preceeding anatomical and physiological concepts.

Exercise physiology is indicated by a bicycle wheel. These sections explore how the preceeding anatomical and physiological concepts can be applied to understanding the physiology of exercise.

## Illustrations

Because anatomy is a descriptive science, great care has been taken to provide an outstanding illustration program that maximizes students' learning. These illustrations represent a collaborative effort between author and illustrator, often involving dissection of cadavers to ensure accuracy. In addition to being aesthetically pleasing, each illustration has been checked and rechecked for conceptual clarity and precision of the linework, labels, and caption. All of the figures are integrated with the text narrative, and most are original full-color art. In addition to the anatomical renderings, color graphics are used to clarify complex physiological processes. Light and scanning electron photomicrographs are also used where appropriate, and carefully selected photographs appear throughout the text. Color-coding is used in certain art sequences as a technique to aid learning. For example, the bones of the skull in chapter 9 are

color-coded so that each bone can be readily identified in the many renderings included in the chapter. In chapters 9, 10, and 11 on the skeletal system and articulations, new orientation diagrams have been added to highlight the location of specific bones and joints relative to the body as a whole or to a particular region of the body. Following chapter 13 is a set of reference plates, including photographs of human cadaver dissections and several full-page illustrations of the male and female trunk. The photographs of dissected human cadavers illustrate the complexity of structural relationships that can be fully appreciated only when seen in a human specimen. Elsewhere in the text, photographs of specific organs from cadavers are used to augment the illustrations.

This fifth edition features many new and revised physiology figures to accompany the new topics and updated discussions. We believe that, for such figures to be understandable and useful to the beginning student, they should be relatively simple. A complex, summary figure that incorporates a great deal of information may be brilliantly conceived and attractive to an instructor, but it is deadly to a beginning student who can be overwhelmed by the complexity. Therefore, in this text, each figure is designed to illustrate a single concept or to summarize only a limited number of concepts. In total, they present all of the information covered in the text, but they do so in digestible bites.

## Chapter Summaries

At the end of each chapter the material is summarized for you in outline form, following the sequence of the text narrative. Review each summary after studying the chapter to be sure that you have not missed any points. In addition, use the chapter summaries in preparing for examinations.

## Review Activities

A series of objective, essay questions, and new critical thinking questions provide you with feedback as to the depth of your learning and understanding. The answers to the objective questions are provided in Appendix A.

## Glossary

The glossary of terms at the end of the text has been updated and expanded, and continues to be particularly noteworthy for its comprehensiveness. Phonetic pronunciations are included for most of the terms, and an easy-to-use pronunciation guide appears at the beginning of the glossary. Synonyms, including eponymous terms, are indicated, and for some terms antonyms are given as well. The majority of the terms in the glossary are accompanied by a page number indicating where the term is discussed in the text narrative. (Adjectival terms and general terms are not page referenced.) Look to the glossary as you review to check your understanding of the technical terminology.

# Multimedia Correlations

This fifth edition introduces the Dynamic Human, Version 2.0, 3-D Visual Guide to Anatomy and Physiology CD-ROM, which interactively illustrates the complex relationships between anatomical structures and their functions in the human body. This program covers each body system, demonstrating clinical concepts, histology, and physiology. The Dynamic Human (dancing man) icon appears in appropriate figure legends to alert the reader to the corresponding information. A list of correlating figures to specific sections of The Dynamic Human, Version 2.0, follows this preface.

A set of five videotapes contains nearly 53 animations of physiological processes integral to the study of human anatomy and physiology. Entitled "WCB's Life Science Animation (LSA) Videotape Series," these videotapes cover such topics as cell division, genetics, and reproduction. A new LSA 3-D Videotape with 42 key biological processes is included in these correlations. Videotape icons appear in appropriate figure legends to alert the reader to these animations. A list of the figures that relate to the animations follows this preface.

# World Wide Web

*Concepts of Human Anatomy and Physiology* has a home page on the World Wide Web. The address is www.mhhe.com/biosci/abio, and is listed at the end of each chapter in a section called "Related Web Sites." At this home page, instructors and students can find up-to-date addresses and hot links to related sites for each chapter.

# Supplementary Materials

The supplementary materials that accompany the text are designed to help students in their learning activities and to guide instructors in planning course work and presentations. Following are brief descriptions of these supplements.

1. *Laboratory Manual to accompany Concepts of Human Anatomy and Physiology*, fifth edition (0–697–28428–X) by Kent M. Van De Graaff, Stuart Ira Fox, and Laurence G. Thouin, Jr., has been thoroughly revised. It can be brought to the laboratory and used as a stand-alone manual. It can also be used as a source of quiz and test questions, without recourse to the textbook. However, this manual is closely tied to the textbook, so that students can maximize their laboratory experience by studying the referenced portions of the textbook in conjunction with the laboratory exercises. The exercises have been carefully refined and updated to keep pace with continuous changes in laboratory technology, vendor supply sources, and address updates in computer-assisted instruction and biohazard health concerns.

2. *Instructor's Manual for the Laboratory Manual* (0–697–28429–8) by Laurence G. Thouin, Jr., provides the answers to the questions that appear in the laboratory reports in the Laboratory Manual.
3. *Student Study Guide* (0–697–28430–1) by Kent M. Van De Graaff features the concept statements from the text, focus questions, mastery quizzes, study activities, and answer keys with explanations.
4. *Instructor's Manual and Test Item File* (0–697–28427–1) by Jeffrey and Karianne Prince provides instructional support in the use of the textbook. It also contains a test item file with approximately 70 items for each chapter to aid instructors in creating examinations.
5. *MicroTest III* (0–697–28440–9 Macintosh or 0–697–28439–5 Windows) is a computerized test generator, available free to qualified adopters, which enables instructors to generate tests from questions in the Instructor's Manual.
6. *Visual Resource Library* (0–697–42202–X) is a CD-ROM containing all of the color line art in this textbook that can be incorporated into computer-assisted lecture presentations.
7. *Transparencies* (0–697–28431–X) include 200 color illustrations from this book reprinted as overhead lecture transparencies, packaged in a 3-ring binder.
8. *The Dynamic Human CD-ROM, Version 2.0* (0–697–38935–9) consists of 3-D and other visualizations of relationships between human structure and function.
9. *The Dynamic Human Videodisc* (0–697–38937–5) contains all of the CD-ROM animations, with a bar code directory.
10. *Virtual Physiology Lab CD-ROM* (0–697–37994–9) has 10 simulations of animal-based experiments common in the physiology component of a laboratory course; allows students to repeat experiments for improved mastery.
11. *WCB Anatomy and Physiology Videodisc* (0–697–27716–X) has more than 30 physiological animations, line art, and photomicrographs, with a bar code directory.
12. *WCB's Life Science Animations (LSA)* contains 53 animations on VHS videocassettes; Chemistry, The Cell, and Energetics (0–697–25068–7); Cell Division, Heredity, Genetics, Reproduction, and Development (0–697–25069–5); Animal Biology No. 1 (0–697–25070–9); Animal Biology No. 2 (0–697–25071–7); and Plant Biology, Evolution, and Ecology (0–697–26600–1). Another available videotape is Physiological Concepts of Life Science (0–697–21512–1). A new 3-D videotape (0–07–290652–9) is also available with 42 key biological processes all narrated and animated in vibrant color with dynamic three-dimensional graphics.
13. *WCB Anatomy and Physiology Videotape Series* consists of four videotapes, free to qualified adopters, including Blood Cell Counting, Identification and Grouping (0–697–11629–8); Introduction to the Human Cadaver and Prosection (0–697–11177–6); Introduction to Cat Dissection: Cat Musculature (0–697–11630–1); and Internal Organs and Circulatory System of the Cat (0–697–13922–0).
14. *Human Anatomy and Physiology Study Cards*, third edition (0–697–26447–5) by Kent Van De Graaff, Ward Rhees, and Christopher Creek is a boxed set of 300 illustrated cards (3 × 5 in.), each of which concisely summarizes a concept of structure or function, defines a term, and provides a concise table of related information.
15. *Coloring Guide to Anatomy and Physiology* (0–697–17109–4) by Robert and Judith Stone consists of outline drawings and text that emphasize learning through color association. Students retain information through a meditative exercise in color-coding structures and correlated labels. This can be an especially effective aid for students who more easily remember visual concepts than verbal ones.
16. *An Atlas to Human Anatomy* (0–697–38793–3) by Dennis Strete and Christopher Creek is a new full-color atlas that contains over 200 full-color photographs and over 150 black-and-white illustrations that accompany and portray the necessary detail of human anatomy.
17. *Atlas of the Skeletal Muscles*, second edition (0–697–13790–2) by Robert and Judith Stone illustrates each skeletal muscle in a diagram that the student can color, and provides a concise table of the origin, insertion, action, and innervation of each muscle.
18. *Laboratory Atlas of Anatomy and Physiology*, second edition (0–697–39480–8) by Douglas Eder et al. is a full-color atlas containing histology, human skeletal anatomy, human muscular anatomy, dissections, and reference tables.
19. *Case Histories in Human Physiology*, third edition (0–697–34234–4) by Donna Van Wynsberghe and Gregory Cooley is a web-based workbook that stimulates analytical thinking through case studies and problem solving; includes an instructor's answer key.
20. *Explorations in Human Biology CD-ROM* (0–697–37907–8 Macintosh and 0–697–37906–X Windows) by George Johnson consists of 16 interactive animations of human biology.
21. *Explorations in Cell Biology and Genetics CD-ROM* (0–697–37908–6) by George Johnson contains 17 animations that afford an engrossing way for students to delve into these often-challenging topics.
22. *Life Science Living Lexicon CD-ROM* (0–697–37993–0) by William Marchuk provides interactive vocabulary-

building exercises. It includes the meanings of word roots, prefixes, and suffixes with illustrations and audio pronunciations.

23. *Survey of Infectious and Parasitic Diseases* (0–697–27535–3) by Kent Van De Graaff is a booklet of essential information on 100 of the most significant infectious diseases.

## Acknowledgments

This book could not have been written without the enduring patience and support of our wives, Karen Van De Graaff and Ellen Fox, to whom this book is gratefully dedicated.

Many of the improvements in the fifth edition of *Concepts of Human Anatomy and Physiology* came about through comments that we received from the many users of previous editions. Although it would be impossible in this space to acknowledge them individually, we are deeply grateful to each one. As in the past, our colleagues at our respective institutions were very supportive and helpful. In particular, we would like to thank Michael J. Shively, Laurence G. Thouin, Jr., R. Ward Rhees, James Rikel, Samuel I. Zeveloff, and J. Ronald Galli.

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### Reviewers

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## Life Science 3D Animations Correlation Guide

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| 2.5 | Module 1 | Atomic Structure and Covalent and Ionic Bonding |
| 2.8 | Module 1 | Atomic Structure and Covalent and Ionic Bonding |

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| 3.19 | Module 18 | Transcription |
| 3.22 | Module 18 | Transcription |
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| 3.28 | Module 14 | DNA Replication |
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## Life Science Animations Correlation Guide

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| 19.5 | Tape 6 | Concept 10 | Action of Steroid Hormone on Target Cells |
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**Chapter 20**

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**Chapter 21**

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