Preface

Biology is an exciting and dynamic science that affects every aspect of our lives from our health and behavior to the challenging environmental issues that confront us. Recent discoveries in the biological sciences have increased our understanding of both the unity and diversity of life's processes and adaptations. With this understanding, we have become more aware of our interdependence with the vast diversity of organisms with which we share planet Earth.

BIOLOGY IS A BOOK FOR STUDENTS

One of our principal goals in developing *Biology* has been to share with beginning biology students our sense of excitement about biology. We seek to help students better appreciate Earth's diverse organisms, their remarkable adaptations to the environment, and their evolutionary and ecological relationships. We want students to understand the dynamic way that science works and to appreciate the contributions of scientists whose discoveries not only expand our knowledge of biology but also help shape and protect the future of our planet.

Since the earliest edition of *Biology,* we have focused on presenting the principles of biology in a way that is accurate, interesting and accessible to the student. In this seventh edition of *Biology,* we continue this tradition. We have worked hard to write in a student-friendly style. Throughout the text, we spark interest by relating concepts to experience within the student's frame of reference. By helping students make such connections, we facilitate the integration of concepts. In addition, we use *Focus On boxes* to explore issues of special relevance to students (such as the effects of smoking or alcohol abuse). These boxes also provide a forum for discussing certain topics of current interest in more detail, such as Alzheimer's disease and seed banks. We include numerous tables, many illustrated, to help the student organize and summarize material presented in the text. We hope the combined effect of an engaging writing style and interesting features will fascinate students and encourage them to continue their study of biology.

INTRODUCING OUR LEARNING SYSTEM

We have developed a text that is enjoyable to read, with a well-developed art program, and in the seventh edition we introduce our new Learning System, which focuses on learning outcomes. Learning the principles of biology is challenging. To help students master this complex subject, we provide Learning Objectives both for the course and for each major section of every chapter. At the end of each section, we provide Review questions based on the learning objectives so students can assess their mastery of the material presented in the section. Throughout the book, students are directed to BiologyNow, a powerful diagnostic tool on the free CD-ROM, which helps students assess their study needs and master the chapter objectives. After taking a pretest on BiologyNow, students receive feedback based on their answers, and links to animations and other resources keyed to their specific learning needs. Select illustrations in the text are also keyed to Active Figures on the BiologyNow CD-ROM.

Course Learning Objectives

The student can demonstrate mastery of the principles of biology by responding accurately to the following Course Learning Objectives:

- Design an experiment to test a given hypothesis, using the procedure and terminology of the scientific method.
- Cite the cell theory, and relate structure to function in both prokaryotic and eukaryotic cells.
- Describe the theory of evolution, explain why it 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, chemical signals (such as hormones and pheromones), electrical signals (for example, neural transmission), signal transduction, sounds, and visual displays.

- Argue for or against the classification of organisms in three domains and six kingdoms, characterizing each of these clades; based on your knowledge of genetics and evolution, give specific examples of the unity and diversity of these organisms.
- 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.

Learning System Strategies

We use numerous learning strategies to increase the student's success:

- ***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 ***Review* questions** that assess comprehension by asking the student to describe, explain, compare, contrast, or illustrate important concepts. The review questions are based on the section Learning Objectives.
- A list of the major section headings at the beginning of each chapter provides a ***Chapter Overview***. Chapter outlines, including heads and subheads, are posted on our Web site at **http://biology.brookscole.com/solomon7**.
- ***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 structures or steps.
- A ***Summary with Key Terms*** 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 are provided with the opportunity to study vocabulary words within the context of related concepts.
- **End-of-chapter questions** provide students with the opportunity to evaluate their understanding of the material in the chapter. The ***Post-Test*** consists of multiple-choice questions, some of which are based on the recall of important terms, whereas others challenge students to integrate their knowledge. Answers to the Post-Test questions are provided at the end of the chapter. A series of ***Critical Thinking* questions** encourages the student to make connections among important concepts. To answer these questions, the student must apply the concepts just learned to new situations or relate concepts learned in previous chapters to concepts in the current chapter.
- 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. The vertical purple bar along the margin facilitates rapid access to the Glossary. The companion Web Site also includes glossary flash cards with audio pronunciations.
- An ***art program that is fully integrated with the text*** brings to life, reinforces, and expands concepts discussed in the text. New in this edition are figures featured to illustrate key concepts. Many figures have numbered, multiple parts that show sequences of events in important processes or life cycles. Numerous photographs, both alone and combined with line art, help students understand concepts by connecting the "real" to the "ideal." The line art uses devices such as ***orientation icons*** to help the student put the detailed figures into the broad 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.

Emphasis on the Process of Science

Understanding how scientific knowledge is derived is crucial for scientists and nonscientists alike. *Biology* provides insight into what science is, how scientists work, the roles of the many scientists who have contributed to our current understanding of biology, and how scientific knowledge affects daily life. Two features clearly reflect this emphasis:

- A ***"Process of Science"* icon**, embedded at relevant points in the text, highlights discussions about the work that scientists do and helps students to understand that the process of scientific discovery is ongoing and indefinite. In addition to the discussion on the process and method of science in Chapter 1, we give many examples of this dynamic process within the context of each particular subject discussed.
- ***On the Cutting Edge* boxes** present exciting research areas, such as how some plant-eating insects "eavesdrop" on plant defensive signals and respond by activating their own defenses (see Chapter 36). The abstract for the Cutting Edge box is formatted like a much-abbreviated science report, which further reinforces the student's understanding of the scientific process being reported.

AN OVERVIEW OF *BIOLOGY*, SEVENTH EDITION

Three themes provide the structural foundation for *Biology:* the evolution of life, the transmission of biological information, and the flow of energy through living systems. 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. The instructor can present the eight parts and their 55 chapters in any number of sequences with pedagogical success. Chapter 1, which introduces the student to the major principles of biology, provides a good springboard for future discussions, whether the professor prefers to start with the "big picture" and work down, or vice versa.

In this edition, as in previous editions, we examined every line of every chapter for accuracy and currency, and we made a serious attempt to update every topic and verify all new material. The following brief survey provides a general overview of the eight parts of *Biology* and some changes made to the seventh edition.

Part 1: The organization of life

The five chapters that make up Part 1 give the student basic background knowledge. We begin Chapter 1 by discussing the Human Genome Project and then introduce the main themes of the book—evolution, energy transfer, and information transfer. Chapter 1 examines several fundamental concepts: the characteristics and similarities of living things; the organization of life on individual and ecological levels; information transfer; evolution as the main unifying concept in biology; the diversity of life and how biologists classify organisms; energy transfer; and how science works. Chapters 2 and 3, which focus on the molecular level of organization, establish the foundations in chemistry necessary for understanding biological processes. Chapters 4 and 5 focus on the cell level of organization. Research on receptors and signal transduction is shedding light on many life processes on a cell level. We introduce these concepts in Chapter 5. However, we are convinced that this information is best delivered within a context, so we integrate many research findings on receptors and signal transduction in relevant chapters throughout the book.

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 6 examines how cells capture, transfer, store, and use energy. Chapters 7 and 8, which can be taught in either order, 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 completely revised and updated the eight chapters of Part 3 for the seventh edition. There are many new illustrations, seven new ones in Chapter 10 alone. In these chapters we explore the science of genetics, giving students the tools they need to grasp the important new findings reported almost daily. We begin this unit by discussing mitosis and meiosis (Chapter 9), thus providing a foundation for considering Mendelian genetics and related patterns of inheritance in Chapter 10. We then turn our attention to the flow of information in cells, beginning with the structure and replication of DNA (in Chapter 11), followed by a discussion of RNA and protein synthesis (Chapter 12). Gene regulation is discussed in Chapter 13, and in Chapter 14, we focus on genetic engineering. These chapters build the necessary foundation for exploring the human genome in Chapter 15. In Chapter 16, we introduce the role of genes in development, emphasizing studies on specific model organisms that have led to spectacular advances in this field. Changes in these chapters include new material on how genes interact with the environment to determine phenotype, latest findings on telomeres and telomerase, new material on mammalian cloning, and a new Cutting Edge box on studying aging in mice. New tables show a timeline of selected historical DNA discoveries, present color-coded data that support Chargaff's rules, and summarize the enzymes involved in DNA replication.

Part 4: The continuity of life: evolution

Although we explore evolution as the cornerstone of biology throughout the book, Part 4 delves into the subject in depth. We provide the history behind the discovery of the theory of evolution, the mechanism by which it occurs, and the methods by which it is studied and tested. Chapter 17 introduces the Darwinian concept of evolution and presents several kinds of evidence that support the theory of evolution. In Chapter 18, we examine evolution at the population level. Chapter 19 describes the evolution of new species and discusses aspects of macroevolution. Chapter 20 summarizes the evolutionary history of life on Earth. In Chapter 21 we recount the evolution of the primates, including humans. Many topics and examples have been added to the seventh edition, including new material on molecular clocks, the evolutionary species concept, sexual selection, recent fossil discoveries of human ancestors, and a new Cutting Edge box on the origin of flight in birds.

Part 5: The diversity of life

In this edition of *Biology,* we emphasize the cladistic approach. Based on recent developments and on reviewer input, we have replaced the phylogenetic trees of past editions with cladograms. We use an evolutionary framework to discuss each group of organisms, presenting current hypotheses of how groups of organisms are related. By focusing on evolutionary relationships and the structural and functional adaptations of each group of organisms, we avoid the traditional parade through the phyla that is characteristic of many biology textbooks.

In Chapter 22, we discuss *why* organisms are classified and provide insight into the scientific process of deciding *how* they are classified. Chapter 23, focuses on the viruses and prokarotes, compares the three domains, and discusses viroids, prions, and emerging diseases. We have revised Chapter 24 to reflect the developing consensus on protist diversity. We summarize the eight major eukaryote groups, and include a new table and new figure showing evolutionary relationships among the groups. Chapter 25 describes the fungi. Chapters 26 and 27 present the members of the plant kingdom. In Chapters 28 through 30, which cover the diversity of animals, we present the most recent classification of animal phyla, including division into Lophotrochozoa, Ecdysozoa, and Deuterostomia clades.

Part 6: Structure and life processes in plants

Part 6 introduces students to the fascinating plant world. It stresses relationships between structure and function in plant cells, tissues, organs, and individual organisms. In Chapter 31, we introduce plant structure, growth, and differentiation. Chapters 32 through 34 discuss the structural and physiological adaptations of leaves, stems, and roots. Chapter 35 describes reproduction in flowering plants, including asexual reproduction, flowers, fruits, and seeds. Chapter 36 focuses on growth responses and regulation of growth. In the seventh edition, we present the latest findings generated by the continuing explosion of knowledge in plant biology, particularly at the molecular level. Some of the new topics include an updated section on stomatal opening and closing, new information on floral meristem identity genes, updated research on self-incompatibility in plant reproduction, and new data on nastic movements and tropisms.

Part 7: Structure and life processes in animals

In Part 7, we emphasize 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 similar and diverse problems. In Chapter 37, we discuss the basic tissues and organ systems of the animal body, homeostasis, and how animals regulate their body temperature. Chapter 38 focuses on body coverings, skeletons, and muscles. In Chapters 39 through 41, we discuss neural signaling, neural regulation, and sensory reception. In Chapters 42 through 49, we compare how different animal groups carry on specific life processes, such as internal transport, internal defense, gas exchange, digestion, reproduction, and development. Each chapter in this part considers the human adaptations for the life processes being discussed. The unit ends with a discussion of behavioral adaptations in Chapter 50, which includes a reorganized and updated sections on sexual selection and on helping behavior.

Reflecting recent research findings, we have added material on glial cells, new findings on a neurotrophin that opens certain sodium channels, and a Cutting Edge box on the neurophysiology of traumatic experience. In the immunology chapter, we have added a discussion of the danger hypothesis and have included new findings on Toll signaling receptors and pathogen-associated molecular patterns. We introduce new findings on mechanisms of hormone action and have added a brief section on enzyme-linked receptors.

Part 8: The interactions of life: ecology

Part 8 focuses on the dynamics of populations, communities, and ecosystems and on the application of ecological principles to disciplines such as conservation biology. Chapters 51 through 54 give the student an understanding of the ecology of populations, communities, ecosystems, and the biosphere, whereas the final chapter (55) focuses on environmental problems humans have caused. We continue to interweave ecological theory and the scientific process by giving clear, concrete examples of ecological studies to illustrate conceptual points. Among the many changes in this unit, the authors have updated Vitousek's work on human appropriation of global NPP, expanded the definition of biological diversity, and added a new section on dominant species.

A COMPREHENSIVE PACKAGE FOR LEARNING AND TEACHING

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

Resources for Students

Study Guide to Accompany *Biology*, Seventh Edition, by Ronald S. Daniel of California State Polytechnic University, Pomona; Sharon C. Daniel of Orange Coast College; and Ronald L. Taylor. Extensively updated for this edition, the study guide provides the student with many opportunities to review chapter concepts. Multiple-choice study questions, coloring book exercises, vocabulary-building exercises, and many other types of active-learning tools are provided to suit different cognitive learning styles.

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.

Web Site. The content-rich companion Web site that accompanies *Biology*, seventh edition, gives students access to a wealth of high-quality resources, including focused quizzing, a Glossary complete with pronunciations, *InfoTrac College Edition* (with questions), Internet Activities (with questions), Chapter Summaries, Learning Objectives, further readings for each chapter, and annotated Web links. The site also includes an all-new genetics resource, including specialized genetics problems. Finally, Career Visions interviews on the Web site help students become aware of the many doors that a biology degree can open by shar-

ing the experiences of young people who have found fulfilling careers in which they use their knowledge of biology.

Additional Resources for Instructors

The instructors' Examination Copy for this edition lists a comprehensive package of print and multimedia supplements, including online resources, that are available to qualified adopters. Please ask your local sales representative for details.

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