

Preface

Inspired by the thousands of students in our own classes over the years and by enthusiastic feedback from the many instructors who have used our book, we are delighted to present this new, Eighth Edition. We authors have worked together closely to ensure that both the book and the supplementary material online reflect the changing needs of today's courses and students, as well as current progress in biology. Titled *Campbell Biology: Concepts & Connections* to honor Neil Campbell's founding role and his many contributions to biology education, this book continues to have a dual purpose: to engage students from a wide variety of majors in the wonders of the living world and to show them how biology relates to their own existence and the world they inhabit. Most of these students will not become biologists themselves, but their lives will be touched by biology every day. Understanding the concepts of biology and their connections to our lives is more important than ever. Whether we're concerned with our own health or the health of our planet, a familiarity with biology is essential. This basic knowledge and an appreciation for how science works have become elements of good citizenship in an era when informed evaluations of health issues, environmental problems, and applications of new technology are critical.

Concepts and Connections

Concepts Biology is a vast subject that gets bigger every year, but an introductory biology course is still only one or two semesters long. This book was the first introductory biology textbook to use concept modules to help students recognize and focus on the main ideas of each chapter. The heading of each module is a carefully crafted statement of a key concept. For example, "A nerve signal begins as a change in the membrane potential" announces a key concept about the generation of an action potential (Module 28.4). Such a concept heading serves as a focal point, and the module's text and illustrations converge on that concept with explanation and, often, analogies. The module text walks the student through the illustrations, just as an instructor might do in class. And in teaching a sequential process, such as the one diagrammed in Figure 28.4, we number the steps in the text to correspond to numbered steps in the figure. The synergy between a module's narrative and graphic components transforms the concept heading into an idea with meaning to the student. The checkpoint question at the end of each module encourages students to test their understanding as they proceed through a chapter. Finally, in the Chapter Review, all the key concept statements are listed and briefly summarized under the overarching section titles, explicitly reminding students of what they've learned.

Connections Students are more motivated to study biology when they can connect it to their own lives and interests—for example, when they are able to relate science to health

issues, economic problems, environmental quality, ethical controversies, and social responsibility. In this edition, blue Connection icons mark the numerous application modules that go beyond the core biological concepts. For example, the new Connection Module 26.12 describes the potential role oxytocin plays in human–dog bonding. In addition, our Evolution Connection modules, identified by green icons, connect the content of each chapter to the grand unifying theme of evolution, without which the study of life has no coherence. Explicit connections are also made between the chapter introduction and either the Evolution Connection module or the new Scientific Thinking module in each chapter; new high-interest questions introduce each chapter, drawing students into the topic and encouraging a curiosity to explore the question further when it appears again later in the chapter.

New to This Edition

New Scientific Thinking Modules In this edition we placed greater emphasis on the process of scientific inquiry through the addition to each chapter of a new type of module called Scientific Thinking, which is called out with a purple icon. These modules cover recent scientific research as well as underscore the spirit of inquiry in historical discoveries. All Scientific Thinking modules strive to demonstrate to students what scientists do. Each of these modules identifies key attributes of scientific inquiry, from the forming and testing of hypotheses to the analysis of data to the evaluation and communication of scientific results among scientists and with society as a whole. For example, the new Module 2.15 describes how scientists use both controlled experiments and observational field studies to document the effects of rising atmospheric CO₂ on coral reef ecosystems. Module 13.3 describes the scientific search for the common ancestor of whales, using different lines of inquiry from early fossil clues, molecular comparisons, and a series of transitional fossils that link whales to cloven-hoofed mammals, animals that live on land. And to prepare students for the renewed focus in the book on how biological concepts emerge from the process of science, we have significantly revised the introduction in Chapter 1, Biology: Exploring Life. These changes will better equip students to think like scientists and emphasize the connections between discovery and the concepts explored throughout the course.

New Visualizing the Concept Modules Also new to this edition are modules that raise our hallmark art–text integration to a new level. These Visualizing the Concept modules take challenging concepts or processes and walk students through them in a highly visual manner, using engaging, attractive art; clear and concise labels; and instructor "hints" called out in light blue bubbles. These short hints emulate the one-on-one coaching an instructor might provide to a students during

office hours and help students make key connections within the figure. Examples of this new feature include Module 9.8, which demonstrates to students the process of reading and analyzing a family pedigree; Module 17.3, which introduces the concept of plant life cycles through a combination of photographs and detailed life cycle art displayed across an impressive two-page layout; and Module 26.8, which walks students through the concept of homeostatic controls in blood glucose levels.

New “Try This” Tips One theme of the revision for the Eighth Edition is to help all students learn positive study habits they can take with them throughout their college careers and, in particular, to encourage them to be active in their reading and studying. To foster good study habits, several figures in each chapter feature a new “Try This” study tip. These action-oriented statements or questions direct students to study a figure more closely and explain, interpret, or extend what the figure presents. For example, in Figure 3.13B, students are asked to “Point out the bonds and functional groups that make the R groups of these three amino acids either hydrophobic or hydrophilic.” Figure 6.10B is a new figure illustrating the molecular rotary motor ATP synthase, and the accompanying Try This tip asks students to “Identify the power source that runs this motor. Explain where this ‘power’ comes from.” Figure 36.7, on the effect of predation on the life history traits of guppies, offers the following Try This tip: “Use the figure to explain how the hypothesis was tested.”

Improvements to End-of-Chapter Section The Testing Your Knowledge questions are now arranged to reflect Bloom’s Taxonomy of cognitive domains. Questions and activities are grouped into Level 1: Knowledge/Comprehension, Level 2: Application/Analysis, and Level 3: Synthesis/Evaluation. In addition, a new Scientific Thinking question has been added to each chapter that connects to and extends the topic of the Scientific Thinking module. Throughout the Chapter Review, new questions have been added that will help students better engage with the chapter topic and practice higher-level problem solving.

New Design and Improved Art The fresh new design used throughout the chapters and the extensive reconceptualization of many figures make the book even more appealing and accessible to visual learners. The cellular art in Chapter 4, A Tour of the Cell, for example, has been completely reimaged for more depth perspective and richer color. The new big-picture diagrams of the animal and plant cells are vibrant and better demonstrate the spatial relationships among the cellular structures with an almost three-dimensional style. The illustrations of cellular organelles elsewhere in Chapter 4 include electron micrographs overlaid on diagrams to emphasize the connection between the realistic micrograph depiction and the artwork. Figure 4.9, for example, shows a micrograph of an actual Golgi apparatus paired with an illustration; an accompanying orientation diagram—a hallmark of *Concepts and Connections*—continues to act as a roadmap that reminds students of how an organelle fits within the overall cell structure. Finally, throughout the book we have

introduced new molecular art; for example, see Figure 10.11B for a new representation of a molecule of tRNA binding to an enzyme molecule.

The Latest Science Biology is a dynamic field of study, and we take pride in our book’s currency and scientific accuracy. For this edition, as in previous editions, we have integrated the results of the latest scientific research throughout the book. We have done this carefully and thoughtfully, recognizing that research advances can lead to new ways of looking at biological topics; such changes in perspective can necessitate organizational changes in our textbook to better reflect the current state of a field. You will find a unit-by-unit account of new content and organizational improvements in the “New Content” section on pp. xvii–xviii following this Preface.

New MasteringBiology® A specially developed version of MasteringBiology, the most widely used online tutorial and assessment program for biology, continues to accompany *Campbell Biology: Concepts & Connections*. In addition to 170 author-created activities that help students learn vocabulary, extend the book’s emphasis on visual learning, demonstrate the connections among key concepts (helping students grasp the big ideas), and coach students on how to interpret data, the Eighth Edition features two additional new activity types. New Scientific Thinking activities encourage students to practice the basic science skills explored in the in-text Scientific Thinking feature, allowing students to try out thinking like a scientist and allowing instructors to assess this understanding; new Visualizing the Concept activities take students on an animated and narrated tour of select Visualizing the Concept modules from the text, offering students the chance to review key concepts in a digital learning modality. MasteringBiology® for *Campbell Biology: Concepts & Connections*, Eighth Edition, will help students to see strong connections through their print textbook, and the additional practice available online allows instructors to capture powerful data on student performance, thereby making the most of class time.

This Book’s Flexibility

Although a biology textbook’s table of contents is by design linear, biology itself is more like a web of related concepts without a single starting point or prescribed path. Courses can navigate this network by starting with molecules, with ecology, or somewhere in between, and courses can omit topics. *Campbell Biology: Concepts & Connections* is uniquely suited to offer flexibility and thus serve a variety of courses. The seven units of the book are largely self-contained, and in a number of the units, chapters can be assigned in a different order without much loss of coherence. The use of numbered modules makes it easy to skip topics or reorder the presentation of material.

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For many students, introductory biology is the only science course that they will take during their college years. Long after today’s students have forgotten most of the specific

Unit IV, The Evolution of Biological Diversity The diversity unit surveys all life on Earth in less than a hundred pages! Consequently, descriptions and illustrations of the unifying characteristics of each major group of organisms, along with a small sample of its diversity, make up the bulk of the content. Two recurring elements are interwoven with these descriptions: evolutionary history and examples of relevance to our everyday lives and society at large. For the Eighth Edition, we have improved and updated those two elements. For example, Chapter 16, Microbial Life: Prokaryotes and Protists, opens with a new introduction on human microbiota and the question “Are antibiotics making us fat?” The related Scientific Thinking module (16.11) updates the story of Marshall’s discovery of the role of *Helicobacter pylori* in ulcers with a new hypothesis about a possible connection between *H. pylori* and obesity. A new chapter introduction and Scientific Thinking module in Chapter 17, The Evolution of Plant and Fungal Diversity, highlight the interdependence of plants and fungi. The alternation of generations and the life cycle in mosses and ferns are presented in an attractive two-page Visualizing the Concept module (17.3), while details of the pine life cycle have been replaced with a new Module 17.5 that emphasizes pollen and seeds as key adaptations for terrestrial life. The animal diversity chapters (18, The Evolution of Invertebrate Diversity; and 19, The Evolution of Vertebrate Diversity) also have new opening essays. A Visualizing the Concept module (18.3) beautifully illustrates features of the animal body plan. A new Module 18.16 calls attention to the value of invertebrate diversity. Chapter 19 includes a Visualizing the Concept module (19.9) on primate diversity and also updates the story of hominin evolution, including the recently described *Australopithecus sediba*.

Unit V, Animals: Form and Function This unit combines a comparative approach with an exploration of human anatomy and physiology. Many chapters begin with an overview of a general problem that animals face and a comparative discussion of how different animals address this problem, all framed within an evolutionary context. For example, the introduction to Chapter 20, Unifying Concepts of Animal Structure and Function, begins with the question “Does evolution lead to the perfect animal form?” Module 20.1 is a new Evolution Connection that discusses the long, looped laryngeal nerve in vertebrates (using the giraffe as an example) to illustrate that a structure in an ancestral organism can become adapted to function in a descendant organism without being “perfected,” thereby combating common student misconceptions about evolution. The main portion of every chapter is devoted to detailed presentations of human body systems, frequently illuminated by discussion of the health consequences of disorders in those systems. For example, Chapter 28, Nervous Systems, includes new material describing a genetic risk for developing Alzheimer’s disease, the long-term consequences of traumatic brain injury, and how some antidepressants may not be as effective at combating depression as once thought. In many areas, content has been updated to reflect

newer issues in biology. The chapter introduction and new Scientific Thinking module in Chapter 26, Hormones and the Endocrine System, discuss the consequences of endocrine disruptors in the environment. The Scientific Thinking module in Chapter 23 describes large clinical trials investigating the hypothesis that heart attacks are caused by the body’s inflammatory response. Chapter 27, Reproduction and Embryonic Development, has a new chapter introduction on viral STDs, improved figures presenting embryonic development, as well as a Visualizing the Concept module on human pregnancy. Improvements to this unit also include a significant revision to the presentation of nutrition in Modules 21.14 to 21.21 and a reorganization of text and art in Modules 25.6 and 25.7 to guide students through the anatomy and physiology of the kidneys.

Unit VI, Plants: Form and Function To help students gain an appreciation of the importance of plants, this unit presents the anatomy and physiology of angiosperms with frequent connections to the importance of plants to society. New Connections in this edition include an increased discussion of the importance of agriculture to human civilization (including presentation of genomic data investigating this question) in Chapter 31, issues surrounding organic farming (including presentation of data on the nutritional value of organic versus conventionally grown produce) in Chapter 32, an expanded discussion of phytoestrogens, as well as a new discussion on the production of seedless vegetables in Chapter 33. Throughout the unit, the text has been revised with the goal of making the material more engaging and accessible to students. For example, the difficult topic of transpiration is now presented in an entirely new, visual style within a Visualizing the Concept module (Module 32.3), and streamlined and simplified discussions were written for such topics as the auxin hormones and phytochromes. All of these changes are meant to make the point that human society is inexorably connected to the health of plants.

Unit VII, Ecology In this unit, students learn the fundamental principles of ecology and how these principles apply to environmental problems. Along with a new introduction in each chapter, the Eighth Edition features many new photos and two Visualizing the Concept modules (35.7 and 37.9)—one focuses on whether animal movement is a response to stimuli or requires spatial learning and the other explores the interconnection of food chains and food webs. Scientific Thinking modules sample the variety of approaches to studying ecology, including the classic field study that led to the concept of keystone species (37.11); the “natural experiment” of returning gray wolves to the Yellowstone ecosystem (38.11); and the combination of historical records, long-term experimentation, and modern technology to investigate the snowshoe hare–lynx population cycle (36.6). The pioneering work of Rachel Carson (34.2) and Jane Goodall (35.22) is also described in Scientific Thinking modules. Modules that present data on human population (36.3, 36.9–36.11), declining biodiversity (38.1), and global climate change (38.3, 38.4) have all been updated.