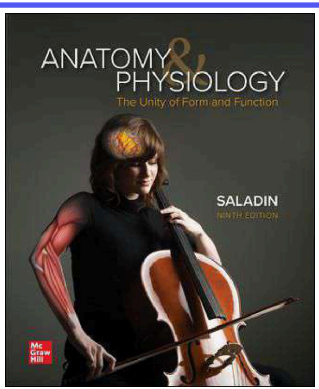


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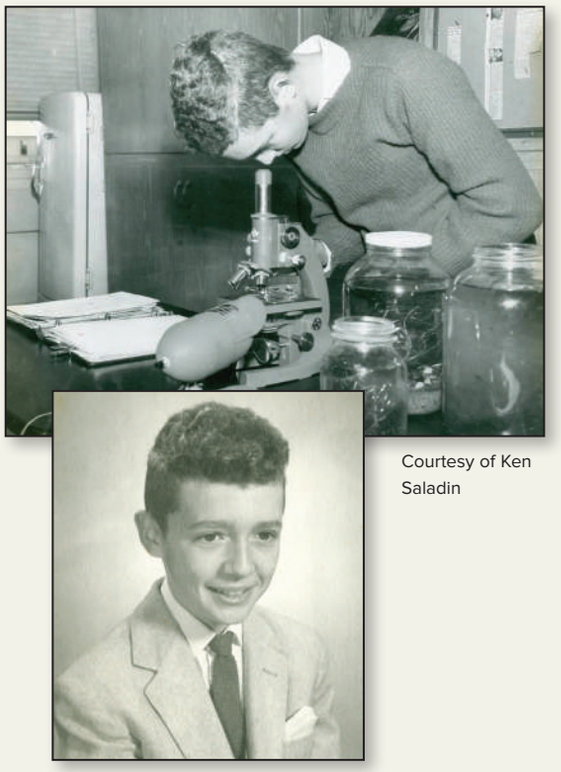
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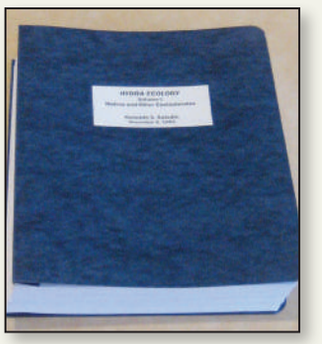
Courtesy of Ken Saladin

Ken in 1964

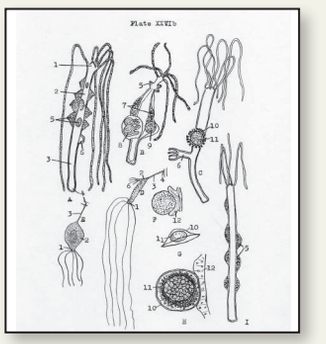
Ken Saladin's first step into authoring was a 318-page paper on the ecology of hydras written for his tenth-grade biology class. With his "first book," featuring 53 original India ink drawings and photomicrographs, a true storyteller was born.

When I first became a textbook writer, I found myself bringing the same enjoyment of writing and illustrating to this book that I first discovered when I was 15.

—Ken Saladin

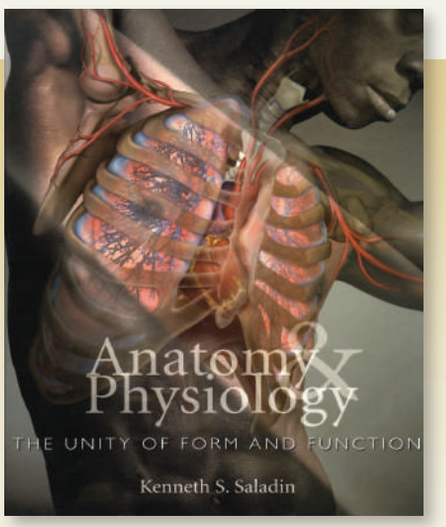


Ken's "first book," *Hydra Ecology,* 1965
Courtesy of Ken Saladin

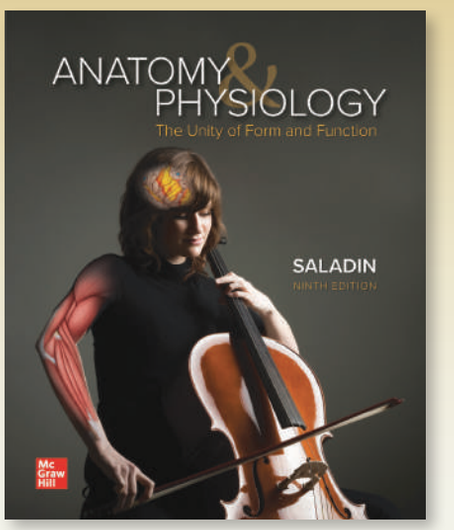


One of Ken's drawings from *Hydra Ecology*
Courtesy of Ken Saladin

Ken began working on his first book for McGraw-Hill in 1993, and in 1997 the first edition of *The Unity of Form and Function* was published. In 2020, the story continues with the ninth edition of Ken's best-selling A&P textbook.



The first edition (1997)



The story continues (2020)

PREFACE

Anatomy & Physiology: The Unity of Form and Function tells a story comprised of many layers, including core science, clinical applications, the history of medicine, and the evolution of the human body. Saladin combines this humanistic perspective on anatomy and physiology with vibrant photos and art to convey the beauty and excitement of the subject to beginning students.

To help students manage the tremendous amount of information in this introductory course, the narrative is broken into short segments, each framed by expected learning outcomes and self-testing review questions. This presentation strategy works as a whole to create a more efficient and effective way for students to learn A&P.

Writing Style and Level

Saladin's text is written using plain language for A&P students who may be taking this course early in their curricula. Careful attention has been given to word selection and paragraph structure to maintain the appropriate writing level for all students.

CHANGES TO THE NINTH EDITION

New Science

This edition draws on recent literature and scientific conferences attended by the author to update many topics, including but not limited to molecular, vascular, and brain imaging techniques; peroxisome and mitochondrial behavior; the DNA damage response; gene regulation; epigenetics; the tissue interstitium; regenerative medicine; osteoporosis; prosthetic joints; fibromyalgia; sleep physiology; trigeminal neuralgia; pain physiology; endocrine functions of osseous and adipose tissue; diabetes mellitus; cord blood transplants; thrombopoiesis; AIDS; prostate diseases; breast cancer; aging; life expectancy; and assisted reproductive technology.

New Deeper Insight sidebar essays have been added on cardiac tamponade; biopsy; stem-cell therapy; regenerative medicine; osteomalacia and rickets; vertebral disc herniation; rotator cuff injury; carpal tunnel syndrome; shinsplints; calcaneal tendon rupture; plantar fasciitis; brain connectomics and diffusion tensor imaging; lumbar puncture; stroke; blindness; alcoholic ascites; diverticulosis and diverticulitis; colorectal cancer; and cleft lip and palate.

While new science has been added, keeping up with such growth also means pruning back topics discredited by newer literature. For this edition, these include adult cerebral neurogenesis; endorphins and runner's high; human pheromones; pineal tumors and precocial puberty; prophylactic use of low-dose aspirin; myocardial regeneration; female ejaculation; and the free-radical DNA damage theory of senescence.

In consideration of user and reviewer suggestions to reduce detail in a few areas, this edition has more concise discussions of some topics: chromatin coiling; apoptosis; skin grafting; the hair cycle; calcium and phosphate homeostasis; and spinal cord tracts.

New Art and Photography

This edition features new drawings of epidermal histology, flat bone structure, lever mechanics, Parkinson disease, lumbar puncture, hand innervation, Bell palsy, the vagus nerve, olfactory pathways, erythropoiesis, cardiac innervation, regulation of cardiac output, air embolism, colonic histology, lipoprotein structure, cleft lip and palate, and senescent muscle atrophy.

New photos in this edition include digital subtraction angiography, molecular-scale cryo-EM imaging, diabetic gangrene, embryonic stem cells, albinism, jaundice, osteocyte SEM, rickets, muscle fiber histochemistry, diffusion tensor imaging of the brain connectome, shingles, cataracts, glaucoma, forelimb veins used for phlebotomy, kidney stones, gallstones, hepatic cirrhosis, MRI of obesity, and intracytoplasmic sperm injection.

Organizational Changes

For improved readability, narrative descriptions of some systems are moved from tables into chapter text; selected illustrations are moved outside of the tables; and tables are distilled to more concise summaries. These include the skeletal muscles (chapter 10), spinal nerve plexuses (chapter 13), cranial nerves (chapter 14), and blood vessels (chapter 20). A detailed list of changes by chapter follows.

Detailed List of Changes

Chapter 1, Major Themes of Anatomy and Physiology, now includes digital subtraction angiography among the common clinical imaging techniques.

Atlas A, General Orientation to Human Anatomy, has an added Deeper Insight A.1 on cardiac tamponade in relation to body cavities and membranes.

Chapter 2, The Chemistry of Life, has added the Nobel-winning new technique of cryo-electron microscopic imaging of biological structure at the atomic level.

Chapter 3, Cellular Form and Function, has enhanced discussions of limitations on cell size, the origin of peroxisomes, mitochondrial fusion and fission, and clinical mitochondrial transfer and three-parent babies.

Chapter 4, Genes and Cellular Function, updates protein processing by the Golgi complex, epigenetics, the DNA damage response, and the role of the nuclear lamina in gene silencing.

Chapter 5, The Human Tissues, has a new perspective on the tissue interstitium, updates on stem-cell therapy and regenerative medicine, and a new Deeper Insight on biopsy methods.

Chapter 6, The Integumentary System, has a new drawing of epidermal histology, new discussion of the evolutionary genetics of apocrine glands, an update on skin-grafting technology, and a simpler description of the hair growth cycle.

Chapter 7, Bone Tissue, gives a less detailed overview of calcium and phosphate homeostasis, adds a Deeper Insight on osteomalacia and rickets, and updates the pathology and treatment of osteoporosis.

Chapter 8, The Skeletal System, conforms the description of normal and pathological spinal curvatures to orthopedic terminology and has a new Deeper Insight on herniated discs.

Chapter 9, Joints, improves the discussion of joint biomechanics and updates the discussions of temporomandibular joint dysfunction and engineering of prosthetic joints.

Chapter 10, The Muscular System, pulls illustrations and narrative descriptions from the muscle tables, converts the narrative to easier-to-read normal text, and condenses the tables to more concise summaries. It updates inguinal hernias and adds new Deeper Insights on rotator cuff injury, shinsplints, calcaneal tendon rupture, and plantar fasciitis.

Chapter 11, Muscular Tissue, adds a photo of the histochemistry of fast glycolytic and slow oxidative muscle fiber types and updates the discussion of fibromyalgia.

Chapter 12, Nervous Tissue, includes updates on astrocyte functions, beta-endorphin and enkephalin, mutations affecting neurotransmitter reuptake and neurological disorders, and the implication of lipofuscin in some diseases. It introduces the frontier neuroscience of brain connectomics and the use of diffusion tensor imaging to visualize the connectome. There is now an illustration of the midbrain histological change and body posture characteristic of Parkinson disease.

Chapter 13, The Spinal Cord, Spinal Nerves, and Somatic Reflexes, adds a new Deeper Insight and illustration of lumbar puncture, reduces detail on spinal cord tracts, reformats the tables of spinal nerve plexuses, illustrates regional innervation of the hand by the major forearm nerves, and adds a photo of a shingles lesion.

Chapter 14, The Brain and Cranial Nerves, now adopts the concept of brainstem as excluding the diencephalon. It adds Deeper Insights on stroke and diffusion tensor imaging, and updates the Deeper Insight on trigeminal neuralgia and Bell palsy, adding an illustration of the latter. It updates sleep physiology and the functions of the midbrain colliculi and pretectal nuclei. It corrects a common misconception about the subdural space. The discussion and table of cranial nerves are reorganized.

Chapter 16, Sense Organs, has an updated discussion of pain physiology and includes phantom limb pain. It updates the genetics and functions of some taste sensations and flawed assumptions about human olfactory sensitivity. It deletes discredited or dubious views of endorphins and runner's high and human pheromones. It enhances the figure of olfactory projection pathways; adds the dorsal and ventral streams of visual processing pathways; adds photos of cataracts and glaucoma; adds macular degeneration and diabetic retinopathy to the Deeper Insight on blindness; and has better insights into the functions of the cornea, choroid, and vitreous body.

Chapter 17, The Endocrine System, updates the histology and cytology of the thyroid gland and pancreatic islets and the effects of melatonin; adds new information on hormones of osseous and adipose origin; updates the enteroendocrine system; and adds effects of lipocalin 2 on insulin action. It deletes the now-questionable idea about pineal tumors and precocial puberty. It updates the pathologies of Addison disease and myxedema, and the genetic, immunological, and treatment aspects of diabetes mellitus.

Chapter 18, The Circulatory System: Blood, now explains how blood is fractionated to obtain plasma and then serum, and the uses of blood serum. It has an enhanced explanation of the functional significance of the discoidal shape of erythrocytes, and includes cell proliferation in the illustration of erythropoiesis. It reports updated clinical research on the number of known blood groups and RBC antigens, cord blood transplants, other methods of bone marrow replacement, and pharmaceutical anticoagulants. It adds the surprising new discovery of abundant platelet production by megakaryocytes in the lungs and megakaryocyte migration between the lungs and bone marrow.

Chapter 19, The Circulatory System: Heart, is reorganized at section 19.1 to place figures closer to their references. Cardiac innervation is moved to section 19.6 on regulation of cardiac output, with a new illustration. The electrocardiogram is described with more detailed attention to interpretation of each wave, segment, and interval, with an added table. The section on cardiac arrhythmias includes a fuller explanation of atrial fibrillation.

Chapter 20, The Circulatory System: Blood Vessels and Circulation, has improved discussions of the vasa vasorum and metarterioles; describes the measurement of blood pressure in more depth; adds photos of edema, circulatory shock, and upper limb veins most often used for phlebotomy; and has a new drawing of air embolism. It discusses the difficulty of pancreatic surgery in light of the complex, delicate branches of the celiac trunk. The Deeper Insight on ascites is rewritten to relate it to alcoholism. The tables of blood vessels and routes of flow are now converted to normal, easier-to-read text.

Chapter 21, The Lymphatic and Immune Systems, updates bone marrow histology; the sources of macrophages; T cell diversity; asthma and AIDS mortality; and the obstacles to treating AIDS in pandemic countries. It adds the risk in splenectomy and the role of ATP and ADP as inflammatory chemoattractants.

Chapter 22, The Respiratory System, enhances descriptions of the nasal epithelium; the cricothyroid ligament in relation to emergency tracheotomy; the Deeper Insight on tracheotomy; cor pulmonale; and squamous cell carcinoma. It adds a mutational cause of Ondine's curse; discovery of pulmonary platelet production; and the potential of electronic cigarettes and legalization of recreational marijuana as emerging risk factors for lung cancer.

Chapter 23, The Urinary System, adds to the function of glomerular mesangial cells and has an improved Deeper Insight on kidney stones, with a new photo.

Chapter 24, Fluid, Electrolyte, and Acid–Base Balance, has further information on sodium and the effects of hypernatremia, and has added a new table summarizing the major electrolyte imbalances.

Chapter 25, The Digestive System, includes additions on the immune role of the omenta; dental proprioception; aspirin and peptic ulcer; the cell-signaling function of the intestinal mucous coat; anatomical variability of the colon and a new drawing of its histology; an updated Deeper Insight on gallstones, with a photo; a new Deeper Insight on diverticulosis and diverticulitis; a new Deeper Insight on colorectal cancer; and an improved description of intestinal lymphatic nodules.

Chapter 26, Nutrition and Metabolism, includes new MRI images of a morbidly obese individual compared to one of normal BMI; a new drawing of lipoprotein structure and chart of composition of the lipoprotein classes; new information on the effects of leptin on sympathetic nerve fibers and lipolysis; and a new photo of hepatic cirrhosis.

Chapter 27, The Male Reproductive System, has a new table and discussion of the composition of semen and function of the bulbourethral preejaculatory fluid, and updates on benign prostatic hyperplasia and prostate cancer. It adds discussion of zinc deficiency as a cause of infertility, hypothalamic maturation and GnRH in relation to the onset of puberty, and andropause in relation to declining androgen secretion.

Chapter 28, The Female Reproductive System, has improvements in hymen anatomy and the figure of ovarian structure; a new perspective on morning sickness as a possible factor mitigating birth defects; and updates on contraception and on breast cancer genes, risk factors, and mortality.

Chapter 29, Human Development and Aging, adds the role of the sperm centrosome in fertilization; chromosomal defects as a leading cause of first-trimester miscarriages; and the formation of monozygotic twins. It adds a new Deeper Insight and illustration of cleft lip and palate. It updates the telomere theory of senescence but deletes the now-doubtful theory of DNA damage by endogenous free radicals. It adds a new, MRI-based drawing of muscle atrophy in old age and a discussion of pineal gland senescence as a factor in the insomnia experienced by some older people. It updates statistics on human life expectancy and the major causes of death. The final Deeper Insight is retitled Assisted Reproductive Technology and has a new photo of intracytoplasmic sperm injection.

Appendix D, The Genetic Code and Amino Acids, now adds a table of the 20 amino acids and their symbols, and the structural formulae of the amino acids.

ACKNOWLEDGMENTS

Peer review is a critical part of the scientific process, and very important to ensure the content in this book continues to meet the needs of the instructors and students who use it. We are grateful for the people who agree to participate in this process and thank them for their time, talents, and feedback. The reviewers of this text (listed here) have contributed significant comments that help us refine and update the print and digital components of this program.

Christina Gan and Heather Cushman have updated the question bank and test bank to closely correlate with the intricate changes made in this ninth edition and have greatly increased the educational value of these books through their work to create self-assessment tools and align McGraw-Hill's Connect resources with the textbook. This has contributed significantly to student and instructor satisfaction with our overall package of learning media and to the students' success as they master A&P en route to their career aspirations.

I would also like to extend appreciation to members of the Life Sciences Book Team at McGraw-Hill Education who have worked with me on this project, including Matthew Garcia, Senior Portfolio Manager; Valerie Kramer, Marketing Manager; Donna Nemmers, Senior Product Developer; Vicki Krug, Senior Content Project Manager; Lori Hancock, Lead Content Licensing Specialist; Brent dela Cruz, Senior Content Project Manager; Egzon Shaqiri, Designer; and Jeanne Patterson, freelance copy editor. Their efforts have yielded another great edition of the text and its companion media suite of Connect products.

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THE STORY OF

FORM AND FUNCTION

INNOVATIVE CHAPTER SEQUENCING

Some chapters and topics are presented in a sequence that is more instructive than the conventional order.

Early Presentation of Heredity

Fundamental principles of heredity are presented in the last few pages of chapter 4 rather than at the back of the book to better integrate molecular and Mendelian genetics. This organization also prepares students to learn about such genetic traits and conditions as cystic fibrosis, color blindness, blood types, hemophilia, cancer genes, and sickle-cell disease by first teaching them about dominant and recessive alleles, genotype and phenotype, and sex linkage.

Urinary System Presented Close to Circulatory and Respiratory Systems

Most textbooks place this system near the end of the book because of its anatomical and developmental relationships with the reproductive system. However, its physiological ties to the circulatory and respiratory systems are much more important. Except for a necessary digression on lymphatics and immunity, the circulatory system is followed almost immediately with the respiratory and urinary systems, which regulate blood composition and whose functional mechanisms rely on recently covered principles of blood flow and capillary exchange.

Muscle Anatomy and Physiology Follow Skeleton and Joints

The functional morphology of the skeleton, joints, and muscles is treated in three consecutive chapters, 8 through 10, so when students learn muscle attachments, these come only two chapters after the names of the relevant bone features. When they learn muscle actions, it is in the first chapter after learning the terms for the joint movements. This order brings another advantage: The physiology of muscle and nerve cells is treated in two consecutive chapters (11 and 12), which are thus closely integrated in their treatment of synapses, neurotransmitters, and membrane electrophysiology.

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