This eleventh edition of Solomon, Martin, Martin, and Berg's *Biology* conveys our vision of the dynamic science of biology and how it affects every aspect of our lives, from our own health and behavior to the challenging global environmental issues that confront us. New discoveries in the biological sciences continue to increase our understanding of both the unity and diversity of life's processes and adaptations. With this understanding, we become ever more aware of our interdependence with the vast diversity of organisms with which we share planet Earth.

Biology: The Student-Friendly Biology Textbook

We want beginning students to experience learning biology as an exciting journey of discovery. In the eleventh edition of *Biology*, we explore Earth's diverse organisms, their remarkable adaptations to the environment, and their evolutionary and ecological relationships. We present the workings of science and the contributions of scientists whose discoveries not only expand our knowledge of biology but also help shape and protect the future of our planet. *Biology* provides insight into what science is, how scientists work, what scientists have contributed, and how scientific knowledge affects daily life.

Since the first edition of *Biology*, we have worked very hard to present the principles of biology in an integrated way that is accurate, interesting, and conceptually accessible to students. In this eleventh edition of *Biology*, we continue this tradition. We also continue to present biology in an inquiry-based framework. Some professors interpret inquiry as a learning method that takes place in the laboratory as students perform experiments. While laboratory research is certainly an integral part of inquiry-based learning, inquiry is also a way of learning in which students actively pursue knowledge outside the laboratory. In *Biology*, we have always presented the history of scientific advances, including scientific debates, to help students understand that science is a process—that is, a field of investigative inquiry—as well as a body of knowledge, the product of inquiry. In the eleventh edition of *Biology*, we further integrate inquiry-based learning into the textbook, as discussed in the following sections.

Throughout the text, we stimulate interest by relating concepts to experiences within the student's frame of reference. By helping students make such connections, we facilitate their mastery of general concepts. The combined effect of an engaging writing style, interesting and exciting features, and our well-tested *Learning System* provides the ingredients for students to succeed in their study of biology.

The Solomon/Martin/Martin/Berg Learning System

In the eleventh edition, we have continued to refine our highly successful *Learning System*. This system provides the student with the learning strategies needed to integrate biological concepts and demonstrate mastery of these concepts. Learning biology is challenging because it requires learning many new terms and facts that must then be integrated into the framework of biological principles. To help students focus on important principles and concepts, we provide *Learning Outcomes* for the course and *Learning Objectives* for each major section of every chapter. At the end of each section, we provide *Checkpoint* questions based on the *Learning Objectives* so that students can assess their level of understanding of the material presented in the section. At the end of each chapter, we include a *Summary: Focus on Learning Objectives* that is organized around the *Learning Objectives* and emphasizes key terms in context. The *Summary* is followed by *Test Your Understanding*, a set of questions organized according to Bloom's taxonomy. Questions include *Know and Comprehend* multiple-choice exercises as well as a variety of questions that encourage the student to *Apply and Analyze* and *Evaluate and Synthesize* the topics in the chapter.

Students are directed to **www.cengagebrain.com**, a powerful online tool that offers access to *MindTap* and additional study materials. See the Resources for Students section of the Preface for details.

Pedagogical Features

Our *Learning System* includes numerous learning strategies that help students increase their success:

- Our updated *art program* reinforces concepts discussed in the text and presents complex processes in clear steps. *Key Experiment* figures emphasize the scientific process in both classic and modern research. These figures encourage students to evaluate investigative approaches that scientists have taken. Examples include Figures 4-12, 8-9, and 52-1. *Key Point* figures state important concepts in process diagrams of complex topics. Examples include Figures 4-11, 4-15, 27-2, 31-32, and 42-6. Many of the *Key Point* figures have numbered parts that show sequences of events in biological processes or life cycles.
- Numerous photographs, both alone and combined with line art, help students grasp concepts by connecting the "real" to the "ideal." The line art uses features such as *orientation icons* to help students put the detailed figures into the broader context. We use symbols and colors consistently throughout the book to help students connect

concepts. For example, the same four colors and shapes are used throughout the book to identify guanine, cytosine, adenine, and thymine. Similarly, the same colors are used consistently in illustrations and tables to indicate specific clades of organisms. *Research Method* figures describe why biologists use a particular method and explain how the method is executed. Examples include Figures 4-7 and 15-9.

- Many questions carry special designations: *Predict; Connect; Visualize; Evolution Link; Interpret Data;* or *Science, Technology, and Society*. These questions emphasize that learning is enhanced by many diverse approaches.
- *Inquiring About* boxes explore issues of special relevance to students, such as the effects of smoking, how traumatic experiences affect the body, and breast cancer. These boxes also provide a forum for discussing some interesting topics in more detail, such as the smallest ancient humans, ancient plants and coal formation, hydrothermal vent communities, declining amphibian populations, and stratospheric ozone depletion.
- A list of *Key Concepts* at the beginning of each chapter provides a chapter overview and helps the student focus on important principles discussed in the chapter.
- *Learning Objectives* at the beginning of each major section in the chapter indicate, in behavioral terms, what the student must do to demonstrate mastery of the material in that section.
- Each major section of the chapter is followed by a series of *Checkpoint* questions that assess comprehension by asking the student to describe, explain, compare, contrast, or illustrate important concepts. The *Checkpoint* questions are based on the section *Learning Objectives*.
- *Concept Statement Subheads* introduce sections, previewing and summarizing the key idea or ideas to be discussed in that section.
- *Sequence Summaries* within the text simplify and summarize information presented in paragraph form. For example, paragraphs describing blood circulation through the body or the steps by which cells take in certain materials are followed by a *Sequence Summary* listing the sequence of structures or steps.
- Numerous *tables*, many illustrated, help the student organize and summarize material presented in the text. Many tables are color-coded.
- A *Summary: Focus on Learning Objectives* at the end of each chapter is organized around the chapter *Learning Objectives*. This summary provides a review of the material, and because selected key terms are boldfaced in the summary, students learn vocabulary words within the context of related concepts.
- *Test Your Understanding* end-of-chapter questions are organized according to Bloom's taxonomy, providing students with the opportunity to evaluate their understanding of the material in the chapter. *Know and Comprehend* multiple-choice questions reinforce important terms and concepts. *Apply and Analyze* questions challenge students to integrate their knowledge. Higher-level *Evaluate and Synthesize* questions encourage students to apply the concepts just learned to new situations or to make connections among important concepts. Each chapter has one or more *Evolution Link* questions, and many chapters contain one or more *Interpret Data* questions that require students to actively interpret experimental data presented in the chapter. Also included are *Predict, Connect, Visualize,* and *Science, Technology, and Society* questions. Answers to the *Test Your Understanding* questions are provided in Appendix E online at **www.cengagebrain.com**.
- The *Glossary* at the end of the book, the most comprehensive glossary found in any biology text, provides precise definitions of terms. The *Glossary* is especially useful because it is extensively cross-referenced and includes pronunciations for many terms. The vertical yellow bar along the margin facilitates rapid access to the *Glossary*. *MindTap* also includes glossary flash cards with pronunciations.

Course Learning Outcomes

At the end of a successful study of introductory biology, the student can demonstrate mastery of biological concepts by responding accurately to the following *Course Learning Outcomes:*

- Design an experiment to test a given hypothesis, using the procedure and terminology of the scientific method.
- Cite the cell theory and relate the structure of organelles to their functions in both prokaryotic and eukaryotic cells.
- Describe the mechanisms of evolution, explain why evolution is the principal unifying concept in biology, and discuss natural selection as the primary agent of evolutionary change.
- Explain the role of genetic information in all species and discuss applications of genetics that affect society.
- Describe several mechanisms by which cells and organisms transfer information, including the use of nucleic acids in genetic transmission of information, signal transduction, chemical signals (such as hormones and pheromones), electrical signals (such as neural transmission), sounds, and visual displays.
- Provide examples (at various levels of complexity) of interactions among biological systems that illustrate the interdependence of these systems.
- Explain how any given structure is related to its function.
- Argue for or against the classification of organisms in three domains and several kingdoms or supergroups, characterizing each of these clades; based on your knowledge

of genetics and evolution, give specific examples of the unity and diversity of organisms in different domains and supergroups.
- Compare the structural adaptations, life processes, and life cycles of a prokaryote, protist, fungus, plant, and animal.
- Define *homeostasis* and give examples of regulatory mechanisms, including feedback systems.
- Trace the flow of matter and energy through a photosynthetic cell and a nonphotosynthetic cell and through the biosphere, comparing the roles of producers, consumers, and decomposers.
- Describe the study of ecology at the levels of an individual organism, a population, a community, and an ecosystem.

What's New: An Overview of *Biology*, Eleventh Edition

Five themes are interwoven throughout *Biology*: the evolution of life, the transmission of biological information, the flow of energy through living systems, interactions among biological systems, and the inter-relationship of structure and function. As we introduce the concepts of modern biology, we explain how these themes are connected and how life depends on them.

Educators present the major topics of an introductory biology course in a variety of orders. For this reason, we carefully designed the eight parts of this book so that they do not depend heavily on preceding chapters and parts. This flexible organization means that an instructor can present the 57 chapters in any number of sequences with pedagogical success. Chapter 1, which introduces the student to the major principles of biology, provides a comprehensive springboard for future discussions, whether the professor prefers a "top-down" or "bottom-up" approach.

In this edition as in previous editions, we examined every line of every chapter for accuracy and currency. We carefully updated each topic and verified new material. The following brief summary provides a general overview of the organization of *Biology* and some of the changes made to the eleventh edition.

Part 1 The Organization of Life

The six chapters that make up Part 1 provide basic principles of biology and the concepts of chemistry and cell biology that lay the foundation upon which the remaining parts of the book build. We begin Chapter 1 with a discussion of the promise and challenges of CRISPR research. We then introduce the main themes of the book: evolution, information transfer, energy transfer, interactions in biological systems, and the inter-relationship of structure and function. Chapter 1 examines several fundamental concepts in biology and the nature of the scientific process, including a discussion of systems biology. Chapters 2 and 3, which focus on the molecular level of organization, establish the foundations in chemistry necessary for understanding biological processes. Chapters 4, 5, and 6 focus on the cellular level of organization, including cell structure and function, cell membranes, and cell signaling. We emphasize the interdisciplinary nature of cell research. Topics discussed include transport between the nucleus and cytoplasm, routing of proteins through the endomembrane system, and cell communication.

Part 2 Energy Transfer through Living Systems

Because all living cells need energy for life processes, the flow of energy through living systems—that is, capturing energy and converting it to usable forms—is a basic theme of *Biology*. Chapter 7 examines how cells capture, transfer, store, and use energy. Chapters 8 and 9 discuss the metabolic adaptations by which organisms obtain and use energy through cellular respiration and photosynthesis.

Part 3 The Continuity of Life: Genetics

We have updated and expanded the eight chapters of Part 3 for the eleventh edition. We begin this unit by discussing mitosis and meiosis in Chapter 10. Chapter 11 builds on this foundation as it considers Mendelian genetics and related patterns of inheritance. We then turn our attention to the structure and replication of DNA in Chapter 12. The discussion of RNA and protein synthesis in Chapter 13 includes insights into how the small percentage of DNA that codes for polypeptides relates to the much larger percentage of the genome that is expressed. We provide information establishing that much of the genome encodes different classes of non-protein-coding RNAs, including microRNAs and long non-coding RNAs. The regulatory functions of these RNAs are further explored in Chapter 14, which also includes information on eukaryotic promoters, enhancers, and silencers as well as on epigenetic inheritance. In Chapter 15 we focus on DNA technology and genomics, including a discussion of rapid DNA sequencing and CRISPR-mediated gene editing. We discuss the importance of gene databases as tools for understanding gene regulation, gene functions, and molecular evolution. We have also added a section on genetically engineered gene drive systems. These chapters build the necessary foundation for exploring human genetics and the human genome in Chapter 16, which includes sections on genomic imprinting and on genome-wide association studies. In Chapter 17 we introduce the role of genes in development, emphasizing studies on specific model organisms that have led to spectacular advances in this field. We discuss

induced pluripotent stem cells and present a comprehensive view of cancer and its relationship to cell signaling. We link these advances to the application of genome-wide association studies and whole genome sequencing.

Part 4 The Continuity of Life: Evolution

Although we explore evolution as the cornerstone of biology throughout the book, in Part 4 we discuss evolutionary concepts in depth. We provide the history behind the discovery of the scientific theory of evolution, the mechanisms by which it occurs, and the methods by which it is studied and tested. Chapter 18 introduces the Darwinian concept of evolution and presents several kinds of evidence that support the scientific theory of evolution. In Chapter 19 we examine evolution at the population level. Chapter 20 describes the evolution of new species and discusses aspects of macroevolution. Chapter 21 summarizes the evolutionary history of life on Earth. In Chapter 22 we recount the evolution of primates, including humans. We explore recent molecular and fossil findings, including those relating to human relatives such as the Denisovans (a sister species to the Neandertals) as well as *Australopithecus sediba* and *Homo naledi*, species whose fossils exhibit unique mixtures of apelike and humanlike features.

Part 5 The Diversity of Life

Emphasizing the cladistic approach, we use an evolutionary framework to discuss each group of organisms. We present current hypotheses of how groups of organisms are related. In Chapter 23 we discuss *why* organisms are classified and provide insight into the scientific process of deciding *how* they are classified. New advances have enabled us to further clarify the connection between evolutionary history and systematics in the eleventh edition. Chapter 24 focuses entirely on viruses and subviral agents. Topics include giant viruses, viral origins, and the evolutionary importance of viruses. Chapter 25 is devoted to the prokaryotes, both bacteria and archaea. Information about the evolution, structure, ecology, and phylogeny of archaea has been updated and expanded. Implications of research on the human microbiome are discussed and discussion of antibiotic resistance has been expanded.

Chapter 26 describes the protists in the context of five "supergroups" of eukaryotes. Chapters 27 and 28 present the members of the plant kingdom. Chapter 27 considers the evolution of land plants and the evolution of seedless vascular plants. Discussion of the origin and early evolution of angiosperms is included in Chapter 28. Chapter 29 describes the fungi. In Chapters 30 through 32, we discuss the diversity of animals. We have updated the discussions of phylogenetic relationships to reflect recent research.

Part 6 Structure and Life Processes in Plants

Part 6 introduces students to the fascinating plant world. Here we stress relationships between structure and function in plant cells, tissues, organs, and individual organisms. In Chapter 33 we consider plant structure, growth, and differentiation in the context of cell division, cell expansion, cell differentiation, tissue culture, morphogenesis, pattern formation, positional information, and *Arabidopsis* mutants. Chapters 34 through 36 discuss the structural and physiological adaptations of leaves, stems, and roots; these chapters include special consideration of plant transport systems. Chapter 37 describes reproduction in flowering plants, including asexual reproduction, flowers, fruits, and seeds. Chapter 38 focuses on growth responses and regulation of growth, including the latest findings generated by the continuing explosion of knowledge in plant biology, particularly at the molecular level.

Part 7 Structure and Life Processes in Animals

In Part 7 we provide a strong emphasis on comparative animal physiology, showing the structural, functional, and behavioral adaptations that help animals meet environmental challenges. We use a comparative approach to examine how various animal groups have solved both similar and diverse problems. In Chapter 39 we discuss the basic tissues and organ systems of the animal body, homeostasis, and the ways that animals regulate their body temperature. Chapter 40 focuses on different types of body coverings, skeletons, and muscles, and discusses how they function. In Chapters 41 through 43, we discuss neural signaling, neural regulation, and sensory reception. In Chapters 44 through 51, we compare how different animal groups carry on life processes, such as internal transport, internal defense, gas exchange, digestion, osmoregulation and disposal of metabolic wastes, endocrine regulation, reproduction, and development. Each chapter in Part 7 considers the adaptations for the life processes being discussed. Part 7 ends with a discussion of behavioral adaptations in Chapter 52. Reflecting recent research findings, we have updated or added new material on many topics, including neurotransmitters, cardiovascular disease, immune function, nutrition, regulation of appetite and energy metabolism, the mesentery, endocrine function, contraception, sexually transmitted infections, and transmission of culture in vertebrates.

Part 8 The Interactions of Life: Ecology

In Part 8 we discuss the ecology of populations, communities, and ecosystems and the application of ecological principles to disciplines such as conservation biology. Throughout Chapters 53 through 57, we focus on human interdependence with

other organisms, how we have disrupted the biosphere, and what we can do to stop global climate change, decreases in species diversity, and other negative human impacts.

In Chapter 53 we focus on population ecology. In Chapter 54 we focus on community ecology. We discuss research advances that facilitate understanding of community structure, interactions, synergy, and potential medical benefits. For example, we discuss research on the keystone wolves of Yellowstone and ecosystem cascade effects. We have added a new box, *Inquiring About: The Human Microbiota: Our Many Symbionts*, which introduces students to the various relationships we have with our microbiota, including health, metabolism, and immune functions.

In Chapter 55 we discuss ecosystems and the biosphere. We present updated discussions on community composition research, illustrating the potential for balance between species richness and agricultural productivity. Chapter 56 focuses on ecology and the geography of life. We discuss the degradation of permafrost and the resulting concerns for global climate change. We have added a discussion of research suggesting ecotones as potential global climate change indicators and have expanded research information on coral reef bleaching and recovery and the effects of global warming.

In Chapter 57 we discuss biological diversity and conservation biology. We have expanded information on human-caused extinctions and decreases in biodiversity. We include updated information on biodiversity hotspots and conservation partnerships.

This chapter includes new conservation biology research on ecosystem restoration partnerships. We have also expanded information linking global climate change with sea level rise and the increasing diseases spread by mosquitos.

A Comprehensive Package for Learning and Teaching

A carefully designed supplement package is available to further facilitate learning. In addition to print resources, we are pleased to present student multimedia tools that have been developed in conjunction with the text.

Resources for Students

MindTap A fully online learning experience built on Cengage Learning content. *MindTap* combines student learning tools—readings, study tools, animations, activities, and assessments—into a singular Learning Path that guides students through their course. New features for the eleventh edition include Data Analysis activities and Mastery Training powered by Cerego. Mastery Training uses the science of how we learn to support students' understanding of the key concepts in each chapter and can be accessed through your computer or the mobile app. Each *MindTap* product offers the full, mobile-ready textbook combined with superior and proven learning tools at one affordable price. Students who purchase digital access can add a print option at any time.

A Problem-Based Guide to Basic Genetics by Donald Cronkite of Hope College. This brief guide provides students with a systematic approach to solving genetics problems along with numerous solved problems and practice problems.

Spanish Glossary This glossary includes key terms and definitions in Spanish.

Additional Resources for Instructors

This edition includes a comprehensive package of supplements, available to qualified adopters. Please ask your local sales representative for details.

Instructor Companion Site Everything you need for your course in one place! This collection of book-specific lecture and class tools is available online via **www.cengage.com/login**. Access and download PowerPoint presentations, images, instructor's manual, videos, and more.

Cengage Learning Testing Powered by Cognero A flexible, online system that allows you to import, edit, and manipulate test bank content from the test bank or elsewhere, including your own favorite test questions; create multiple test versions in an instant; and deliver tests from your LMS, your classroom, or wherever you want.

MindTap A fully online, highly personalized learning experience built on Cengage Learning content. *MindTap* combines student learning tools—readings, multimedia, activities, and assessments—into a singular Learning Path that guides students through their course. Instructors personalize the experience by customizing authoritative Cengage Learning content and learning tools, including the ability to add their own content in the Learning Path via apps that integrate into the *MindTap* framework seamlessly with Learning Management Systems.

MindTap for Biology is easy to use and saves instructors time by allowing them to:

- Seamlessly deliver appropriate content from a number of providers.
- Break course content down into movable objects to promote personalization, encourage interactivity, and ensure student engagement.
- Customize the course—from tools to text—and make adjustments "on the fly," making it possible to intertwine breaking news into their lessons.

- Bring interactivity into learning through the integration of multimedia assets.
- Track students' use, activities, and comprehension in real time, which provides opportunities for early intervention to influence progress and outcomes. Grades are visible and archived so that students and instructors always have access to current standings in the class.

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